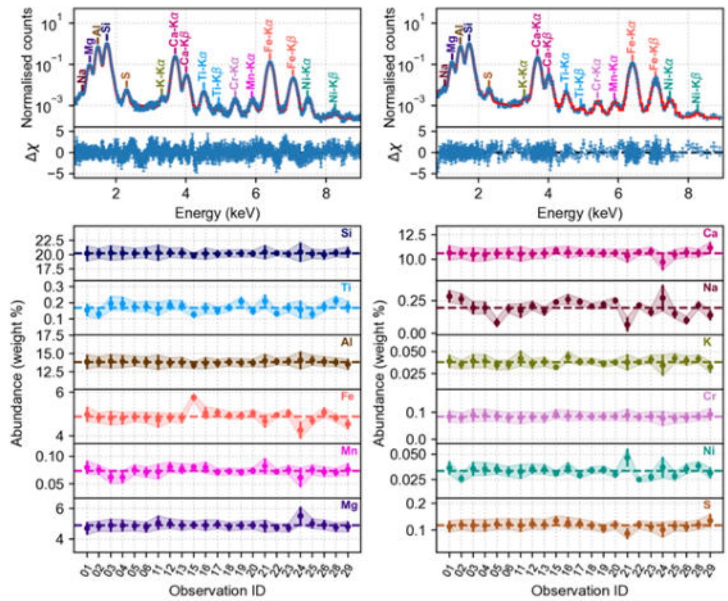
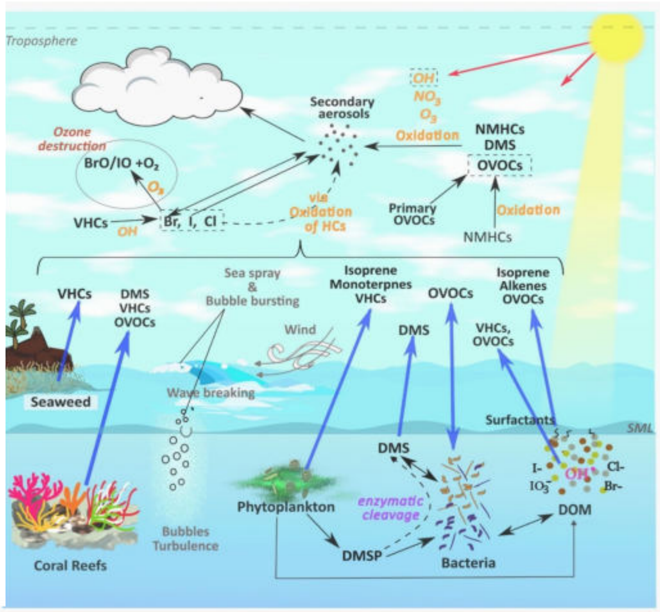
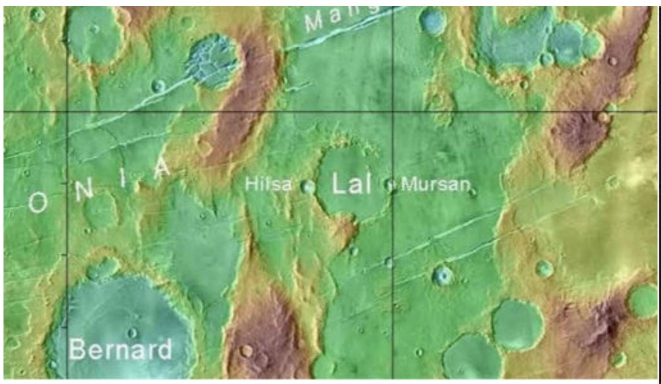
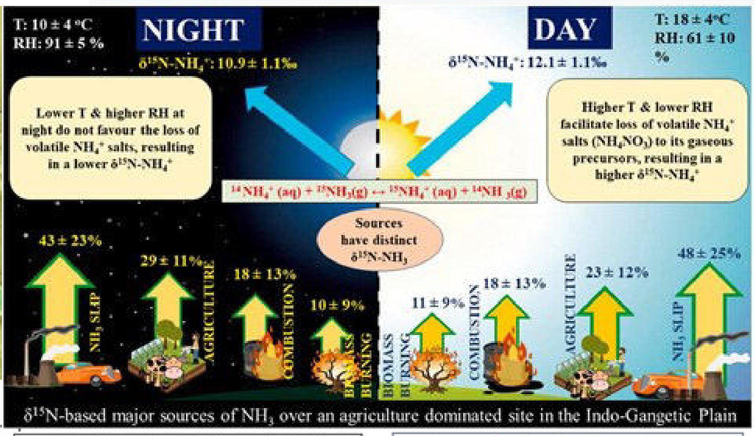
# भौतिक अनुसंधान प्रयोगशाला, अहमदाबाद

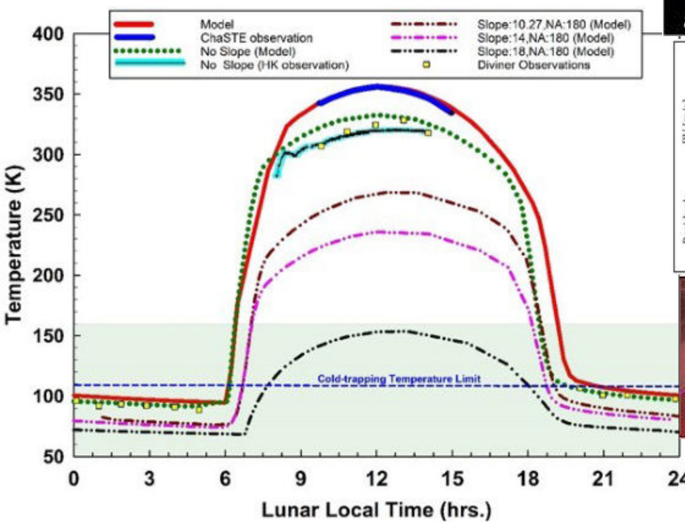
# Physical Research Laboratory, Ahmedabad

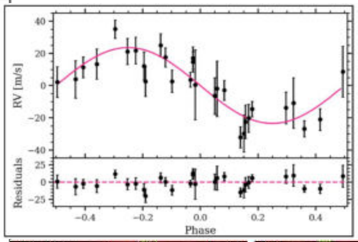


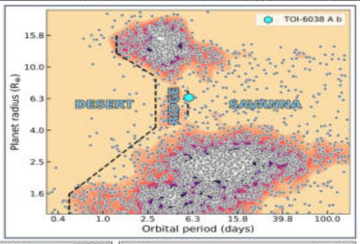



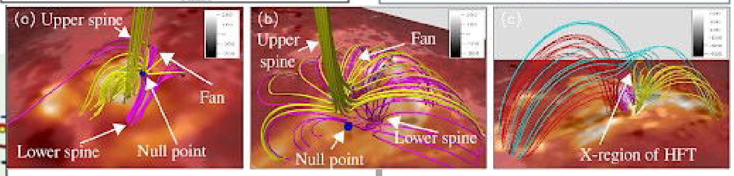




# वार्षिक प्रतिवेदन

# Annual Report

# 2024-2025

# Contents

# From The Director's Desk

This Annual Report presents a comprehensive overview of PRL's multifaceted scientific endeavours. This report details the significant advancements and diverse research findings across its various scientific domains, highlighting Physical Research Laboratory's commitment in exploring our Universe's fundamental aspects and contributing to national and global scientific understanding. Over the past year, PRL has demonstrated exemplary commitment in its scientific endeavors. This dedication from PRL's faculty and staff has resulted in a substantial output of high-quality research, including the publication of nearly two hundred eighty research papers in prestigious peer-reviewed journals and the completion of 23 PhD theses.

PRL has achieved significant results from participating in major space missions, specifically the Chandrayaan-3 Lander and Rover and the Aditya-L1 missions. India's first dedicated solar mission, Aditya-L1, includes the ASPEX instrument (SWIS and STEPS) from PRL for measuring solar wind and energetic particles, providing newer insights into solar wind origin, ion acceleration, and space weather impact. PRL's comprehensive efforts span various critical areas, including producing excellent space-borne experiments, developing in-house instrumentation, conducting detailed laboratory analyses, and running intense academic and scientific programs, thereby contributing to generating knowledge and human resources in niche areas of science.

These remarkable efforts have garnered significant recognition, with PRL's faculty and staff receiving coveted awards and honors, the research fellows receiving best paper awards at national and international scientific conferences, as well as the best theses awards. Additionally, PRL faculty members have been highly sought after, receiving over two hundred and forty invitations to deliver talks and lectures at various scientific gatherings and academic institutions. The period of 2024-2025 was particularly fruitful, yielding several new and vital scientific findings. The overall commitment and diligence displayed by PRL's talented personnel are a source of great satisfaction and pride for me.

A summary of significant science results from diverse research domains, ranging from direct observations of celestial bodies to fundamental theoretical physics, is given below. These inputs not only underscore the contributions of PRL researchers to national space missions and global scientific understanding, but also represent significant advancements in their respective fields.

PRL astrophysicists discovered two new exoplanets using the PARAS-2 spectrograph: (i) TOI-6651b, a dense sub-Saturn (5.1 Earth radii, 61 Earth masses) with a core primarily of rock and iron, orbiting a sun-like star in 5 days. It is one of the densest sub-Saturns detected by TESS and, is crucial for understanding the Neptunian desert, and (ii) TOI-6038A b, a dense sub-Saturn (6.41 Earth radii, 78.5 Earth masses) with a massive rocky core, orbiting an F-type star every 5.83 days, offering insights into planetary formation between Neptune-like and gas giants.

Investigations by PRL's researchers suggest that molecular cloud collisions contribute to forming hub-filament systems, which are key sites for massive star formation, with filaments forming cone-like structures influenced by turbulence, shocks, magnetic fields, and gravity.

Research in low-metallicity clouds (like S284-RE) shows that gas remains warmer, favoring the formation of massive stars, wherein a massive young star driving a 2.7 parsec outflow was discovered.

A newly hatched star cluster ($\sim$0.5 Myr old) in our Galaxy was discovered, showing high star formation efficiency (20%) and a rate of 330 solar masses per million years, indicating its potential to evolve into a massive cluster.

A multiwavelength study of IGR J06074+2205 revealed complex pulse profiles of the neutron star and a dynamic, growing circumstellar disc around the Be star, even during X-ray outbursts, which might lead to a future giant outburst.

A 15-year study of Seyfert 1 AGN Mrk 50 showed that its variability reduced over time, becoming non-variable, and it evolved into a "bare" nucleus without obscuration, with a prominent soft X-ray excess that later vanished due to accretion disk dynamics.

The Interplanetary Flux Rope Simulator (INFROS) model accurately forecasts magnetic fields for isolated CMEs, but it underestimates field strength for CMEs interacting with high-speed/density streams, as their evolution is no longer self-similar. Constraining the model with inner-spacecraft observations significantly improves accuracy.

Analysis of Earth-impacting CMEs showed that while deflections and tilt changes are common, rotation in the heliosphere is relatively rare, driven by solar wind interactions and magnetic fields, aiding space weather forecasting.

Solar Spicules, small-scale plasma jets from the chromosphere, can reach coronal temperatures and replenish the solar corona with hot plasma. Atmospheric Gravity Waves (AGWs) may propagate along spicular structures, suggesting that spicules act as waveguides. Further, investigations showed the important role of AGWs in heating the quiet-Sun atmosphere, as they are shown to persist beyond the photosphere.

ChaSTE observations from Chandrayaan-3 provided the first in-situ temperature measurements up to 10 cm depth near the lunar South Pole, revealing significant spatial variability and the possibility of the presence of water-ice at such shallow depths.

The APXS instrument aboard Chandrayaan-3 Pragyan rover, developed by PRL, is used to provide the first in-situ elemental abundance of lunar soil near the South Polar region, not only supporting the Lunar Magma Ocean hypothesis but also indicating deeper material contributions from the South Pole-Aitken basin.

The Chandrayaan-3 landing region is estimated to be approximately 3.7 billion years old, providing insights into the origin of material deposited there. Analysis of Chandrayaan-3 and -2 images revealed the landing site is within a buried impact crater ($\sim$160 km diameter), likely older than the South Pole-Aitken (SPA) basin.

Study of lunar basaltic meteorite A-881757 offered insights into lunar interior melting mechanisms and may represent unexplored cryptomare basalts.

Theoretical studies suggest that Martian dust devils can generate electric fields strong enough to trigger lightning. This has implications for rover missions.

A chloride-rich topographic depression in Mars' Terra Sirenum may have held water for thousands of years, with chemicals potentially favorable for life, making it a “possible lost basin”.

The mineralogy of sulfates in India's Matanomadh Formation (Kutch) suggests acidic, water-limited conditions analogous to Mars' Noachian-Hesperian epoch ($\sim$3.7 Ga), relevant to past Martian weathering.

A system for experimental simulation of Venusian lightning was developed, suggesting $CO_2$, superimposed by conducting ions, is the primary cause.

Research on vertical mixing in exoplanet atmospheres found that it significantly affects transmission spectra only within a narrow parameter space, allowing for tight constraints on mixing strength, and $NH_3$ abundance can help constrain internal temperatures for hot exoplanets.

A model for active comets found that while some organic molecules (like formic acid) can form in the coma, others (like glycine) primarily originate from the nucleus.

Analysis of the lunar dusty plasma environment reveals that dust particles gain charge in the photoelectron sheath, leading to dynamic behaviors (hopping/ballistic motion), critically affecting movement in low-density plasma and posing hazards to lunar missions.

A study in urban Western India showed that the variability of monoterpenes is controlled by a complex interplay of anthropogenic activities, biogenic emissions, and photochemical/meteorological factors, with daytime biogenic contributions significantly increasing from winter to summer.

Analysis of cloud base height over Udaipur using multiple data sources and an investigation into a dust storm over Ahmedabad, showed a notable transformation in the boundary layer driven by convective system outflows.

Global analysis showed a 20-40% decrease in aerosol optical depth (AOD) during peak COVID-19 lockdowns in spring/summer 2020, with significant reductions in black carbon AOD over South Asia. However, changes in aerosol single scattering albedo (SSA) during COVID-19 were negligible ($<$4%), implying a minimal effect on the net contribution of aerosol scattering/absorption to total extinction.

Analysis of aerosol absorption parameters showed lower SSA in Central and South Asia compared to East and Southeast Asia, with annual mean AOD being highest over South Asia ($\sim$0.07) and central Africa in winter due to biomass burning and dust.

Investigations revealed that the zonally symmetric semidiurnal tide during Sudden Stratospheric Warming is excited by non-linear interaction with stationary planetary waves and by ozone absorption of solar UV radiation.

Study of OH(3-1) nightglow showed annual and semi-annual oscillatory behavior in horizontal winds in the Mesosphere-Lower Thermosphere region and an anti-correlation with vertical wavelength.

The first daytime measurements of Stable Auroal Red (SAR) arcs were reported as caused by downward electron heat flux along with the corresponding heat flux values. The SAR arcs enable key linkages to the Plasmasphere Ionosphere coupling, and this new result enables such investigations round-the-clock.

Post-sunset enhancements in redline airglow are attributed to poleward meridional winds, driven by a strong quarter-diurnal tidal component.

During geomagnetic storms of May 2024, Nitric oxide (NO) emissions increased infrared radiative cooling in low-latitudes due to equatorward meridional winds transporting NO from high latitudes, highlighting persistent latitudinal coupling.

Exceptionally low helium abundance events ($<$1%) in solar wind originate from boundaries of coronal holes, particularly quiescent helmet streamers, where gravitational settling and interchange reconnection release helium-depleted plasma.

A weaker geomagnetic storm can cause a much stronger low-latitude ionospheric response than a stronger one if accompanied by steady southward interplanetary magnetic field (IMF) conditions and favorable meridional winds.

It has been shown that Phosphate availability and sea surface temperature are primary controls for Trichodesmium abundance along zonal transects, while dust deposition and temperature drive inter-hemispheric variability in the Tropical Atlantic Ocean.

A study of tropical semi-arid soils showed $CO_2$ emissions are strongly influenced by soil moisture, primarily from root respiration and fresh organic matter decay, with older soil carbon contributing minimally, suggesting climate warming is unlikely to significantly increase $CO_2$ release from these soils.

Non-agricultural sources dominate ammonia ($NH_3$) emissions over Patiala, with $NH_3$-slip from vehicles being the largest contributor (47%).

Isotopic evidence from oceans suggests that particulate black carbon may not be as recalcitrant as previously believed.

Chromium isotope studies suggest a higher flux of carbonaceous-like impactors in the Archean and a mixed flux after 3000 Ma, indicating that volatiles were likely delivered to Earth before 3000 Ma.

Extra-tropical cyclones play a critical role in the advancement of smaller glaciers in the Zanskar Himalaya over the last 4000 years and the deterioration of permafrost conditions after 2500 years.

Haphazard construction and man-made barriers in floodplains (like hotels) amplified damage during the 2023 Beas floods by blocking natural river pathways.

Engineering modifications of rivers, such as river fronts, led to an increase in primary productivity (carbon fixation) due to increased water residence time.

Deep Machine Learning applied to Particle Physics to explore physics-inspired feature extractors for enhanced interpretability and performance, particularly in point cloud analysis and graph-based methods for the Large Hadron Collider (LHC) phenomenology.

Viable dark matter models were explored by examining their direct production at the LHC, aiming to refine the understanding of dark matter interactions and enhance prospects of discovery.

A theoretical framework has been proposed for new kinds of forces to explain the differing masses of elementary particles, predicting new physics around 1000 TeV and offering insights into neutrino masses.

A large Josephson diode effect without any magnetic field has been demonstrated in low-dimensional chiral quantum dot junctions, with potential for superconductor-based quantum devices.

A novel and efficient method for calculating leading threshold logarithms at next-to-leading power accuracy, suitable for processes involving jets at the Large Hadron Collider has been developed.

Researchers at PRL precisely estimated the blackbody radiation (BBR) shift for the Zinc (Zn) atomic clock transition and accurately determined the magnetic dipole-driven BBR shift in the $Al^+$ clock, crucial for improving clock accuracy.

Calculations on spin-dependent Parity Violation (PV) interactions in Cesium ($^{133}$Cs) established a new limit on a nucleon-nucleon PV coupling constant, contributing to the debate around nuclear anapole moments.

Combining isotope shift measurements with atomic calculations, precise values of nuclear charge radii for silver (Ag) and tin (Sn) isotopes were reported, revealing overestimated shape-staggering in Ag and evidence for a doubly magic $^{100}$Sn nucleus.

Quantum Computing research explored leveraging noisy intermediate-scale quantum (NISQ) computers, demonstrating a reduction from a six-qubit to a four-qubit problem for ground-state calculations, with relatively low errors for energies and hyperfine constants.

High bit rate quantum random number generation using heralded single photons, a dead-zone-free single-beam atomic magnetometer for sensitive magnetic field, and optical coherence tomography using quantum correlations have been demonstrated.

Lens-free imaging (Talbot effect) for measuring small periodic variations and lens aberrations has been demonstrated.

Hydrogen bonding between water and ethylene glycol has been demonstrated under astrochemical conditions, showing water stability up to 240 K (higher than pure ice), opening new reaction pathways in cometary ices.

The first temperature-dependent VUV and mid-IR spectra of pure ethanolamine ices were obtained under astrochemical conditions, revealing correlations between spectral changes and physical transitions, which is valuable for future identification in interstellar and cometary bodies.

Luminescence response of quartz for very high radiation doses (1–21 kGy) showing characterised the increased Thermoluminescence (TL) intensity up to 11 kGy, with implications for extending dating limits.

Changes in Thermoluminescence Sensitivity (TLS) of quartz grains in the Ganga River system have been documented, suggesting its use for sediment provenance and flux estimation.

Complex excited-state dynamics and fragmentation of $CH_3Cl$ dications induced by femtosecond laser pulses are studied using a in-house built recoil ion mass spectrometer which demonstrated the influence of pulse chirp on fragmentation.

Significant signal enhancement in molecular emission lines ($C_2$, CN) was observed after laser ablation of graphite with nanoparticles, improving detection limits for weak molecular bands in Laser-Induced Breakdown Spectroscopy (LIBS).

The Drop-casting method for determining trace elements in liquids using LIBS was demonstrated, showing reasonable agreement with ICP-OES for river water samples.

Certification methods for quantum entanglement were proposed and experimentally implemented to ensure the unpredictability of quantum random number generation, also incorporating statistical tests for quality checks.

PRL is committed to enhancing the country's capacity in specialised scientific fields. To achieve this, PRL continues to run robust human resource development programmes, that include Junior Research Fellowships (JRFs) leading to Ph.D. degrees, and postdoctoral programmes. In the year 2024-2025, 26 new JRFs joined, and 27 SRFs were awarded Ph.D. degrees. Beyond these core programs, PRL offers a Visiting Scientist program; Project training opportunities for both graduate and post-graduate students in engineering and science disciplines; and intensive summer internship programs. PRL also collaborates with similar programs conducted by the Indian Science Academies. Collectively, these capacity-building initiatives have successfully trained over 150 students this year. Furthermore, PRL maintains strong academic partnerships with universities and institutes across Gujarat and throughout India.

Faculty and students received significant recognition, including the prestigious COSPAR Vikram Sarabhai Medal, Chair of a COSPAR Scientific Commission-first by any Indian, the Rashtriya Vigyan Puraskar (RVP) Award-2024 as part of the ISRO-Team Chandrayaan-3, various national and international recognitions, and best paper and presentation awards.

PRL has hosted a diverse array of conferences. They are: The Venus Science Conference, Emerging Trends in Hydrology Research: An Indian Perspective, Students' Conference in Optics and Photonics, Conference on Meteoroids, meteorites and Meteors: Messengers from Space, the $2^{nd}$ Vikram Discussion on Astrobiology & Astrochemistry, $3^{rd}$ Vikram Discussion on Neutrino Astrophysics, and the Frontiers in Geosciences Research Conference. The schools/workshops conducted include: $2^{nd}$ Winter School at Udaipur Solar Observatory, a Pre-conference Workshop (Karyashala) on a "Hands-on Lab Analysis and Study of Meteorites", a three-day High Performance Computing training workshop on "Parallel Programming and Concepts of AI", DIG Astrochemistry - 2: Icy Dust Astrochemistry Workshop, and Astrophysical Dust Ices: Insights from recent telescopes, the Indo-German Solar Physics Workshop, titled "Two Eyes on the Sun Aditya-L1 and Solar Orbiter".

PRL's trademark, the "*PRL ka Amrut Vyakhyaan-PKAV*" and "*PRL Amrut Rajbhasha Vyakhyaan* (PARV)" series continue with sustained vigour, featuring eminent speakers on diverse fields. PRL observes all the events mandated by the Government to promote safety, security, cleanliness, health, culture, patriotism, and scientific temper, among all the staff members and scholars. They include, Dr Babasaheb Ambedkar's birth anniversary, Vikram Jayanti, World Environment Day, Vishwa Hindi Diwas, Martyrs's Day, Fire Safety Day, Swachhata Pakhwada, Hindi Mah, International Women's Day, International Day of Yoga, Independence Day, National Youth Day, Vigilance Week, Constitution Day, National Unity Day, National Anti-Terrorism Day, Republic Day, World No Tobacco Day, World Blood Donor Day, Sadbhavna Diwas, Communal Harmony week, and Armed Forces Flag Day.

On 23 August 2023, India's Chandrayaan-3 achieved a historic soft landing near the Moon's South Pole, making India the fourth nation to land on the Moon and the first at the South Pole. The Government declared this date as National Space Day (NSpD). On 12 August 2024, PRL kick-started the $1^{st}$ National Space Day celebrations, coinciding with Dr. Vikram Sarabhai's $105^{th}$ birth anniversary, with Open House Exhibitions across its campuses in Ahmedabad, Udaipur, and Mt. Abu, featuring lab visits, exhibits, quizzes, and science talks. The events drew 3000+ visitors in Ahmedabad, 340 in Udaipur, and 350 participants in Mt. Abu. The aim was to spark scientific curiosity and encourage future contributions to India's space program. PRL is dedicated to promoting science among the public. As part of this commitment, PRL organised its National Science Day (NSD) 2025 celebrations in two distinct phases, involving 22 different locations across Gujarat with a participation of over 1200 students, leading eventually to screening and their selection for the Aruna Lal scholarships. Along with NSD screening tests, the Vikram Sarabhai Protsahan Yojana (VIKAS) Scholarship exam was also conducted, wherein around 3500 students participated. Phase 2 of the NSD celebrations, held on March 1, 2025, saw the participation of about 160 students, accompanied by around 60 teachers or parents, wherein the winners of the Aruna Lal scholarship were also declared. In addition to the above, PRL's outreach activities include participation in the $25^{th}$ Rashtra Katha Shivir, showcasing models of instruments from Aditya-L1 and Chandrayaan missions. PRL leveraged its 1 PetaFLOPS Param Vikram-1000 High Performance Computing (HPC) facility for scientific research, which was acknowledged in 24 scientific peer reviewed publications.

The Library & Information Services introduced new initiatives like PRIME (PRL Research Information and Metrics Engine), Annif (AI/ML-Powered Subject Indexing), and QueryQuest (AI-Powered Library Chatbot) to enhance information access and management. PRL also enhanced its cybersecurity activities and implemented new IT services, including a VSAT network link and specialised web applications for budget monitoring and JRF induction.

PRL is committed to integrating Hindi into its official functions and administrative communications, taking appropriate measures to ensure its widespread use. This commitment is further demonstrated by PRL's maintenance of a bilingual website. PRL's dedication in implementing Hindi across various departments has received significant acclaim, earning it an award for outstanding work in Hindi from the Town Official Language Committee for two consecutive years. This recognition has also come from the Department of Space (DOS) and the Parliamentary Committee on Hindi, following their evaluations of PRL's progress in Hindi implementation.

I express profound gratitude to the Council of Management members for their encouragement, invaluable advice, and unwavering support for all scientific activities undertaken at the institution. Special commendation is given to Shri A. S. Kiran Kumar, the Chairman of the PRL Council of Management, Dr. S. Somanath, former Secretary, Department of Space and Chairman, ISRO and Dr. V. Narayanan, the present Secretary, Department of Space and Chairman, ISRO, for their steadfast support, guidance, and encouragement.

**Anil Bhardwaj**
**Director**

# PRL in News

1. “Primitive lunar mantle materials at the Chandrayaan-3”, https://www.nature.com/articles/s43247-025-02305-1.
2. “Primitive mantle material revealed by Chandrayaan-3 APXS volatile measurements in the South Polar Region of the Moon, ISRO release, 30.04.2025” , https://www.isro.gov.in/ISRO_EN/Ch3_APXS_volatile_measurements.html.
3. “Chandrayaan discovers water-ice, India finds success on the Moon” , https://indianexpress.com/article/opinion/editorials/chandrayaan-discovers-water-ice-india-finds-success-on-the-moon-9885650/.
4. “CHASTE onboard Chandrayaan-3 measured higher surface temperatures at SHIV-SHAKTI point: New insight about harboring water-ice on the Moon” , https://www.nature.com/articles/s43247-025-02114-6.
5. “How ISRO propulsion system broke records - Times of India” , https://timesofindia.indiatimes.com/city/ahmedabad/how-isro-propulsion-system-broke-records/articleshow/118366314.cms.
6. “Indian scientists discovered a dense sub-Saturn size exoplanet - ISRO” , https://www.isro.gov.in/PRL_Scientists_Discovered_DenseSub-Saturn.html.
7. “Solved: How dust storm led to downpour last May” , https://timesofindia.indiatimes.com/city/ahmedabad/solved-how-dust-storm-led-to-downpour-last-may/articleshow/117865762.cms.
8. “Deep inside your lungs: Delhi roads expose pedestrians to millions of harmful nanoparticles daily” , https://timesofindia.indiatimes.com/city/delhi/deep-inside-your-lungs-nanoparticles/articleshow/117213903.cms.
9. “Ceilometer Lidar Observatory established at CUJ - January 11, 2025, Daily Excelsior” , https://www.dailyexcelsior.com/ceilometer-lidar-observatory-established-at-cuj/.
10. “PRL scientists study impact of solar wind on coronal mass ejections, NEWS9LIVE, 08 December 2024” , https://www.news9live.com/science/prl-scientists-study-impact-of-solar-wind-on-coronal-mass-ejections-2769012.
11. “Ancient Martian lake provides habitable conditions for life to evolve, say Indian scientists - Deccan Herald” , https://www.deccanherald.com/science/ancient-martian-lake-provides-habitable-conditions-for-life-to-evolve-say-indian-scientists-3298660.
12. “International Conference on Meteoroids, Meteors, Meteorites: Messengers from Space” (MetMeSS-2024)” , https://metmess2024.ipsa-asso.in/.
13. “Indian scientists discover new planet. It’s five times larger than Earth - India Today” , https://www.indiatoday.in/science/story/indian-scientists-prl-ahmedabad-discover-new-planet-it-is-five-times-bigger-than-earth-2624404-2024-10-28.
14. “ISRO launches space club in Saudi Arabia for Indian students - mynation” , https://www.mynation.com/world/isro-launches-space-club-in-saudi-arabia-for-indian-students-rtm-sl4vyh.
15. “Indian Institute of Technology Roorkee, Roorkee and Physical Research Laboratory (PRL), Ahmedabad sign a memorandum of understanding to Promote Research, Education, and Innovation” , https://www.prl.res.in/~notices/websitedocs/2024/10/09/IITRoorkee-PRL-MoU-PRL-website-08Oct2024-09-10-2024-09-05-40.pdf.
16. “Exclusive conversation with Prof. Anil Bhardwaj, Director, PRL Ahmedabad, Part - 2, DD News Girnar” , https://www.youtube.com/watch?v=U5kyAtQjgGw.
17. “Covid lockdown on Earth led to dip in moons temperature: Study” , https://timesofindia.indiatimes.com/science/covid-lockdown-on-earth-led-to-dip-in-moons-temperature-study/articleshow/113793794.cms.
18. “Chandrayaan-3 landed on possibly oldest craters of Moon, say researchers” , https://www.thehindu.com/sci-tech/science/chandrayaan-3-landed-on-possibly-oldest-craters-of-moon-say-researchers/article68697073.ece/amp/.
19. “Chandrayaan-3: Pragyan rover discovers ancient 160-km-wide crater on the Moon - India Today” , https://www.indiatoday.in/science/chandrayaan-3/story/chandrayaan-3-pragyan-rover-discovers-ancient-160-km-wide-crater-on-the-moon-2604543-2024-09-22.
20. “In 1 yr, Aditya-L1 has found sweet spot with uninterrupted view of Sun, studied solar winds, space weather, ThePrint” , https://theprint.in/science/in-1-yr-aditya-l1-has-found-sweet-spot-with-uninterrupted-view-of-sun-studied-solar-winds-space-weather/2249079/.
21. “PRL signs MoU with Ahmedabad University for joint research” , https://timesofindia.indiatimes.com/city/ahmedabad/prl-signs-mou-with-ahmedabad-university-for-joint-research/amp_articleshow/112936882.cms?utm_source=whatsapp&utm_medium=social&utm_campaign=AmpArticleshowicon.
22. “Chandrayaan-3 finds evidence of long-lost ocean of magma beneath lunar surface X-ray data from Pragyan rover is first-ever sample analysis from Moon’s south pole; indicates

more evidence for Lunar Magma Ocean origin theory." , https://tinyurl.com/33acbtf5.

23. "PRL-built APXS on Pragyan Rover of Chandrayaan-3 made the First Elemental Abundance Measurements of Lunar Soil in the South Polar Region of the Moon" , https://www.prl.res.in/~notices/websitedocs/2024/08/21/APXS_Science-Press-Release_ISRO-on-21-August-2030hrs_PRL-21-08-2024-18-57-02.pdf.
24. "PRL celebrates National Space Day with Open House Exhibition - Ahmedabad Mirror" , https://epaper.ahmedabadmirror.com/3906477/Ahmedabad-Mirror/Aug-19-2024#page/6/1.
25. "Next Chandrayaan Mission to Explore Human Habitability on Moon - Udaipur Times" , https://udaipurtimes.com/news/future-chandrayaan-mission-to-explore-human-living/cid15145460.htm.
26. "A journey into the known & the unknown, at Ahmedabad Physical Research Laboratory -ThePrint" , https://www.youtube.com/watch?v=F9nK4v2P7cI.
27. "Prof. Anil Bhardwaj, Director PRL, is awarded the 2024 COSPAR Vikram Sarabhai Medal" , https://pib.gov.in/PressReleasePage.aspx?PRID=2033849.
28. "Ahmedabad moon lab is waiting for Chandrayaan-4 samples. It has already studied Apollo rocks" , https://theprint.in/ground-reports/ahmedabad-moon-lab-is-waiting-for-chandrayaan-4-samples-it-has-already-studied-apollo-rocks/2170769/.
29. "A Workshop on Parallel Computing and AI at PRL, Ahmedabad - PIB" , https://pib.gov.in/PressReleasePage.aspx?PRID=2030659.
30. "Mount Abu observatory is India's eye in the sky. It's hunting for Earth's distant cousins, The Print, 03 July 2024" , https://www.youtube.com/watch?si=ZMa-7jaqE6_taqq&v=LQE2RCWnPOU&feature=youtu.be.
31. "PRL scientists discover three craters on Mars" , https://www.deccanherald.com/science/prl-scientists-discover-three-craters-on-mars-2-3062513.
32. "A Summer Camp for Young Researchers on Science Technology & Innovation (STI) at Gujarat Science City, Ahmedabad - Doordarshan News - June 05, 2024" , https://www.prl.res.in/~notices/websitedocs/2024/06/06/prl-news-06june2024.mp4.
33. "Jupiter's icy moon Callisto may harbour ozone, Nature India, RESEARCH HIGHLIGHT" , https://www.nature.com/articles/d44151-024-00050-6.
34. "Watch this Space: What's next, after ISS? Change is coming soon to Low-Earth Orbit, Hindustan Times" , https://www.hindustantimes.com/lifestyle/art-culture/watch-this-space-what-s-next-after-iss-change-is-coming-soon-to-low-earth-orbit-101713522910518.html.
35. "Alternative landing site for Chandrayaan-3 on Moon has potential for future lunar experiments, The Print, 17-April-2024" , https://theprint.in/science/alternative-landing-site-for-chandrayaan-3-on-moon-has-potential-for-future-lunar-experiments/2043737/.
36. "Team led by PRL Ahmedabad finds ozone on Jupiter's' moon - The Hindu, 02/04/2024" , https://www.thehindu.com/sci-tech/science/prl-ahmedabad-ozone-callisto-habitability/article68015568.ece.
37. "Machine Learning helps predict growing ozone threat in Ahmedabad, TOI, 01 April 2024" , https://timesofindia.indiatimes.com/city/ahmedabad/machine-learning-helps-predict-growing-ozone-threat-in-ahmedabad/articleshow/108926552.cms.
38. "4th workshop: International Network in Space Quantum Technologies (INSQT), PIB, 19.03.2024" , https://pib.gov.in/PressReleseDetail.aspx?PRID=2015513.

# Science Highlights

### Astronomy and Astrophysics

- A team of scientists from PRL and ISRO reported the first in-situ elemental abundance of lunar soil near the Southern Polar region using measurements made by the Alpha Particle X-ray Spectrometer (APXS) on the Pragyan rover of the Chandrayaan-3 mission. The study provided evidence that supports the Lunar Magma Ocean hypothesis, which predicts that the primordial lunar crust was formed as a result of the floatation of lighter anorthite plagioclase – but APXS also detected a higher abundance of magnesium-rich minerals, suggesting contributions from deeper layer material ejected from South Pole-Aitken basin during its formation. These results are published in Nature.

- A team of astrophysicists from PRL, Ahmedabad, has discovered a new exoplanet named TOI-6651b using the PARAS-2 spectrograph attached to the PRL 2.5m telescope at Mount Abu Observatory in Rajasthan. This sub-Saturn, which boasts a radius 5.1 times that of Earth and a mass 61 times greater, orbits a metal-rich, sun-like star in just 5 days. The discovery not only showcases the advanced capabilities of Indian astronomical facilities but also enriches our understanding of the diversity of planetary systems beyond our solar system. TOI-6651b is one of the densest sub-Saturns detected by TESS, with a density exceeding $2.0g/cm^3$, making it the second-highest density sub-Saturn known. Its composition suggests a core mass of approximately 53 Earth masses, primarily composed of dense materials like rock and iron, with a low-density hydrogen/helium envelope. This unique structure hints at a complex formation history, potentially involving dynamical instabilities, planetary mergers, and tidal heating. Located at the edge of the Neptunian desert, this exoplanet will be crucial for understanding the factors that define desert boundaries.

- Scientists from PRL, Ahmedabad, have discovered an exoplanet TOI-6038A b, a dense sub-Saturn with a mass of 78.5 Earth masses and a radius of 6.41 Earth radii, orbiting a bright, metal-rich F-type star every 5.83 days. TOI-6038Ab lies in the transition region between Neptune-like and gas giants planets, providing a unique opportunity to study planetary formation. This marks the second exoplanet identified using the PARAS-2 spectrograph at the PRL 2.5-meter telescope and the fifth detection from the combined efforts of PARAS-1 and PARAS-2. The discovery highlights India's advancements in astronomical instrumentation, with PARAS-2 being Asia's highest-resolution stabilized radial velocity spectrograph. TOI-6038A b has a high density of $1.62g/cm^3$, suggesting a massive rocky core comprising about 74% of its mass, with a low-density H/He envelope. Its host star is part of a binary system with a K-type companion, raising intriguing questions about the planet's formation and migration. This discovery offers valuable insights into the transition between terrestrial planets and gas giants and positions TOI-6038A b as a prime candidate for further atmospheric studies.

- Massive stars, with masses exceeding 8 solar masses, play a crucial role in shaping their host galaxies through intense radiation and stellar winds. Hub-filament systems are considered key sites for massive star formation, where molecular gas and dust are funnelled through filaments into a central hub, creating a dense region favourable for star formation. The origins of hub-filament system, however, remain poorly understood. Recent observations suggest that molecular cloud collisions may contribute to forming hub-filament systems. To explore this aspect, an analysis of magneto-hydrodynamic simulation data has been conducted, where a spherical turbulent molecular cloud collides with a plane-parallel sea of denser gas at about 10 km/s and shock compression creates filaments mostly aligned perpendicular to the magnetic field. These filaments form a cone-like structure, shaped initially by turbulence and shocks; and later by gravitational collapse. The formation process involves the combined effects of turbulence, shock compression, magnetic fields, and gravity. Position-velocity diagrams reveal gas flowing toward the cone's vertex, where high-density objects form. The magnetic field curves toward the collision site, providing strong evidence of cloud-cloud collisions

- Massive stars ($>$ 8 solar masses) influence their surroundings through radiative and mechanical energy. Hub-filament systems consisting of dense filaments converging into a central hub; are crucial for massive star formation. However, these system's processes driving mass accumulation are not yet fully understood. A recent observational study of the molecular cloud G321.93-0.01 (distance $\sim$1.98 kpc) uncovered multiple hub-filament systems at various evolutionary stages, including early and evolved ones. Studying the early stages of hub-filament systems, where massive stars have minimal influence, can provide important insights into the initial conditions for massive star formation. To investigate gas kinematics and spatial morphology, high-resolution James Webb Space Telescope (JWST) and Atacama Large Millimeter/submillimeter Array (ALMA) data were analyzed toward the massive protostar G11P1 (distance $\sim$2.92 kpc). The study reveals several gas streams flowing toward the central hub, primarily driven by gravity. It introduces a new observational signature of the early hub-filament system: a wiggled, funnel-shaped structure in position-position-velocity (PPV) space.

- Studying star formation in low-metallicity clouds provides valuable insights into how stars form under distinct physical conditions. Unlike regions with higher metal content, low-metallicity environments exhibit unique characteristics influencing gas cooling, heating, and star formation processes. These differences offer an opportunity to understand better the mechanisms driving star formation in such environments. Previously reported research shows that gas tends to remain warmer in low-metallicity environments due to less efficient cooling, creating conditions that favor the formation of massive stars (M $>$ 8 $M_{\odot}$). In this context, the low-metallicity region S284-RE (distance $\sim$5.5 kpc), containing only one-fifth of the Sun's metal content, has been analyzed using multi-wavelength data from the Spitzer Space Telescope, Herschel Space Observatory, James Webb Space Telescope (JWST) and Atacama Large Millimeter/submillimeter Array (ALMA). The study detected multiple molecular outflows, signaling active star formation driven by young stars embedded in dense gas and dust, some showing signs of episodic accretion. Notably, a massive young star is also discovered driving an outflow that stretches about 2.7 parsecs (5.5 $\times$ $10^5$ AU).

- A team of scientists, led by PRL, Ahmedabad, has captured a newly hatched star cluster at the heart of a giant molecular cloud in our Galaxy, using the near-infrared camera mounted on the 3.6m Devasthal Optical Telescope. The team found that the cluster is extremely young, with an age of 0.5 Myr and also found that the parental cold clump is converting gas into stars at an efficiency of 20% and a rate of 330 solar masses per million years. The cluster is connected to the external reservoir of cold gas and dust through a filamentary network; they estimated that with the current star formation rate, the cluster can to evolve into a massive cluster of mass greater than 1000 solar masses over the next few million years. This study provides critical insights into the evolution and growth of star clusters during their nascent phase.

- A multiwavelength study of a Be/X-ray binary pulsar IGR J06074+2205 was carried out by a group of scientists of PRL using X-ray and optical observations, focusing on before, during, and after the X-ray outbursts in October and December 2023. The properties of the neutron star in the binary are investigated using NICER and NuSTAR observations during the X-ray outbursts. The pulse profiles across a broad energy range, are found to be strongly dependent on luminosity and energy, revealing the complex nature of the emitting region. Utilizing the MAXI/GSC long-term light curve, the team estimated the probable orbital period to be 80 or 80/n (n = 2, 3, 4) days. Evolution of the circumstellar disc around the Be star is investigated by using optical spectroscopic observations from PRL's 1.2 m telescope at Mnt. Abu and the 2.01 m Himalayan Chandra Telescope at Hanle, Ladakh, between 2022 and 2024. Variable H$\alpha$ and Fe II emission lines with an increase in equivalent width are observed, indicating the presence of a dynamic circumstellar disc. The appearance of additional He emission lines (such as 5875.72 Å, 6678 Å, and 7065 Å), during the post-outburst observation in February 2024 suggests the growing of a larger or denser circumstellar disc. The group found that the disc continues to grow without any noticeable mass loss, even during the 2023 X-ray outbursts, which may lead to a future giant X-ray outburst.

- Identification of Active Galactic Nuclei (AGN), $i.e.$, accreting super-massive black holes (SMBHs) in the centres of galaxies, is challenging in distant and dusty galaxies as the optical, UV and X-ray emission arsing from AGN gets absorbed by the dust present around them.We studied their X-ray spectra to search for AGN hosted in dusty galaxies. By modelling the X-ray spectra we found that the line-of-sight column densities ($N_H$) in dusty galaxies span across a wide range (1.02 $\times$ $10^{22}$ $cm^{-2}$ $\leq N_H \leq$ 1.21 $\times$ $10^{24}$ $cm^{-2}$), with a substantial fraction (18 per cent) of them being heavily obscured ($N_H \geq 10^{23}$ $cm^{-2}$). The absorption$-$corrected X-ray luminosities of dusty galaxies suggest that they host luminous quasars. Our work reveals that AGN in dusty galaxies consist of a heterogeneous population that includes a small fraction (12%) of AGN belonging to an early phase during which accretion and obscuration peaks. In contrast the remaining AGN belong to an intermediate or late phase during which radiative feedback from the dominant AGN blows away surrounding obscuring material.

- A team of scientists of PRL, Ahmedabad, carried out an extensive study of the Seyfert 1 AGN Mrk 50 using 15 years (2007–2022) of multiwavelength observations from XMM-Newton, Swift, and NuSTAR for the first time. Timing analysis showed that the source exhibited variability of $\sim$20% during the 2007 observation, which reduced to below 10% in the subsequent observations and became non variable in the observations from 2010 onward. Spectral analysis showed that the spectra are nearly featureless. Nondetection of absorption in the low-energy domain during the 15 years of observations infers the absence of obscuration around the central engine, rendering the nucleus a "bare" type. A prominent soft X-ray excess below 2 keV was detected in the source spectrum between 2007 and 2010, which vanished during the later observations. To describe the nature of the soft excess, we use two physical models, such as warm Comptonization and blurred reflection from the ionized accretion disk. Two physical models the warm Componization model and blurred reflection from the ionized accretion disk model, explain the nature and origin of the soft excess in this source.

- A group of researchers of PRL, Ahmedabad, performed a comprehensive analysis of approximately 15 years (2006-2021) of X-ray observations of a low-mass bare AGN UGC 6728 for the first time. The study encompasses both spectral and temporal aspects of this source. Using various phenomenological and physical models, the team concluded that (a) the observed variability in X-ray luminosity is not attributed to the hydrogen column density ($N_H$) as UGC 6728 exhibits a bare nucleus, implying a negligible $N_H$ contribution along the line of sight, and (b) the spectral slope in the X-ray band demonstrates a systematic variation over time, indicating a transition from a relatively hard state to a comparatively soft state. The team proposes that the underlying accretion dynamics around the central object account for this behaviour. The mass of the supermassive black hole in UGC 6728 is estimated to be $M_{BH} = 7.13 \times 10^5$ $M_{\odot}$. Based on the spectral and temporal analysis, the team suggests that UGC 6728 lacks a prominent Compton hump or exhibits a very subtle hump that remains undetectable in the analysis. The team also noticed a strong soft excess component in the initial part of the observations, which was later reduced substantially. This variation of soft excess is explained given accretion dynamics.

- A group of researchers from PRL, Ahmedabad, are involved in studying the aspects of particle acceleration, processes behind the high-energy emission, geometry, neutrino production, PeV transitions, magnetic fields, etc., hosted in the astrophysical jets, especially in AGNs and micro-quasars. The group uses multi-wavelength data on a sample of blazars, radio galaxies, and X-ray binaries from state-of-the-art multi-messenger facilities across the globe in close collaboration and model the broadband information carriers using multiple incarnations of the best theoretical understanding of the subject. Recently, phenomenal work from such an effort, including data from the Event Horizon Telescope (EHT) among many participating facilities, resulted in enabling the physics of the jet in our nearest AGN, M87 (d$\sim 16.8 \pm 0.8$ Mpc; $\mathrm{M_{SMBH}} \sim 6.5 \times 10^9\,\mathrm{M_\odot}$). For the first time, the AstroSat-UVIT images were extensively used to model the Far UV contribution ($BaF_2$ band) in M87, utilizing the 2D image decomposition method. The resulting constraints were comparable to those obtained from the HST observations in the 2017 and 2018 EHT campaigns. The UVIT based estimations were used to model the broadband emission starting from radio to TeV bands. This recent study highlights the importance of a global observing effort in understanding the enigmatic phenomena hosted in such an object showing variable broadband emission encompassing variable TeV (a day-scale flare with $\tau \sim 3.10 \pm 1.03$ days) and mm-core emission, and producing the best possible dataset ever for future utilization. The ongoing continuation of such works on M87 and extending it further to other nearest SMBH (SgrA*), which is an inactive accretor, is expected to result in more valuable insights about the disk-jet connection, particle energization, accretion flows, etc., around gigantic black holes hosted at massive galaxies across the universe, to be revealed in the near future.

- It is shown that to explain the observed homogeneity and near-flatness of the Universe, the arguments based on inflation are circular. For example, the horizon problem, which leads to the causality arguments for the homogeneity, is derived in the Friedmann-Robertson-Walker (FRW) world models where homogeneity and isotropy of the Universe at some large enough scale, i.e. Cosmological Principle (CP), is presumed to begin with. We do not know whether a horizon problem would still arise in non-homogeneous world models that do not depend on the Robertson-Walker line element. Therefore, as long as we confine ourselves to investigating the properties of FRW world models, there will be no homogeneity issue. Further, the flatness problem, as it is posed, is not even falsifiable

### Solar Physics

- Coronal Mass Ejections (CMEs), which are large scale magnetic eruptions from the Sun, during their propagation in the heliosphere often experience changes in direction, tilt, and structure due to interactions with the solar wind. This study analyzed 15 Earth-impacting CMEs (2010 – 2018) observed by the Heliospheric Imager on STEREO. About half of these CMEs followed self-similar expansion up to 40 solar radii, while others showed deflections or tilt changes. Only two exhibited significant rotation, assessed using in situ flux rope fitting at L1. These findings suggest that rotation is relatively rare in the heliosphere. Deflections and rotations are likely driven by solar wind interactions and magnetic field influences. The results underscore the importance of HI observations for linking solar and near-Earth CME behavior, aiding space weather forecasting.

- Spicules are defined as small-scale, short-lived jets of plasma originating from the Sun's chromosphere. These features are powerful plasma streams that erupt from the chromosphere, ubiquitously seen in the lower solar atmosphere, and are believed to play a crucial role in transporting mass and energy from the lower solar atmosphere into the corona, contributing to the heating of the corona and acceleration of the solar wind. Based on coordinated observations from ground and space-based observatories, provides evidence that spicules can reach coronal temperatures and may play a significant role in replenishing the solar corona with hot plasma. This analysis also indicates that at least a subset of the strong redshifts observed in the emissions from TR result from the upper atmosphere flow of plasma reaching the chromosphere in the form of bundles of spicules. Further, analysing the multi-height velocity oscillations, it was observed that Atmospheric Gravity Waves (AGWs), which are low-frequency in nature, reach the upper atmosphere; AGWs often originate in or near regions of magnetic flux concentration—the same regions where spicules are formed. Therefore, the authors proposed that AGWs might propagate upward through the solar atmosphere, guided along the spicular structures, as spicules may act as waveguides.

- One of the key challenges in space weather forecasting is reliably predicting the strength of the southward component (Bz) of the magnetic field within an Earth-impacting interplanetary coronal mass ejection (ICME). The Interplanetary Flux Rope Simulator (INFROS) is an observationally constrained analytical model designed to forecast the magnetic field vectors of ICMEs in near-real time. Utilizing the modelling framework of INFROS, the authors investigated six ICMEs sequentially observed by two radially aligned spacecraft positioned at different heliocentric distances. The six selected ICMEs in this study comprise cases associated with isolated coronal mass ejection (CME) evolution as well as those interacting with high-speed streams (HSSs) and high-density streams (HDSs). For the isolated CMEs, the results show that the INFROS model outputs at both spacecraft are in good agreement with in-situ observations. However, for most interacting events, the model correctly captures the CME evolution only at the inner spacecraft. Due to the interaction with HSSs and HDSs, mostly at heliocentric distances beyond the inner spacecraft, the ICME evolution no longer remains self-similar. Consequently, the model underestimates the field strength at the outer spacecraft. The findings indicate that constraining the INFROS model with inner-spacecraft observations significantly enhances the prediction accuracy at the outer spacecraft for the three events undergoing self-similar expansion, achieving a 90

- The solar atmosphere provides a conducive environment for generating, propagating, and dissipation of various mechanical waves. These waves are considered to play an essential role in the heating and dynamics of the solar atmosphere. Acoustic waves are generated by turbulent convection inside the Sun's convection zone. These waves are trapped inside the acoustic cavities, which are formed due to the high temperature inside the Sun and the sharp fall in density at the photosphere. The work carried out towards the propagation characteristics of these acoustic waves in the quiet-Sun atmosphere using the observations obtained with the Multi-Application Solar Telescope (MAST) operational at the Udaipur Solar Observatory, PRL, Udaipur, shows the important role of acoustic waves in heating of the solar atmosphere. Investigations on the frequency and height-dependent phase shift variations indicate the non-evanescent nature of acoustic gravity waves, which persists beyond the photosphere.

**Planetary Sciences**

- It is speculated that Martian dust devils yield large electric fields within the vortex, due to the charging of dust via triboelectrification. Our theoretical studies have shown, that for certain dust-atmospheric conditions, the electric fields can exceed the atmospheric break-down value, which may trigger lightning on Mars. This has important implications at local scales, to lander and rover missions on Mars.

- Using ChaSTE observations from the Chandrayaan-3 mission, we have reported the first-ever in-situ temperatures up to a depth of 10 cm inside the lunar surface near the southern polar region of the Moon at 69.37$^\circ$ S. ChaSTE observations indicate that the lunar surface temperatures show a significant spatial variability at meter scales at high latitudes (unlike at the equatorial regions), and possible presence of water-ice even at high-latitude locations having larger poleward slopes. These locations could be promising sites for future lunar exploration and habitation

- India's Chandrayaan-3 mission marked a historic achievement on August 23, 2023, by successfully soft landing near the Moon's South Polar Region. This milestone made India the fourth nation to achieve a successful landing on the lunar surface and the first to reach near to the Moon's South Pole. In a recent study, the age of the landing region has been estimated to be approximately 3.7 billion years, which provides valuable insights into the provenance of material deposited at the site. Additionally, the study identified meter and centimeter-sized rock fragments scattered within and around the landing site, tracing their origin to fresh craters formed in the region

- Scientists from PRL and ISRO have shown that Indian Lunar mission Chandrayaan-3 landed within a buried impact crater, and likely to be older than the South Pole Atkin (SPA) basin. This is revealed based on analysis of images obtained by Navigation Cameras on Chandrayaan-3 Pragyan rover and Chandrayaan-2 Orbiter's Optical High Resolution Camera. The landing site is located $\sim 350$km from the SPA basin rim, an ancient and the largest impact basin in the Solar System. The regional exploration around the Chandrayaan-3 landing site revealed a near semi-circular like highly degraded structure. This semi-circular structure encompassed the Station Shiv Shakti. Further detailed geomorphological and topographical analysis revealed that the semi-circular structure is a heavily degraded crater structure or a buried impact crater with a diameter of $\sim 160$km and depth of $\sim 4.4$km

- A Comprehensive Analysis of a Chloride-Rich Topographic Depression was carried out for the Terra Sirenum region of Mars. It was found that the basin may have held water for several thousands of years and that the area had a mix of chemicals that could have been good for life. It has shown to be a possible lost basin with astrobiological significance

- The study of lunar basaltic meteorite A-881757 has provided important insights to our understanding of melting mechanisms in the lunar interior. The meteorite likely represents hidden cryptomare basalts present at the lunar surface and subsurface, which are yet to be chemically explored by any missions. This study suggests more sample returns from the unexplored regions of the Moon

- Meteorites have been successfully classified using reflectance spectroscopy and deep learning for the first time using data from RELAB (USA), C-TAPE (Canada) and Planetary Remote Sensing Laboratory (PRSL), PRL.

- Any new meteorite fall holds significant importance to the meteoricist or cosmochemist for its dynamic dataset and higher scientific value. The recent fall of Kopargaon chondrite (January 24, 2023 at 06:50 IST) resembles fragmental breccia and classified as LL5. The mineralogical and chemical characteristics align with those of the stony meteorite samples returned by the Hayabusa mission (JAXA) from the asteroid Itokawa.

- The occurrences of iron sulfates (natrojarosite) and associated natroalunite and kaolinite in the post-volcanic province is consistent with an oxidising environment and periodic shift of humid to arid environment reminiscent of the early geologic history of Earth and Mars. Based on mineralogy of sulfates, we contend that acidic and water limited conditions of Matanomadh Formation of Kutch is analogous to the Noachian-Hesperian epoch ($\sim$3.7 Ga) of Mars with implications for the past weathering process.

- A system and method for experimental simulation of Venusian lightning, its characterization and its detection have been designed and developed as a collaborative work. The key achievements are analysis of Venusian lightning source strength at the pressure of clouds through its generation, the breakdown of gas mixture present in the clouds and its detection by electrically short antenna. Our results show that majority of Venusian lightning should be due to the $CO_2$ present, superimposed by any conducting ions (like $H^+$ or $SO_4^-$). The results are useful for lightning project at PRL, for Venus Orbiter Mission (VOM). (Official Journal of the Patent Office, Issue Number 05/2025, Dated 31/01/2025)

- Influence of vertical mixing on exoplanet atmospheric spectra is carried out, using parameters like eddy diffusion, gravity, temperatures, and metallicity. Using 1D chemical kinetics and a fast quenching-based model, the impact on transmission spectra is analyzed. A custom forward model, integrated with a retrieval code, effectively recovers atmospheric properties from simulated JWST data. Results show vertical mixing significantly affects spectra only within a narrow parameter space. In such regions, retrieval models can tightly constrain mixing strength and provide optimal exoplanets to study vertical mixing. In addition, the $NH_3$ abundance can be used to constrain the internal temperature for equilibrium temperature $>$ 1400 K

- A multifluid chemical-hydrodynamic model is used to analyse the origins of organic molecules in four active comets. It found that while some species like formic acid and methyl formate can form in the coma, others like glycine and ethanol mainly originate from the nucleus. The model incorporated an updated chemical network, focusing on C-H-O and N-bearing compounds. Molecular formation in the coma depends heavily on initial abundances, temperature, and reactant ratios. Coma-synthesized molecules can reach substantial production rates, potentially detectable by future space missions.

- The dusty plasma environment near the lunar surface is analyzed. It is influenced by solar UV radiation and solar wind, first hinted at by strange horizon glows during Apollo and Surveyor missions. Dust particles gain charge within the photoelectron sheath, leading to dynamic behaviors like periodic hopping or single ballistic motion, depending on local conditions. The discrete charging of dust is found to crucially affect its movement in low-density plasma regions. These findings help explain the lunar surface's evolving dusty atmosphere. Understanding this is vital, as charged dust poses significant hazards to equipment, spacesuits, and human health during lunar missions due to its abrasive nature.

**Space and Atmospheric Sciences**

- The significance of terpenoid emissions from traffic-related and biogenic sources in urban areas of the developing world is largely unknown, leading to uncertainties in their contributions to ozone and organic aerosol formation. Our study is based on well time-resolved continuous measurements of ambient monoterpene ($\alpha$- and $\beta$-pinene) concentrations at an urban site in western India during January-May 2020, coinciding with winter-to-summer and COVID-19 pre-lockdown to lockdown transitions. The trends in monoterpenes concentrations do not directly reflect the impact of enhanced biogenic contributions in summer due to counterbalancing effects of increased rates of oxidation and dilution. The estimated relative daytime biogenic contributions to $\alpha$-pinene increased from $66 \pm 10\%$ in January to $88 \pm 13\%$ in May, while that of $\beta$-pinene increased from $56 \pm 8\%$ to $70 \pm 19\%$. Overall, depending on the season, the complex interplay between the variability in anthropogenic activities, biogenic emissions, and photochemical/meteorological factors controls the ambient air variability of monoterpenes. The study provides insights into seasonal changes in anthropogenic and biogenic contributions of atmospheric monoterpenes. The knowledge of monoterpene sources is critical to assess secondary organic aerosol (SOA) formation contributing to regional climate.

- In the recent period, significant advancements were made in understanding atmospheric cloud characteristics and boundary layer dynamics over the Western-Indian region. For the first time, cloud base height (CBH) over Udaipur, an urban city in the Aravalli ranges, was analyzed using ground-based Lidar, satellite data, and reanalysis products. The study provided monthly and seasonal statistics of cloud occurrence and CBH, while also validating ERA5 and satellite-derived CBH against Lidar observations. Additionally, an investigation into a dust storm over Ahmedabad revealed a notable transformation in the boundary layer, driven by outflows from two convective systems originating in southwest Gujarat and southeast Rajasthan. The findings underscore the role of moist convection in triggering dust storms and shaping boundary layer behavior. Together, these studies offer valuable insights into regional weather patterns and contribute to broader efforts in environmental impact assessment and climate adaptation.

- The temporal characteristics of black carbon (BC) aerosol, its source apportionment into fossil fuel and wood fuel components to infer their contribution to the total BC emission, and their trends measured over an urban location (Ahmedabad) in India covering a 14-year period (2006-2019) are comprehensively investigated using a multi-wavelength aethalometer. A statistically significant increasing trend is detected in BC mass concentration at the rate of 11% $yr^{-1}$ with an apportionment of increasing trend for fossil fuel 29% $yr^{-1}$ whereas a decreasing trend in the contribution of wood fuel burning at the rate of 36% $yr^{-1}$. The study reveals a significant decrease in wood fuel burning emissions over the past decade, attributed to the adoption of cleaner household cooking fuel and an increase in emissions from fossil fuel combustion.

- An analysis of multi-source data comprising ground-based and satellite observations in combination with two high resolution global models revealed that aerosol content in the atmosphere, expressed as aerosol optical depth (AOD), decreased by a statistically significant amount of 20-40% during the peak lockdown period in spring and summer of 2020 across the globe. The changes in AOD were highest during spring over Middle East, South and East Asia. The change in dust AOD was maximum over South Asia during spring ($> 75\%$; -0.04 decrease in dust AOD in -0.05 change in total AOD). Black carbon AOD decreased significantly and was maximum over South Asia (50%) during spring 2020 providing an evidence for the impact of applied restrictions on anthropogenic activities. Decrease in AOD over North America, Europe, Russia, Middle East, South Asia, East Asia, and South East Asia led to global decrease in AOD. This rigorous analysis showed that during lockdown the changes in aerosol content were a resultant of changes in both natural and anthropogenic aerosols, and their sources.

- A comprehensive analysis of aerosol absorption parameters - single scattering albedo (SSA, ratio of aerosol scattering to scattering and absorption) and absorption aerosol optical depth (AAOD) - showed that SSA is lower in Central (0.86) and South Asia (0.90) than East (0.93) and Southeast Asia (0.94). Annual mean AAOD is higher over South Asia ($\sim$0.07) and it is $\sim$50% lower over Southeast and East Asia. Globally, AAOD ($> 0.1$) is highest over central Africa in winter because of high AOD and lower SSA due to intense biomass burning and dust aerosols. Seasonal variabilities in spectral SSA and AAOD over North America, South America, Europe, and Middle East are not statistically significant revealing no significant variations in aerosol composition and size distribution throughout the year over these regions. Our findings provide critical global insights for a better understanding of the characteristics and variabilities of aerosol absorption, and for improving model simulated aerosol absorption on seasonal and global scales, which are useful to substantially reduce uncertainties in global assessment of radiative and climate impact of aerosols.

- A comprehensive global investigation on the impact of changes in aerosol emissions due to Coronavirus disease-2019 (COVID-19) lockdowns on aerosol single scattering albedo

(SSA) utilizing satellite observations and model simulations demonstrated that the changes in SSA are $< 4\%$ ($< 0.04 - 0.05$) globally during COVID (2020) compared to normal (2015-2019) period. Change in SSA during COVID lockdown was not significantly different from long-term and year-to-year variability in SSA. A small change in SSA indicated that the significant reduction in anthropogenic aerosol emissions during COVID-19 induced lockdowns had a negligible effect in changing the net contribution of aerosol scattering and/or absorption to total aerosol extinction.

- A comprehensive study on regional and spatial distributions of observed aerosol columnar optical and physical characteristics along with spatio-temporal co-located validation of two high-spatially resolved models simulated aerosol optical depth (AOD) revealed that AOD is highest over South Asia in all seasons, followed by South-East, East, and Central Asia. For high AOD conditions, underestimation in model AODs was higher and lower fraction of model AODs satisfied the Global Climate Observing System (GCOS) requirement over all regions, and the underestimation was more pronounced over Asia. Biases in model AODs are higher over Asia and lower over North America, Europe, and Australia compared to other regions of the globe. These findings over the globe are crucial for accurate simulation and fine-tuning of aerosol characteristics by regional and global models, and for reducing uncertainties in assessment of radiative and climatic impact of aerosols.

- An investigation was carried out to determine the excitation mechanism of the zonally symmetric semidiurnal tide component (S0) during Sudden Stratospheric Warming (SSW). The sun-synchronous semidiurnal tide, a major component at mid and high latitude middle atmosphere, was found to be non-linearly interacting with the dominant stationary planetary wave in the stratosphere to produce the observed S0, during two boreal SSWs. The zonally symmetric distribution of ozone is also believed to excite the concerned S0 by absorption of solar ultraviolet radiation as evident during a rare Austral SSW.

- Using OH(3-1) nightglow brightness and temperature over Ahmedabad for the year 2023, characteristics of the vertically propagating waves in the Mesosphere-Lower Thermosphere (MLT) region have been investigated. The model horizontal winds show annual and semi-annual oscillatory (AO and SAO) behaviour in the resultant horizontal wind ($U_h$). The nightly mean vertical wavelength ($\lambda_z$) and $U_h$ and their residuals showed anti-correlation between the observed AO and SAO in both parameters. A sine fitting model is proposed, accounting for the observed AO and SAO, to provide a first-order estimate of the $\lambda_z$ as a function of the day of the year.

- During geomagnetic storms, energy transfer occurs in the form of electron heat flux or soft particle precipitation ($< 10$ eV) along closed geomagnetic field lines. Downward heat flux increases the ambient electron temperature in the topside ionosphere (300 – 400 km above the surface of the Earth) resulting in oxygen redline emissions called the Stable Auroral Red (SAR) arcs. We have not only reported the first measurements of such SAR arcs in the daytime but also obtained the corresponding heat flux, which is found to be in the range of $1.0$ to $4.6 \times 10^{10}$ eV cm$^{-2}$ s$^{-1}$.

- Observations from PRL's optical aeronomy observatory at Mt. Abu occasionally showed enhancements in the redline airglow during post-sunset hours which is attributed to enhancement in electron density caused due to the poleward meridional winds. The cause of such reversal in winds towards the poleward direction from the usually equatorward has been examined using the Whole Atmosphere Community Climate Model with thermosphere-ionosphere eXtension (WACCM-X) and it is shown that a strong tidal contribution, especially the quarter-diurnal component, is the cause behind the poleward reversal of meridional winds after sunset.

- The infrared emissions by Nitric oxide (NO) contribute to the loss of heat in the thermosphere and facilitate its recovery from the enhanced density during geomagnetic storms. Investigations on the distribution of NO emissions during the two recent severe geomagnetic storms of May and October 2024 reveal that the infrared radiative cooling increased in the low-latitudes even though the particle precipitation occurred at high latitudes. This is interpreted to be due to the storm time equatorward meridional winds that transport NO from high latitudes. Such investigations reveal the persistent latitudinal coupling that is set up during space weather events.

- Aditya–L1, the first dedicated Indian solar mission, was launched on 02 September 2023 and was placed in a halo orbit around the first Lagrange point (L1) of the Sun-Earth system on 06 January 2024. Aditya Solar wind Particle EXperiment (ASPEX) is one of the three in situ science experiments on board the Aditya–L1 mission that provide measurements of primarily protons and alpha particles in the solar wind, suprathermal, and energetic particles in the energy range from 100 eV to 6 MeV/nucleon . ASPEX consists of two independent spectrometers: the Solar Wind Ion Spectrometer (SWIS: 100 eV - 20 keV) and the Supra Thermal and Energetic Particle Spectrometer (STEPS: 20 keV/nucleon - 6 MeV/nucleon). In two separate works, along with the instrumental novelties, it is suggested that ASPEX-SWIS data can throw light on the origin of slow and fast solar wind, suprathermal ions, directional anisotropies, and the space weather impact on the Earth while the ASPEX-STEPS data provide important clues to the origin, acceleration and anisotropy of suprathermal and energetic ions in the interplanetary medium.

- It is believed that helium abundance in solar wind plasma may reveal the nature of the solar source region and can exert significant influence on the solar wind speed. Helium abundance in the solar wind typically varies in the range of $2\%$ to $5\%$. However, in interplanetary coronal mass ejection structures, this abundance can go as high as $30\%$. Interestingly, there are instances when the observed helium abundance in solar wind is found to be exceptionally low ($< 1\%$). These low helium events have not been understood in detail so far. Based on satellite observations and modeling, it is shown that the low helium abundance events have originated from the boundaries of coronal holes, primarily from large quiescent helmet streamers. The streamer core serves as an ideal location for gravitational settling, leading to the availability of helium-depleted plasma at higher heights. Interchange reconnection near the cusp eventually releases this helium-depleted plasma parcel into the solar wind.

- Geomagnetic storms driven by Interplanetary Coronal Mass Ejections (ICMEs) generate stronger effects on the low latitude ionosphere. However, in this work, it is shown that a weaker geomagnetic storm caused a much stronger ionospheric response over low latitudes than a stronger storm that occurred a few days later. The investigation suggests that the steady southward interplanetary magnetic field (IMF) condition is more effective than the fluctuating IMF $B_z$ condition in generating a stronger ionospheric response over the low latitudes. It is also shown that favourable meridional (north-south) wind conditions can enhance the degree of ionospheric impact.

#### Geosciences

- Trichodesmium, a nitrogen-fixing microbe, plays a crucial role in marine nitrogen cycling, but its distribution is influenced by various environmental factors. Our study reveals that phosphate availability and sea surface temperature primarily control trichodesmium abundance along the zonal transect, while dust deposition and temperature drive inter-hemispheric variability in the Tropical Atlantic Ocean.
- Re-Os dating of two sedimentary sequences yield important chronological pins in the upper Cambrian to Middle Ordovician. The Re-Os dating of (i) Cambrian Alum Shale yields an age of 488.6 $\pm$5.1 Ma, and (ii) Lower-Middle Ordovician boundary Tøyen shale yields age of 469.7 $\pm$1.4 Ma. Seawater $^{187}$Os/$^{188}$Os declines through the late Cambrian-Ordovician, indicating reduced weathering and global cooling. Redox-sensitive element relationships indicate metal that drawdown was influenced by euxinic conditions in the latest Cambrian to Early Ordovician.
- Soils release more $CO_2$ into the atmosphere than human activities, making them a key player in the carbon cycle. A study on tropical semi-arid soils examined $CO_2$ emissions, their sources, and controlling factors. Soil pore space $CO_2$ levels ranged from 13,780 to 26,300 ppm, with emissions between 4.6 and 15.0 µmol $CO_2$/m$^2$/sec, strongly influenced by soil moisture. Radiocarbon analysis showed that emissions mainly come from root respiration and fresh organic matter decay, while older soil carbon, present in deep soil layers, contributes less than 5%. This suggests that carbon storage and emissions function separately, and climate warming is unlikely to significantly increase $CO_2$ release from these soils.
- Emissions of atmospheric $NH_3$ is found to be dominated from non-agricultural emissions sources over Patiala, a region dominated by agricultural practices (Major Sources of $NH_3$ - $NH_3$-slip: 47%; agricultural emissions: 24%; combustion sources: 19%; and biomass burning: 10%).
- A study to decipher the recalcitrant nature of the particulate black carbon was undertaken and the isotopic evidence obtained from oceans suggested that the particulate black carbon may not be as recalcitrant as previously believed.
- Chromium isotopes in Archean rocks and impactites from different time (3243 Ma to 66 Ma) are studied to understand the change in the impactor flux with time. Our findings suggest that the flux of carbonaceous-like impactors was higher in the Archean, and mixed flux (carbonaceous and non-carbonaceous) material was dominant after 3000 Ma. These results suggest that the volatiles to the Earth was likely delivered before 3000 Ma.
- The work on the Himalayan glacial terrain in 2024 has highlighted the critical role of extra-tropical cyclones in supplying adequate moisture along with lowering of the temperatures in the advancement of smaller glaciers in the last four thousand years and deteriorating permafrost conditions after 2500 years in the Zanskar Himalaya.
- After severe Beas floods in July 2023, a general article evaluated the role of man-made barriers (particularly hotels, buildings in floodplains) in amplification of the damage caused by torrential floods. It was suggested that haphazard construction and blockages of natural pathways led to aggravated disaster.
- The engineering modifications of rivers (in form of river fronts etc.) lead to increase in primary productivity (i.e., carbon fixation) due to increase in residence time of water.

#### Theoretical Physics

- Non-factorizable charm loop effects are crucial in understanding the $B \to K\ell\ell$ and similar modes. Studies employing B-meson Distribution Amplitudes (DAs) have led to the conclusion that these effects are rather small. Employing light meson DAs and computing the effects is an independent check. It is found that charm loop effects vanish to the sub-sub-leading accuracy. A suggestive reason could be a more symmetric light meson light-cone DA structure, and thus, leads one to conclude that such charm loop effects can be safely neglected in such modes, thereby being important for new physics searches.
- Deep machine learning (DML) techniques have revolutionised data analysis in physics and natural sciences, enabling the extraction of meaningful information from complex datasets. However, while DML's power is undeniable, integrating physics-inspired feature extractors alongside these techniques offers significant benefits. These features enhance the interpretability and performance of deep learning models by providing a deeper understanding of the extracted information. This work explores the application of deep learning in particle physics, specifically focusing on automatic feature extraction and the advantages of physics-informed architectures. We highlight the potential of leveraging prior physics knowledge to improve data representation, particularly in point cloud analysis, and investigate graph-based methods for LHC phenomenology.
- The elusive nature of dark matter, a dominant yet unseen component of the cosmos, continues to challenge our understanding of the universe. While its gravitational influence is well-established through various astrophysical observations, the fundamental properties of dark matter particles remain shrouded in mystery. This research delves into the exploration of viable dark matter models, employing a multi-pronged approach that includes examining their potential direct production at the Large Hadron Collider (LHC). By scrutinizing these models against data from ongoing LHC experiments, we aim to provide crucial experimental feedback, refining our understanding of dark matter interactions and significantly enhancing the prospects of discovering these enigmatic particles in future high-energy physics endeavours.

This approach bridges theoretical modelling with direct experimental searches, offering a powerful avenue to illuminate the dark universe.

- The Gor'kov-Teitel'baum Thermal Activation (GTTA) model is applied to $Sr_{2-x}\mathrm{La}_x\mathrm{I}r\mathrm{O}_4$ to obtain its Pseudogap phase boundary. The results agree with previously reported Pseudogap signatures. Thus this work confirms the presence of Pseudogap in this system. "Fermi arc" evolution with temperature is studied for $x \sim 0.08$ which is in qualitative agreement with reported results. An updated phase diagram predicting the Pseudogap phase boundary for $Sr_{2-x}\mathrm{La}_x\mathrm{I}r\mathrm{O}_4$ is drawn.

- A theoretical framework based on new kinds of forces is proposed that explains why elementary particles have different masses. The heaviest ones get their mass directly, while lighter ones gain mass through small quantum effects. These effects come from a new force, similar to electromagnetism but with key differences, ensuring consistency with observed particle properties. It predicts that new physics could emerge at around 1000 TeV energy and also offers insights into the tiny masses of neutrinos.

- Semiconductor p-n junction diodes are widely used in various electronic devices for the made unidirectional current driven by voltage bias. Unlike semiconductor diodes, superconducting phase difference can drive dissipation-less current in Josephson junction, which can be made unidirectional by applying external magnetic field. Large Josephson diode effect is shown without any magnetic field for the first time in low-dimensional chiral quantum dot junctions. The proposed model has the potential for application in superconductor-based quantum device components.

- A novel, efficient, and straightforward method for calculating leading threshold logarithms has been developed at the next-to-leading power accuracy. Its simplicity makes it inherently robust and suitable for application to any processes involving jets in the final states at the Large Hadron Collider.

**Atomic, Molecular and Optical Physics**

- Shifts in the energy levels of atomic clock candidates caused by blackbody radiation (BBR) limits the accuracy of clock frequency measurements. The $^1\mathrm{S}_0 \rightarrow {}^3\mathrm{P}_0$ transition of the zinc (Zn) atom is identified as the potential optical clock frequency measurement. An equation-of-motion relativistic coupled-cluster method was employed for the first time to precisely estimate the BBR shift of the Zn atom coming from the dominant electric dipole (E1) component. Among the singly charged ion based atomic clocks, the clock frequency between the fine-structure splitting $^3\mathrm{P}_0 \rightarrow {}^3\mathrm{P}_1$ of the singly ionized aluminum ($\mathrm{A}l^+$) is known to be measured very precisely. In this clock transition, the BBR shift due to the magnetic dipole component can contribute significantly, but its contribution was less explored. By carrying out a detailed analysis, we provide accurate determination of the magnetic dipole driven BBR shift in the $\mathrm{A}l^+$ clock.

- In an atomic system, parity violation (PV) interactions originate from two primary sources. The first source is the neutral current weak interactions between the atomic nucleus and electrons. The second is the electromagnetic interaction between electrons and a possible parity-violating nuclear anapole moment (NAM) within the nucleus. The concept of NAM in the atomic system is still under debate and should be addressed decisively. Though a finite value of NAM has been inferred by combining the measured PV amplitude in cesium ($^{133}\mathrm{C}s$) with the atomic calculations earlier, the inferred value is at variance with the results of the shell model calculations and the nucleon-nucleon scattering experiments. Moreover, the sign of the NAM coupling constant from the Cs measurement is not in agreement with the measurement using the thallium (Tl) atom. In view of this, we carried out calculations of the electric dipole amplitudes due to spin-dependent PV interactions in $^{133}\mathrm{C}s$ using the Dirac-Coulomb atomic Hamiltonian. Based on these calculations, we reported a new limit on the magnitude of a nucleon-nucleon PV coupling constant.

- Adding or removing neutrons to/from an atomic nucleus results in variations of its nuclear density, which in turn influences the energy levels of its atomic electrons. The change in an energy level due to this effect is termed isotope shift (IS). IS measurements are sensitive to the changes in mean-squared nuclear charge radii and nuclear masses. By combining IS measurements with atomic calculations, very precise values of nuclear charge radii can be inferred. The mean-squared nuclear charge radius difference between isotopes is a unique probe of nuclear structural changes in isotopic chains. By performing rigorous calculations and combining with IS measurements carried out in other parts of the world, precise values of nuclear charge radii of silver (Ag) and tin (Sn) isotopes are reported. Our study in Ag showed that the previously calculated shape-staggering effects were overestimated on the neutron-rich side, and there are discontinuities around nuclear mass numbers 96 and 102. We also observed evidence for the doubly magic character in the $^{100}Sn$ nucleus

- The achievement of scalable, fault-tolerant computers that can solve classically intractable problems is the holy grail of quantum computing. The currently available noisy intermediate-scale quantum (NISQ) computers are an important milestone in the journey towards achieving this goal. These computers are restricted by fairly large error rates and a limited number of qubits, among other challenges. Despite these limitations, NISQ devices are being actively explored to harness their maximum quantum computational power and broaden the scope of their applicability. We computed relativistic and correlation effects in the energies and magnetic-dipole hyperfine structure constants of the ground states of four lithium-like atomic systems. A symmetry conserving Bravyi-Kitaev transformation was used to reduce the original six-qubit problem to a four-qubit problem, which was contrived by reducing the hardware requirement by employing a virtual two-qubit gate. The ground-state wave functions were obtained by using quantum state tomography. Our results showed that the averaged relative errors for the ground-state energies and hyperfine constants are about 1% and 10%, respectively.

- The high bit rate quantum random number using the temporal and spatial correlations of heralded single photons has been demonstrated

- The dead-zone-free single-beam atomic magnetometer for sensitive magnetic field measurement has been demonstrated
- Using the quantum correlation of the heralded single photon, the optical coherence tomography has been demonstrated of an optical sample with a large length, beating the classical sensing techniques
- The lens-free imaging known as the Talbot effect has been demonstrated to measure the small variation in the period of a periodic object and also measured the aberration of a spherical lens
- The hydrogen bonding between water and ethylene glycol molecules in astrochemical conditions has been demonstrated. As a result of which, water molecules can be bonded with the ethylene glycol and can be stable up to a temperature 240 K, while the sublimation temperature of pure water ice is at 180 K. So water can be present in the comets at a higher temperature (at a nearer distance) opening up new reaction pathways in cometary ices.
- The first temperature-dependent VUV and mid-IR spectra of pure ethanolamine ices under astrochemical conditions have been obtained experimentally. Findings from this study demonstrate a close correlation between VUV and IR spectral changes and physical transitions, specifically phase change (around 180 K) and sublimation (around 230 K). The significant influence of deposition temperature and isothermal conditions on the phase change has also been observed. It is anticipated that the VUV and IR spectral features detailed herein will be valuable for the future identification of ethanolamine in interstellar ices, as well as in other cold regions of planetary and cometary bodies. Notably, this is the first report of experimentally determined temperature-dependent spectral features and morphological behavior for pure ethanolamine ices within the 2 – 12 $\mu m$ (MIR) and 120 – 230 nm (VUV) ranges under astrochemical conditions.
- PRL Scientists characterised the luminescence response of quartz for very high radiation doses (1–21 kGy) to improve existing understanding of the luminescence mechanism for multispectral emissions. Results show that Thermoluminescence (TL) in multi-spectral detection (UV–Visible) band increases in 340–380℃ peak intensity up to 11 kGy dose. This has implications for increasing the dating limits.
- We have documented changes in TLS of quartz grains from active bar sediments from four transects totaling to $\sim 4000$ km in the Ganga River system (the Ganga, Yamuna, Ramganga and Chambal rivers), and examines its possible use for sediment provenance and in the estimation of sediment fluxes at confluences. The study reveals several interesting findings.
- The complex excited-state dynamics and fragmentation dynamics of $\mathrm{CH_3C}l$ dications induced by intense femtosecond laser pulses are studied using a home-built Recoil Ion Momentum Spectrometer setup. Our study demonstrates that the pulse chirp influences the complex fragmentation dynamics of the $\mathrm{CH_3C}l$ dication.
- A significant signal enhancement has been observed in molecular emission lines of C2 and CN, formed after laser ablation of a graphite sample in the presence of nanoparticles. The observed enhancements have been explained by carrying out a systematic study of plasma evolution to estimate the lifetime of species in the plasma in the presence of silver nanoparticles. This study has a direct impact on improving the detection limits of weak molecular bands using laser-induced breakdown spectroscopy.
- A technique utilising a drop-casting method for determining trace elements in liquids using Laser Induced Breakdown Spectroscopy (LIBS) was demonstrated. The drop-casting method results in a homogeneous sample distribution over a laser-pre-treated target. This methodology was also used for some of the river water samples, and the results were compared with the ICP-OES technique, showing reasonable agreement.
- An easy-to-implement technique to obtain asymptotic key rates for the secure BB84 protocol under photon number splitting attacks has been demonstrated. Additionally, we experimentally implemented it to monitor coincidences in the decoy state protocol, leading to enhanced key rates under realistic conditions.
- Certification methods using two-photon Hong-Ou-Mandel interference and Bell-CHSH inequality for quantum entanglement to ensure the unpredictability of quantum random number generation has been proposed and experimentally implemented. Additionally, the NIST statistical test suite and min-entropy to check the quality of the generated random bits has been implemented.

# Collaborations of PRL with National/International institutions/universities

### Astronomy and Astrophysics

1. **Area of Collaboration:** Daksha mission, Future Broadband X-ray Astronomy mission,
   **Collaborating Institute:** IIT Bombay, Mumbai; TIFR, Mumbai, SAG-URSC, Bangalore; RRI, Bangalore, IUCAA, Pune
   **Scope of PRL:** Development of LE and HE detector
   **Scope of Collaborating Institute:** Development of Medium Energy detector
   **Exchange of Human Resources:** No

2. **Area of Collaboration:** Astronomical Spectroscopy for Stellar and Solar System Bodies
   **Collaborating Institute:** Royal Observatory of Belgium, Universite Libre de Bruxelles, Universite de Liege, KU Leuven, Aryabhatta Research Institute of Observational Sciences (ARIES), Indian Institute of Astrophysics, SN Bose National Centre for Basic Sciences (SNBNCBS), University of Calicut
   **Scope of PRL:** Astronomical Observation with PRL telescopes, joint research
   **Scope of Collaborating Institute:** Spectroscopy and Data analysis
   **Exchange of Human Resources:** Exchange visits of students and faculties

### Solar Physics

3. **Area of Collaboration:** Global Oscillation Network Group (GONG) Program
   **Collaborating Institute:** National Solar Observatory, Boulder, CO, USA
   **Scope of PRL:** Operations of the GONG solar telescope, installed at Udaipur Solar Observatory (USO), dedicated to Helioseismology and Space Weather.
   **Scope of Collaborating Institute:** Management and operations of the six-site network of GONG solar telescopes located around the globe.
   **Exchange of Human Resources:** The engineering team comprising of Mr. Timothy John Purdy, Mr. Bounds Stephen Edwin, and Mr. Detrick Demond Branston from GONG HQ, Boulder, CO, USA, visited USO during the period from March 18-30, 2025, for the upgradation of the Camera, Data Acquisition System, and Workstation of the GONG system.

4. **Area of Collaboration:** Solar Flares: Exploration of solar flare X-ray emission: magnetic reconnection, heating, and particle acceleration
   **Collaborating Institute:** Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany
   **Scope of PRL:** Joint research, exchange visits
   **Scope of Collaborating Institute:** Joint research, exchange visits
   **Exchange of Human Resources:** From India to Germany: Mithun N.P.S., Bhuwan Joshi, From Germany to India: Alexander Warmuth, Jake Arthur Jack Mitchell

### Planetary Sciences

5. **Area of Collaboration:** Martian Geology
   **Collaborating Institute:** Louisiana State University, USA
   **Scope of PRL:** Established scope of research on the formation and evolution of Mars; published scientific papers in peer-reviewed journals
   **Scope of Collaborating Institute:** Scientific publications in peer-reviewed journals
   **Exchange of Human Resources:** NA

6. **Area of Collaboration:** Lunar Geoscience
   **Collaborating Institute:** Scripps Institution of Oceanography, USA
   **Scope of PRL:** Established scope of research on the formation and evolution of the Moon; published scientific papers in peer-reviewed journals
   **Scope of Collaborating Institute:** Scientific publications in peer-reviewed journals
   **Exchange of Human Resources:** NA

7. **Area of Collaboration:** Lunar Geoscience
   **Collaborating Institute:** National Institute of Polar Research, Japan
   **Scope of PRL:** Established scope of research on the formation and evolution of the Moon; published scientific papers in peer-reviewed journals
   **Scope of Collaborating Institute:** Scientific publications in peer-reviewed journals
   **Exchange of Human Resources:** NA

8. **Area of Collaboration:** Planetary mission data science
   **Collaborating Institute:** U R Rao Satellite Centre, ISRO, India
   **Scope of PRL:** Research on ISRO's planetary mission data
   **Scope of Collaborating Institute:** Scientific publications
   **Exchange of Human Resources:** NA

9. **Area of Collaboration:** Analysis by lab instrumentation related to planetary samples
**Collaborating Institute:** National Geophysical Research Institute (NGRI), Hyderabad, India
**Scope of PRL:** Research on meteorite samples
**Scope of Collaborating Institute:** Scientific publications
**Exchange of Human Resources:** NA

10. **Area of Collaboration:** Chandrayaan-1 and Chandrayaan-2 data based surface studies
**Collaborating Institute:** Technical University Dortmund
**Scope of PRL:** Data analysis, interpretation
**Scope of Collaborating Institute:** Data reduction, modeling
**Exchange of Human Resources:** Two Students; Sachana Sathyan and Dibyendu Misra, visited TU Dortmund for one month.

11. **Area of Collaboration:** Exploration of Mars
**Collaborating Institute:** Georgia Tech, USA
**Scope of PRL:** This collaboration will further provide new insights into the mars related works carried out at PRL.
**Scope of Collaborating Institute:** To explore new areas and people who are expert in Martian studies.
**Exchange of Human Resources:** Student visit

12. **Area of Collaboration:** Experimental Simulation of Lightning and Development of Lightning Detection Antenna for Future Planetary Missions
**Collaborating Institute:** CHARUSAT, Changa
**Scope of PRL:** Guidance, testing and analysis of results, as a Co-PI of the ISRO RESPOND BASKET Project from PRL
**Scope of Collaborating Institute:** Design, development and testing, as a PI of the ISRO RESPOND BASKET Project from CHARUSAT
**Exchange of Human Resources:** Occasional visit on both sides, by group members of CHARUSAT and PRL

13. **Area of Collaboration:** Shear Strength, Compressibility, and Load- Settlement Behavior of Lunar and Martian Regolith Simulants: Lunar and Martian Geotechnics
**Collaborating Institute:** NIT, Srinagar
**Scope of PRL:** Guidance for regolith procurement/preparation and testing approach, analysis of results, as a Co-PI of the ISRO RESPOND BASKET Project from PRL
**Scope of Collaborating Institute:** Design, development of samples, testing and analysis, as a PI of the ISRO RESPOND BASKET Project from NIT, Srinagar
**Exchange of Human Resources:** Occasional visit on both sides, by group members of NIT, Srinagar and PRL

14. **Area of Collaboration:** Planetary Geology
**Collaborating Institute:** IIT(ISM), Dhanbad
**Scope of PRL:** Uses of Analytical Instruments, Scientific discussion, formulation of new project
**Scope of Collaborating Institute:** Experimental studies of water-rock interaction
**Exchange of Human Resources:** PhD Student visits

**Space and Atmospheric Sciences**

15. **Area of Collaboration:** Daytime upper atmospheric dynamics
**Collaborating Institute:** Jawaharlal Nehru Technological University (JNTUH), Hyderabad
**Scope of PRL:** To carry out experiments by housing in-house built optical experiments
**Scope of Collaborating Institute:** To provide logistics support and maintenance of the instrument
**Exchange of Human Resources:** no

16. **Area of Collaboration:** Daytime equatorial dynamics
**Collaborating Institute:** Indian Institute of Geomagnetism (IIG), Navi Mumbai
**Scope of PRL:** To carry out daytime optical data analysis
**Scope of Collaborating Institute:** To provide magnetic equatorial electrojet data and participate in discussions
**Exchange of Human Resources:** no

17. **Area of Collaboration:** Investigations of space weather effects over mid-latitude
**Collaborating Institute:** University of Massachussetts, Lowell (UML)
**Scope of PRL:** To carry out daytime airglow analysis of SAR Arcs
**Scope of Collaborating Institute:** To provide the data from radio measurements from UML and participate in disucssions
**Exchange of Human Resources:** no

18. **Area of Collaboration:** Investigations of space weather effects over mid-latitude
**Collaborating Institute:** Institute for Sun-Earth Environment (ISEE), Nagoya Unversity, Japan
**Scope of PRL:** To carry out airglow analysis of SAR Arcs
**Scope of Collaborating Institute:** To provide the data from the mid-latitude optical network and participate in disucssions
**Exchange of Human Resources:** Enabled through SVS Competition which was won by Kshitiz Upadhyay, where ISEE provided local hospitality to him

19. **Area of Collaboration:** Tidal dynamics in the upper atmosphere
**Collaborating Institute:** High Altitude Observatory, Boulder, CO, USA
**Scope of PRL:** To investigate optical and radio observational data
**Scope of Collaborating Institute:** To provide WACCM-X model simulation
**Exchange of Human Resources:** no

20. **Area of Collaboration:** Tidal dynamics in the upper atmosphere
**Collaborating Institute:** Laboratory for Atmosphere and Space Physics (LASP), CO, USA
**Scope of PRL:** To investigate optical and radio observational data
**Scope of Collaborating Institute:** To analyze WACCM-X model data

**Exchange of Human Resources:** no

21. **Area of Collaboration:** Ionospheric physics
**Collaborating Institute:** IIG
**Scope of PRL:** Formulated Science idea and prepared the manuscript
**Scope of Collaborating Institute:** Partial data support and science discussion
**Exchange of Human Resources:** no

22. **Area of Collaboration:** Ionospheric physics
**Collaborating Institute:** NARL
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

23. **Area of Collaboration:** Solar wind physics
**Collaborating Institute:** GSFC, NASA, USA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science and modeling inputs
**Exchange of Human Resources:** This work has been done as part of the SVS fellowship that enabled one PhD student of PRL to visit GSFC, NASA.

24. **Area of Collaboration:** Solar wind physics
**Collaborating Institute:** IIT-Indore
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

25. **Area of Collaboration:** Ionospheric physics
**Collaborating Institute:** IIT-Roorkee
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

26. **Area of Collaboration:** Solar wind Physics
**Collaborating Institute:** University of California at Berkeley, USA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

27. **Area of Collaboration:** Ionospheric electrodynamics
**Collaborating Institute:** Utah State University, USA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

28. **Area of Collaboration:** Magnetospheric physics
**Collaborating Institute:** SPL, VSSC
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

29. **Area of Collaboration:** Interplanetary shock physics
**Collaborating Institute:** GSFC, NASA, USA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

30. **Area of Collaboration:** Heliospheric Physics
**Collaborating Institute:** GSFC, NASA, USA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** This work is done as part of the COSPAR Task Group on International Geospace Systems Program (TGIGSP), 2021-2025

31. **Area of Collaboration:** Geomagnetic storm
**Collaborating Institute:** IIA
**Scope of PRL:** Contributed in formulating science idea, and preparing the manuscript
**Scope of Collaborating Institute:** Science idea and preliminary draft of the manuscript
**Exchange of Human Resources:** no

32. **Area of Collaboration:** Continuous measurements of VOCs at IIT Delhi (Sonipat campus), upwind of Delhi
**Collaborating Institute:** IIT Delhi
**Scope of PRL:** C2-C6 & C2-C6 VOC Analyzers
**Scope of Collaborating Institute:** Operation and Maintenance of instruments and support in field campaigns
**Exchange of Human Resources:** no

33. **Area of Collaboration:** Effect of the sea and land breeze circulations in the levels and compositions of VOCs in the coastal environments
**Collaborating Institute:** CSIR-NIO, Goa
**Scope of PRL:** VOC measurements using C2-C6 & C6-C12 VOC Analyzers and Sulfur Trace Gas Analyzer
**Scope of Collaborating Institute:** Operation and Maintenance of instruments and support in field campaigns
**Exchange of Human Resources:** no

34. **Area of Collaboration:** Study the temporal characteristics of ozone precursors at urban site in Doon valley of the Indian

Himalaya
**Collaborating Institute:** Graphic Era (Deemed to be University), Dehradun,
**Scope of PRL:** NOx Analyzer
**Scope of Collaborating Institute:** Operation and Maintenance of instruments and support in field campaigns
**Exchange of Human Resources:** no

35. **Area of Collaboration:** Atmospheric composition observations for the validation of simulated chemical composition over India
**Collaborating Institute:** Meteorological Research Institute (MRI), Tsukuba, Japan
**Scope of PRL:** VOCs data measured at different sites of India
**Scope of Collaborating Institute:** Model simulations
**Exchange of Human Resources:** Visit to MRI by PRL scientist

36. **Area of Collaboration:** Continuous Cloud and Boundary Layer height observation along with ground temperature/pressure/humidity/precipitation measurement under Indian Lidar Network (ILIN) Programme
**Collaborating Institute:** NRSC Hyderabad
**Scope of PRL:** Researching and developing an improved atmospheric model to enhance existing models, including satellite calibration.
**Scope of Collaborating Institute:** Instrumentation Support for Research Scholars
**Exchange of Human Resources:** no

37. **Area of Collaboration:** Continuous Cloud and Boundary Layer height observation along with ground temperature/pressure/humidity/precipitation measurement under Indian Lidar Network (ILIN) Programme.
**Collaborating Institute:** Central University of Jammu
**Scope of PRL:** Researching and developing an improved atmospheric model to enhance existing models, including satellite calibration.
**Scope of Collaborating Institute:** Instrumentation Support for Research Scholars
**Exchange of Human Resources:** no

38. **Area of Collaboration:** Intersection of air pollution and remote sensing of aerosol and trace-gases
**Collaborating Institute:** Indian Institute of Technology Bombay, Mumbai (Prof. Virendra Sethi and Prof. V. S. Vamsi Botlaguduru)
**Scope of PRL:** Co-Guidance
**Scope of Collaborating Institute:** Research Collaboration
**Exchange of Human Resources:** M.Tech and PhD students

39. **Area of Collaboration:** Satellite remote sensing of aerosol and trace-gases
**Collaborating Institute:** NASA Langley Research Centre, Virginia, USA (Dr. Jean-Paul Vernier)
**Scope of PRL:** Collaborative field campaigns
**Scope of Collaborating Institute:** future field campaigns
**Exchange of Human Resources:** no

40. **Area of Collaboration:** Measurements of greenhouse gases
**Collaborating Institute:** National Institute for Environmental Studies (NIES) Japan and Belgium Royal Institute of Aeronomy (BIRA), Belgium
**Scope of PRL:** Collaborative discussions
**Scope of Collaborating Institute:** Collaborative discussions
**Exchange of Human Resources:** no

41. **Area of Collaboration:** Small scale and transient features in the Mesosphere Lower Thermosphere (MLT) region using airglow technique"
**Collaborating Institute:** Indian Institute of Information Technology, Kalyani
**Scope of PRL:** Providing data, Formulating science problems, and interpretation
**Scope of Collaborating Institute:** Developing data analysis using ML/DL Techniques
**Exchange of Human Resources:** no

42. **Area of Collaboration:** SSW influences in the MLT region
**Collaborating Institute:** Institute for Space-Earth Environmental Research (ISEE), Nagoya University, Japan
**Scope of PRL:** Formulating science problems and their interpretation, data analysis
**Scope of Collaborating Institute:** To provide Lidar, MF/MR radar data and participate in the discussion
**Exchange of Human Resources:** no

43. **Area of Collaboration:** Upper atmospheric investigations
**Collaborating Institute:** Shivaji University, Kolhapur (SUK),
**Scope of PRL:** Formulating science problems, Development of instruments, data analysis, and interpretation
**Scope of Collaborating Institute:** logistics for housing the PRL instruments
**Exchange of Human Resources:** no

44. **Area of Collaboration:** Upper Atmospheric Investigations Using Optical Airglow Emission Measurements
**Collaborating Institute:** Atmospheric and Space Research Facility (ASRF), Chandipur, Odisha
**Scope of PRL:** Formulating science problems, Development of instruments, data analysis, and interpretation
**Scope of Collaborating Institute:** logistics for housing the PRL instruments
**Exchange of Human Resources:** no

45. **Area of Collaboration:** Middle atmospheric wave dynamics
**Collaborating Institute:** National Institute for Space Research, São Paulo, Brazil
**Scope of PRL:** Utilization of the meteor radar data from the Southern hemispheric locations, scientific discussion and publications
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

46. **Area of Collaboration:** Study of atmospheric waves
**Collaborating Institute:** Federal University of Campina Grande, Brazil

Scope of PRL: Utilization of the meteor radar data from the Southern hemispheric locations, scientific discussion and publications
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

47. **Area of Collaboration:** Mesospheric wave activities
**Collaborating Institute:** Indian Institute of Technology, Roorkee, India
**Scope of PRL:** Utilization of the all-sky airglow imager data, scientific discussion and publication
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

48. **Area of Collaboration:** MLT region wave dynamics
**Collaborating Institute:** British Antarctic Survey, Cambridge, UK
**Scope of PRL:** Utilization of the data of meteor radars at Antarctica and various other locations and publication
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

49. **Area of Collaboration:** Mid-latitude wave dynamical processes
**Collaborating Institute:** Leibniz Institute for Atmospheric Physics (IAP), Germany
**Scope of PRL:** Utilization of the data of meteor radars at various Northern mid-latitude locations, scientific discussion and publication
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

50. **Area of Collaboration:** MLT coupling phenomena
**Collaborating Institute:** National Physical Laboratory, New Delhi
**Scope of PRL:** Utilization of ionosonde data for scientific publications
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

51. **Area of Collaboration:** MLT wave coupling using Airglow observations
**Collaborating Institute:** Aryabhatta Research Institute of Observational Sciences, Nainital
**Scope of PRL:** Operation of PRL photometer to carry out observations from Himalayan location and publications
**Scope of Collaborating Institute:** Fruitful research work, scientific discussion and publication
**Exchange of Human Resources:** no

52. **Area of Collaboration:** Space weather impacts on upper atmosphere
**Collaborating Institute:** Universidade do Vale do Paraiba (UNIVAP), Brazil
**Scope of PRL:** Investigations of storm time TEC variations
**Scope of Collaborating Institute:** Operation of instruments and interpretation of data
**Exchange of Human Resources:** no

53. **Area of Collaboration:** GNSS network to understand Ionospheric dynamics around the EIA crest (GUIDE)
**Collaborating Institute:** Indian Institute of Technology, Indore, India
**Scope of PRL:** Setup and operation of GNSS receiver
**Scope of Collaborating Institute:** Infrastructural support for the GNSS experiment and monitoring.
**Exchange of Human Resources:** no

54. **Area of Collaboration:** GNSS network to understand Ionospheric dynamics around the EIA crest (GUIDE)
**Collaborating Institute:** Central University of Rajasthan, Ajmer, India
**Scope of PRL:** Setup and operation of GNSS receiver
**Scope of Collaborating Institute:** Infrastructural support for the GNSS experiment and monitoring.
**Exchange of Human Resources:** no

55. **Area of Collaboration:** GNSS network to understand Ionospheric dynamics around the EIA crest (GUIDE)
**Collaborating Institute:** Saurashtra University, Rajkot, India
**Scope of PRL:** Setup and operation of GNSS receiver
**Scope of Collaborating Institute:** Infrastructural support for the GNSS experiment and monitoring.
**Exchange of Human Resources:** no

56. **Area of Collaboration:** Studies on ionospheric modelling
**Collaborating Institute:** Space Physics Laboratory, Trivandrum, India
**Scope of PRL:** Operation of Digisonde and investigations on ionospheric height modelling
**Scope of Collaborating Institute:** Operation of digisonde data and interpretations of observations
**Exchange of Human Resources:** no

57. **Area of Collaboration:** Geomagnetic storm effects on Ionospheric irregularities
**Collaborating Institute:** Andhra University, India
**Scope of PRL:** Studies on the variations of Scintillations and ROTI
**Scope of Collaborating Institute:** Operation of GNSS receiver and studies on storm effects
**Exchange of Human Resources:** no

58. **Area of Collaboration:** Effects of scintillations on GNSS positioning
**Collaborating Institute:** Koneru Lakshmaiah Educational Foundation, India
**Scope of PRL:** Studies on the GNSS positioning errors during ionospheric irregularities
**Scope of Collaborating Institute:** GNSS data collection and analysis of ionospheric and scintillations

**Exchange of Human Resources:** no

59. **Area of Collaboration:** Atmospheric chemistry over Himalyan region
**Collaborating Institute:** Graphic Era (deemed to be University), Dehradun
**Scope of PRL:** Modeling, NOx measurements
**Scope of Collaborating Institute:** Trace gas measurements
**Exchange of Human Resources:** no

60. **Area of Collaboration:** Aerosol distribution over Indian Ocean
**Collaborating Institute:** CSIR-NIO, Goa
**Scope of PRL:** Modeling
**Scope of Collaborating Institute:** Ship-borne measurements
**Exchange of Human Resources:** no

**Geosciences**

61. **Area of Collaboration:** Basin-scale $N_2$ fixation
**Collaborating Institute:** Mediterranean Institute of Oceanography (MIO), Marseille, France
**Scope of PRL:** Conducting cruises to understand the chemistry of $N_2$ fixation dynamics in the Indian Ocean
**Scope of Collaborating Institute:** Conducting cruises to understand the microbial part of $N_2$ fixation dynamics in the Indian and Southern Ocean
**Exchange of Human Resources:** One Indian student completed PhD in France under this project

62. **Area of Collaboration:** Groundwater dynamics
**Collaborating Institute:** Gujarat Water Resource Development Corporation, Symbiosis Institute of Geoinformatics
**Scope of PRL:** Sample collection, processing, measurements, interpretation, manuscript writing
**Scope of Collaborating Institute:** Sample collection, manuscript writing
**Exchange of Human Resources:** One JRF and one technician for groundwater processing and dating

63. **Area of Collaboration:** River water dynamics
**Collaborating Institute:** IIT Roorkee
**Scope of PRL:** Sample collection, processing, measurements, interpretation, manuscript writing
**Scope of Collaborating Institute:** Sample collection, manuscript writing
**Exchange of Human Resources:** None

64. **Area of Collaboration:** Study of stratospheric aerosols (BATAL campaign)
**Collaborating Institute:** NASA, USA
**Scope of PRL:** Aerosol analysis & characterization
**Scope of Collaborating Institute:** Study of Asian Tropopause Aerosol Layer (ATAL) during Asian summer monsoon, analyzing its climate impacts
**Exchange of Human Resources:** One PDF from France

65. **Area of Collaboration:** Study of carbonaceous aerosols over North India
**Collaborating Institute:** Delhi University
**Scope of PRL:** Aerosol analysis & characterization
**Scope of Collaborating Institute:** Understanding brown carbon aerosol characteristics over North India
**Exchange of Human Resources:** One JRF from Delhi University

66. **Area of Collaboration:** Atmospheric Chemistry
**Collaborating Institute:** University of Hyderabad
**Scope of PRL:** Sample analysis
**Scope of Collaborating Institute:** Sample collection, data analysis, manuscript writing
**Exchange of Human Resources:** None

67. **Area of Collaboration:** Biogeochemistry and climate
**Collaborating Institute:** CSIR-NIO (Goa), PEPU (Gandhinagar), IIT Kharagpur, Manipal Institute of Technology, Manipal, Karnataka.
**Scope of PRL:** Partial project management, sample analysis, publication
**Scope of Collaborating Institute:** Project management, sample analysis, publication
**Exchange of Human Resources:** Students trained at PRL on instruments and sample analysis

68. **Area of Collaboration:** Geology
**Collaborating Institute:** Guwahati University
**Scope of PRL:** Sample preparation, data acquisition, data analysis
**Scope of Collaborating Institute:** Sample collection, data analysis, interpretation, manuscript writing
**Exchange of Human Resources:** PhD students visited PRL for sample preparation and data acquisition

69. **Area of Collaboration:** Planetary Sciences
**Collaborating Institute:** IIT Kharagpur
**Scope of PRL:** Testing methods
**Scope of Collaborating Institute:** Sample preparation, data interpretation, manuscript writing
**Exchange of Human Resources:** PhD student visited PRL for data acquisition

70. **Area of Collaboration:** Geochemistry
**Collaborating Institute:** Manipur University
**Scope of PRL:** Data acquisition and analysis
**Scope of Collaborating Institute:** Sample collection, data analysis, interpretation, manuscript writing
**Exchange of Human Resources:** None

71. **Area of Collaboration:** Isotope Hydrology
**Collaborating Institute:** Indian Institute Of Science Education And Research Bhopal
**Scope of PRL:** Isotopic analysis to understand dryland river dynamics and surface-groundwater interaction; interpretation; manuscript writing
**Scope of Collaborating Institute:** Sample collection, data analysis, modeling, non-isotopic aspects

**Exchange of Human Resources:** Training provided to students and project staff

#### Theoretical Physics

72. **Area of Collaboration:** DUNE
**Collaborating Institute:** Fermilab, US
**Scope of PRL:** Theoretical and simulation work
**Scope of Collaborating Institute:** Collaborative work
**Exchange of Human Resources:** None

73. **Area of Collaboration:** Neutrino Physics
**Collaborating Institute:** Northwestern University, USA
**Scope of PRL:** Implications of Pseudo-Dirac Neutrinos
**Scope of Collaborating Institute:** Analytic calculations and numerical work
**Exchange of Human Resources:** None

74. **Area of Collaboration:** Neutrino Physics
**Collaborating Institute:** Texas A & M USA
**Scope of PRL:** Self interacting sterile neutrinos
**Scope of Collaborating Institute:** Analytic calculations and numerical work
**Exchange of Human Resources:** None

75. **Area of Collaboration:** Neutrino Physics
**Collaborating Institute:** Washington University, St Louis
**Scope of PRL:** Neutrinoless double beta decay
**Scope of Collaborating Institute:** Analytic calculation and numerical work
**Exchange of Human Resources:** Prof. Bhupal Dev from Washington University visited PRL during 23rd November to 4th December 2024

76. **Area of Collaboration:** Neutrino Physics
**Collaborating Institute:** Oklahoma State University , USA
**Scope of PRL:** Leptogenesis
**Scope of Collaborating Institute:** Analytic calculations and numerical work
**Exchange of Human Resources:** None

77. **Area of Collaboration:** Theoretical High Energy Physics
**Collaborating Institute:** Tata Institute of Fundamental Research
**Scope of PRL:** Theoretical Calculations and numerics
**Scope of Collaborating Institute:** Theoretical Calculations and numerics
**Exchange of Human Resources:** None

78. **Area of Collaboration:** Deep machine learning with physics-intuitive feature extraction
**Collaborating Institute:** IPPP, Durham University, United Kingdom
**Scope of PRL:** Part of conceptual formalism and development
**Scope of Collaborating Institute:** Part of conceptual formalism and development
**Exchange of Human Resources:** None

79. **Area of Collaboration:** Deep machine learning with physics-intuitive feature extraction
**Collaborating Institute:** Department of Physics, Oklahoma State University (OSU), Stillwater, OK, United States
**Scope of PRL:** Part of conceptual formalism and development
**Scope of Collaborating Institute:** Part of conceptual formalism and development
**Exchange of Human Resources:** None

80. **Area of Collaboration:** Investigating freeze-in dark matter model at LHC
**Collaborating Institute:** Indian Institute of Technology Kanpur (IITK), Kanpur, U.P.,India
**Scope of PRL:** Part of conceptual formalism and development
**Scope of Collaborating Institute:** Part of conceptual formalism and development
**Exchange of Human Resources:** None

81. **Area of Collaboration:** Investigating freeze-in dark matter model at LHC
**Collaborating Institute:** Harish-Chandra Research Institute (HRI), Chhatnag Road, Jhunsi, Allahabad, India
**Scope of PRL:** Part of conceptual formalism and development
**Scope of Collaborating Institute:** Part of conceptual formalism and development
**Exchange of Human Resources:** None

82. **Area of Collaboration:** Investigating freeze-in dark matter model at LHC
**Collaborating Institute:** Birla Institute of Technology and Science (BITS-Pilani), Goa, India
**Scope of PRL:** Part of conceptual formalism and development
**Scope of Collaborating Institute:** Part of conceptual formalism and development
**Exchange of Human Resources:** None

83. **Area of Collaboration:** Condensed matter physics
**Collaborating Institute:** Institute of Physics, Bhubaneswar
**Scope of PRL:** Theoretical and simulation work
**Scope of Collaborating Institute:** Collaborative work
**Exchange of Human Resources:** None

84. **Area of Collaboration:** Quantum Materials
**Collaborating Institute:** Indian Institute of Science, Bengaluru
**Scope of PRL:** Theoretical Work
**Scope of Collaborating Institute:** Experimental Work
**Exchange of Human Resources:** None

85. **Area of Collaboration:** Transport in low dimensional systems
**Collaborating Institute:** Bar-Ilan University, Israel
**Scope of PRL:** Theoretical Work
**Scope of Collaborating Institute:** Experimental and Theoretical Work
**Exchange of Human Resources:** None

86. **Area of Collaboration:** Fractional quantum Hall effect
**Collaborating Institute:** The Institute of Mathematical Sciences, Chennai
**Scope of PRL:** Theoretical Work
**Scope of Collaborating Institute:** Theoretical Work
**Exchange of Human Resources:** None

87. **Area of Collaboration:** Radiative corrections
**Collaborating Institute:** The Institute of Mathematical Sciences, Chennai
**Scope of PRL:** Theoretical development
**Scope of Collaborating Institute:** Theoretical development
**Exchange of Human Resources:** None

#### Atomic, Molecular and Optical Physics

88. **Area of Collaboration:** VUV and IR spectroscopy of astrochemical ices Impact and shock process in the solar system and beyond
**Collaborating Institute:** University of Kent, UK
**Scope of PRL:** VUV and IR spectroscopy and astrochemical ices experiments Shock processing of micrometeorite analogues
**Scope of Collaborating Institute:** Impact processing of micrometeorite analogues VUV spectroscopy of astrochemical ices experiments
**Exchange of Human Resources:** No

89. **Area of Collaboration:** VUV spectroscopy of astrochemical ices
**Collaborating Institute:** National Synchrotron Radiation Research Center, Taiwan
**Scope of PRL:** VUV spectroscopy of astrochemical ices experiments
**Scope of Collaborating Institute:** Beamtime, experimental setup and experiments
**Exchange of Human Resources:** No

90. **Area of Collaboration:** VUV spectroscopy of astrochemical ices
**Collaborating Institute:** Center for Interstellar catalysis (InterCat), Aarhus University, Denmark
**Scope of PRL:** VUV spectroscopy astrochemical ices experiments
**Scope of Collaborating Institute:** Beamtime and experiments
**Exchange of Human Resources:** No

91. **Area of Collaboration:** Astrochemistry and Astrobiology
**Collaborating Institute:** International Space University, France
**Scope of PRL:** Experimental astrochemistry and astrobiology
**Scope of Collaborating Institute:** Theory support for astrochemistry/astrobiology and workshops on hypervelocity impact
**Exchange of Human Resources:** No

92. **Area of Collaboration:** Morphology of astrochemical ices
**Collaborating Institute:** Indian Institute of Science, Bangalore.
**Scope of PRL:** Experimental data from low temperature astrochemical ices
**Scope of Collaborating Institute:** Molecular dynamics simulation of astrochemical ices
**Exchange of Human Resources:** No

93. **Area of Collaboration:** High temperature astrochemistry
**Collaborating Institute:** Indian Institute of Science, Bangalore
**Scope of PRL:** Shock processing of astrochemical dust analogues
**Scope of Collaborating Institute:** Analytical facility and support in shock experiments
**Exchange of Human Resources:** No

94. **Area of Collaboration:** High temperature astrobiology
**Collaborating Institute:** Indian Institute of Technology - Gandhinagar, India
**Scope of PRL:** Shock processing of biomolecules
**Scope of Collaborating Institute:** Analytical facility and support in shock experiments
**Exchange of Human Resources:** No

95. **Area of Collaboration:** Chemistry in the ISM
**Collaborating Institute:** Institute of Astronomy Space and Earth Sciences, Kolkata, India
**Scope of PRL:** Experimental astrochemistry
**Scope of Collaborating Institute:** Theoretical astrochemistry
**Exchange of Human Resources:** No

96. **Area of Collaboration:** Modeling and spectroscopic study of in-homogenous plasma & Analysis of environmental samples using LIBS Pulsed laser ablation in liquids
**Collaborating Institute:** PDEU(Gandhinagar), CUSAT(Kerala)
**Scope of PRL:** Development of experimental set-up at PRL, Development of LIBS algorithms for data analysis
**Scope of Collaborating Institute:** Development of experimental set-up and performing experiments (PDEU and CUSAT)
**Exchange of Human Resources:** No

# Externally Funded Projects in PRL

### Solar Physics

1. **Name of Project:** Exploration of solar flare X-ray emission: magnetic reconnection, heating and particle acceleration
**Name of Funding Agency:** DST-DAAD
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Bhuwan Joshi
**Status:** Active
**Duration:** From Aug 2023 to Jul 2025
**Scientific Objectives:** To investigate thermal and non-thermal processes in solar flares through the synergistic analysis of observations from two advanced X-ray instruments central to the Indo-German collaborative project between PRL (India) and AIP (Germany): the Solar X-ray Monitor (XSM) aboard the Indian Chandrayaan-2 mission and the Spectrometer/Telescope for Imaging X-rays (STIX) onboard the European Solar Orbiter mission.
**Manpower:** NA

2. **Name of Project:** Space Weather consequences of Coronal Mass Ejection
**Name of Funding Agency:** DST India-Uzbekistan
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Nandita Srivastava
**Status:** Non Active
**Duration:** From March 2021 to September 2024
**Scientific Objectives:** a) To advance understanding of space weather consequences of coronal mass ejections (CMEs), Long-term variations of compositional signatures of CMEs, To make effort for prediction of geomagnetic storms based on properties of solar eruptions, Understanding the role of CME-CME interaction in the heliosphere and their geomagnetic consequences, Investigation of relation between Forbush decrease and CMEs

   b) Education and Training To deliver special courses in Astronomy and Solar Physics in the Physics department of SSU for undergraduate and graduate students, Training of faculty during the collaborative visits in the field of Solar and Space Physics at SSU, Develop specialized modules pertaining to solar data analysis tools to aid the students and faculty for research projects will be useful for training programme
**Manpower:** NA

3. **Name of Project:** Understanding the CME propagation and its internal structure in the interplanetary space to predict Bz
**Name of Funding Agency:** Indo-US IUSSTF
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Nandita Srivastava
**Status:** Active
**Duration:** From March 2022 to September 2024
**Scientific Objectives:** The overarching science goal of this proposal is to understand the propagation of coronal mass ejection (CME) flux ropes from the Sun to Earth, so that the magnetic field vectors of the CME at 1 AU of the flux rope can be predicted at any point in the inner heliosphere.
**Manpower:** NA

### Planetary Sciences

4. **Name of Project:** Study of cometary atmosphere
**Name of Funding Agency:** DST-SERB
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Kinsuk Acharyya
**Status:** Active
**Duration:** From February 2023 to October 2026
**Scientific Objectives:** To study the chemical and physical evolution of volatiles in the comet.
**Manpower:** One JRF

5. **Name of Project:** Role of physical and chemical processes on the climate of Mars and Venus (National)
**Name of Funding Agency:** SERB-CRG, DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Varun Sheel
**Status:** Active
**Duration:** From March 2023 to March 2026
**Scientific Objectives:** To investigate the ion chemistry in the lower and middle atmosphere of Mars and Venus and to understand the dust dynamics in the lower atmosphere of Mars.
**Manpower:** One Project Associate

6. **Name of Project:** Study of the Venusian climate through Radio Occultation experiments and modelling" (International)
**Name of Funding Agency:** DSST-DAAD
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Varun Sheel
**Status:** Active
**Duration:** From June 2023 to June 2025
**Scientific Objectives:** To study the electron density profiles in the Venusian ionosphere.
**Manpower:** NA

7. **Name of Project:** Modelling of Dust Devil/Storm,Modelling of Dust Devil/Storm, Variability and Possible Existence of Lightning on Mars Variability and Possible Existence of Lightning on Mars
**Name of Funding Agency:** DST-SERB
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Jayesh Pabari
**Status:** Active
**Duration:** From June 2024 To May 2027
**Scientific Objectives:** (i) To carry out modelling/analysis of dust storm on Mars. (ii) To understand variability and

repeatability of dust devils/storms on Mars. (iii) To carry out analysis of measured magnetic fields on Mars by InSight magnetometer, for possible presence lightning.
**Manpower:** One JRF

#### Space and Atmospheric Sciences

8. **Name of Project:** Characterization of bottom side ionosphere for improving accuracies of electron content estimation
**Name of Funding Agency:** Science and Engineering Research Board - Start-up Research Grant
**PI/Co-PI:** PI
**Name of PI/Co-PI:** K. Venkatesh
**Status:** Active
**Duration:** 2023-2025
**Scientific Objectives:** Characterization of bottom side ionosphere for improving accuracies of electron content estimation
**Manpower:** JRF

#### Geosciences

9. **Name of Project:** Size-resolved Sources, Composition, and Optical Characteristics of Brown Carbon Aerosols over two Indian Megacities through Chromophoric and Isotopic Measurements
**Name of Funding Agency:** DST-CRG (SERB)
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Neeraj Rastogi
**Status:** Active
**Duration:** 2024-2027
**Scientific Objectives:** To investigate size-resolved sources, composition, and optical characteristics of brown carbon aerosols
**Manpower:** JRF

10. **Name of Project:** Exploring the Asian pollution signature in the upper troposphere/lower stratosphere using medium duration balloon flights
**Name of Funding Agency:** DST-CEFIPRA
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Neeraj Rastogi
**Status:** Non Active
**Duration:** 2024-2024
**Scientific Objectives:** To study and explore the Asian pollution signature in the upper troposphere/lower stratosphere (UTLS) region using medium duration balloon flights
**Manpower:** NA

11. **Name of Project:** Unravelling the food-web dynamics and energy flow in the northern Indian Ocean using stable isotopes
**Name of Funding Agency:** MoES
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Sanjeev Kumar
**Status:** Active
**Duration:** 2021-2026
**Scientific Objectives:** To study some of the unexplored aspects of marine nitrogen and carbon cycling in the northern Indian Ocean using stable isotope techniques with prime focus on organic matter dynamics and flow of elements and energy through the food web.
**Manpower:** PA

12. **Name of Project:** Rice rhizosphere metabolome- and microbiome functions for improved crop establishment, growth, and yield
**Name of Funding Agency:** NASF
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Sanjeev Kumar
**Status:** Active
**Duration:** 2022-2026
**Scientific Objectives:** (i) To profile the rhizosphere metabolites and the recruited microbiome at selected growth stages of rice under flooded and aerobic conditions. (ii) To analyze the effect of low and high N on the metabolome-microbiome relationships. (iii) To develop synthetic microbial consortia with metabolites for improved nitrogen use efficiency, growth and yield traits
**Manpower:** NA

13. **Name of Project:** High precision mass-independent Chromium and Nickel isotope systematics of the primitive solar system objects and their components: Implications for the nebular environment and evolution of planetary precursors in the first few million years of the solar system
**Name of Funding Agency:** ANRF
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Yogita Kadlag
**Status:** Active
**Duration:** 2025-2028
**Scientific Objectives:** To investigate sources of nucleosynthetic Ni and Cr isotope variations
**Manpower:** JRF

14. **Name of Project:** Ocean Alkalinity Enhancement
**Name of Funding Agency:** DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Arvind Singh
**Status:** Active
**Duration:** 2022-2026
**Scientific Objectives:** Potential of ocean alkalinity enhancement for atmospheric $CO_2$ removal
**Manpower:** JRF

15. **Name of Project:** Dinitrogen Fixation in the Indian Ocean
**Name of Funding Agency:** DST-CEFIPRA
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Arvind Singh
**Status:** Non Active
**Duration:** 2022-2024
**Scientific Objectives:** Estimate nitrogen fixation rates and understand the role of monsoon on nitrogen dynamics
**Manpower:** JRF

16. **Name of Project:** Role of Biogeochemical processes in C:N:P Stoichiometry
**Name of Funding Agency:** MoES
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Arvind Singh
**Status:** Active
**Duration:** 2022-2026
**Scientific Objectives:** Role of $N_2$ fixation in governing C:N:P ratios in the Indian Ocean
**Manpower:** PDF

**Theoretical Physics**

17. **Name of Project:** Probing BSM physics through neutrinos
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Srubabati Goswami
**Status:** Active
**Duration:** From Oct 2020 to Oct 2025
**Scientific Objectives:** Probing BSM physics through neutrinos
**Manpower:** One Scientific Administrative Assistant

18. **Name of Project:** Computing Hadronic matrix Elements relevant for B and D decays
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Namit Mahajan
**Status:** Active
**Duration:** From Feb 2024 to Feb 2027
**Scientific Objectives:** Computing Hadronic matrix Elements relevant for B and D decays
**Manpower:** None

19. **Name of Project:** Quantifying Baryogenesis in Grand Unified Theories
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Ketan Patel
**Status:** Non Active
**Duration:** From Feb 2022 to Feb 2025
**Scientific Objectives:** Quantifying Baryogenesis in Grand Unified Theories
**Manpower:** None

20. **Name of Project:** Signatures of emergent phases of matter in transport phenomena
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Paramita Dutta
**Status:** Non Active
**Duration:** From Jan 2023 to Jan 2025
**Scientific Objectives:** Signatures of emergent phases of matter in transport phenomena
**Manpower:** None

21. **Name of Project:** Precision calculation via non-local slicing
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Satyajit Seth
**Status:** Active
**Duration:** From Jan 2023 to Jan 2026
**Scientific Objectives:** Precision calculation via non-local slicing
**Manpower:** None

22. **Name of Project:** Synergy between neutrino and dark matter using advanced neutrino detector
**Name of Funding Agency:** ANRF (erstwhile SERB), DST
**PI/Co-PI:** PI
**Name of PI/Co-PI:** Animesh Chatterjee
**Status:** Active
**Duration:** From June 2022 to June 2027
**Scientific Objectives:** Synergy between neutrino and dark matter using advanced neutrino detector
**Manpower:** Two project assistants

# Field work/ Campaigns/ Observations Conducted

#### Planetary Sciences

1. **Objective:** Meteorite Search in Kutch region
**Duration:** From 22 March 2025 To 23 March 2025
**Type of fieldwork:** Geological Sample collection from a recent meteorite fall in the Kutch region
**Outcome:** An Extensive search was carried out, and no meteorite was found, but a possible region was sorted out
**Implications Significance:** Very recent fall, potential to form a recent impact crater
**PRL Members Participated in Fieldwork:** Vijayan S., Bhalamurugan S and Jaya Krishna M

2. **Objective:** Clay sulfate mineral formation on Earth and its relevance to Mars
**Duration:** From 20 September 2024 To 23 September 2024
**Type of fieldwork:** Geological Sample collection
**Outcome:** One paper published and others are in preparation
**Implications Significance:** The geology of Kutch in Gujarat mimics the alternatinng wet and dry conditions observed during the Noachian-Hesperian transition on Mars. The unique paleoclimate condition is essential for the formation of phyllosilicate-sulfate minerals similar to those found on Mars. Consequently, terrestrial analog studies thus are vital for validating orbiter data, testing and performance evaluation of various payloads, and selection of potential future landing sites.
**PRL Members Participated in Fieldwork:** Dwijesh Ray

#### Space and Atmospheric Sciences

3. **Objective:** Study the sources and variability of non–methane hydrocarbons (NMHCs) using C2-C6 & C2-C6 VOC Analyzers and other trace gases (Ozone, CO, Methane, etc.), in the marine air of the Arabian
**Duration:** May to June 2024
**Type of fieldwork:** Ship-borne campaign, onboard Sagar Sampada, over the northeast Arabian Sea
**Outcome:** The time series of mixing ratios of carbon monoxide (CO) and aromatic compounds reveal significant influences of anthropogenic sources for the near-shore measurements. Further analysis is being performed to assess the impact of air-sea exchange controlling the levels and variability of light alkenes (ethene and propene) and isoprene, which are produced from dissolved organic matter (DOM). Simultaneously, several oceanic parameters, such as sea surface temperature (SST) and salinity, were measured continuously along with detailed conductivity-temperature-depth (CTD) profiles. This data will be crucial for assessing the significance of ocean-atmosphere coupling in controlling the variations of volatile organic compounds (VOCs) and trace gases in the marine boundary layer of the northeastern Arabian Sea during southwest monsoon season.
**Implications Significance:** The findings of this study are important to understand the sources of reactive trace gases and their role in chemistry-climate interaction in remote marine atmospheres.
**PRL Members Participated in Fieldwork:** Mansi Gupta

4. **Objective:** Investigate the sources and variability of non–methane hydrocarbons (NMHCs) using C2-C6 & C2-C6 VOC Analyzers at Sonipat, IITD campus
**Duration:** November 2023 to March 2025 (Ongoing)
**Type of fieldwork:** Station-based continuous ambient air observations
**Outcome:** Based on the analysis of VOC data, we have investigated the role of different sources anthropogenic and biogenic sources as well as the impact of meteorological parameters. We have been doing analysis of data to investigate the diurnal, seasonal and episodic changes in VOC composition.
**Implications Significance:** The measurements in the upwind of urban regions can be helpful to quantify the contributions from the transport and local sources. It is important to develop emission control strategies.
**PRL Members Participated in Fieldwork:** Mansi Gupta

5. **Objective:** Installation of Ceilometer and Automated Weather Station (AWS) at NRSC Hyderabad .
**Duration:** 31 December 2024 to 03 January 2025
**Type of fieldwork:** Installation of Instruments
**Outcome:** Measurement of cloud and boundary layer profile along with the other weather parameters such as temperature, pressure, humidity, precipitation, etc.
**Implications Significance:** Instruments are installed under PRL's ILIN Programme, and it is important to under the cloud and boundary layer dynamics over the Indian region
**PRL Members Participated in Fieldwork:** Aniket

6. **Objective:** Installation of Ceilometer, AWS and Disdrometer at Central University of Jammu.
**Duration:** 06 January 2025 to 09 January 2025
**Type of fieldwork:** Installation of Instruments
**Outcome:** Measurement of cloud and boundary layer profile along with the other weather parameters such as temperature, pressure, humidity, precipitation, etc.
**Implications Significance:** Instruments are installed under PRL's ILIN Programme, and it is important to under the cloud and boundary layer dynamics over the Indian region
**PRL Members Participated in Fieldwork:** Som Kumar Sharma and Aniket

7. **Objective:** Commissioning of PAIRS, SIRI, and CMAP for multi-wavelength night glow measurements

**Duration:** 19 to 31 May 2024
**Type of fieldwork:** Installation of the instruments
**Outcome:** Multi-wavelength and multi-instrument observations of the night glow emission.
**Implications Significance:** The data will be important to understand nighttime MLT dynamics and transient features
**PRL Members Participated in Fieldwork:** Pradip Suryawanshi

8. **Objective:** Setup the laboratories for the surface, columnar, and vertical measurements of aerosol properties over western India
**Duration:** Monthly trip to the laboratories at Udaipur and Gurushikhar.
**Type of fieldwork:** Installation, measurements and calibrations.
**Outcome:** The expected outcomes include the spatial and temporal heterogeneity in aerosol characteristics and their dynamical nature, state of mixing and its impact on aerosol radiative forcing, classification of aerosol types, sources, source regions, delineation and quantification of natural and anthropogenic aerosol components, and therefore a more accurate and reliable quantitative estimate of aerosol radiative forcing.
**Implications Significance:** The quantitative results can provide observational constraints to help improve regional model simulations of aerosols and associated climate change, and can serve as the ground truth for satellite retrievals, validation and calibration.
**PRL Members Participated in Fieldwork:** T. A. Rajesh and Vishnu Kumar Dhaker

9. **Objective:** Study of middle and upper atmospheric dynamical coupling over central Himalayan region
**Duration:** 25 to 29 November 2024
**Type of fieldwork:** Installation of the PRL Airglow photometer at High Altitude ARIES Climate Laboratory, Devasthal, Uttarakhand maintained by Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital.
**Outcome:** Interesting results of post mid-night enhancement of ionospheric airglow emission intensity was found which is believed to be linked to dynamics.
**Implications Significance:** The study will help to understand dynamical coupling processes over various regions of the atmosphere and their plausible drivers.
**PRL Members Participated in Fieldwork:** Amitava Guharay

10. **Objective:** Commissioning of GNSS receiver at IIT Indore under PRL GUIDE network
**Duration:** 25 to 27 April 2024
**Type of fieldwork:** Installation and configuration of GNSS receiver for ionospheric monitoring.
**Outcome:** Multi frequency and multi constellation GNSS receiver is made operational
**Implications Significance:** Observations from this receiver will provide valuable dataset to explore the longitudinal behaviour of ionospheric TEC and scintillations along with the similar experiments from other locations in GUIDE network.
**PRL Members Participated in Fieldwork:** K. Venkatesh and Sandip Bhattacharyya

11. **Objective:** Installation and operation of GNSS receiver at CURAJ, Ajmer under PRL GUIDE network
**Duration:** 18 to 21 September 2024
**Type of fieldwork:** Setup and configuration of GNSS receiver for ionospheric studies
**Outcome:** Installed multi frequency and multi constellation and started observations
**Implications Significance:** Observations from this receiver together with those from Ahmedabad will provide crucial inputs to study the latitudinal gradients of ionospheric TEC around the EIA crest.
**PRL Members Participated in Fieldwork:** K. Venkatesh and Anil Kumar Yadav

12. **Objective:** GNSS receiver setup at Saurashtra University, Rajkot under PRL GUIDE network
**Duration:** 25 to 27 December 2024
**Type of fieldwork:** Commissioning of GNSS receiver for ionospheric observations
**Outcome:** With the setup of this receiver, first phase of the GUIDE network is made operational.
**Implications Significance:** Continuous observations form this network provide pertinent data set to explore propagation features of ionospheric irregularities and waves in zonal and meridional directions.
**PRL Members Participated in Fieldwork:** K. Venkatesh, Pradip Suryawanshi and Harsh Kava

### Geosciences

13. **Objective:** Biogeochemical potential of the Arabian Sea in removing atmospheric $CO_2$
**Duration:** 27 May - 14 June 2024
**Type of fieldwork:** Collection of samples
**Outcome:** samples were collected for the measurements of alkalinity and DIC to see the effect of mineral dissolution on the $CO_2$ flux
**Implications Significance:** We aim to study the process of carbon and nitrogen fixation for which we did the incubation experiments using $^{13}$C and $^{15}$N tracers. To study the change in the phytoplankton community, we collected samples for DNA and flow cytometry analysis. Our expectations are that this study will provide valuable insights into the effectiveness, risks, and feasibility of OAE as a CDR method.
**PRL Members Participated in Fieldwork:** Shreya Mehta, Nazirahmed Sipai, Jitender Kumar, Abul Qasim, Mansi Gupta, and Arvind Singh.

14. **Objective:** Role of enhanced alkalinity and $N_2$ fixation on the carbon uptake potential in the Indian Sector of the Southern Ocean (ISSO)
**Duration:** Feb-March 2025
**Type of fieldwork:** Cruise for sample collection
**Outcome:** It will improve our understanding of meneral disslution and CDR potential.
**Implications Significance:** We investigated the controls of cyanobacterial and non-cyanobacterial $N_2$ fixation in the ISSO. In addition, we also conducted enhanced alkalinity experiment
**PRL Members Participated in Fieldwork:** Shreya Mehta and Mansa Singh

15. **Objective:** Understanding the role of weathering on trace elements and isotopes
**Duration:** 10 May – 25 May 2024

**Type of fieldwork:** Collection of water and sediment samples
**Outcome:** Analyses of major ions completed. Sample analysis for trace elements is ongoing
**Implications Significance:** The samples were collected to understand the impact of various processes (weathering, groundwater discharge, redox changes) on the supply of Mo and its isotopes to the river. Further, these samples will also be used to understand the weathering in the region using stable and radiogenic Sr isotopes
**PRL Members Participated in Fieldwork:** Deependra Singh, Vineet Goswami

16. **Objective:** Understanding the geochemical Cycling of Lithium (Li) and its isotopes ($^{7}$Li) and other trace elements in the Narmada and Tapti Rivers
**Duration:** 15 Sept – 30 Sept 2024
**Type of fieldwork:** Collection of water and sediment samples
**Outcome:** Sample analysis is ongoing
**Implications Significance:** This study is aimed to understand the distribution of Li and isotopic composition ($\delta^{7}$Li) and other trace elements in Narmada and Tapi Rivers to assess the contemporary weathering in these tropical rivers of India, and to understand the impact of weathering on cycling and supply of trace elements.
**PRL Members Participated in Fieldwork:** Rakesh Kumar Tiwari

17. **Objective:** Carbon dynamics in arctic permafrost
**Duration:** 28 Jun - 31 July, 2024
**Type of fieldwork:** soil, soil and surface air
**Outcome:** Sample analysis is ongoing
**Implications Significance:** The study is to estimate the impact of warming on permafrost soil carbon reserve and the emission of greenhouse gases $CO_2$ and $CH_4$. Also identification of the pathways of carbon loss is another objective of the study.
**PRL Members Participated in Fieldwork:** Rahul Kumar Agrawal

18. **Objective:** Understanding the high-altitude soil carbon dynamics
**Duration:** 7-14 September, 2024
**Type of fieldwork:** soil, soil and surface air, and stream water sampling
**Outcome:** Sample analysis is ongoing
**Implications Significance:** The study is to estimate the storage time of organic carbon in soils under cold climatic conditions and assess the impact of global warming on the emission of the major greenhouse gases $CO_2$ and $CH_4$ from the subtropical high altitude ($>$4000 m) cold soils of Himalaya. Also identification of the pathways of carbon loss is another objective of the study.
**PRL Members Participated in Fieldwork:** Bankimchandra Pandya, Rahul Kumar Agrawal

19. **Objective:** Groundwater dynamics in Godavari Basin
**Duration:** 4-14 November, 2024
**Type of fieldwork:** Groundwater sampling from hard rock aquifers of Godavari Basin
**Outcome:** Sample analysis is ongoing
**Implications Significance:** To understand the groundwater dynamics, estimation of residence time, surface-ground water interaction, impact of dams on groundwater dynamics in hard rock aquifers of Godavari basin.
**PRL Members Participated in Fieldwork:** Amzad Hussain Laskar

20. **Objective:** Groundwater dynamics
**Duration:** 11 Dec, 2024 - 15 Jan, 2025
**Type of fieldwork:** groundwater sampling from multi-layered aquifers of Gujarat
**Outcome:** Sample analysis is ongoing
**Implications Significance:** To understand the groundwater dynamics, estimation of residence time, impact of recent activities related to groundwater level improvement on the groundwater aquifers of Gujarat.
**PRL Members Participated in Fieldwork:** Amzad Hussain Laskar, Ranjan Kumar Mohanty, Bankimchandra N. Pandya

21. **Objective:** Flux of $^{10}$Be in southern and western India
**Duration:** 6-13 January, 2025
**Type of fieldwork:** Soil, sediment, plant remains
**Outcome:** Sample analysis is ongoing
**Implications Significance:** To estimate the dependence of meteoric $^{10}$Be flux on precipitation along a precipitation gradient in Western India by measuring 10Be concentration in the surface soil..
**PRL Members Participated in Fieldwork:** Bankimchandra N Pandya, Muhhmmed Mehafus

22. **Objective:** To estimate greenhouse gas emission from wetlands of Gujarat and identify the pool of organic matter causing the emissions
**Duration:** 25 Feb-3 March, 2025
**Type of fieldwork:** Soil, soil air, chamber based soil surface air and water surface air.
**Outcome:** Sample analysis is ongoing
**Implications Significance:** To estimate the inventory of greenhouse gases emitted from the wetlands of semi-arid Gujarat. Also identification of the pool of organic matter causing the emission and pathways of the loss of soil organic matter are important objectives of the study. Impact of warming and impact on the emission due to anthropogenic modifications are also being assessed.
**PRL Members Participated in Fieldwork:** Rahul Kumar Agrawal

23. **Objective:** Biogeochemical assessment of the Mahi River Basin focusing on the assimilation and fixation rates of carbon and nitrogen.
**Duration:** 09 – 13 May 2024
**Type of fieldwork:** Sample collection of river water.
**Outcome:** Sample analysis is ongoing.
**Implications Significance:** The study will help us to understanding the processes like primary productivity, dinitrogen fixation and nutrients assimilation by phytoplankton in the subtropical riverine ecosystems of India.
**PRL Members Participated in Fieldwork:** Ajayeta Rathi, Ganika Kushawah, and Janaarthanan P A, Bankim Pandya

24. **Objective:** Reconnaissance survey for paraglacial terrain and sampling for in situ TCN bedrock samples
**Duration:** 19 Sept - 04 Oct 2024
**Type of fieldwork:** Quaternary/high-altitude/Himalaya
**Outcome:** Collected samples and data
**Implications Significance:** Understanding paraglacial terrain

and landforms for processes
**PRL Members Participated in Fieldwork:** Shubhra Sharma

25. **Objective:** To collect Archean BIF samples
**Duration:** 02 Dec 2024 - 06 Dec 2024
**Type of fieldwork:** Collection of rock samples
**Outcome:** Archean BIFs are collected and being analysed for element and isotope compositions
**Implications Significance:** These samples will be used by Dr. Ajay Dev Asokan for his NPDF project and for the PhD work of Mr. Janaarthanan P. A.
**PRL Members Participated in Fieldwork:** Dr. Yogita Kadlag, Dr. Ajay Dev Asokan, and Mr. Janaarthanan P. A.

**Atomic, Molecular and Optical Physics**

26. **Objective:** Meteorite collection in Wadwani district where a meteorite fall was reported around 6th March 2025
**Duration:** From 06 – 08 March, 2025
**Type of fieldwork:** Sample collection
**Outcome:** The meteorite undergoes classification and will be registered. The meteorite sample will be used in core and allied meteorite research
**Implications Significance:** Very important for the meteorite research carried out in PRL in order to understand the secrets of the solar system formation
**PRL Members Participated in Fieldwork:** B. Sivaraman

# Awards and Honors

**Faculty**

**Abhijit Chakraborty**

1. Elected as Fellow of National Academy of Sciences, India (NASI) in 2024.

**Amit Basu Sarbadhikari**

2. Editor of “Habitability Across the Solar System and Exoplanets” of the ”Frontiers-Astronomy and Space Sciences Astrobiology” journal.

**Anil Bhardwaj**

3. COSPAR Vikram Sarabhai Medal, 2024.
4. International Academy of Astronautics, Basic Sciences Section Award, 2024.
5. Featured in the Book ’100 Great IITians: Dedicated to the Service of the Nation’, Compiled by Commander V. K. Jaitly, 2024.
6. Member, Governing Council, Indian Institute Astrophysics, Bangalore.
7. President, IPSA Indian Planetary Science Association.
8. Chair, Sunanda & Satimay Basu International Early Career Award Committee of AGU, 2024.

**Arpit Patel**

9. Part of the team which received - Rashtriya Vigyan Puraskar (RVP) Award-2024, Vigyan Team award - ISRO-Team Chandrayaan-3, in the category of Space Science and Technology.

**Arvind Singh**

10. Editor: JGR: Oceans (an AGU journal) (July 2021 - present)
11. Member: International Implementation Committee of BioGeoScapes (2024 – present)
12. Member: AGU’s Diversity and Inclusion Advisory Committee (2022-present)
13. Member: National Committee for Scientific Committee on Oceanic Research (SCOR, 2024-2027)
14. Member: “Kiel Training for Excellence, Germany,” Postdoc selection board (2024)
15. Steering Committee member of SOLAS (Surface Ocean Lower Atmosphere Study) (2022-2024)
16. Member: Board of Studies, Pandit Deendayal Petroleum University, India (2020 - present)
17. Member: Board of Studies, Geology Department, Gujarat University, Ahmedabad (2019 - present)
18. Guest faculty in the Department of Botany at Gujarat University, Ahmedabad (2016 – present)

**B. K. Sahoo**

19. Listed among Top 2% of Scientists in the world in the respective research fields published in 2024 by Stanford University

**B. Sivaraman**

20. Invited as a chief guest for the National Space Day celebrations at Sathyabhama University, Chennai on 19th August, 2024
21. Invited as a chief guest for the National Space Day celebrations at IIT Mandi on 23rd August, 2024
22. Awarded visiting Fellowship, Aarhus Institute of Advanced Studies, Aarhus Univeristy, Denmark, 1st May - 30 June 2024
23. Invited as a coordinator for the Astrochemistry - Astrobiology (SG3) part of the Brainstorming meeting on Space Science Road Map Formulation at U R Rao Space Center, 22-23 April, 2024

**Chandan Kumar**

24. Part of the team which received - Rashtriya Vigyan Puraskar (RVP) Award-2024, Vigyan Team award - ISRO-Team Chandrayaan-3, in the category of Space Science and Technology.

**Dibyendu Chakrabarty**

25. Guest Editor, Solar Physics, Springer Nature
26. Member, AGU Space Physics and Aeronomy Fellows Committee (SPAFC)
27. Member, COSPAR Task Group on International Geospace Systems Program (TGIGSP)
28. Nominated by ISRO, Executive Committee, International Heliophysics Data Environment Alliance (IHDEA), 2024
29. Represented ISRO in Global Space based Inter-Calibration System (GSICS) GRWG SWx Sub-group meeting, 2024-2025
30. Represented ISRO in ISRO-NOAA, ISRO-NASA and ISRO-ESA discussions related to Aditya-L1 on multiple occasions.
31. Lead, RAMBHA-LP peer review committee for Chandrayaan-3 payload data, ISRO, 2024
32. Member, Payload Design Review Committee of DISHA Project, ISRO, 2024

**Duggirala Pallamraju**

33. Elected Chair, Scientific Commission C of Committee on Space Research (COSPAR).
34. Member, COSPAR Scientific Advisory Committee
35. Member, 46th COSPAR Scientific Assembly (COSPAR 2026) Program Committee.
36. Member, Scientific Organizing Committee, 17th International Symposium on Equatorial Aeronomy (ISEA-17) Costa Rica during 9 – 13 February 2026.
37. Editor, Earth Planets, and Space, Springer Journal
38. Guest Editor, Journal of Atmospheric and Solar Terrestrial Physics, Elsevier Journal
39. Member, Board of Studies, Deptartment of Physics, Osmania University, Hyderabad.
40. Member, Board of Studies, Department of Physics, MIT World Peace University, Pune
41. Member, Academic Council of Indian Institute of Space Science and Technology, Tiruvananthapuram, India.
42. Member Research Council, Gujarat Technological University, Ahmedabad.
43. Member, Board of Studies, Physics, Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar.

**G.K.Samanta**

44. Editorial Board Member, Journal of Optics, IOP

**Harish Gadhavi**

45. NASA Group Achievement Award for Balloon borne studies of Asian Tropopause Aerosol Layer (BATAL).

**Jayesh Pabari**

46. Member of the Research Advisory Council of Dr. Subhash University, Junagadh, 2024-25.
47. Member, Research Advisory Council, L. D. College of Engineering, Ahmedabad, 2024-25.
48. Member, Industry Advisory Board, E.C. Engg. Dept. of LDCE, Ahmedabad, 2024-25.
49. Member, 'Board of Studies' at CSPIT, CHARUSAT, Changa, Nadiad, 2024-25.
50. Member of Doctoral Research Committee for Several Disciplines at GTU, Ahmedabad, 2024-25.

**K. Durga Prasad**

51. Invited to serve as an External Member of the AU Trans-Disciplinary Research Board, Andhra University, Visakhapatnam
52. Team member which received - Rashtriya Vigyan Puraskar (RVP) Award-2024, Vigyan Team award - ISRO-Team Chandrayaan-3, in the category of Space Science and Technology.

**Lokesh Kumar Sahu**

53. Member experts committee of the Atmospheric and Ocean Sciences for finalizing the projects for the Indian Arctic Expedition, Years: 2025 & 2026
54. Nodal Faculty for Gujarat, the National Clean Air Programme (NCAP), Ministry of Environment, Forest & Climate Change, since 2019 to Present
55. Member Expert Group for Gujarat Pollution Control Board (GPCB), peer review of Emission inventory, Source Apportionment Study, and carrying capacity of concerned million-plus cities/non-attainment cities viz. Ahmedabad, Surat, since 2021 to present

**M. Shanmugam**

56. Part of the team which received - Rashtriya Vigyan Puraskar (RVP) Award-2024, Vigyan Team award - ISRO-Team Chandrayaan-3, in the category of Space Science and Technology.

**Manmohan Sarin**

57. Member, United Nations Group of Experts on Scientific Aspects of Marine Environmental Protection (UN/GESAMP)

58. Chair, United Nations/GESAMP Working Group on "Climate Change and Greenhouse Gas Related Impacts on Contaminants in the Ocean" sponsored by IAEA (Monaco) as lead agency

59. Chair, INSA-National Committee (2024 – 2026) for International SCOR (Scientific Committee on Oceanic Research)

60. Member, Board of Studies (BoS) for Environmental Science – School of Science, Gandhi Institute of Technology and Management (GITAM), Visakhapatnam

**Megha Bhatt**

61. Elected as Chair, COSPAR-B3.1 for the period 2024-2026.

**Naveen Chauhan**

62. Invited to attend an academic discussion meeting being organized by Tamil Nadu State Archaeology Department, Chennai on 23rd January 2025

63. Invited for Guest Lecture and as resource person in '4th international conference on Geology: Emerging Methods and Applications' conference on "Some recent developments of luminescence dating methods and applications" during 28-30 January 2025

**Neeraj Rastogi**

64. Member Editorial Board, Scientific Reports (Nature) since Jan-2024

65. Member of the Doctoral Research Committee (DRC) of Science discipline at the Gujarat Technological University (GTU), Ahmedabad since 2024

66. Vice President of Indian Aerosol Science and Technology Association (IASTA) since Jan-2023

67. Editorial Advisory Board, Asian Journal of Atmospheric Environment (Springer) since Jan-2020

68. Nodal Faculty for Gujarat, the National Clean Air Programme (NCAP), Ministry of Environment, Forest & Climate Change since 2018

69. Member, Board of Studies Committee for the Space and Atmospheric Science, Centre for Space Science and Technology Education in Asia and the Pacific, (CSSTEAP), United Nations since Sep-2021

**Rishitosh Sinha**

70. INSA Young Associate (IYA) 2024 award by the Indian National Science Academy (INSA).

**S. A. Haider**

71. Elected Chair of Sub-Commission C3 for $46^{th}$ COSPAR Scientific Assembly to be held in Florence, Italy, 1-9 August 2026.

**S. Ramachandran**

72. Member, National Expert Committee (NEC) of the Climate Change Programme, Department of Science and Technology (DST), India.

**Sanjeev Kumar**

73. Associate Editor, Frontiers in Marine Sciences, since 2016

**Shubhra Sharma**

74. Member of the Doctoral Research Committee (DRC) of Earth Science Department, Geography discipline at the University of Gujarat (GU), Ahmedabad since 2024

**Srubabati Goswami**

75. Elected as the President of the Indian Physics Association (2025-2027)

76. Awarded a Short term Visiting Scientist fellowship by the Excellence Cluster ORIGINS, Germany to visit Technical University, Munich from 23/06/2024 to 16/07/2024

**Tinkal Ladiya**

77. Part of the team which received - Rashtriya Vigyan Puraskar (RVP) Award-2024, Vigyan Team award - ISRO-Team Chandrayaan-3, in the category of Space Science and Technology.

**Varun Sheel**

78. Scientific High Level Visiting Fellowships (SSHN), awarded by the French Government, as part of Indo-French Research Cooperation, during 12-26 December 2024

79. Re-elected Vice Chair, Commission B4, COSPAR, 2024-2027

**Vineet Goswami**

80. Member: Scientific Steering Committee, GEOTRACES (2019 – 2025)

**Student**

**Malika Singhal**

81. Recieved award for best oral presentation in UKLUM2024 held at Oxford University, UK; Prize money: 200 GBP

**Mansi Gupta**

82. Secretary of the Early Career Scientist Network of International Indian Ocean Expedition-2 (IIOE-2-ECSN) from March 2022 to present

# Recognition, Best paper & Thesis awards

**Faculty**

**Amit Basu Sarbadhikari**

1. Moderator for Venus Surface Science and Exploration in Venus Science Conference (Venus-SC 2024), PRL, Ahmedabad, September 23-24, 2024.

**Amitava Guharay**

2. SCOSTEP Scientific Discipline Representative (SDR)
3. Executive council member, Ahmedabad Chapter, Indian Meteorological Society

**Anil Bhardwaj**

4. Guest of Honour and Invited Public talk at AVINASHFEST-2024, - International Symposium on Promises and Challenges in Plasma Sciences, University of Delhi, April 29, 2024.
5. Chief Guest, Vastu Vid - New Sainik School Teachers' Training Program Inauguration Ceremony, Indian Institute of Teacher Education, May 13, 2024.
6. Chief Guest at National Conference on "Population Dynamics and Sustainable Development: Insights from Western India", Faculty of Science, The Maharaja Sayajirao University of Baroda, Baroda, May 30, 2024.
7. INSA Distinguished Public Lecture on "First National Space Day", at INSA New Delhi, August 22, 2024.
8. Chief Guest, NASA Space Application Challenge "The Sun Touches Everything", Nirma University, Oct. 5, 2024.
9. Chief Guest, 3$^{rd}$ Indian Space Weather Conference, IIT Roorkee, Oct. 7-9, 2024.
10. Chief Guest, WAAH Award Ceremony, Jan. 3, 2025.
11. Invited for TEDx Talk, at TEDx Surat, Dec. 22, 2024.

**Anshu Kumari**

12. Session co-convener: AGU Fall Meeting 2024 – "Diagnosing Heliospheric and Terrestrial Plasma with Radio Observations"
13. Session co-convener: AGU Fall Meeting 2024 – "Massive to extreme flares in the Sun and young Sun-like stars: long-term activity evolution and space weather consequences"
14. Session Chair, "Solar Cycle Variability: From Understanding to Making Prediction," jointly organized by IIT BHU and ARIES, Nainital, October 14–18, 2024

**Aveek Sarkar**

15. External examiner for Ph.D. thesis defense held at Indian Institute of Science Education and Research, Kolkata, 19 September 2024

**Bhuwan Joshi**

16. Guest Editor, Proceedings of the 3rd BINA Workshop: Scientific Potential of Indo-Belgian Co-operation, Bulletin de la Société Royale des Sciences de Liège (BSRSL), 93(2),1-31, `https://doi.org/10.25518/0037-9565.11581`
17. Co-Chair, Scientific Organizing Committee, ISRO Structured Training Program (STP), "Multi-Wavelength Astronomy with Ground- and Space-based Facilities," 25 - 29 November, 2024
18. Chair of the technical session titled "Extreme Events" during the International Conference "Sun, Space Weather and Solar-Stellar Connections" organized to commemorate 125 years of the Kodaikanal Solar Observatory (KSO), Indian Institute of Astrophysics (IIA), Bangalore, India, January 20 – 24, 2025.

**Brajesh Kumar**

19. Invited to chair a session on "Asteroseismology of Magnetic Activity" at the International Conference "Sun, Space Weather and Solar-Stellar Connections" to commemorate 125 years of the Kodaikanal Solar Observatory (KSO) held at the Indian Institute of Astrophysics (IIA), Bangalore, India, during January 20 – 24, 2025.
20. Invited by the Mohan Lal Sukhadia (MLS) University, Udaipur, for preparing Question Paper for one of the Subjects in their curriculum for M.Sc. (Physics) Examination.

**Dibyendu Chakrabarty**

21. Invited reviewer, National Science Foundation (USA) research proposal, 2024

22. Nominated by ISRO as member in the International Heliospheric Data Environment Alliance Executive Council (IHDEA EC), 2024.

23. Member, Scientific Organizing Committee, Space for Sustainability: Science, Technology, Education and Policy (S2:STEP2025) during 04-07 March 2025 and 6th Indian Interplanetary Science Conference (IPSC-2025), 2025

24. Invited reviewer for best research paper award, IIT-Indore, 2024

25. Invited reviewer, IIT-Kanpur for the Course titled "Space Environment and its Effects on Orbital Spacecrafts " to be offered on the SWAYAM-NPTEL platform

26. Invited reviewer, CSIR-ASPIRE research proposal, 2024

27. Chair of a session, Symposium on Emerging Trends in Hydrology Research: An Indian Perspective, PRL, 2024

28. Nominated from PRL as member to participate in the DSA: INDUS-X Space challenges discussion, 2024

29. Lead, RAMBHA-LP data Peer Review Team, Chandrayaan-3, 2024

30. Moderator, Splinter group-6 (Near-Earth Space Exploration, Aeronomy, Ionosphere-Thermosphere-Magnetosphere) for Future Space Science Roadmap (ISRO), 2024

31. Member, Panel discussion, PRL Industry meet, 2024

32. Member, Interview Committee for selection of Scientists at IIG-Navi Mumbai, 09-11 September, 2024

33. Chairman, Expert Committee for the evaluation of Scientific equipment/instruments, IIG, 2024

34. Member, Board of Studies for Space and Atmospheric Sciences Course, CSSTEAP, 2024

35. Chair, Prof. R. Raghavarao Memorial Lecture Committee, 2024

36. Member Scientific Organizing Committee, Venus Science Conference, 2024

37. Member Scientific Organizing Committee, Indian Space Weather Conference, 2024

38. Member Scientific Organizing Committee, Aditya L1 workshop at IIT-Indore, 2024

39. Member, SOC, Workshop-1 (Aditya-L1: India's Solar & Heliospheric Observatory in space), ASI-2024, 31 January – 04 February, 2024 at IISc, ISRO and JNP, Bengaluru.

**Duggirala Pallamraju**

40. Member, Scientific Organizing Committee, Session C1.4 on Space Weather and Earth's Atmosphere, 45th COSPAR General Assembly, Busan, South Korea, 13 – 21 July 2024

41. Chair, Scientific Session C1.1, COSPAR General Assembly, Busan, South Korea.

42. Chair, Scientific Session C1.4, COSPAR General Assembly, Busan, South Korea.

43. Member, Scientific Organizing Committee, Session D0.1 "Existing and Future Solar and Heliospheric Missions for Heliophysics Sciences and Space Weather Applications)", 6th COSPAR Symposium 3 – 7 November 2025, NICOSIA, Cyprus.

44. Member, Scientific Organizing Committee, Session C0.2 on "Impact Assessment of Extreme Space Weather Events of 2024 on the Near Earth Space Environment and Technological Systems", 6th COSPAR Symposium 3 – 7 November 2025, NICOSIA, Cyprus.

45. Panel Member, "Drivers and Enablers for Enhanced Space Sustainability", International Conference on Space for Sustainability: Science, Technology, Indian Institute of Technology, Roorkee. 04 – 07 March 2025.

46. Expert Member, Splinter Group 6 (Near-Earth Space Exploration (Aeronomy, Ionosphere-Thermosphere-Magnetosphere) in Brainstorming Meeting on Space Science Roadmap Formulation (SSRF) 22-23 April 2024, URSC.

47. Chair, 44th Indian Science Expedition to Antarctica Team Selection Panel for proposals submitted in the domains of "Atmospheric Sciences" constituted by NCPOR, Goa. Meeting held at NCPOR, Goa during 30 April – 1 May 2024.

48. Moderator, Atmosphere and Ionosphere, Venus Science Conference, 23 – 24 September 2024 held online at PRL.

49. Chief Guest, Inauguration 2nd Workshop on Space Weather Science and Opportunities, Dept. of Physics & Centre for Space Science and Technology, Indian Institute of Technology Roorkee, Roorkee. 5 -6 October 2024.

50. Co-Chair, 3rd Indian Space Weather Conference , Dept. of Physics & Centre for Space Science and Technology, IIT Roorkee, Roorkee. 7 – 9 October 2024.

51. Covener, Workshop on Ionospheric Measurement Techniques and Instrumentation, URSI-RCRC, Graphic Era Hill University, Bhimtal, 22 Oct 2024.

52. Chair, 3rd Indian Arctic Team Selection Panel for proposals submitted in the domains of "Atmospheric and Ocean Sciences" and "Space Science, Astronomy and Astrophysics" constituted by NCPOR, Goa. Meeting held at NCPOR, Goa during 20 – 21 January 2025.

53. Member, National Advisory Committee, 3rd One Day National Coneence on Advances in Materials science: Challenges and Opportunities, Maharaja Krishnakumarsinhji Bhavnagar University, Bhavnagar. 7 March 2025.

54. External Examiner for Ph.D. thesis, Indian Institute of Technology Roorkee, Roorkee.
55. Alternate Chair, of a ISRO committee for Technical Review and Realization of the ISRO specific Instruments at Atmospheric & Space Research Facility (ASRF)", Balasore, Chandipur, Odisha, 2024.

**Dwijesh Ray**

56. Co-Convener, Meteoroid, Meteor, Meteorites: Messengers from Space (MetMeSS), November 20-22, 2024, PRL, Ahmedabad.

**Jayesh Pabari**

57. Member of the Industrial Advisory Committee of ICACS 2025, CHARUSAT, Changa.
58. Convener, Venus Science Conference (Venus-SC 2024), PRL, Ahmedabad, September 23-24, 2024.
59. Panelists of Two Scientific Discussions, Venus-SC 2024, PRL, Ahmedabad, September 23-24, 2024.

**K Venkatesh**

60. Elected as Vice-Chair, of the Sub-Commission C1 of Committee on Space Research (COSPAR) on 'The Earth's Upper Atmosphere and Ionosphere'
61. Guest Editor in Advances in Space Research (ASR) for a special issue on Mesosphere-Thermosphere-Ionosphere Studies (Vol.73, issue 7, ASR, 2024)
62. Deputy Organizer (DO), scientific session "C1.1- Recent advances in equatorial, low- and mid-latitude mesosphere, thermosphere and ionosphere studies", 45th scientific assembly of COSPAR, Busan, South Korea
63. Member, Splinter Group-6 on Near-Earth Space Exploration, to prepare the Space Science Roadmap Formulation, ISRO.

**K. Durga Prasad**

64. Session Chair, Science from Indian Recent Moon Missions, $6^{th}$ Indian Planetary Science Conference, IPSC-2025, March 4-7, 2025, IIT Roorkee.
65. Session Chair, "Surface Science and Exploration of the Moon and Airless Planetary Bodies (PS16), AOGS-2024, South Korea
66. Member-LOC, $6^{th}$ Indian Planetary Science Conference, IPSC-2025, March 4-7, 2025, IIT Roorkee.
67. Convenor, Session on "Surface Science and Exploration of the Moon and Airless Planetary Bodies (PS16)" at the $21^{st}$ Annual meeting of Asia Oceania Geosciences Society (AOGS-2024) held at Pyeongchang, South Korea.

**Kuljeet K. Marhas**

68. Convener, Meteoroid, Meteor, Meteorites: Messengers from Space (MetMeSS), November 20-22, 2024, PRL, Ahmedabad.

**Lokesh Kumar Dewangan**

69. SOC member of "Astrophysical Dust-Ices: Insights from Recent Telescopes Workshop (online)", 2025, March 10, organized by the Physical Research Laboratory (PRL), India.

**Manan Shah**

70. 2nd prize for project presentation on subject "Mission to Asteroid : A Case Study" in the STP on "Indian Space Exploration : Challenges and Way Forward" during December 16-20, 2024 at Bengaluru organized by ISRO HQ

**Manash Samal**

71. SOC member of "The 1st Indo-Thai Symposium on Astrophysics and Technology Development (ITSAT 2024)", 26-28 August 2024, organized by NARIT, Thailand.

**Megha Bhatt**

72. Main Scientific Organizer (MSO) of COSPAR 2024-B3.1: Lunar Science and Exploration.
73. Scientific Organization Committee (SOC) of Planetary Science and Space Exploration workshop, July 22-25, 2024, South Korea
74. Member: Local Organizing Committee, International Conference on Space for Sustainability: Science, Technology, Education and Policy and $6^{th}$ Indian Planetary Science Conference, March 4-7, 2025, IIT Roorkee.

**Nandita Srivastava**

75. Chairperson, SCOSTEP Awards Selection Committee, 2024
76. National Coordinator, International Space Weather Initiative (ISWI) programme, since January 2022
77. Member, ISWI Monthly Webinar Series Committee
78. Science Discipline Representative, SCOSTEP, since 2020
79. Member, Scientific Organizing Committee (SOC), COSPAR Capacity Building Workshop, Samarkand State University, Uzbekistan, August 19–30, 2024
80. Member, SOC, "Sun, Space Weather and Solar-Stellar Connection" meeting (KSO-125), Indian Institute of Astrophysics, Bangalore, January 21–24, 2025
81. Session Chair, "Solar Cycle Variability: From Understanding to Making Prediction," jointly organized by IIT BHU and ARIES, Nainital, October 14–18, 2024
82. Chaired two scientific sessions and organized the concluding session of the COSPAR Workshop at Samarkand State University, Uzbekistan, August 2024
83. Mentor to a group of six international participants during COSPAR workshop; guided analysis of solar eruption events and group presentations
84. Session Chair, "Shocks and Particle Acceleration and Transport in IP Medium," KSO-125 Meeting, IIA Bangalore, January 2025
85. Invited Expert Member, Splinter Group-4 on Heliosphere and Space Weather, Brainstorming Session at URSC, Bangalore, April 22–23, 2024
86. Member, Aditya-L1 Time Allocation Committee, ISRO
87. Member, Research Advisory Committee, Indian Institute of Geomagnetism, Mumbai, since March 2023
88. Chair, PRL ka Amrut Vyakhyan Committee; successfully completed 100 lectures

**Neeraj Rastogi**

89. Third prize for the platform presentation titled "Inter-annual variability in sources and characteristics of carbonaceous aerosols using dual carbon isotopes over a mega city in eastern India", in the conference organized by Indian Aerosol Science and Technology Association (IASTA-2024) at Doon University, Dehradun during 17-20 December 2024
90. Group Achievement Award' from National Aeronautics and Space Administration (NASA) as a team member of 'Volkilau Team' for outstanding achievement conducting a rapid development during the 2018 Kilauea volcanic eruption to profile emissions from volcanic fissures
91. Group Achievement Award' from National Aeronautics and Space Administration (NASA) as a team member of 'BATAL Team' for scientific excellence and sustained achievement to better understand the Asian Tropopause Aerosol Layer through international collaborative partnering

**Neeraj Srivastava**

92. Member: National Organizing Committee, International Conference on Space for Sustainability: Science, Technology, Education and Policy and $6^{th}$ Indian Planetary Science Conference, March 4-7, 2025, IIT Roorkee.
93. Convener of the Committee, Gujarat Science Academy (GSA) Prof. M.B. Patel Best Ph. D. Thesis Award in Geology - 2024
94. Member, Space Science Subcommittee 3, Assessing the science objectives of the space science missions, ISRO

**Rishitosh Sinha**

95. Bharatiya Antariksh Hackathon (BAH) 2024: Mentored a team of 4 students from Thapar Institute of Engineering and Technology, Patiala, on a project titled 'Identification of safe navigation routes on the Moon using Chandrayaan Images' during Bharatiya Antariksh Hackathon (BAH) 2024 conducted by ISRO, August 13-14, 2024, NRSC Ahmedabad. Our project team won the first prize at the BAH 2024.

**S. A. Haider**

96. Convener of C3.2 sessions on "Planetary Upper atmospheres, ionospheres and magnetospheres" during July 15-16, 2024 in the $45^{th}$ COSPAR Scientific Assembly, which was held between July 13-21, 2024 at Busan, South Korea

**Sachindra Naik**

97. Charing the session "Galaxies and Cosmology" in the "43rd Meeting of the Astronomical Society of India" at the National Institute of Technology, Rourkela, Odisha, during 15-19 February 2025.
98. External examiner for Ph.D. thesis submitted to CHRIST (Deemed to be University), Bengaluru
99. Member, Science Advisory Committee : Aryabhatta Research Institute of Observational Sciences, Nainital.
100. External examiner for Ph.D. thesis submitted to Homi Bhabha National Institute, Mumbai.

**Shashikiran Ganesh**

101. Chair of the Time Allocation Committee for the Telescopes operated by the Indian Institute of Astrophysics

102. Member of the Nominating Committee of the Astronomical Society of India for the triennium 2025-27

103. Member of the Board of Studies (BoS) Committee for the Space and Atmospheric Science (SAS) P. G. Diploma course of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP)

104. External reviewer and examiner for PhD thesis submitted to University of Delhi (Jan 2025)

105. External reviewer for PhD thesis submitted to University of Calcutta (Feb 2025)

**Som Kumar Sharma**

106. Invited Reviewer, National Science Foundation (USA) Research Proposals, 2024

107. Best Paper Award as a co-author for the paper entitled, "Analysis of Atmospheric Clouds and Boundary Layers through Indian Lidar Network Programme of PRL" presented in the Inter-Center Hindi Technical Seminar-2024 held at the Space Applications Center (ISRO), Ahmedabad. (Authors: Som Kumar Sharma, Dharmendra Kumar Kamat and Aniket)

108. Member of Board of Studies (BoS) Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, 2024

109. Member of a national committee for technical Review and Realization of the national project; "Atmospheric & Space Research Facility (ASRF)", Balasore, Chandipur, Odisha, 2024

110. Member of a ISRO committee for Technical Review and Realization of the ISRO specific Instruments at Atmospheric & Space Research Facility (ASRF)", Balasore, Chandipur, Odisha, 2024

111. Member of Board of Studies (BoS) for the Space and Atmospheric Science (SAS) course, under CSSTEAP (affiliated to UN), 2024

112. Member of Board of Studies (BoS) for the Satellite Meteorology (SATMET) course, under CSSTEAP (affiliated to UN), 2024

113. An Expert Member of the DRDO Technical vocabulary augmentation board under CSTT (Ministry of HRD), 2024

114. Invited Reviewer, National Science Foundation (USA) Research Proposals, 2024

115. Invited as a resource person and expert for the ISRO- YUVIKA programme at NESAC, Shillong during May 2024.

116. Member (external Expert) Recruitment Committee at IPR, Gandhinagar, 2024

117. Expert member of Departmental Promotion Committee (DPC) in DOS/ISRO centres, 2024

118. Invited, expert member of the evaluation committee of Scientific equipment/instruments, IPR Gandhinagar, 2024

119. On the review panel of the scientific projects submitted to various funding schemes/agencies such as DST-INSPIRE, CSIR, and MoES.

120. Invited as a Resource Person during the national Space Day -2024 celebrations on 23 August 2024 at Rajiv Gandhi Central University, Itanagar, Arunachal Pradesh.

121. Member, selection committee at CSIR-HRDG. New Delhi, 2025

122. Invited, Lead speaker at International workshop at IIFSR, Meerut, March 2025

123. Invited, expert member of the evaluation committee of Scientific equipment/instruments, SAC (ISRO), Ahmedabad, 2024

**Srirag N Nambiar**

124. Secretary, Venus Science Conference (Venus-SC) September 23-24, 2024, Physical Research Laboratory, Ahmedabad.

**Varun Sheel**

125. Secretary, IPSA, helped in organising the $6^{th}$ Indian Planetary Science Conference, IPSC-2025, March 4-7, 2025, IIT Roorkee.

126. Member of SOC, $6^{th}$ Indian Planetary Science Conference, IPSC-2025, March 4-7, 2025, IIT Roorkee.

127. Member of SOC, 2nd Workshop on Space Weather Science and Opportunities & $3^{rd}$ Indian Space Weather Conference, October 5-9, 2024, IIT Roorkee.

128. Member of SOC, Meteoroid, Meteor, Meteorites: Messengers from Space (MetMeSS), November 20-22, 2024, PRL, Ahmedabad.

129. Convenor of session "Science and Exploration of Mars and Venus", $21^{st}$ Annual meeting of the AOGS, June 23-28, 2024, South Korea

130. Chair-LOC, Meteoroid, Meteor, Meteorites: Messengers from Space (MetMeSS), November 20-22, 2024, PRL, Ahmedabad.

**Veeresh Singh**

131. Served as an external examiner for Ph.D. thesis defence held at Inter-University Centre for Astronomy and Astrophysics (IUCAA) Pune, 21 January 2025.

**Research Fellows**

**Aakash Gupta**

132. Young Researcher, 15th issue of international newsletter of INDUS (Indian Network for Dynamical & Unified Solar Physicists) in October, 2024.

**Binal D. Patel**

133. Best Paper Presentation Award in the 10th Plasma Science Society of India Plasma Scholars Colloquium (PSSI-PSC 2024)

**Denesh K.**

134. Best Poster Award in Meteoroid, Meteor, Meteorites: Messengers from Space (MetMeSS), November 20-22, 2024, PRL, Ahmedabad.

**Dibyendu Misra**

135. The Early Career Researcher Award for the poster presentation in the $6^{th}$ Indian Planetary Science Conference (IPSC2025), held at the Indian Institute of Technology Roorkee during March 4-7, 2025.

**Kiran**

136. Best Poster Award in the theme - Climate: Past, Present & Future in the Frontiers in Geosciences Research Conference (FGRC-2025) held at PRL, Ahmedabad during 5 - 7 February 2025.

**Malika Singhal**

137. Best oral presentation award in UK Luminescence and ESR dating conference (UKLUM2024) held at Oxford University, UK; September 11-13, 2024.

**Mansi Gupta**

138. Best poster presentation award, 9th Surface Ocean–Lower Atmosphere Study (SOLAS) Open Science Conference (OSC) held at NIO, Goa, India during 10-14 November 2024.
139. Best poster presentation award, Frontiers in Geosciences Research Conference (FGRC-2025) held at PRL, Ahmedabad, during 5-7 February 2025.

**Mr. Anirban Ghosh**

140. Best Poster Award of the Indian Laser Association at the $33rd$ National Laser Symposium (NLS-33), jointly organized by the Board of Research in Nuclear Sciences (BRNS), RRCAT Indore, and Medi-Caps University from March 6-9.

**Namita Uppal**

141. The Justice Oak Award (Honourable Mention) for Outstanding Thesis in Astronomy, 2024 by the Astronomical Society of India (Feb 2025).

**Prabir K. Mitra**

142. International Astronomical Union (IAU) PhD Thesis Honorable Mention Award for his thesis titled “Investigations of the Initiation and Evolution of Transient Phenomena in the Solar Atmosphere.”

**Suryansh Dongre**

143. Best oral presentation award, International Conference on Next Generation Materials and Devices, 1-3 August, 2024, Kalasalingam Academy of Research and Education, Tamil Naidu, India.

**Vikas Soni**

144. K. D. Abhyankar Best Thesis Presentation Award at the $43^{rd}$ meeting of the Astronomical Society of India (ASI-2025) at the National Institute of Technology Rourkela, India.

**Wafikul Khan**

145. Best Oral presentation and Early Career Researcher award for the oral talk in the International Conference on Sustainability: Science, Technology, Education and Policy (S2: STEP 2025) and 6th Indian Planetary Science Conference (IPSC 2025), 4-7 March 2025, Organized by Indian Institute of Technology (IIT) Roorkee. India

# Human Resource Development

### Human Resource Development at PRL

PRL has a strong Human Resource Development (HRD) component with Research Fellowship programme leading to PhD degree, Post-Doctoral and Visiting Scientist programs. In addition, we have an Associate program for university teachers and project training for graduate and post graduate students in both science and engineering. PRL hosts science and engineering disciplines students for their project training as a part of their curriculum. The purpose is to provide the students with an insight into current research activities being pursued at PRL which they can continue even after returning to their colleges/universities/institutes. It is also aimed at motivating them to take up research in basic sciences in their higher studies and career. Brief details of scientific output and staff in numbers during the reporting year are provided here.

### Research Fellowship Programmes

One of the important aims of the laboratory is to serve as a post-graduate and post-doctoral study centre in Physics, Earth & Planetary sciences and Chemistry to train research scholars in various aspects of experimental and theoretical research. With this in view, PRL offers a research fellowship programme leading to Ph. D. degree. PRL provides opportunities for carrying out post-doctoral research. The strength of fellows under these programmes are presented in figure 1.

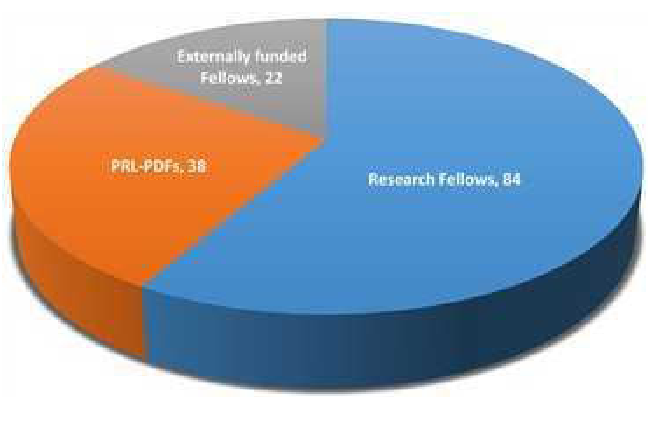



Figure 1: Research Programmes.

### Research Programmes through Extrernally funded schemes

PRL encourages candidates with external funding from Government agencies such as DST, CSIR, NBHM, UGC, ISRO RESPOND, etc., to carry out their research in all campuses of PRL. Such candidates are governed by fellowship rules of the concerned funding agencies as applicable from time to time. Such candidates have an option to register for a Ph.D. degree in any of the institutes/universities with which PFIL, has an MoI, subject to their fulfilling the required eligibility criteria and course work requirements of the concerned university/institude. Following table summarize the ongoing externally handed projects in PFIL, and figure 1 give statistics of the Research Scholars/PDF/RAS in PEL, including the ones employed through the externally funded projects.

### Training Opportunities

PRL provides project training in engineering disciplines like computer engineering, electronics & communication, instrumentation & control information technology to graduate/post-graduate students. Detalls of the same are presented in figure 2.

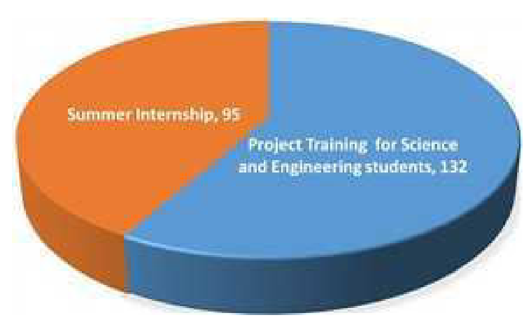



Figure 2: Internship Training Programmes.

PRL also offers training programmes in computers, electronics, library science, engineering and administrative services


Figure 3: Training Programmes in technical and administrative areas.

**Research Contributions**

The research work carried out by PRL scientists are published in reputed and peer reviewed national and international journals. Several of our scientists are also invited to write review articles in the field of their specialization. Some of our scientists have also edited books. Many of our scientists attended conferences and symposia at home and abroad where they present the results of their research investigations. Some of them are invited to present review talks. Few of them serve as chairpersons and Members of scientific committees for organizing national and international conferences and symposia They are also invited to Convene and Chair sessions during symposia and meetings. The research output during the AY 2023-24 is shown in figure 4.

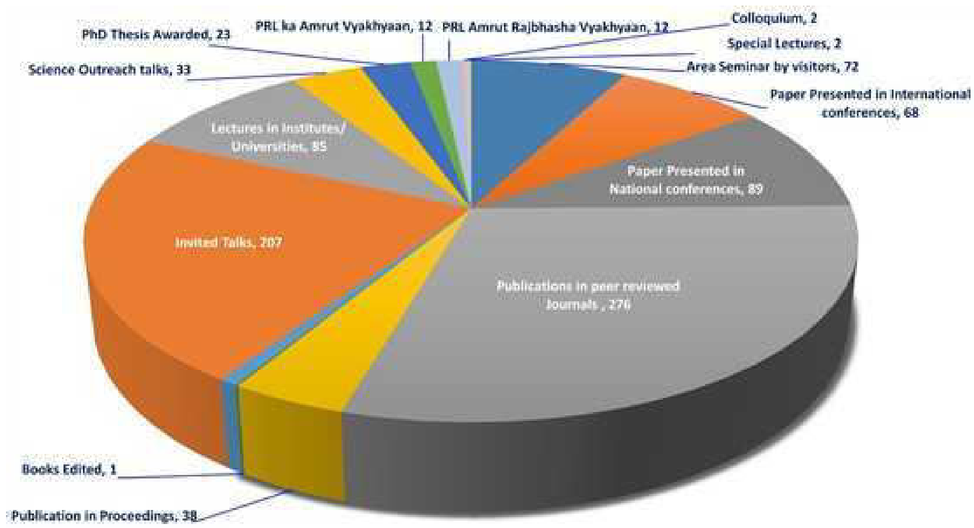



Figure 4: Research Contributions.

**Administrative Support**

Behind the scientific achievements of PRL, is the able and efficient support given by the administrative and the technical staff. The administrative section of our laboratory continues to play an important role in providing an excellent management support to carry out our scientific activities. In addition, it also provides management support to the Solar Observatory at Udaipur and the Infrared Observatory al Mt. Abu. The staff structure of PRL is shown in figure 5.

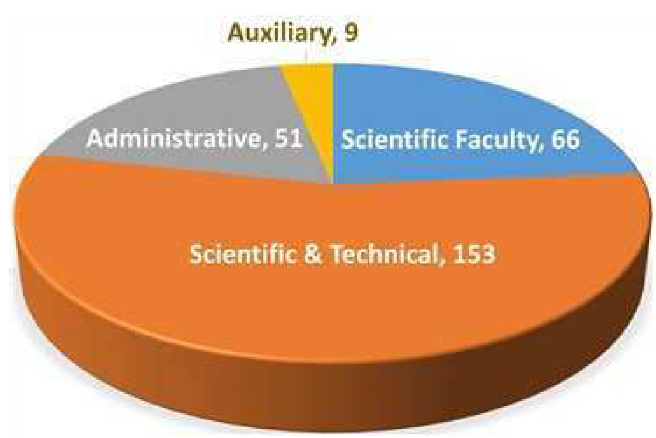



Figure 5: The distribution of PRL staff (as on 31 March 2024).

#### Research Fellowship Programme and Pre-PhD courses

PRL Offers' Junior Research Fellowships (JRF's) leading to a PhD. degree in the broad areas of ongoing research activities in PRL. Since inception of PRL, around 500 research scholars have obtained their PhD degree. PRL alumni have played a key role in the development of institutions and programmes in India and abroad. The Indian Space Research Organization (ISRO) was nucleated in PRL in the early seventies and two of the past ISRO Chairmen, Prof. UR. Rao and Prot K. Kasturikangan are distinguished alumni of PRL.

After admission to PRL, each JRF needs to undergo a prescribed pre-Ph.D. coursework prior to joining the research. In consideration of the requirements of (a) various Universities/ IIT, where PRL research scholars register for their Ph.D. degree, and (b) University Grants Commission guidelines, two semesters of rigorous coursework is offered to JRFs. In addition, JRFs are also required to do four projects as a part of their coursework. In the year 2024-25, 26 new JRFs have joined PRL and 27 SRFs have been awarded Ph.D. degree.

Following is the list of courses offered to Junior Research Fellow of 2024 batch. Each course is of tour credits and 40 hours of teaching

Following is the list of courses offered to Junior Research Fellow of 2024 batch. Each course is of four credits and 40 hours of teaching.

##### Semester 1 courses

1. Writing-[Instructors: Dr. Bhushit Viwshnav & Mr. Anand Mehta]
2. Research Methodology-[Instructors: Dr. Arvind Singh & Dr Shashi Prabhakar]
3. Review of Electrodynamics-[Instructors: Dr. Narmit Mahajan]
4. Advanced Quantum Mechanics-[Instructors: Dr. Ketan Patel]
5. Advanced Statistical Mechanics-[Instructors: Dr. Paramita Dutta]
6. Fundamentals of Atmospheres and Climate-[Instructors: Dr. Shubhva Sharma & Dr. Narendra Ojha]
7. Application of Isotopes in Natural Science-[Instructors: Dr. Vineet Goswami & Dr. Amzad Hussain Laskar]
8. Tools and Techniques in Experimental Methods-[Instructors: Dr. Mudit Srivastava & Dr. T. A. Rajesh]
9. Remote sensing: Basics & Applications-[Instructors: Dr. S. Vijayan & Dr. Megha Bhatt]]
10. Star formation and Star Clusters-[Instructors: Dr. Lokesh Dewangan & Manash R Samal]
11. Upper atmosphere, ionosphere and space weather-[Instructors: Dr. Brajesh Kumar & Dr. Girjesh Gupta]
12. The active Sun and space weather-[Instructors: Dr. Bhuwan Joshi]
13. Solar instrumentation-[Instructors: Rohan Eugene Louis]
14. Physicochemical processes of trace gases, aerosols and atmospheric radiative transfer-[Instructors: Dr. L. Sahu & Dr. H. Gadhavi]
15. Dynamical, chemical and coupling processes in the Earth's atmosphere-[Instructors: Dr. A. Guharay & Dr. Som K. Sharma]

##### Semester 2 courses

16. Radiative Transfer and stellar astrophysics-[Instructors: Dr. Aveek Sarkar & Dr. Arvind Singh Rajpurohit]
17. Astronomical Instrumentation and Fundamental Astronomy-[Instructors: Dr. Mudit Srivastava & Dr. Vishlal Joshi]]
18. Galactic and Extragalactic Astronomy-[Instructors: Dr. S. Naik & Dr. Veeresh Singh]
19. Molecular Spectroscopy-[Instructors: Dr. Bhalamurugan Sivaraman]
20. Advanced Laser Science-[Instructors: Dr. Rajesh Kushwaha Dr. Prashant Kumarj]
21. Quantum Optics & Nano Photonics-[Instructors: : Dr. Satyendra Gupta & Dr. Shashi Prabhakar]
22. Luminescence Physics-[Instructors: Instructors: Dr. Naveen Chauhan& Dr. Vinayak]]
23. Advanced stable isotopes and their applications in Earth Sciences-[Instructors: Dr. Amzad Laskar]
24. Solar Magnetohydrodynamics-[Instructors: Dr. Ramit Bhattacharyya]
25. Upper atmosphere, ionosphere and space weather-[Instructors: Dr. K. Venkatesh & Dr. D. Chakrabarty]

List of projects done by JRF of 2024 batch are as follows:

##### Achintyaa

1. "Properties of Ordinary Superconductors", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Paramita Dutta, Division: Theoretical Physics].
2. "Topological Phases of Matter", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Paramita Dutta, Division: Theoretical Physics].

**Kamani Namit Bharatkumar**

3. "Physics of Higgs Boson", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof. Partha Konar, Division: Theoretical Physics].
4. "Introduction to General Relativity and Cosmology", Semester 2 project, from January 2025 to April 2025, [Supervisior: Prof. Namit Mahajan, Division: Theoretical Physics].

**Shuvendu Roy**

5. "Exploring Helicity Formalism", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Satyajit Seth, Division: Theoretical Physics].
6. "Calculating Loop Amplitudes", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Satyajit Seth, Division: Theoretical Physics].

**Divya Paliwal**

7. "Evaluation of the Signatures of stream/corotating interaction Regions at Sun-Earth L1 point.", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof. Dibyendu Chakrabarty, Division: Space, Atmospheric, Molecular and Laser Physics].
8. "Solar Flares and Flare-Associated Phenomena.", Semester 2 project, from January 2025 to April 2025, [Supervisior: Prof. Bhuwan Joshi, Division: Solar Physics].

**Sinha Shruti Girishkumar**

9. "Evaluation of the signatures of interplanetary coronal mass ejections at the Sun-Earth L1 point", Semester 1 project, from August 2024 to April 2025, [Supervisior: Dr. Dibyendu Chakrabarty, Division: Space, Atmospheric, Molecular and Laser Physics].
10. "Estimation of Fried parameter from the angle of arrival fluctuations", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. A. Raja Bayanna, Division: Solar Physics].

**Abhishek**

11. "Study of the formation of ionospheric layers and interpretation of ionograms", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof. D. Pallamraju, Division: Space, Atmospheric, Molecular and Laser Physics].
12. "Thermal structure of atmosphere over Ahmedabad region", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Amitava Guharay, Division: Space, Atmospheric, Molecular and Laser Physics].

**BHAVESH KULI**

13. "Study of atmospheric aerosols: Secondary formation of inorganic and organic aerosols", Semester 1 project, from August 2024 to December 2024, [Supervisior: S. Ramachandran, Division: Space, Atmospheric, Molecular and Laser Physics].
14. "Evaluation of AOD and PM2.5 associations and the impact of meteorological parameters over Delhi", Semester 2 project, from January 2025 to April 2025, [Supervisior: S. Ramachandran, Division: Deanś Office].

**Dibyani Singh**

15. "Study of Ionospheric Total Electron Content(TEC) during geomagnetic storm conditions", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. K Venkatesh, Division: Space, Atmospheric, Molecular and Laser Physics].
16. "Theory of Rotational Temperature measurement using OH(6-2) and OH(3-1) Meinel Bands", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Ravindra Pratap Singh, Division: Space, Atmospheric, Molecular and Laser Physics].

**Samarpan Dutta**

17. "Dispersing Elements in Optics and Spectrographs", Semester 1 project, from July 2024 to December 2024, [Supervisior: Dr. K. Venkatesh, Division: Space, Atmospheric, Molecular and Laser Physics].
18. "Dispersing Elements in Optics and Spectrographs", Semester 2 project, from January 2025 to May 2025, [Supervisior: Prof. D. Pallamraju, Division: Space, Atmospheric, Molecular and Laser Physics].

**Arvind**

19. "Wavelength Calibration of LHIRES-III spectrometer", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof. Shashikiran Ganesh, Division: Astronomy and Astrophysics].
20. "Extinction Coefficient for different Filters", Semester 2 project, from January 2025 to April 2025, [Supervisior: Prof. Shashikiran Ganesh, Division: Astronomy and Astrophysics].

**Ashad Ahmad**

21. "Telescope and Techniques for Astronomical Radio Observation", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Veeresh Singh, Division: Astronomy and Astrophysics].

22. "Astrophysical Neutrinos: Origins and Detection", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Sunil Chandra, Division: Astronomy and Astrophysics].

**Ayush Rana**

23. "Probing Physical Processes in Star forming Regions", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Lokesh Kumar Dewangan, Division: Astronomy and Astrophysics].

24. "Spectroscopic Observation and Data Reduction of a CV", Semester 2 project, from January 2025 to May 2025, [Supervisior: Dr. Vishal Joshi, Division: Astronomy and Astrophysics].

**SUBE SINGH GURJAR**

25. "Deriving Light Curve from Deriving Light Curve from Photometric Data Using Aperture Photometry", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Vishal Joshi, Division: Astronomy and Astrophysics].

26. "Wavefront Reconstruction and Optics in Adaptive Optics System", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Mudit K. Srivastava, Division: Astronomy and Astrophysics].

**Jatin Parashar**

27. "Study of inert gas ionization through mass spectrometry.", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Prashant Kumar, Division: Atomic, Molecular and Optical Physics].

28. "Simulation and calculation of ion trajectories in a gradient magnetic field Thomson Parabola Spectrometer", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Prashant Kumar, Division: Atomic, Molecular and Optical Physics].

**SACHIN KUMAR HAZARI**

29. "Estimation of alpha efficiency of feldspar samples for different signals", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Naveen Chauhan, Division: Atomic, Molecular and Optical Physics].

30. "Fine-grain sample preparation technique for luminescence measurement", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Naveen Chauhan, Division: Atomic, Molecular and Optical Physics].

**Satyam Dalmiya**

31. "Quantum Dot As a Single Photon Source", Semester 1 project, from August 2024 to December 2024, [Supervisior: Satyendra Nath Gupta, Division: Atomic, Molecular and Optical Physics].

32. "Lifetime measurement of Quantum Dots on different substrates", Semester 2 project, from January 2025 to April 2025, [Supervisior: Satyendra Nath Gupta, Division: Atomic, Molecular and Optical Physics].

**Aditya Vikram Mishra**

33. "Carbon isotopic composition of Antarctica lake sediments", Semester 1 project, from July 2024 to December 2024, [Supervisior: Prof. Sanjeev Kumar, Division: Geosciences].

34. "Carbon and oxygen isotopic study of carbonates of Marwar Supergroup", Semester 2 project, from January 2025 to May 2025, [Supervisior: Prof. J.S. Ray, Division: Geosciences].

**GARIMA**

35. ""Understanding the basics of aerosol measurements and analysis "", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Neeraj Rastogi, Division: Geosciences].

36. ""Carbonaceous aerosols: Sources and Impacts"", Semester 2 project, from January 2025 to May 2025, [Supervisior: Dr. T. A. Rajesh, Division: Space, Atmospheric, Molecular and Laser Physics].

**Maitri Mukeshkumar Maheshwari**

37. "Estimating Source Contribution In Oceanic Particulate Nitrogen", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Arvind singh, Division: Geosciences].

38. "Study of lonar crater impactites", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Yogita kadlag, Division: Geosciences].

**MD FAHAD ALAM**

39. "Carbon dioxide and methane distribution in groundwater of Gujarat", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof Sanjeev Kumar, Division: Geosciences].

40. "Measurement of Total organic carbon in black shale", Semester 2 project, from January 2025 to May 2025, [Supervisior: Dr Vineet Goswami, Division: Geosciences].

**Nilima Mishra**

41. "Geochemical and isotopic studies on assessing the continental weathering", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr Vineet Goswami, Division: Geosciences].
42. "Identification of features and determination of parent body in meteorite NWA-1124", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Yogita kadlag, Division: Geosciences].

**Manoj Jat**

43. "Reflectance Spectroscopy and Hapke Radiative Transfer Modeling", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Neeraj Srivastava, Division: Planetary Sciences].
44. "Application of the Modified Gaussian Model to retrieve mineralogical information from remote sensing data", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Megha Upendra Bhatt, Division: Planetary Sciences].

**Omkar Kumar Gupta**

45. "Geology & Clay minerals of Mars: An up-to-date review with future perspectives", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Amit Basu Sarbadhikari, Division: Planetary Sciences].
46. "Volcanoes Less Than 5 km in Diameter on Venus: A Synthesis of Morphological Characteristics and Spatial Distribution and their possible relation to Central Indian Ocean Basin (CIOB)", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Dwijesh Ray, Division: Planetary Sciences].

**Patil Chaitanya**

47. "Lava Breaches from Fractures on Venus's Surface", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Vijayan S, Division: Planetary Sciences].
48. "Ground-based Spectroscopy of Venus' Nightside", Semester 2 project, from January 2025 to April 2025, [Supervisior: Dr. Kinsuk Acharyya, Division: Planetary Sciences].

**Roshni M**

49. "Study of Lightning Spectrum of Earth", Semester 1 project, from August 2024 to December 2024, [Supervisior: Prof. Jayesh Pabari, Division: Planetary Sciences].
50. "Fourier Analysis to understand Magnetic Activity using Venus Express Magnetometer Data", Semester 2 project, from January 2025 to April 2025, [Supervisior: Prof. Jayesh Pabari, Division: Planetary Sciences].

**Subhangini Soni**

51. "A Comprehensive Polarimetric Analysis of Mare Serenitatis", Semester 1 project, from August 2024 to December 2024, [Supervisior: Dr. Magha U. Bhatt, Division: Planetary Sciences].
52. "Spatial Variaton of Temperature at Shiv Shakti Point", Semester 2 project, from January 2025 to May 2025, [Supervisior: Dr. K. Durga Prasad, Division: Planetary Sciences].

**Status of Scheduled Caste/ Scheduled Tribe Personnel as on 31/03/2025**

| Centre/ Unit | Total Strength of Employees 2024-25 | Strength of SC Employees | Strength of ST Employees | Strength of OBC Employees |
|---|---|---|---|---|
| PRL | 279 | 13 | 06 | 62 |

**Status of Differently Abled persons as on 31/03/2025**

| Centre/ Unit | Total Strength of Employees | Strength of Differently Abled Persons | Classification of employees with Disabilities | | | |
|---|---|---|---|---|---|---|
| | | | Deaf and Dumb | Blind | Partially Blind | Orthopedically Handicapped |
| PRL | 279 | 6 | 1 | 0 | 0 | 5 |

# Ph.D. Awarded

**[Research work carried out at the Physical Research Laboratory by PRL Research Fellows/Project Associates/Employees towards Ph.D. degree]**

**Binal D. Patel**

1. "Source Region Characteristics of Coronal Mass Ejections and their Interplanetary propagation", Indian Institute of Technology, Gandhinagar, 18-06-2024, [Supervisor: Bhuwan Joshi].

**Arup Chakraborty**

2. "High-precision study of Parity-violation in $^{133}$C$s$", IIT Gandhinagar, 21-06-2024, [Supervisor: B. K. Sahoo].

**Neha Panwar**

3. "Eastern limb of the Moon through the lens of multi-ring basins: Insights from remote sensing data", Indian Institute of Technology, Gandhinagar, 24-06-2024, [Supervisor: Neeraj Srivastava].

**Yash Srivastava**

4. "Exploring Lunar Geochemistry beyond the Procellarum KREEP Terrane: Insights from Basaltic and Brecciated Meteorites", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Amit Basu Sarbadhikari].

**Vikas Soni**

5. "The Effect of Metallicity and Vertical Mixing on the Abundance of Major H-C-N-O-bearing Species in the Atmosphere of Exoplanets", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Kinsuk Acharyya].

**Deepak Kumar Rai**

6. "Reconstructing paleo-oxygenation in the Arabian Sea", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Arvind Singh].

**Devaprasad M.**

7. "Isotopic Characterization of Carbonaceous Aerosols over Different Regions of India", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Neeraj Rastogi].

**Siddhartha Sarkar**

8. "Biogeochemistry of carbon and nitrogen in the inland waters of India", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Sanjeev Kumar].

**Sanjit Kumar Jena**

9. "Quaternary Evolution of the Upper Equatorial Indian Ocean: Insights from the Paleothermocline Reconstructions using Planktonic Foraminiferal Mg/Ca and Isotopic Records", Indian Institute of Technology, Gandhinagar, 29-06-2024, [Supervisor: Ravi Bhushan].

**Arijit Roy**

10. "Mote of Dust Suspended in Shock Waves", IIT Gandhinagar, 29-06-2024, [Supervisor: B. Sivaraman].

**Rujuta Chaudhary**

11. "Application of satellite remote sensing for regional and local air quality mapping.", Indian Institute of Technology, Bombay, 24-08-2024, [Supervisor: Harish Gadhavi].

**• Saurabh Kumar Shukla**

12. "Unravelling the Scalar Sector of Grand Unification: Phenomenology & Implications", Indian Institute of Technology, Gandhinagar, 10-09-2024, [Supervisor: Ketan M. Patel].

**Mithun N. P. S**

13. "Intricacies of Astrophysical X-ray Spectroscopy and Investigations of Multi-scale Solar Flares", IIT Gandhinagar, 12-09-2024, [Supervisor: S. V. Vadawale].

**Swagatika Chakra**

14. "Spatio-temporal variability of Indian summer monsoon rainfall: identifying multi-decadal trends, trends reversal and the underlying factors", Indian Institute of Technology, Gandhinagar, 25-11-2024, [Supervisor: R. D. Deshpande].

**Satyam Agarwal**

15. “Numerical Simulations of Solar Eruptive Events”, Indian Institute of Technology, Gandhinagar, 26-11-2024, [Supervisor: Ramit Bhattacharyya].

**Gourav Mitra**

16. “Investigation of middle atmospheric dynamics during sudden stratospheric warming”, Indian Institute of Technology Gandhinagar, Gandhinagar/Physical Research Laboratory, 24-12-2024, [Supervisor: Amitava Guharay].

**Yogesh Kumar Maurya**

17. “On Topology of Solar Coronal Magnetic Field”, Indian Institute of Technology, Gandhinagar, 30-12-2024, [Supervisor: Ramit Bhattacharyya].

**Tanya Sharma**

18. “Information Security and Quantum Communication”, IIT Gandhinagar, 09-01-2025, [Supervisor: Shashi Prabhakar].

**Vineet Rawat**

19. “Exploring the formation mechanism of star clusters in molecular clouds: The role of physical processes and gas-to-star conversion factors”, IIT Gandhinagar, 05-02-2025, [Supervisor: Manash Samal].

**Birendra Chhotaray**

20. “Understanding the mechanism of X-ray and optical emission in Be/X-ray binary systems”, IIT Gandhinagar, 10-02-2025, [Supervisor: Sachindra Naik].

**Bijoy Dalal**

21. “Investigations on Suprathermal Particles in the Solar Wind and Earth’s Magnetosphere”, Indian Institute of Technology Gandhinagar, Gandhinagar/Physical Research Laboratory, 25-02-2025, [Supervisor: Dibyendu Chakrabarty].

**Rajiv Ranjan Bharti**

22. “The study of surface & subsurface characteristics of volcanic region on Mars using Remote Sensing and GIS”, Gujarat University, 19-03-2025, [Supervisor: Neeraj Srivastava].

**Kshitiz Upadhyay**

23. “Investigations of Upper Atmospheric Phenomena over Mid-Latitudes during Daytime”, Indian Institute of Technology Gandhinagar, Gandhinagar/Physical Research Laboratory, 24-03-2025, [Supervisor: Duggirala Pallamraju].

# Special Talks, PRL ka Amrut Vyakhyaan (PKAV) & PRL Amrut Rajbhasha Vyakhyaan (PARV)

**Colloquium**

1. **Prof. A. P. Dimri**
FNA, FNASc., Director, Indian Institute of Geomagnetism, Mumbai.
***Himalayan Weather and Climate 16 April 2024***

2. **Prof. R D Deshpande**
Sr. Professor, Geosciences Division, Physical Research Laboratory, Ahmedabad
***My Journey at PRL: excitement in hydrology research and...Beyond 20 September 2024***

**PRL ka Amrut Vyakhyaan**

1. **Prof. Rajat Moona**
Director, IIT Gandhinagar
***Data Security for end-to-end applications in distributed applications 26 April 2024***

2. **Prof. Kathrin Altwegg**
Professor Emeritus, Department of Space Research and Planetology, University of Bern
***Deciphering the origin and evolution of our solar system from the chemical composition of 67P 22 May 2024***

3. **Dr. Dinesh Kumar Aswal**
Director, Health, safety and environment group, BARC
***Radiation, nuclear energy and environment 12 June 2024***

4. **Dr. Harshil Mehta**
Zonal Head of Emergency Medicine, Marengo CIMS Hospital, Ahmedabad
***Basic Life Support (BLS) and Cardiopulmonary Resuscitation (CPR) 24 July 2024***

5. **Shri Nilesh M. Desai**
Director and Distinguished Scientist, Space Applications Centre, Ahmedabad
***Trends in Indigenous Space Technologies for Societal Applications 14 August 2024***

6. **Prof. Takashige Omatsu**
Director, Molecular Chirality Research Center, Chiba University, Japan
***Structured light for materials science 25 September 2024***

7. **Prof. Narinder Mehra**
Honorary Emeritus scientist, ICMR, Former Dean and National chair of All India Institute of Medical Sciences, New Delhi Vice President (International Affairs), INSA
***The twin crises of climate change and antimicrobial resistance: impact on health 21 October 2024***

8. **Prof. Hisayoshi YuriMoto**
Hokkaido University Faculty of Science, Department of Natural History Sciences, Earth and Planetary System Science, Hokkaido University (HokuDai), Japan
***Asteroid Sample Return 20 November 2024***

9. **Dr. Alexei Pevtsov**
National Solar Observatory, Boulder, Colorado, USA
***Research in Synoptic and High-Resolution Solar Physics at the US National Solar Observatory 18 December 2024***

10. **Prof. Shailendra Saraf**
National Institute of Pharmaceutical Education and Research (NIPER), Ahmedabad
***Healthcare system in India: ancient to contemporary 29 January 2025***

11. **Dr. V. Narayanan**
Secretary, Department of Space, Chairman, ISRO Chairman, Space Commission
***Propulsion System for Launch Vehicles and Satellites 18 February 2025***

12. **Prof. Sharada Srinivasan**
National Institute of Advanced Studies (NIAS), Bengaluru
***A Journey in Archaeometallurgy 26 March 2025***

**PRL ka Amrut Rajbhasha Vyakhyaan**

1. **Mr. Praveen Prakash Ambasth**
Deputy Chief Commissioner, Department of Empowerment of Persons with Disabilities (Divyangjan) Ministry of Social Justice and Empowerment, Government of India
***Constitutional Guidelines: Civil Services with the Constitution of India 09 April 2024***

2. **Dr. Nityesh Bhatt**
Professor and Head of Department, Information Management, Nirma University, Ahmedabad
***Brief description of Industry 4.0 31 May 2024***

3. **Shri Siba Prasad Hota**
   Registrar Indian Institute of Technology (IIT), Indore
   ***The story of building a world-class institution: lessons and challenges 21 June 2024***

4. **Mr. Utkrisht Pandey**
   Marcelon Agrofarms, Former Assistant Commandant, Border Security Force
   ***Self-reliance through agroforestry and traditional-natural farming 31 July 2024***

5. **Mr. Neeraj Kumar Pathak**
   Joint Director, Ministry of Defence, New Delhi
   ***Mountaineering and adventure sports 28 August 2024***

6. **MG Som Shekaran Nair**
   Joint Director, Official Language, Department of Space, Bengaluru
   ***Role of mother tongue in the overall development of the nation 27 September 2024***

7. **Dr. Nupur Birenbhai Ojha, Clinical Psychologist**
   Gips Hospital, Ahmedabad
   ***Managing Emotions At Workplace 23 October 2024***

8. **Dr Jitendra Sharma**
   Director Pandit Deendayal Upadhyaya National Institute for the Physically Handicapped, New Delhi
   ***Role of national institutions in the field of physical disability 25 November 2024***

9. **Dr Chirag Dave**
   Founder and Veterinary Surgeon - Dr. Chirag Dave Pets Clinic, Ahmedabad
   ***The balance of coexistence: animal-human conflict in urban environments 26 December 2024***

10. **Mr. Ujjwal Shukla**
    Chief Editor (News) Nai Duniya, Jabalpur Edition
    ***Changing dimensions of journalism 27 January 2025***

11. **Dr. Tejas S. Doshi**
    Family Physician Brand Ambassador "Cleanliness is Service", Motivational Speaker, Nature Activist
    ***Environmental protection, cleanliness, and plastic liberation: An essential duty of democracy 20 February 2025***

12. **Mr. Gaurav Seth**
    Co-Founder, Piercy Space and Chief Executive Officer
    ***My Entrepreneurial Journey in Space Tech 19 March 2025***

**Prof. Ravipati Raghavarao Memorial Lecture**

- **Dr. Sanjib Kumar Agarwalla**
  Associate Professor - G, Institute of Physics, Bhubaneswar, Odisha, India
  ***Imaging the Deep Earth with Neutrinos 21 February 2025***

**Dr. Bibha Chowdhuri Memorial Lecture**

- **Prof. Sharada Srinivasan**
  National Institute of Advanced Studies (NIAS), Bengaluru
  ***A Journey in Archaeometallurgy 26 March 2025***

# Conference/Symposium/Workshop organized by PRL

### Solar Physics

1. “USO-PRL 2$^{nd}$ Winter School”, Udaipur Solar Observatory, PRL, 9-13 Dec, 2024..
2. “Solar and Heliospheric Science with the SKAO and its Precursors Workshop”, 43rd meeting of the Astronomical Society of India (ASI), 15-19 February 2025, National Institute of Technology Rourkela, Odisha.
3. “Indo-German Solar Physics Workshop: ”Two Eyes on the Sun – Aditya-L1 and Solar Orbiter””, The Indo-German Solar Physics Workshop, titled “Two Eyes on the Sun – Aditya-L1 and Solar Orbiter”, was held online on March 19, 2025..

### Planetary Sciences

4. “Pre-conference Workshop (Karyashala) on ”Hands-on Lab Analysis and Study of Meteorites””, PRL, Ahmedabad, 18-19 November, 2024.
5. “Vikram Discussion-II”, PRL, Ahmedabad, 2 January, 2025.
6. “Venus Science Conference (Venus-SC 2024)”, PRL, Ahmedabad, 23-24 September, 2024.
7. “International conference on Meteoroids, meteorites and Meteors: Messengers from Space (MetMeSS-2024)”, PRL, Ahmedabad, 20-22 November, 2024.

### Geosciences

8. “3$^{rd}$ FGRC-2025”(Frontiers in Geosciences Research Conference), February 5–7, 2025.
9. “Emerging Trends in Hydrology Research: An Indian Perspective”, 20 September 2024.

### Theoretical Physics

10. “Vikram Discussion on Neutrino Astrophysics”, from 19/03/2025 to 21/03/2025, PRL.

### Computer Networking and Information Technology (CNIT) Division

11. “Parallel Programming and Concepts of AI”, A three-day High Performance Computing (HPC) training workshop on “Parallel Programming and Concepts of AI” during July 01-03, 2024.

### Atomic, Molecular and Optical Physics

12. “SCOP-the Students’ conference in optics and photonics”, PRL, Ahmedabad.
13. “Vikram Discussions, VD-II (Astrobiology & Astrochemistry)”, Vikram Discussions, VD-II (Astrobiology & Astrochemistry), on $2^{nd}$ January, 2025.
14. “DIG Astrochemistry - 2: Icy Dust Astrochemistry Workshop”, PRL in collaboration with Aarhus Institute of Advanced Studies, Aarhus and IASES, Kolkata organised a one-day DIG Astrochemistry - 2: Icy Dust Astrochemistry Workshop on 25th June, 2024.
15. “Astrophysical Dust Ices: Insights from recent telescopes”, 10 March 2025, PRL.

# Invited Talks at Conference / Symposia / Workshops

**Astronomy and Astrophysics**

**Abhijit Chakraborty**

1. “The Legacy of EPRV at PRL”, Structured Training Programme (STP), ISRO HQ, Devanahalli, 19 Dec, 2024.
2. “Exoplanet: How to detect them? The legacy of exoplanet sciences at PRL”, ISRO START Programme, ISRO HQ, 20 Jan 2024.
3. “Exoplanet Sciences in India”, Structured Training Program (STP) on ”Multi-Wavelength Astronomy with Ground- and Space-based Facilities, PRL, Ahmedabad, 25 - 29 Nov, 2024.

**Arvind Singh Rajpurohit**

4. “Dusty Atmosphere of Cool M dwarfs”, Workshop on “Astrophysical Dust Ices: Insights from Recent telescopes”, Physical Research Laboratory, 10 Mar, 2025.

**Aveek Sarkar**

5. “Physics of Solar Wind”, Eighth Aditya-L1 Support Cell Workshop, Indian Institute of Technology, Indore, 27 Sep, 2024.
6. “Upper atmosphere of sun and the solar wind”, 2nd winter school on Solar physics, Udaipur Solar Observatory, PRL, Udaipur, 13 Dec, 2024.

**Ashok K. Singal**

7. “Our peculiar motion in the Universe vs. the Cosmological Principle”, International Symposium “Space-science, Astrophysics and Cosmology”, ISSAC, Banguluru, 20 - 22 Nov, 2024.

**Manash Samal**

8. “The life cycles of star formation in Galactic molecular clouds”, Ahmedabad Astrophysics Meet-I, Ahmedabad University, Ahmedabad, 22 Feb, 2025.
9. “Sub-mm to Meter Wavelength Astronomy: New Sciences and Emerging Trends”, ISRO Structured Training Program on Multi-wavelength Astronomy with Ground and Space based Facilities, PRL Ahmedabad, 25 - 29 Nov, 2024.

**Mithun NPS**

10. “Solar studies with Daksha”, Second Daksha Science Workshop, IUCAA Pune, 30-31 Mar, 2025.
11. “An Introduction to Observational High-Energy Astrophysics”, ISRO Structured Training Program on Multi-wavelength Astronomy with Ground and Space based Facilities, PRL Ahmedabad, 25 - 29 Nov, 2024.
12. “The X-ray Sun: A Brief Introduction to Solar X-ray Astronomy”, CSSTEAP online short course on Solar Physics, USO, PRL, 02-06 Sept, 2024.

**Mudit K. Srivastava**

13. “Development of ProtoPol: a medium resolution echelle spectro-polarimeter for PRL 1.2m and 2.5m telescopes, Mt. Abu, India”, Ground-based and Airborne Instrumentation for Astronomy X, SPIE Astronomical Telescopes + Instrumentation 2024, Yokohama, Japan, 16-21 June 2024.
14. “Design and Development of Spectro-polarimeters for PRL Telescopes”, 1st Indo-Thai Symposium on Astrophysics and Technology Development (ITSAT 2024), Chiang Mai, Thailand, 26 - 28 Aug, 2024.

**Santosh Vadawale**

15. “5 Years of Solar X-ray observations with Chandrayaan-2/XSM”, Indo-German Solar Physics Workshop - “Two Eyes on the Sun – Aditya-L1 and Solar Orbiter”, PRL Ahmedabad, 19 Mar, 2025.
16. “Hard X-ray Polarimetry with AstroSat-CZTI”, Recent Trends in the study of Compact Objects: Theory and Observation (RETCO-VI), Indian Institute of Technology, Indore, 10 Mar, 2025.
17. “Introduction To Time-Domain X-ray Astronomy”, ISRO Structured Training Program on Multi-wavelength Astronomy with Ground and Space based Facilities, PRL Ahmedabad, 25 - 29 Nov, 2024.
18. “GRB Prompt Emission Polarization - Why & How?”, Transients 2024 meeting, Indian Institute of Technology - Bombay, Mumbai, 1 April, 2024.

**Sachindra Naik**

19. “X-ray Astronomy : An Approach to Understand Compact Objects”, ISRO Structured Training Program on Multi-wavelength Astronomy with Ground and Space-based Facilities, PRL Ahmedabad, 25 - 29 Nov, 2024.

**Veeresh Singh**

20. “Multiwavelength observational perspectives of Active Galactic Nuclei”, Ahmedabad Astrophysics Meet-I, Ahmedabad, 22 Feb, 2025.

**Abhijit Kayal**

21. “X-ray view jetted narrow-line Seyfert 1 galaxies”, ”, Conference on Blazars and Restless AGN : A High Energy View, ., 24 - 26 Jul, 2024.

**Arup Kumar Maity**

22. “Cloud-cloud collision: Formation of hub-filament systems and associated gas kinematics”, Physics of Extreme Massive Stars, Observatório Nacional, Rio de Janeiro, Brazil, 24 - 28 Jun, 2024.
23. “From collision to creation: Origin of hub-filament systems through cloud-cloud collision”, XXXII IAU General Assembly, Cape Town, South Africa, 5 - 16 Aug, 2024.

**Birendra Chhotaray**

24. “Long-term study of the first Galactic ultraluminous X-ray source Swift J0243.6+6124 using NICER”, BeXRB2024 meeting, Cape Town, South Africa, 31 Jul - 2 Aug, 2024.

**K. Aravind**

25. “Unveiling Cometary Composition: Importance of Spectroscopic Follow-up in the Era of Large Discovery Surveys”, 32nd IAU General Assembly, Cape Town, South Africa, 6 - 15 Aug, 2024.

**Naval Kishor Bhadari**

26. “On the Formation of Massive Stars in Filamentary Clouds: Importance of the Edge Collapse Process”, XXXII IAU General Assembly, Cape Town, South Africa, 5 - 16 Aug, 2024.
27. “NIRCAM Imaging of Star-forming region G11P1”, JWST Data Analysis and Processing Workshop (Southeast Asia), Chiang Mai, Thailand, 24 Jun - 5 Jul, 2024.
28. “Early Phase and Initial Conditions of Galactic Massive Star Formation”, A focused conference, KIAA-PKU, China, 1 - 2 Jul, 2024.

**Omkar Ratan Jadhav**

29. “Role of Magnetic fields in Star-formation: New Insights into the Galactic ‘Snake’ IRDC G11.11-0.12”, XXXII IAU General Assembly, Cape Town, South Africa, 5 - 16 Aug, 2024.

**Solar Physics**

**A. Raja Bayanna**

30. “Understanding & Exploring the Sun”, YUva VIgyani KAryakram (YUVIKA-2024), IIRS, Dehradun, 21/05/2024.

**Ramit Bhattacharyya**

31. “CME initiation and its characteristic evolution in the low corona”, Workshop-3, ASI-2024, ISRO HQ, 20/01/2024.
32. “Data-constrained magnetohydrodynamic simulation of solar coronal transients”, PSSI-2024, PDEU, Gandhinagar, 17/12/2024.

**Brajesh Kumar**

33. “GONG Program: Sounding the Solar Interior”, Recent Trends and Developments in Science and Technology, B.N. University, Udaipur, 01/05/2024.

**Anshu Kumari**

34. “Particle Acceleration by Shocks and Radio Bursts”, ASI Symposium 002: Particle acceleration in the Sun and Heliosphere, Arul Anandar College, Madurai, 16/12/2024 – 18/12/2024.
35. “Solar Radio Observations: Statistical Insights and Solar Cycle Variability”, Solar cycle variability: From understanding to making predictions, ARIES, Nainital, 14/10/2024 – 18/10/2024.

**Bhuwan Joshi**

36. “Exploration of the Sun and Sun-Earth system: Aditya-L1 perspective”, Recent Trends and Developments in Science and Technology (RTDST-2024), Bhupal Nobles’ University, Udaipur, 01/05/2024-02/05/2024.
37. “Solar flares and flare-CME association: present understanding and prospects with Aditya-L1 observations”, Workshop on Solar Physics, Space Research Centre Polish Academy of Sciences, Wrocław, Poland, 13/05/2024.
38. “Magnetic Reconnection and Particle Acceleration in Solar Flares Revealed Through Multi-Wavelength Observations”, Astronomical Society of India (ASI) Symposium on “Particle Acceleration and Space Weather Impacts”, Arul Anandar College, Madurai, 16/12/2024-18/12/2024.
39. “The Sun: Our Daytime Star”, IUCAA- sponsored Introductory workshop on Astronomy and Astrophysics, Dolphin (PG) Institute of Biomedical and Natural Sciences (DIBNS), Dehradun, 18/12/2024-20/12/2024.
40. “Unresolved Science of Solar Eruptions: Aditya-L1 Perspectives”, IUCAA-sponsored Introductory workshop on Astronomy and Astrophysics, Dolphin (PG) Institute of Biomedical and Natural Sciences (DIBNS), Dehradun, 18/12/2024-20/12/2024.
41. “Exploration of the Sun and Sun-Earth System”, National Symposium on National Science Day 2025, JECRC University, Jaipur, 28/03/2025.

**Nandita Srivastava**

42. "Ground-based Solar and Geomagnetic Observatories of the World", Space Weather Training Course for the Indian Armed Forces Met Officers, CESSI, Kolkata, 15/07/2024–26/07/2024.
43. "Variable Sun: CMEs and Space Weather", 2nd Workshop on Space Weather Science and Opportunities, IIT Roorkee, 0510/2024–06/10/2024.
44. "A Space Weather Modelling Framework to Estimate Dst Index at 1 AU", BIRA-IASB Seminar, Belgian Institute for Space Aeronomy, Brussels, Belgium, 02/05/2024.
45. "National ISWI Activity", ISWI Steering Committee Meeting, Vienna, Austria, 07/02/2025.
46. "ISRO-RESPOND Basket Projects at PRL", Space Research Opportunities in North East – An ISRO Academia Collaboration Effort (RESONANCE) Interest Exploration workshop, Gauhati University, Guwahati, 08/08/2024.
47. "Research Areas in Space Sciences", Research Areas in Space Sciences, Technology and Applications, IIT, Guwahati, 09/08/2024.
48. "Research Areas of PRL", ISRO Academia Day, IIST, Thiruvananthapuram, 10/12/2024.

**Planetary Sciences**

**Varun Sheel**

49. "Brainstorming Meeting on Space Science Roadmap Formulation", Solar System Exploration, URSC, Bangalore, 22 April - 23 April, 2024.
50. "Turbulence in the Boundary Layer of Mars", $6^{th}$ Indian Planetary Science Conference (IPSC)-2025, IIT Roorkee, 4 March - 7 March, 2025.
51. "Panel Discussion: Future Indian Planetary Missions: Scope and Development", $6^{th}$ Indian Planetary Science Conference (IPSC)-2025, IIT Roorkee, 4 March - 7 March, 2025.
52. "Panel discussion: Current challenges for future planetary explorations and modelling studies of planetary ionospheres and atmospheres", $45^{th}$ COSPAR Scientific Assembly 2024, Busan, South Korea, 13 July - 21 July, 2024.
53. "Panel Discussion", Venus Science Conference, PRL, Ahmedabad, 23 Sep - 24 Sep, 2024.
54. "Planetary Atmospheres", CSSTEAP, -, 9 Sep - 13 Sep, 2024.
55. "Panel Discussion: Theoretical Studies to Understand Planetary Processes", (START) programme of ISRO, -, $9^{th}$ May, 2024.
56. "Panel Discussion: Comparative Planetary Aeronomy", $2^{nd}$ Workshop on Space Weather Science and Opportunities, IIT Roorkee, 5 Oct - 7 Oct, 2024.

**Jayesh Pabari**

57. "Interplanetary Dust Science: Observations, Results and Research Opportunities, SAMVAAD, A Multidisciplinary Symposium", Silver Oak University, Ahmedabad, Ahmedabad, 5 December, 2024.
58. "Interplanetary Dust Science: Observations, Results and Research Opportunities", $2^{nd}$ Short Term Programme, MMTTC, IIT Gandhinagar, 6 January, 2025.
59. "Interplanetary dust in the inner solar system and its detection", Venus Science Conference (Venus-SC 2024), PRL, Ahmedabad, 23 Sept - 24 Sept, 2024.
60. "Panel Discussion: Interplanetary Dust Science", Venus Science Conference, PRL, Ahmedabad, 23 Sept - 24 Sept, 2024.
61. "Panel Discussion: Lightning and Habitability", Venus Science Conference, PRL, Ahmedabad, 23 Sept - 24 Sept, 2024.

**M Shanmugam**

62. "Fundamentals of Planetary Instrumentation", CSSTEAP, -, 09 Sept - 13 Sept, 2024.
63. "Science Payload Electronics - Challenges", Specialised Structured Training Programme (SSTP) in Space Science: Challenges in Science Experiments, Spacecraft and Mission Operations, URSC Bangalore, URSC Bangalore, 23 Sept - 26 Sept, 2024.
64. "Particle Detectors for Space Missions", ASI Symposium 002 - Particle Acceleration in the Sun and Heliosphere, Arul Anandar College, Madurai, Madurai, Tamilnadu, 16 Dec - 18 Dec, 2024.

**Ramakant R. Mahajan**

65. "Indian Meteorites", International conference on Meteoroids, meteorites and Meteors: Messengers from Space (MetMeSS-2024), PRL, Ahmedabad, 20 Nov - 22 Nov, 2024.
66. "An overview of meteorites and meteorite study", Hands-on Lab Analysis and study of Meteorites Workshop, PRL, Ahmedabad, 18 Nov - 19 Nov, 2024.

**Amit Basu Sarbadhikari**

67. "Planetary Differentiation", CSSTEAP short course on "PLANETARY SCIENCE, -, 9 Sept - 13 Sept, 2024.
68. "Geochemical evolution of Mars", Distinguished Speaker of National Space Day. Parul University - Vadodara, Vadodara, 23 August, 2024.

**Kinsuk Acharyya**

69. "Understanding the impact of diffusion of CO in the astrochemical models", American Chemical Society Spring Meeting, 2025 (San Diego, CA$<$ USA), San Diego, USA, 23 March - 27 March, 2025.
70. "Studying Venus using Balloon Probe", Venus-SC-2024, PRL, Ahmedabad, 23 Sept - 24 Sept, 2024.

**Neeraj Srivastava**

71. “Quest for the Moon: India’s Space Saga”, National Space Day celebrations, Department of Physics, GGDSD College Chandigarh, -, 23 August, 2024.
72. “Lunar Science and Key advancements from Chandrayaan-3 mission”, National Space Day celebrations, Amar Singh College, Srinagar, Jammu and Kashmir, -, 22 August, 2024.

**K. Durga Prasad**

73. “Keynote address on “Role of Thermophysical Modeling in Science and Exploration of the Moon”, $5^{th}$ International Conference on Recent Advances in Mechanical Infrastructure (ICRAM-2025), IITRAM, Ahmedabad, Ahmedabad, 10 Jan - 12 Jan, 2025.
74. “Distinct thermophysics at lunar high latitudes and poles: Insights through recent observations and improved 3-D modelling”, $21^{st}$ Annual meeting of Asia Oceania Geosciences Society (AOGS-2024) held at Pyeongchang, South Korea, Pyeongchang, South Korea, 23 June - 28 June, 2024.
75. “Prospecting the Moon: Insights and opportunities from recent missions”, $6^{th}$ Indian Planetary Science Conference (IPSC)-2025, IIT Roorkee., IIT Roorkee, 4 March - 7 March, 2025.

**K Durga Prasad (on behalf of Neeraj Srivastava)**

76. “Role of Ancient impact basins in facilitating late stage volcanism on the Moon: New Insights”, AOGS $21^{st}$ Annual Meeting 2024, South Korea, South Korea, 25 June, 2024.

**Vijayan**

77. “Chandrayaan 3 mission: Exploring the Moon”, $4^{th}$ International Conference on Geology: Emerging Methods and Applications (GEM-2025), Kerala, 28 Jan - 30 Jan, 2025.

**Rishitosh Kumar Sinha**

78. “Satellite Remote Sensing and Geospatial Technologies”, Short Term Course on Geospatial Technologies: Theory, Practice and Future Directions, Lovely Professional University., Punjab, 24 March - 29 March, 2025.
79. “Fundamentals of Remote Sensing Techniques”, Short Term Course on Geospatial Technologies: Theory, Practice and Future Directions, Lovely Professional University, Punjab, 24 March - 29 March, 2025.
80. “Martian analogues study with a focus on Indian sites”, One Day Online Workshop on ”MARTIAN SURFACE, ANALOGUES AND ATMOSPHERE”, IIRS Dehradun, Dehradun, 12 March, 2025.

**Megha Bhatt**

81. “The lunar regolith: Unveiling Its Composition and Significance”, Department of Space, Planetary and Astronomical Science and Engineering (SPASE), IIT Kanpur, Kanpur, 3 October, 2024.
82. “Airless Planetary Bodies of our solar system”, CSSTEAP short course on Planetary Science, -, 11 September, 2024.

**S. A. Haider**

83. “Trace gases in the lower atmosphere of Mars: Effect of GDS 2018”, $6^{th}$ Indian Planetary Science Conference (IPSC)-2025, IIT Roorkee., IIT Roorkee, 4 March - 7 March, 2025.
84. “Effects of magnetic fields on Venus and Mars’ ionosphere”, Venus Science Conference, PRL, Ahmedabad, 23 Sept - 24 Sept, 2024.
85. “Chemistry of hydrated, nitrogenized and deuterated cluster ions in the lower atmosphere of Mars: TGO measurements”, $45^{th}$ COSPAR, Busan, South Korea, 13 July - 21 July, 2024.

**Debabrata Banerjee**

86. “Envisioning future of the Solar System”, ISRO START Program, ISRO, 16 January, 2025.
87. “The Solar System”, CSSTEAP Course on Planetary Science, ISRO, 9 September, 2024.
88. “Optically Stimulated and Thermally Stimulated Luminescence: Application to Space Dosimetry”, $5^{th}$ Workshop on Luminescence Dating and its Applications, PRL, Ahmedabad, 23 February, 2024.

**Dwijesh Ray**

89. “Meteorites: Messengers from the Solar System”, Space science and Technology Awareness Training (START-2024), -, 24 April - 10 May, 2024.

**Anil Bhardwaj**

90. “Lunar Science Program of India”, Keynote Talk at International Conference on Advances in Aerospace and Energy Systems (IAES- 2024), LPSC, Valiamala, Thiruvananthapuram, 4-6 April 2024.
91. “Vedic Applications in Science and Technology”, Special Talk at Indian Think Council Meeting on Design and Development of International Vedic Sciences Research Centre at Naimisharanya, Lucknow, 25 April 2025.
92. “Indian Lunar Exploration Program”, Talk at Agency Panel, European Lunar Conference, The Open University (OU), Scotland, 17 June 2024.
93. “Indian Planetary Exploration Program”, International Academy of Astronautics (IAA) Day Lecture, BEXCO COSPAR, Busan, South Korea, 13 July 2024.

94. "Indian Lunar Exploration Program", $45^{th}$ COSPAR Scientific Assembly, Busan, South Korea, 15 July 2024.
95. "Recent Advances in Science and Future Indian Planetary Exploration Program", $45^{th}$ COSPAR Scientific Assembly, Busan, South Korea, 16 July 2024.
96. "Planetary Missions of India: Instruments Review and Science", $45^{th}$ COSPAR Scientific Assembly, Busan, South Korea, 14 July 2024.
97. "Indian Planetary and Space Missions", Plenary Talk at $3^{rd}$ Indian Space Weather Conference, IIT Roorkee, 7 October 2024.
98. "Indian Lunar Exploration Program: Past, Present and Future", Plenary Talk at $6^{th}$ URSI Regional Conference on Radio Science (RCRS), organised by ARIES and Graphic Era Hill University (GEHU), Bhimtal, 22-25 October 2024.
99. "Indian Moon Mission", International Conference on Meteoroid, Meteor, Meteorites: Messengers from Space (MetMESS-2024), PRL, Ahmedabad, 20-22 November 2024.
100. "Planetary and Space Missions of India", Inaugural Talk at Macau International Forum on Space and Planetary Sciences, MUST, Macau, 8 Jan 2025.
101. "Indian Lunar Mission", Plenary Talk at International conference on Space for Sustainability: Science, Technology, Education and Policy (S2: STEP 2025) and $6^{th}$ Indian Planetary Science Conference (IPSC-2025), IIT Roorkee, 4 March 2025.

**Space and Atmospheric Sciences**

**Duggirala Pallamraju**

102. "Space Weather Effects on Equatorial Regions: Complexities and Implications", 45th COSPAR General Assembly, Busan, South Korea, 14 -20 July, 2024.
103. "First ground-based daytime red line observations of stable auroral red arcs and storm enhanced densities — signatures of plasmasphere-ionosphere interactions in the daytime", 45th COSPAR General Assembly, Busan, South Korea, 14 -20 July, 2024.
104. "Space Weather Effects and Challenges of Forecasting", Advanced training for Meteorological Officers (ATMOS), Air Force Academy, Hyderabad, 24 Sept, 2024.
105. "Inaugural Lecture: Overview of Space Weather", : 2nd Space Weather School and Opportunities, Indian Institute of Technology Roorkee, Roorkee, 05-06 Oct, 2024.
106. "Evolution of Space Research in India and current opportunities for Space Weather research", 2nd Space Weather School and Opportunities, Indian Institute of Technology Roorkee, Roorkee, 05 – 06 October 2024.
107. "Solar Wind-Ionosphere-Thermosphere Interactions as Measured in the Daytime OI 630.0nm Emissions from Sondrestromfjord, Greenland by the Ground-based High Resolution Imaging Spectrograph", 3rd Indian Space Weather Conference (ISWC2024), Indian Institute of Technology Roorkee, Roorkee, 07 – 09 October 2024.
108. "In-situ techniques for plasma motion & densities, and introduction to DISHA (Disturbed and quiet time Ionosphere-thermosphere System at High Altitudes) Mission", Workshop on Ionospheric Measurement Techniques and Instrumentation; 6th URSI-RCRS Bhimtal, UK, 22 Oct 2024, Graphic Era Hill University, Bhimtal, UK, 22 Oct, 2024.
109. "Vertical Coupling of Atmospheres", CSSTEAP, Online Short Course on "Earth's Atmosphere and Climate, Physical Research Laboratory, Ahmedabad, 25 Oct, 2024.
110. "The Earth's Upper Atmosphere and Space Weather", Inspiring the Minds of Post-graduates for Research in Earth and Space Sciences (IMPRESS-2025), Indian Institute of Geomagnetism, Navi Mumbai, 28 Feb,2025.
111. "Investigations of Space Weather effects on Earth's Ionosphere - thermosphere through Space-based measurements", International Conference on Space for Sustainability: Science, Technology, Indian Institute of Technology Roorkee, Roorkee, 04 – 07 March 2025.

**S. Ramachandran**

112. "Dust Particles: Characteristics, Radiative and Climate Impact", 18th International Global Atmospheric Chemistry (IGAC), World Trade Centre, Kuala Lumpur, Malaysia, 9-13 September 2024.
113. "Aakash 2.0 The way ahead and challenges", The International workshop on air pollution in the northwestern India and future perspectives organized by Research Institute for Humanity and Nature (RIHN), Japan and Indian Institute of Technology (IIT), Delhi, Indian Institute of Technology (IIT), Delhi, 12-13 March 2025.

**Dibyendu Chakrabarty**

114. "Payload Performance and Finalized Specifications", Aditya-L1 Payload Performance Appraisal and Data Release Meet, ISRO Headquarters, Bengaluru, 6 January 2025.
115. "Holistic investigations of space weather through Aditya-L1 mission combined with proposed DISHA mission and a potential magnetospheric mission of India", IMPRESS-2024 ("Inspiring the Minds of Post-Graduates for Research in Earth and Space Sciences"), Indian Institute of Geomagnetism (IIG), Navi Mumbai, 13 February 2025.
116. "Capturing solar wind through ASPEX instrument in Aditya L1 mission", Invited talk arranged for National Science Day, University of Engineering & Management, Kolkata, 8 March 2024.
117. "Aditya Solar Wind Particle Experiment (ASPEX)", The 42nd meeting of the Astronomical Society of India (ASI), Indian Institute of Science (IISc), Indian Space Research Organisation (ISRO) and Jawaharlal Nehru Planetarium (JNP), Bengaluru, 31 Jan – 4 Feb 2024.
118. "ICME and impact on Magnetosphere-Ionosphere system", The 42nd meeting of the Astronomical Society of India (ASI), Indian Institute of Science (IISc), Indian Space Research Organisation (ISRO) and Jawaharlal Nehru Planetarium (JNP), Bengaluru, 31 Jan – 4 Feb 2024.

119. "Reaching for the Sun through Aditya-L1", National Science Day celebration, Physical Research Laboratory, Ahmedabad, 6 March 2024.
120. "Aditya Solar wind Particle Experiment on-board India's Aditya-L1 mission", United Nations/Germany Workshop on the International Space Weather Initiative: Preparing for the Solar Maximum, Neustrelitz, Germany, 10-14 June 2024.
121. "Near-Earth Space and Sun-Earth connection", Overview of Space Science Exploration course, : Indian Institute of Remote Sensing, Dehradun, 18 June 2024.
122. "Touching solar wind with ASPEX on-board Aditya-L1: New possibilities", National Space Day Celebration, Dibrugarh University, Dibrugarh, 20 August 2024.
123. "Touching solar wind through Aditya Solar wind Particle Experiment (ASPEX) on-board Aditya-L1 mission of India", Invited talk arranged for National Space Day Celebration, Central University of Tamilnadu, Thiruvarur, 6 September 2024.
124. "Science using Aditya Solar wind Particle EXperiment (ASPEX) data", 8th workshop of Aditya-L1 Support Cell workshop, Indian Institute of Technology, Indore, 27-29 September 2024.
125. "Interaction of Solar wind with inner planets", 8th workshop of Aditya-L1 Support Cell workshop, Indian Institute of Technology, Indore, 27-29 September 2024.
126. "Potential of ASPEX Measurements in the Investigation of Space Weather", 3rd Indian Space Weather Conference, 2024, Indian Institute of Technology, Roorkee, 7-9 October 2024.
127. "Solar wind and Magnetosphere", 2nd Workshop on Space Weather Science and Opportunities, Indian Institute of Technology, Roorkee, 5-6 October 2024.
128. "Interaction of Solar wind with Mars and Venus", Venus Science Conference 2024, Physical Research Laboratory, Ahmedabad, 23-24 September 2024.
129. "Aditya-L1 mission of India and Aditya solar wind Particle EXperiment (ASPEX)", Global Space-based Inter-Calibration System (GSICS), GRWG SWx Sub-group meeting, Online Meeting, 18 December 2024.
130. "Investigations on Solar and Space weather processes using ASPEX on-board Aditya-L1 mission of India", USO-PRL winter school on Solar physics, Udaipur Solar Observatory, Udaipur, 09-13 December, 2024.
131. "Recent results on solar wind and suprathermal ions in the interplanetary medium and the relevance of Aditya Solar wind Particle EXperiment (ASPEX) on-board Aditya-L1", Sun, Space Weather, and Solar-Stellar connection, Indian Institute of Astrophysics (IIA), Bengaluru, 20-24 January 2025.
132. "Heliospheric physics using particles as probes", First AL1SC Teacher's Training Workshop, Homi Bhaba Centre for Science Education (HBCSE), TIFR, Mumbai, 3 March 2025.
133. "Probing Solar Wind and Energetic Particles using ASPEX Onboard Aditya-L1", Joint Indo-German Solar Physics Workshop "Two Eyes on the Sun – Aditya-L1 and Solar Orbiter, Physical Research Laboratory, Ahmedabad, 19 March 2025.

**Lokesh Kumar Sahu**

134. "Atmospheric measurements of NMVOCs over the Indian subcontinent and surrounding oceanic regions: Study of Air Quality and Chemistry-Climate interactions", Webinar on Environmental Air Monitoring: Methodologies, Regulations, and Market Trends, organized by Agilent and Markes International, Physical Research Laboratory, Ahmedabad, 20 August 2024.
135. "Long-term and campaign-based measurements of VOCs and other reactive trace gases", The International workshop on air pollution in the northwestern India and future perspectives Indian Institute of Technology (IIT) – Delhi, Indian Institute of Technology (IIT), Delhi, 12-13 March 2025.
136. "Trace gases in the earth's atmosphere: Study of climate change and air quality", UN Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), Physical Research Laboratory, Ahmedabad, 21-25, Oct 2024.
137. "Challenges in atmospheric measurements of trace", UN Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), Physical Research Laboratory, Ahmedabad, 21-25, Oct 2024.

**Ravindra Pratap Singh**

138. "Airglow Processes", UN Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), Physical Research Laboratory, Ahmedabad, 21-25, Oct 2024.

**K Venkatesh**

139. "Longitudinal differences in the TEC variability around the EIA crest regions and the role of electrodynamics and coupling processes", 45th COSPAR Scientific Assembly (COSPAR-2024), Bexco, Busan, South Korea, 13-21 July 2024.
140. "Effect of F-layer peak parameters on the uncertainties in estimating ionospheric electron density profiles and Total Electron Content (TEC) over the low latitudes", 45th COSPAR Scientific Assembly (COSPAR-2024), Bexco, Busan, South Korea, 13-21 July 2024.
141. "Topside ionospheric modelling", :Workshop on Ionospheric measurement techniques and instrumentation, Graphic Era University, Bhimtal, Uttarakhand, 22 October 2024.
142. "Introduction to Ionosphere", 2nd Workshop on space weather science and opportunities, Indian Institute of Technology, Roorkee, 5 October 2024.

**Narendra Ojha**

143. "AI/ML Applications for Simulating Atmospheric Tracers", Ultrafine Aerosol Processes and Numerical Modeling of Urban Climate Extremes, Indian Institute of Technology Madras, Chennai, 24-26 Feb, 2025.

**Jacob Sebastian**

144. "ASPEX STEPS", 6th Aditya-L1 Science Support Cell Workshop, JECRC University, Jaipur, 6-8th Feb 2024.

145. “ASPEX/STEPS - Science, Instrument and Data Analysis”, 7th workshop of Aditya-L1 Support Cell workshop, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, 29 May 2024.

**Abhishek Kumar**

146. “Aditya-L1 ASPEX-SWIS - instrument capabilities, data acquisition, and processing techniques and scientific applications of SWIS data in space weather & solar wind”, 7th Aditya-L1 Science Support Cell Workshop, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, 28 May 2024.
147. “Aditya-L1 ASPEX-SWIS - instrument capabilities, data acquisition, and processing techniques and scientific applications of SWIS data in space weather & solar wind”, 8th workshop of Aditya-L1 Support Cell workshop, Indian Institute of Technology, Indore, 27 September 2024.

**Geosciences**

**Arvind Singh**

148. “Isotope Ratio Mass Spectrometry in Biogeochemical Cycling”, INSA-SCOR workshop on marine biogeochemistry, NIO,Goa., 27th March 2025.
149. “Nitrogen Isotopes in the Ocean Biogeochemistry?”, Visiting Talk, BHU, Varanasi, 5th Sep 2024.
150. “Winter mixing mediating N2 fixation in the Arabian Sea”, Visiting talk, MIO, Marseille, France, 6th May 2024.

**Neeraj Rastogi**

151. “Nanomaterials Toxicity and Life Cycle Analysis”, Nanomaterials: Recent Advances and Future Prospects, IIT, Gandhinagar, 10-11 December 2024.
152. “Aerosol Chemical Composition: Intricacies of Measurements”, Atmospheric Aerosol Instrumentation (NT-AAI), Indian Institute of Tropical Meteorology (IITM), Pune, 30th September - 4th October 2024.

**Sanjeev Kumar**

153. “Paleo-environmental and Paleo-fire reconstruction of the Himalayan region using lake sediments”, Paleo-environmental and Paleo-fire reconstruction of the Himalayan region using lake sediments, Indian Institute of Geo-magnetism, Mumbai, 24th December 2024.

**M. M. Sarin**

154. “Atmospheric Brown Carbon from biomass burning emissions in Northern India”, 3rd Frontiers in Geosciences Research Conference (FGRC-2025), Physical Research Laboratory, Ahmedabad., 5th February - 7th February 2025.
155. “Atmospheric Nanoparticles – Implications to chemistry-climate interaction”, 2nd Frontiers Symposium in Earth, Environmental and Sustainability Sciences 2025, Indian Institute of Science & Education Research (IISER), Thiruvananthapuram, 7th February -8th February 2025.
156. “Uranium in sea water: Inferences on bottom water anoxia during the last glacial maximum”, Refresher Course in Earth System Sciences, Malaviya Mission Teacher Training Centre, University of Kashmir, Kashmir (J & K), 5th March 2025.
157. “Tracers in the ocean”, INSA-SCOR Workshop, CSIR-NIO, Goa, 26th March -28th March 2025.
158. “Atmospheric deposition of chemical constituents to ocean”, INSA-SCOR Workshop, CSIR-NIO, Goa, 26th March -28th March 2025.

**Amzad Hussain Laskar**

159. “Reconstruction of past tropospheric oxidants and temperature variation using clumped isotopes in ice core air O2”, IsoNET ECR, Isotopologue Network for Early Career Researchers (ECR), Europe, 27th November, 2024..

**Theoretical Physics**

**Srubabati Goswami**

160. “The curious case of the sterile neutrino”, Trends in Astroparticle and Particle Physics, IMSc Chennai, 25/09/2024 to 27/09/2024.
161. “The Neutrino Landscape”, 17th International Conference on Interconnections between Particle Physics and Cosmology 2024 (PPC 2024), IIT Hyderabad, 14/10/2024 to 18/10/2024.
162. “Neutrinoless Double Beta Decay from Scalar Leptoquarks: Interplay with Neutrino Mass and Flavor Physics”, CERN Neutrino Platform Pheno Week Workshop, CERN Geneva, 17/02/2025 to 21/02/2025.

**Namit Mahajan**

163. “Charm loop Effects in $\mathrm{B} \to \mathrm{K}^{(*)}\ell\ell$ with Kaon DAs at low q2”, IITGN Flavor Physics Week: Exploring Quark and Lepton Frontiers, IIT Gandhinagar, 06/03/2024.

**Partha Konar**

164. “Physics Meets Deep Learning”, From Big Bang to Now : A Theory-Experiment Dialogue, SRM University, AP-Amaravati, 24/01/2025.
165. “The AI/ML Driven Future of Particle Physics and Cosmology”, Frontiers of Particle Physics, CHEP, IISC, Bengaluru, 10/08/2024.
166. “Probing the dark matter in an era of AI/ML”, Dark Matter and Astroparticle Physics (WDMAP@IoP), IOP, Bhubaneswar, 08/08/2024.

167. “From Atom to Algorithm: Particle Physics in an Era of AI/ML”, Faculty Development Program on Computational techniques using HPC in Physical Sciences, Jaypee Institute of Information Technology (JIIT) Noida, 22/07/2024.
168. “Symbolic Regression in Machine Learning PySR”, ML4HEP - 2024, IOP Bhubaneswar, 10/07/2024.
169. “Discussion on AI/ML in research”, Recent trends and developments in science and technology, Department of Physics, Bhupal Nobles’ University, Udaipur, 01/05/2024.

**Navinder Singh**

170. “Green’s function formalism in condensed matter physics”, Topical school of advanced condensed matter physics, IOP, Bhubaneswar, 20/05/2024 to 31/05/2024.

**Paramita Dutta**

171. “Bogoliubov Fermi surfaces: origin, pairing, and transport signatures”, Engineered 2D Quantum Materials, International Centre for Theoretical Sciences, Bengaluru, 26/07/2024.
172. “Gaplessness of superconducting gap”, Emerging trends in Quantum Condensed Matter Physics (EQCMP) 2024, Institute of Physics, Bhubaneswar, 23/08/2024.

**Udit Khanna**

173. “Quantum Hall Phase Diagram of Bilayer Graphene”, Young Investigator’s Meet on Quantum Condensed Matter Theory 2024, IISER Pune, India, 16/12/2024 to 18/12/2024.
174. “Quantum Hall Phase Diagram of Bilayer Graphene”, 7th Annual Conference on Quantum Condensed Matter, IIT Guwahati, India, 20/12/2024 to 23/12/2024.

**Satyajit Seth**

175. “Decoding NLP logs and demystifying the complexity”, Conference on Cosmology, Astrophysics and Particle Physics, SRM Institute of Science and Technology, Chennai, India, 30/01/2025 to 02/02/2025.

**Animesh Chatterjee**

176. “BSM searches @protoDUNE-SPS”, LLP2024 conference, Tokyo, Japan, 01/07/2024 - 05/07/2024.
177. “Overview of the Sterile neutrino searches and the status of the ICARUS/SBN experiment”, PIC 2024 conference, Athens, Greece, 22/08/2024 - 25/08/2024.
178. “BSM searches at the protoDUNE”, Neutrinos@CERN, CERN, Geneva, 23/01/2025 - 25/01/2025.

**Atomic, Molecular and Optical Physics**

**B. K. Sahoo**

179. “An Overview of Atomic Methods to Estimate Nuclear Charge Radii from Isotope Shifts”, An Invited Talk at International Workshop on “Electroweak Precision Intersections (EPIC 2024), Geremeas, Cagliari, Italy, 23 September- 27 September, 2024.
180. “Implementation Challenges to Study Odd-parity Properties using Coupled-cluster Theory in the Spherical Coordinate System”, An invited talk at the “14th International Conference on Relativistic Effects in Heavy-Element Chemistry and Physics (REHE), Amsterfoot, Netherlands, 7 October - 11 October, 2024.
181. “Testing Atomic Many-body Methods through High-Precision Calculations”, An invited talk at the “24th National Conference on Atomic and Molecular Physics (NCAMP 2025), IIT Dhanbad, Jharkhand, 08 January - 11 January, 2025.
182. “Revisiting Atomic Energy Levels to Probe Fundamental Physics”, An invited talk at “International Conference on Emerging Trends in Physics (ICETP-2025)” along with the 41st Annual Convention of the Orissa Physical Society (OPS), KIIT University, Bhubaneswar, 08 February - 10 February.
183. “Accurate Determination of Target Wave Functions in Electron-Atom Scattering Problems”, An invited talk at the conference on “ECR and Accelerator-Based Atomic Mo lecular Physics and Related Topics (ECAAMP-2025), TIFR, Mumbai, 06 March - 8 March, 2025.

**G.K.Samanta**

184. “Quantum sensing using Hong-Ou-Mandel interferometry of single photon”, An invited talk at Photonics for Energy, sensing and Education (PESE-2025), IIT Gandhinagar, 16 January - 17 January, 2025.
185. “Quantum sensing using Hong-Ou-Mandel interferometry”, An invited talk International Conference on Emerging Trends in Optical Technologies (ETOT-I), SRM University, Andhra Pradesh, 02 January - 04 January, 2025.
186. “Development of quantum sources and their applications”, An invited talk at Photonics 2024, IIT Kharagpur, 12 December - 15 December, 2024.
187. “Spatial structured heralded single photons”, An invited talk at XLVII OSI Symposium on Advances in Optics and Photonics Instrumentation (OPTO In-2024), CSIR-CSIO Chandigarh, 23 October - 25 Octobe,r 2024.
188. “Quantum imaging of biological sample using Hong-Ou-Mandel interferometry”, An invited talk at BRICS WORKSHOP ON BIOPHOTONICS - 2024, Department of Atomic and Molecular Physics, MAHE, Manipal, India, 03 October - 05 October, 2024.
189. “Classical and quantum optics experiments using spatial structured beams”, An invited talk at Tutorial lecture, Summer School on Optics and Photonics (SOP 24), IISc Bangalore, 08 July - 12 July, 2024.

**B. Sivaraman**

190. “Low and high temperature astrochemistry”, An invited talk at The Collisions Physics and Chemistry and their Applications conference (COPCA-2024), Univeristy of Malta, Malta, 15 October - 18 October, 2024.
191. “Astrobiology & Astrochemistry Current status”, An invited talk at Brainstorming meeting on Space Science Road Map Formulation, U R Rao Space Center, 23 April, 2024.

**Naveen Chauhan**

192. “Introduction to Luminescence Dating and Some Recent Advances”, An invited talk in a workshop on ‘Constraining the Little Ice Age in the Western Himalaya’ organized by HNB Garhwal Central University, HNB Garhwal Central University, Srinagar, 08 March, 2025.
193. “Scientific Heritage through Physics”, An invited talk at Online Winter School on ’Scientific Disciplines to Study the Glorious Heritage of Bharat: a 10 Days Online Lecture Series’, Heritage Society, 06 January, 2025.
194. “Luminescence dating for archaeology”, An invited talk in PALAEOSCHOOL-V (2024), PALAEOSCHOOL-V (2024), 16 November, 2024.

**Rajesh Kumar Kushwaha**

195. “Two-color laser field induced ionization of atoms and molecules: Tunnel electron induced processes”, An invited talk at International Conference on Ultrafast Nonlinear Optics and Optical Spectroscopy (UNOOS), Indian Institute of Science Education and Research Mohali (IISER Mohali, Panjab), 10 December - 12 December, 2024.
196. “Quantum control and attosecond delay in photoionization induced by two-color laser field”, An invited talk at National Seminar on Recent Trends in Atomic Collision Physics, Department of Physics, Ramakrishna Mission Residential College, Kolkata, West Bengal, 20 December - 21 December, 2024.
197. “Strong-field ionization of atoms and molecules: Study of tunnel electrons induced reactions”, An invited talk at ECR and Accelerator-Based Atomic Molecular Physics and Related Topics (ECAAMP-2025), TIFR Mumbai, Maharashtra, 06 March - 08 March, 2025.

**Prashant Kumar**

198. “Solar Wind Ion Spectrometer on-board Aditya-L1 spacecraft”, An invited talk at Aditya-L1 Workshop, IIST, Trivandrum, 03 June - 06 June, 2024.
199. “First observations and instrument capabilities of SWIS”, An invited talk at Solar cycle variability: From understanding to making prediction, Aries Nainital, October - 18 October, 2024.

**Shashi Prabhakar**

200. “Long-distance Quantum Communication”, An invited talk at Workshop on Quantum Technology, Woxsen University, Hyderabad, 01 August, 2024.

**Satyendra Nath Gupta**

201. “Observing strong coupling in plasmonic cavities at the limit of a single quantum emitter”, Tropical Conference “Ultrafast photonics and Quantum science”, PRL, Ahmedabad, 15 February - 17 February, 2024.
202. “Observing strong coupling in plasmonic cavities at the limit of a single quantum emitter”, An invited talk at International Network in Space Quantum Technologies Workshop, PRL Ahmedabad, 20 March - 22 March, 2024.
203. “Observing strong coupling in plasmonic cavities at the limit of a single quantum emitter”, An invited talk at International workshop on Photonics for Energy, Science and Education, IIT Gandhinagar, 16 January - 17 January, 2025.

**Tanmoy Chakraborty**

204. “Progress in quantum communication and metrology: my research overview”, Invited as an ’outstanding young researcher’ for participating and presenting (flash talk and poster) in the 13th Indo-German Frontiers of Engineering Symposium (international), Mumbai, 05 December - 08 December, 2024.

**Dipen Sahu**

205. “From Molecular Cores to Protoplanetary Disks: Insights from (sub)Millimeter Astronomy into the Physical and Chemical Pathways of Star and Planet Formation”, An invited talk at NCRA-TIFR Colloquium, Tata Institute of Fundamental Research, Pune, 17 Mar, 2025.
206. “Multiscale Observations of Starless Cores: Visualizing Core Evolution from Collapse to Centrally Dense (Sub)structures and First Core-like Nucleus”, An invited talk at URSI Regional Conference on Radio Science (RCRS), ARIES/GEHU, Bhimtal, India, 22 Oct - 25 Oct, 2024.
207. “From Molecular Core to Star and Planet Formations, and Our Astrochemical Origin”, An invited talk at Aries, ARIES/GEHU, Bhimtal, India, 25 Oct, 2025.

# Lectures at Universities / Institutions

**Astronomy and Astrophysics**

**Arvind Singh Rajpurohit**

1. “The Fundamental Parameters of Very Low Mass Stars”, Konkoly Thege Miklós Astronomical Institute, Budapest, September 12, 2024
2. “Exoplanets: How We Find and Investigate”, National Innovation Foundation-India, Gandhinagar, Gujarat, India, August 23, 2024

**Lokesh Kumar Dewangan**

3. “Celestial bodies”, YUVIKA students at SAC, Ahmedabad, May 14, 2024
4. “Space-based Astronomy in UV and Infrared Wavelengths: Studying the Hidden Universe”, STP PRL 2024 at PRL, Ahmedabad, November 27, 2024
5. “The Formation of Massive Stars: New Evidence, New Perspectives”, National Astronomical Research Institute of Thailand (NARIT), Chiangmai, Thailand, December 17, 2024
6. “Probing the Physical Processes Involved in Forming Massive Stars”, National Astronomical Research Institute of Thailand (NARIT), Chiangmai, Thailand, December 18, 2024

**Manash Samal**

7. “Understanding the Formation and Early Evolution of Star Clusters”, Ahmedabad University, Ahmedabad, September 04, 2024

**Mithun N. P. S.**

8. “An X-ray Perspective on Multi-scale Solar Flares: Spectroscopy to Polarimetry”, Leibniz-Institut für Astrophysik Potsdam (AIP), Germany, July 10, 2024

**Mudit K. Srivastava**

9. “Polarization Measurements in Astronomy: Instruments and Science”, National Seminar: Quantum Scale to Cosmic Structures, Central University of Kerala Kasaragod, Kerala, India, March 3 - 4, 2025
10. “Multi-wavelength Exploration of Symbiotic Binaries and Novae through Diverse Instrumentation”, Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune, India, May 2, 2024

**Santosh Vadawale**

11. “The Alpha Particle X-ray Spectrometer (APXS) onboard Pragyan rover of the Chandrayaan-3 mission - an incredible journey”, Colloquium, Inter-University Centre for Astronomy & Astrophysics, January 30, 2025
12. “APXS onboard Pragyan/Chandrayaan-3 - An Incredible Journey”, Atomic & Molecular Physics Division, Bhabha Atomic Research Center, Mumbai, November 19, 2024

**Sunil Chandra**

13. “Understanding the emission mechanisms and the particle acceleration in astrophysical jets”, Physics Department Colloquium, IIT Jodhpur, November 13, 2024
14. “Multi-Messenger Astronomy: Introductory perspectives”, ISRO’s Structured Training Program (STP), 2024 on Multi-wavelength Astronomy with Ground and Space-based Facilities, PRL Ahmedabad, November 25 - 29, 2024

**Shashikiran Ganesh**

15. “Comets & Planets, ground-based observations”, Online Short course on Planetary Science organized by CSSTEAP and PRL, September 9 - 13, 2024
16. “Minor Bodies: Comets, Asteroids and Meteors”, ISRO Space science and Technology Awareness Training (START-2024) programme talks organized by ISRO HQ and IIRS, Dehradun, May 1, 2024
17. “Telescopes for Solar System Studies”, ISRO Space science and Technology Awareness Training (START-2024) programme talks organized by ISRO HQ and IIRS, Dehradun, May 6, 2024
18. “Observing the Universe from spaceship Earth”, : IIT Gandhinagar symposium on “Celebrating India’s Space Exploration”, organized by IITGN, August 10, 2024

**Vishal Joshi**

19. “Exoplanets and life components”, YUVIKA students at SAC, Ahmedabad, May 15, 2024
20. “An Introduction to the Ground Based Astronomy”, ISRO’s Structured Training Program (STP), 2024 on Multi-wavelength Astronomy with Ground and Space-based Facilities, PRL Ahmedabad, November 25 - 29, 2024
21. “Scaling the Universe”, Dept. of Physics, Saurashtra University, Rajkot, March 7, 2025

#### Solar Physics

#### A Raja Bayanna

22. “Image formation & Adaptive Optics”, Lecture delivered and two practicals taken during USO-PRL $2^{nd}$ Winter School at USO., 09/12/2024 - 13/12/2024
23. “Instrumentation for Spectroscopy of the Sun”, Lecture delivered during Online Short Course on Solar Physics, conducted by PRL under the auspices of CSSTEAP, affiliated to the United Nations, 02/09/2024-06/09/2024

#### Girjesh Gupta

24. “Introduction to Coronal Heating”, Lecture delivered during USO-PRL $2^{nd}$ Winter School at USO., 09/12/2024 - 13/12/2024
25. “Introduction to Coronal Heating”, Lecture delivered during Online Short Course on Solar Physics, conducted by PRL under the auspices of CSSTEAP, affiliated to the United Nations, 02/09/2024-06/09/2024

#### Brajesh Kumar

26. “Solar Internal Structure, Dynamics and Helioseismology”, Lecture delivered and practical taken during USO-PRL $2^{nd}$ Winter School at USO., 09/12/2024 - 13/12/2024
27. “Solar Structure and Dynamics with one practical session”, Lecture delivered during Online Short Course on Solar Physics, conducted by PRL under the auspices of CSSTEAP, affiliated to the United Nations, 02/09/2024-06/09/2024

#### Anshu Kumari

28. “An introduction to Solar Radio Astronomy”, Lecture delivered during USO-PRL $2^{nd}$ Winter School at USO., 09/12/2024 - 13/12/2024
29. “Basics of Solar Radiophysics”, Lecture delivered during Online Short Course on Solar Physics, conducted by PRL under the auspices of CSSTEAP, affiliated to the United Nations, 02/09/2024-06/09/2024
30. “Solar energetic particles and its connection with radio observations”, Lecture delivered during 8th Aditya L1 Support Cell Workshop, IIT Indore, 27/09/2024-29/09/2024

#### Nandita Srivastava

31. “The Sun’s Role in Driving Space Weather”, Lecture delivered during USO-PRL $2^{nd}$ Winter School at USO., 09/12/2024 - 13/12/2024
32. “CMEs and space weather impacts”, Lecture delivered during Online Short Course on Solar Physics, conducted by PRL under the auspices of CSSTEAP, affiliated to the United Nations, 02/09/2024-06/09/2024
33. “Coronal Mass Ejections – Introduction, CMEs and Space Weather Impact, Ground-based Solar Observations”, Three lectures delivered during COSPAR Capacity Building Workshop, Samarkand State University, 19/08/2024–30/08/2024
34. “Heliospheric Propagation of CMEs”, Lecture at Space Physics Laboratory (SPL),Thiruvananthapuram, 09/12/2024

#### Bhuwan Joshi

35. “Multi-Wavelength Exploration of Solar Flares: Current Understanding and Future Perspectives”, lecture during Indo-German Solar Physics Workshop “Two Eyes on the Sun – Aditya-L1 and Solar Orbiter, 19/03/2025
36. “Exploring Solar Eruptions and Space Weather through Remote Sensing and In-Situ Observations: A Perspective”, Lecture delivered at Indian Institute of Remote Sensing (IIRS), Dehradun, 03/03/2025
37. “The Sun: An overview and Solar Eruptive Phenomena”, Two lectures delivered during CSSTEAP Online Short Course on Solar Physics, 22/05/2024-26/05/2024
38. “Sun, Solar Eruptive Phenomena, and Space Weather: A Perspective”, Lecture delivered during ISRO Structured Training Program (STP) - Multi-Wavelength Astronomy with Ground- and Space-based Facilities, 25/11/2024-29/11/2024
39. “Exploration of the Sun, Moon, and Sun-Earth System”, Lecture delivered during Special Session on Space Sciences toward National Space Day (NSpD) 2024 Celebrations at Indian Institute of Management (IIM), Udaipur, 22/08/2024
40. “Exploration of the Sun and Space Weather”, Foundation Day Lecture at Dr. D. S. Kothari Institute for Education and Research, Udaipur, 06/07/2024

#### Ramit Bhattacharyya

41. “Data-constrained magnetohydrodynamic simulation of solar coronal transients”, Colloquium delivered at IPR, Gandhinagar, 06/12/2024

#### Planetary Sciences

#### Kinusk Acharyya

42. “Astrochemistry: Understanding our Chemical Cosmos”, Lecture at Ahmedabad University, November 20, 2024

#### Rishitosh Kumar Sinha

43. “Chandrayaan-3 Pragyan rover’s journey and observations near Shiv-Shakti point”, Indian National Society for Aerospace and Related Mechanisms (INSARM), Bangalore Chapter, URSC Bangalore, August 09, 2024

#### Megha Bhatt

44. “Planetary exploration missions: Discoveries and future directions.”, ISRO-STP, PRL, November 28, 2024

**Anil Bhardwaj**

45. “Indian Space Science Missions”, Foundation Day Lecture of NCPOR, Goa, April 5, 2024
46. “Planetary Science Missions of India”, Invited Lecture, The Energy Research Institute (TERI), New Delhi, April 29, 2024
47. “Past, Present and Future of Indian Lunar Exploration Program”, Special Talk at 50 years of Dept. of Geology, HNB Garhwal University, Srinagar, Uttrakand, March 7, 2025

**Space and Atmospheric Sciences**

**Duggirala Pallamraju**

48. “What is research and why should one pursue it?”, Orientation session for Research Scholars, 19 Feb, 2025

**S. Ramachandran**

49. “Basic aspects of Earth’s atmosphere”, UN CSSTEAP Online short course on “Earth’s atmosphere and climate change, 21-25 October 2024
50. “Aerosols, Climate and Climate Change”, UN CSSTEAP Online short course on “Earth’s atmosphere and climate change, 21-25 October 2024
51. “Anthropogenic aerosols: Chemistry, Observations and Modeling”, Online short course on “Air Pollutants: Implications, monitoring and modelling, 18-22 November 2024
52. “Air Pollution”, Invited Lecture at Anant National University, 14 February 2025

**Dibyendu Chakrabarty**

53. “Solar wind and IMF”, GNSS -05 (Space weather and GNSS), SAC, ISRO, Ahmedabad, 19 February 2025
54. “Interaction of solar wind with Magnetosphere”, GNSS -05 (Space weather and GNSS), SAC, ISRO, Ahmedabad, 19 February 2025

**Lokesh Kumar Sahu**

55. “”Trace gases in the earth’s atmosphere: Study of climate change and air quality””, Online Short course on Earth’s Atmosphere and Climate Change, PRL, 21-25 October, 2024
56. “Challenges in atmospheric measurements of trace gases”, Online Short course on Earth’s Atmosphere and Climate Change, PRL, 21-25 October, 2024

**K. Venkatesh**

57. “Space weather: Role of Global Navigational Satellite Systems”, Public Lecture at School of Earth Sciences, 20 September 2024

**Narendra Ojha**

58. “Deciphering Natural and Human Impacts on Atmosphere Through Sophisticated Modeling”, Mathematical and Physical Sciences Divisonal Seminar Series, 18 Sept, 2024

**Geosciences**

**Arvind Singh**

59. “‘Sustainable forest management’ and ‘Coastal zone management’”, To the III semester M.Sc. students at Gujarat University, Ahmedabad,, June-August 2024
60. “Lectures on Climate action, Life below Water, and Life on the Water”, UGC-HRDC at Pondicherry University by Pondicherry University, 29 Aug 2024
61. “Error Analysis course”, UN CSSTEAP students at SAC, Ahmedabad, Jan 2024

**Theoretical Physics**

**Srubabati Goswami**

62. “Analytic treatment of neutrino oscillation and decay in matter”, Invited talk delivered at Technical University of Munich, offline, 04/07/2024
63. “Neutrino Mass and Mixing”, IITGN Flavour Physics Week: Exploring Quark and Lepton Frontiers, IIT Gandhinagar, offline, 05/03/2025 to 06/03/2025
64. “Neutrino Mass and Mixing”, Understanding the Universe through Neutrinos, ICTS, Bengaluru, offline, 22/04/2024 to 03/05/2024

**Partha Konar**

65. “Micro to Macro: Search for fundamental building blocks of nature”, Department of physics students at Swami Shukdevanand College, Shahjahanpur, Uttar Pradesh, online, 13/09/2024

**Ketan M. Patel**

66. “Quantum Mechanics”, A set of twelve lectures delivered at the Advanced BSc summer school, St. Xavier’s College, Ahmedabad, offline, 11/05/2024 to 30/05/2024

**Paramita Dutta**

67. “Investigating Andreev interferometers: conventional and unconventional ways”, Invited Seminar Lecture delivered at Indian Institute of Technology, Kanpur, offline, 04/04/2024
68. “Investigating Andreev interferometers by tools of statistical mechanics”, Invited Seminar Lecture delivered at Indian Institute of Technology, Kanpur, offline, 08/04/2024
69. “Diode effects in superconductor Josephson junction”, Invited Seminar delivered at Birla Institute of Technology and Science Pilani, Rajasthan, offline, 21 Feb 2025

**Debika Debnath**

70. “Josephson diode effect in quantum dot-based junction”, Invited Seminar delivered at University of Hamburg, Germany, offline, 08/08/2024
71. “Gate-tunable Josephson diode effect in quantum dot-based heterojunction”, Invited Seminar delivered at Indian Institute of Technology, Guwahati, offline, 02/01/2025

**Satyajit Seth**

72. “Event generation, Parton shower, Matching and Merging”, Invited lectures on QCD Lecture series organised by CMS India, TIFR, Mumbai , offline, 01/07/2024 to 05/07/2024

**Computer Networking and Information Technology (CNIT) Division**

**Jigar Raval**

73. “Domain Name System”, Delivered an expert talk on ‘Domain Name System’ at Pandit Deendayal Energy University (PDEU), Gandhinagar on 02/August/2024., August 2, 2024
74. “Anatomy of Email Headers and Phishing”, Delivered an expert talk on ‘Anatomy of Email Headers and Phishing’ at L. D. College of Engineering on April 30, 2024., April 30, 2024

**Girish Padia**

75. “Understanding the Anatomy of Web Server and Domain Name System”, Delivered an expert talk on “Understanding the Anatomy of Web Server and Domain Name System”,Pandit Deendayal Energy University on August 02, 2024, August 02, 2024
76. “Deep dive into most common web attack”, Delivered an expert talk on ‘Deep dive into most common web attack’, LD College of Engineering, Ahmedabad on April 30, 2024., April 30, 2024

**Atomic, Molecular and Optical Physics**

**B. K. Sahoo**

77. “Introduction to Atomic Structure Calculations for Experimentalists”, A series of lectures delivered at Institute for Nuclear and Radiation Physics of the Department of Physics & Astronomy, Faculty of Science, KU Leuven, Belgium, September 27 - October 7, 2024

**B. Sivaraman**

78. “Laboratory Astrochemistry”, A lecture delivered at Aarhus Institute of Advanced Studies, Aarhus University, Denmark, May 24, 2024
79. “Laboratory Astrochemistry”, A lecture delivered at Sathyabhama University, Chennai, India, August 19, 2024
80. “Laboratory Astrochemistry - Cold & Hot”, A lecture delivered at Indira Gandhi Centre for Atomic Research(IGCAR), Kalpakkam, Chennai,India, December 5, 2024
81. “Laboratory Astrochemistry”, A lecture delivered at University of Kent, UK, June 6, 2024
82. “Simulating space in the laboratory”, A lecture delivered at ISRO - START programme, ISRO HQ, May 3, 2024
83. “Laboratory Astrochemistry-Astrobiology”, A lecture delivered at Indian Association for the Cultivation of Science, Kolkata. Mode: Offline, 18 Feb 202, February 18, 2025
84. “Laboratory astrochemistry”, A lecture delivered at Bankura Christian College, Bankura, West Bengal, February 19, 2025

**Tanmoy Chakraborty**

85. “Optical interfaces for quantum communications: frequency multiplexing and hybrid protocols”, A seminar given at I-HUB Quantum Technology Foundation (hosted in IISER Pune), Department of Science and Technology, India in the ’Quantum Seminar Series’, July 30, 2024

# Science Outreach Talks by PRL Scientists

### Solar Physics

#### Bhuwan Joshi

1. “Conversation on National Space Day (NSpD)”, A radio conversation on NSpD on the Akashvani -All India Radio (AIR), Udaipur, on 23-08-2024
2. “Space Exploration”, Chief Guest on National Space Day (NSpD) at the Adinath Sr. Sec. School, Udaipur, on 23-08-2024
3. “Space Exploration”, International Level Expert Talk under Rashtriya Avishkar Abhiyan at the PM Shree Govt. Sen. Sr. Sec. School, Sukher, Udaipur, Rajasthan, on 20-02-2025
4. “The Sun and Solar Explosion”, International Level Expert Talk under Rashtriya Avishkar Abhiyan at the PM Shree Govt. Sen. Sr. Sec. School, Balua, Salumbar, Rajasthan, on 03-01-2025
5. “space walk”, International Level Expert Talk under Rashtriya Avishkar Abhiyan at the PM Shree Govt. Sen. Sr. Sec. School, Karda, Udaipur, on 22-03-2025

#### Ananya Rawat

6. “The Sun: Our Daytime Star”, A lecture delivered at the At USO-PRL, on 01-12-2024

### Planetary Sciences

#### Kinusk Acharyya

7. “Search for extraterrestrial life”, Lecture at NIT Meghalaya on National Space Day, on 23-08-2024

#### S Vijayan

8. “Exploring Opportunities in Space Science and Technology: A Journey with PRL”, Saffrony Institute of Technology and S.P.B. Patel Engineering College, on 04-02-2025

#### Rishitosh Kumar Sinha

9. “Chandrayaan-3 Mission: Insights from Pragyan Journey on the Moon”, Popular talk on National Space Day at NIT Meghalaya, on 23-08-2024
10. “Touching Lives while Touching the Moon: India’s Space Saga”, Popular talk on National Space Day at Lovely Professional University, Phagwara, India, on 23-08-2024

#### Megha Bhatt

11. “Our Celestial Neighbour: Moon”, National Space Day, Gitam University, Bengaluru, on 23-08-2024
12. “Indian Lunar Missions”, Planetary Science Club (online), on 20-12-2024

#### Anil Bhardwaj

13. “Indian Lunar Mission”, Summer Camp for Young Researchers on Science Technology & Innovation (STI), GUJCOST-DST, Govt of Gujarat, Ahmedabad, on 05-06-2024
14. “Indian Lunar Exploration Program”, Special Invited Talk on the National Space Day Celebrations at Mohan Babu University, Tirupati, on 08-08-2024
15. “Chandrayaan-3 Mission”, Talk at Induction Program of NIT, Uttarakhand, on 28-08-2024
16. “Indian Lunar Exploration Program”, Sainik School Teachers’ Training- PRATIBADDHTA Batch 3, IITE, on 19-09-2024
17. “Indian Space Exploration programme”, Lecture for Science India Forum - India International Schools in Saudi Arabia, on 30-09-2024
18. “Lunar Exploration Missions of India”, Special Talk at India International Student Festival, IIT Guwahati, on 02-12-2024
19. “Indian Lunar Exploration Program”, Science Day Talk, BITS KK Birla Campus, Goa, on 28-02-2025

### Space and Atmospheric Sciences

#### Duggirala Pallamraju

20. “Human Resource Development at PRL”, Industry Meet at Physical Research Laboratory, on 28-11-2024

#### Dibyendu Chakrabarty

21. “Aditya Solar Wind Particle Experiment (ASPEX) on board Aditya L1 Mission of India”, ISRO science outreach program at 25th Rashtra Katha Shivir in Village Pransla, Tehsil Upleta, District Rajkot, Gujarat, on 28-12-2024

### Geosciences

#### Arvind Singh

22. “Interaction with class-5 students on ocean and climate”, Ahmedabad International School, on 04-03-2024

#### Theoretical Physics

#### Srubabati Goswami

23. “The Neutrino Odyssey: From an Impossible Dream to the Unreachable Star”, Colloquium, Krea University, Colloquium, on 24-09-2024
24. “The quest for the elusive neutrino : The Nobel Journey”, Online talk organized by the Indian Academy of Sciences and the SOA University, Bhubaneswar, online, on 05-10-2024
25. “Mystery of the missing particle”, Talk delivered at Debkunda Madrasa under INSA outreach programme, offline, on 28-10-2024
26. “The Neutrino Landscape”, Talk delivered at WeCOS programme of Indian Physics Association, Tezpur University, offline, on 19-11-2024
27. “Women in Physics : Challenging the Status Quo”, Talk delivered at IITGN Flavour Physics Week: Exploring Quark and Lepton Frontiers, IIT Gandhinagar, offline, on 08-03-2025

#### Partha Konar

28. “2024 Nobel Prize in Physics”, Talk delivered at Nobel Laureate Lecture Series 2025 at KBR Auditorium, Tezpur University, Assam, online, on 28-01-2025
29. “Computation & Data Analytics - Modelling, Simulation & AI/ML”, Talk delivered for Industry Meet’24 at PRL, Ahmedabad, offline, on 28-11-2024
30. “Scientific Advancement - In an era of Artificial Intelligence”, Talk delivered for Advance BSc student training program at PRL , offline, on 21-05-2024
31. “In an era of Artificial Intelligence”, Talk delivered for PRL NSD program school children, offline, on 06-03-2024

#### Paramita Dutta

32. “Introduction to Superconductivity”, Talk delivered at PRL Navrangpura, offline, on 12-08-2024

#### Atomic, Molecular and Optical Physics

#### Satyendra Nath Gupta

33. “Discovery of Raman scattering”, A talk delivered on National Science Day, PRL, Ahmedabad, on 26-02-2025

# Area Seminar by visitors

**Dr Mirjana Povic**

1. “The African Network of Women in Astronomy (AfNWA) and SciGirls: Examples of social activism”, Space Science and Geospatial Institute, Ethiopia, on 20-03-2025

**Dr Suman Bala**

2. “Gamma-Ray Bursts (GRBs) as electromagnetic (EM) counterparts of Gravitational Wave (GW) sources”, USRA Huntsville, Alabama, USA, on 04-03-2025

**Dr Soumya Sengupta**

3. “Hot Jupiter Exoplanets: The Enigmatic Giants of Astrophysics”, Institut de Ciències de l’Espai-CSIC in Barcelona, Spain, on 04-03-2025

**Dr. Biswajit Mondal**

4. “Solar Coronal Phenomena: Imaging X-ray Spectroscopy”, NASA Marshall Space Flight Center, Huntsville, Alabama, USA, on 11-02-2025

**Ms Pallavi Saraf**

5. “Tracing Cosmic Origins: Unveiling Element Formation Through Stellar Archaeology”, IIA Bengaluru, on 09-01-2025

**Prof. Mathias Schultheis**

6. “Diffuse Interstellar Bands in the Milky Way as seen by GAIA”, Observatoire de la Cote d’Azur, Nice, France, on 04-02-2025

**Dr Govind Nandakumar**

7. “Detailed exploration of the near infrared spectra of M giant stars to chemically characterise the inner Milky Way”, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, on 06-02-2025

**Dr. Manoj Mandal**

8. “Probing accretion process and emission mechanism of X-ray pulsars in multi-wavelength”, Vidyasagar University, West Bengal, on 08-01-2025

**Prof. Kunal Mooley**

9. “Gravitational wave and multi-messenger signals from compact binary mergers”, IIT, Kanpur, on 10-10-2024

**Dr. Hareesh Gautham Bhaskar**

10. “Resonant and Secular Evolution of Three Body Systems - With Applications to Planetary Systems and Gravitational Wave Sources”, Technion-Israel Institute of Technology, Israel, on 26-09-2024

**Dr Siddharth Maharana**

11. “FiberPol-6D- Spectropolarimetric Integral Field mode for the SAAO 1.9 m Telescope using fibres”, South African Astronomical Observatory, Cape Town, South Africa, on 29-07-2024

**Dr. Avik Kumar Das**

12. “Multi-wavelength study of Blazars”, IISER Mohali, on 18-07-2024

**Prof. Varun Bhalerao**

13. “Daksha: Indian Eyes on Transient Skies”, IIT-Bombay, on 15-04-2024

**Ms Nazma Husain**

14. “Gaining insight into radiative and variability phenomena of black hole X-ray binaries”, Jamia Millia Islamia, New Delhi, on 02-04-2024

**Prof. Agnes Fienga**

15. “Tides as a tool for deciphering internal structures of telluric planets, Professor, Observatiore de la Cote dAzur, Nice, France”, , on 05-02-2025

**Dr. Pietro Zucca**

16. “Radio Eyes for the Sun, Heliosphere and Ionosphere: Status and Plans for the LOFAR2.0 Era”, ASTRON (Netherlands Institute for Radio Astronomy), on 16-01-2025

**Dr. Ram Ajor Maurya**

17. “Seismology of the Structures and Dynamics of Magnetized Solar Plasma”, NIT Calicut, on 28-02-2025

**Mr. Bhinva Ram**

18. “Morphology and Evolution of Coronal Loops: A Stereoscopic Analysis”, Max Planck Institute for Solar System Research, Germany, on 24-02-2025

**Ms. Ketaki Deshpande**

19. “Electron Density Mapping: Insights from Radio and In-Situ Observations & EUHFORIA Modeling”, Royal Observatory of Belgium (ROB) and KU Leuven, Belgium, on 09-01-2025

**Dr. Alexander Warmuth**

20. “Studying Solar Flares with the X-ray Telescope STIX on Solar Orbiter”, Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany, on 05-12-2024

**Ms. Shruti Bhatporia**

21. “Fast Radio Bursts, a Recent Discovery in the Field of Transients”, University of Cape Town, South Africa, on 29-11-2024

**Dr. Marek Jerzy Stkeślicki**

22. “PROBA-3 Mission”, Solar Physics Division, Space Research Centre, Polish Academy of Sciences, Wrocław, Poland, on 25-11-2024

**Dr. Tomasz Maciej Mrozek**

23. “Understanding Solar Eruptions: Ongoing and Future Research Programs at Space Research Centre of Polish Academy of Sciences”, : Solar Physics Division, Space Research Centre, Polish Academy of Sciences, Wrocław, Poland, on 25-11-2024

**Dr. Arun Kumar Awasthi**

24. “Probing the Physics of Radiation and Particles Emitted During Energetically-Rich Solar Flares”, Marie Skłodowska-Curie Actions (MSCA) Fellow, Space Research Centre, PAS, Wrocław, Poland, on 21-11-2024

**Dr. Rahul Yadav**

25. “Flare Response in the Photosphere and Chromosphere: A Multi-line Spectropolarimetric Study”, Laboratory for Atmospheric and Space Physics, Boulder, Colorado, USA, on 04-10-2024

**Dr. Ranadeep Sarkar**

26. “Understanding the Space Weather Impact of Coronal Mass Ejections Utilising Observations and Modelling”, Space Physics Department, University of Helsinki, Finland, on 30-09-2024

**Prof. Debi Prasad Choudhary**

27. “Plasma Motion in Sunspots”, Professor and Chair, Department of Physics and Astronomy, Associate Director, San Fernando Observatory California State University Northridge, USA, on 25-06-2024

**Alok Kumar Ranjan**

28. “Radiative Cooling Processes in Earth’s Atmosphere during Extreme Space Weather Events”, Indian Institute of Technology (IIT) Roorkee, on 05-08-2024

**Sanchita Pal**

29. “Investigation, Prediction, and Detection of Space Weather”, GSFC/NASA, USA, on 05-11-2024

**Suman Chakraborty**

30. “Unraveling the mysteries of the Earth’s radiation belts: a giant space doughnut”, Northumbria University, UK, on 08-11-2024

**John Bosco Habarulema**

31. “Combining observations and modeling approaches to explain absence of ionosonde HF echoes during a geomagnetic storm”, South African National Space Agency (SANSA), South Africa, on 18-11-2024

**Pierdavide Coisson**

32. “UPC, IPGP, Paris”, Natural electromagnetic signals in space: how Swarm mission has become able to sense the ionospheric plasma below its altitude and prospects for the upcoming NanoMagSat mission, on 09-12-2024

**Riddhi Bandyopadhyay**

33. “Unravelling Multi-Scale Processes in Space Plasmas”, Princeton University, USA, on 17-12-2024

**Piyushkumar N. Patel**

34. “A New Lens on Aerosol-Cloud Retrievals: Advancing Satellite Remote Sensing with Polarimetric and Lidar Observations”, SRON Netherlands Institute for Space Research, on 09-01-2025

**Paulo Fagundes**

35. "Ionospheric disturbances due to Solar Flare and Coronal Mass Ejection - Space Weather impacts", UNIVAP, Brazil, on 10-03-2025

**Aroh Barjatya**

36. "Distributed high-cadence plasma measurements from Langmuir probes in planetary ionospheres", Embry-Riddle Aeronautical University, USA, on 11-03-2025

**Prof. Chris Clark**

37. "Progress in the Development of Integrated Petrochronological and Geodynamic Models of High- Grade Metamorphic Systems", Curtin University, Perth, Australia, on 03-09-2024

**Prof. Stephen Tooth**

38. "Are humans now the dominant geological agent?", Aberystwyth University, Wales, UK, on 08-01-2025

**Gwenael Berthet**

39. "Physical and Chemical Properties of Stratospheric Aerosols using Balloon Borne Instruments", CNRS, France, on 11-05-2024

**Sagnik Dey**

40. "Health risks of air pollution in a warming climate: Current evidence and New directions", IIT, Delhi, on 26-02-2025

**Dr. Shilpa Kastha**

41. "Let's slip into inspiral", Niels Bohr International Academy, Niels Bohr International Academy, on 05-04-2024

**Dr. Anirban Das**

42. "Dark Matter: the Enigma of our Cosmos", Seoul National University, South Korea, on 18-04-2024
43. "New Ways to Detect Light Dark Matter", Seoul National University, South Korea, on 19-04-2024

**Mr. Divyanshu Gola**

44. "Radio searches of Dark Matter in Dwarf Galaxies", Doon University, Dehradun, on 10-05-2024

**Ms. Anantshree Bhatt**

45. "Study of neutrino Oscillations in 2 and 3 flavour framework", Doon University, Dehradun, on 13-05-2024

**Ms. Chandrima Sen**

46. "Deciphering the Mysteries of the Long-Lived Particles at the colliders", IIT Hyderabad, on 03-06-2024

**Dr. Arghya Chattopadhyay**

47. "Mathematical tales of blackhole, gravity and machine learning", University of Mons, Belgium, on 06-06-2024

**Dr. N Rajeev**

48. "SMEFT analysis of charged lepton flavor violating B-meson decays", IACS Kolkata, on 10-06-2024

**Dr. Chandrodoy Chattopadhyay**

49. "Relativistic hydrodynamics and its applications in heavy-ion collisions", North Carolina State University, USA, on 20-06-2024
50. "Heavy-ion collisions and hydrodynamics", North Carolina State University, USA, on 31-07-2024
51. "Beyond standard hydrodynamics: Maximum-Entropy theory and the dynamics of critical fluctuations", North Carolina State University, USA, on 01-08-2024

**Prof. Saurabh Basu**

52. "Quasiperiodic potential induced corner states in a quadrupolar insulator: A paradigm for higher-order topology", IIT Guwahati, on 18-09-2024

**Dr. Debashis Banerjee**

53. "Efficient Quantum Field Theories for Quantum Computers", Saha Institute of Nuclear Physics, on 03-10-2024

**Mr. Abbas Tinwala**

54. "Quantum aspects of the conformal sector of gravity and torsion in 4D", IISER Bhopal, on 07-10-2024

**Dr. Sai Chaitanya Tadepalli**

55. "Large Blue Spectral Index from a Conformal Limit of a Rotating Complex Scalar", Indiana University, USA, on 22-10-2024

**Dr. Bhupal Dev**

56. “Neutrinos: Dirac or Majorana”, Washington University, on 26-11-2024
57. “Introduction to High-Energy Neutrino Astrophysics”, Washington University, on 02-12-2024

**Dr. Sudeep K. Ghosh**

58. “Unveiling the mechanism behind sign changes in the thermopower and Hall coefficient of strained Sr2RuO4”, IIT Kanpur, on 04-12-2024

**Dr. Adhip Agarwala**

59. “Surface Tension of a Topological Phase”, IIT Kanpur, on 06-12-2024

**Dr. Saptarshi Mandal**

60. “A leisurely walk through few exotic manifestation of interacting spin systems”, Institute of Physics, Bhubaneswar, on 11-12-2024

**Prof. Subhendra Mohanty**

61. “Effective theories at finite temperature”, IIT Kanpur, on 19-12-2024

**Sougata Biswas**

62. “Complete escape from localization on a hierarchical lattice: A Koch fractal with all states extended”, Presidency University, Kolkata, on 02-01-2025

**Dr. Amol V. Patwardhan**

63. “Exploding Stars, Shapeshifting neutrinos, and the Synthesis of Heavy Elements”, New York Institute of Technology, USA, on 16-01-2025

**Dr. Abhishek Samanta**

64. “Non-Fermi Liquid Transport in Semimetals and Strongly Correlated Systems”, IIT Gandhinagar, on 30-01-2025

**Dr. Ravi Kuchimanchi**

65. “Puzzles and predictions of the left right symmetric model”, AID India, on 30-01-2025

**Dr. Anshika Bansal**

66. “LCSR application to $\mathrm{D}^+ \to \pi^+\ell^+\ell^-$”, University of Siegen, Germany, on 13-02-2025

**Prof. Sourin Das**

67. “From Monopole-Induced Berry Phase to Quadrupolar Berry Phase”, Indian Institute of Science Education and Research, Kolkata, on 21-03-2025

**Dr. Aabhaas Vineet Malik**

68. “Hidden magnetism and a mechanism for it”, Birla Institute of Technology and Science Pilani, KK Birla Goa campus, on 25-03-2025

**Dr. Indrakshi Raychowdhury**

69. “Towards Quantum Simulating QCD”, Birla Institute of Technology and Science Pilani, KK Birla Goa campus, on 25-03-2025

**Dr. Namrata Rani**

70. “Reaction Mechanisms and Binding Energies of Interstellar Molecules: From Sulfur-Containing Species to Amides on Icy Grains”, Universidad de Concepción, Concepción, Chile, on 29-01-2025

**Prof. Mishkatul Bhattacharya**

71. “Phonon Laser and Parametric Oscillator with an Optically Levitated Nanoparticle”, Rochester Institute of Technology, New York, on 16-07-2024

**Aanal Jayesh Shah**

72. “Dissipative Phase Transition in the two-photon Dicke Model”, Dept of Physics and Astronomy, Purdue University, Indiana, United States, on 09-01-2025

# Technical/ Scientific talk given in Hindi [Oral & Poster Presentations]

### Astronomy and Astrophysics

#### Kapil Kumar Bharadwaj

1. “Vayumandliya Viksepan Sudharak : Swadeshi rup se design aur vikas”, Hindi Technical Seminar, SAC/ISRO, Ahmedabad, 03-11-2024

### Solar Physics

#### Bhuwan Joshi

2. “Our Sun and Space Weather”, Lecture delivered during TOLIC Technical Workshop at the Udaipur Solar Observatory, Udaipur, 23-03-2025.

#### Anshu Kumari

3. “Udaipur Solar Observatory: Scientific Work”, A talk durign Our Work: Hindi Diwas Competition at PRL, 01-10-2024.
4. “Solar Radio Physics”, Our Work: Hindi Diwas Competition at USO, 14-09-.2024

### Planetary Sciences

#### Anil Bhardwaj

5. “Special Lecture in the Inaugural Session”, Indian Solar System Exploration Programme, Institute for Plasma Research, 08-08-2024.

### Space and Atmospheric Sciences

#### Som Kumar Sharma

6. “Analysis of mid-atmospheric clouds and boundary layers over the Indian LiDAR Network programme of PRL”, Som Kumar Sharma, Dharmendra Kumar Kamat and Aniket, “Analysis of mid-atmospheric clouds and boundary layers over the Indian LiDAR Network programme of PRL” presented in the Inter-Center Hindi Technical Seminar-2024 held at the Space Applications Center (ISRO), Ahmedabad., 07-11-2024.

# Student Training

### Astronomy and Astrophysics

1. Ayush Shivkumar, IISER Thiruvananthapuram, “Unveiling early phases of massive star cluster formation in molecular clumps”, from May 2024 to July 2024, [Supervisor: Manash Samal].
2. Nilesh Pandey, IISER Thiruvananthapuram, “Unveiling early phases of massive star cluster formation in molecular clumps”, from May 2024 to July 2024, [Supervisor: Manash Samal].
3. Kartik Kambhampati, Indian Institute of Technology (Indian School of Mines) Dhanbad, “Understanding protoplanetary disk evolution around young stars”, from May 2024 to July 2024, [Supervisor: Manash Samal].
4. Sarthak Palival, Charotar University of Science and Technology, Changa, “Radio Continuum Synthesis Imaging and related techniques”, from Jan 2024 to April 2024, [Supervisor: Veeresh Singh].
5. Pagnya Mishra, Indian Institute of Science Education and Research, Mohali, “Spectral Properties of Dusty Galaxies”, from May 2024 to July 2024, [Supervisor: Veeresh Singh].
6. Mayuri Dutta, Indian Institute of Science Education and Research, Thiruvananthapuram, “Investigating the Nature of High-redshift Active Galactic Nuclei”, from May 2024 to July 2024, [Supervisor: Veeresh Singh].
7. Shubhashri S Shenoy, Manipal Institute of Technology, “Comparative study of solar X-ray flux measurements with Chandrayaan-2 XSM and GOES XRS”, from May 2024 to July 2024, [Supervisor: Mithun N. P. S.].
8. Pourush Sharma, School of Physical Sciences at Indian Institute of Technology, Mandi, “An investigation of variance in elemental abundances in Confined and Eruptive flares using Chandrayan-2 XRay Solar Monitor (XSM)”, from May 2024 to July 2024, [Supervisor: Mithun N. P. S.].
9. Aashna Shah, Nirma University, “Semi-automated spectral parameter estimation using XSM”, from May 2024 to July 2024, [Supervisor: Santosh V Vadawale].
10. Vishruth Goswami, Osmania University, “Investigation of Photospheric Fe fluorescence emission in flares with Chandrayaan-2 XSM”, from May 2024 to July 2024, [Supervisor: Santosh V Vadawale].
11. Anushka R. Jain, St. Xavier’s College, Mumbai,, “Broadband X-ray Spectral and Timing Analysis of MAXIJ1820+070 using AstroSat”, from November 2024 to March 2025, [Supervisor: Santosh V Vadawale & Mithun N. P. S.].
12. Abhay Mishra, Sharda University, Noida, “Atomization of Atmospheric Dispersion Corrector”, from May 2024 to July 2024, [Supervisor: Kapil Kumar Bharadwaj].
13. Anchal Singh, Silver Oak University, Ahmedabad, “Atomization of Atmospheric Dispersion Corrector”, from May 2024 to July 2024, [Supervisor: Kapil Kumar Bharadwaj].
14. Amogh M Achari, Pandit Deendayal Energy University, Gandhinagar, Gujarat, “Baseline Understanding of the Design of the Detector Mounting Plate and CCD Characterization of the 2x2 CCD Mosaic Array for the Wide Field Camera Instrument on the 2.5m Mt. Abu Telescope”, from May 2024 to July 2024, [Supervisor: Neelam J S S V Prasad].
15. G Abhishek, Osmania University, Hyderabad, “Design and Development of differential image motion monitor (DIMM) for seeing Measurements at the Mt Abu Observation Site”, from May 2024 to July 2024, [Supervisor: Neelam J S S V Prasad].
16. Sanyam Awasthi, Indian Institute of Space science Technology, Thiruvananthapuram, “Searching for coherent periodicities of Cataclysmic Variable Stars”, from May 2024 to July 2024, [Supervisor: Vishal Joshi].
17. Kanchan Jangle, Indian Institute of Science Education and Research, Berhampur, “Bulk Parameter Derivation from ASPEX-SWIS/ Aditya-L1 and CME Observation via Wind Magnetometer Data”, from June 2024 to Mar 31, [Supervisor: Aveek Sarkar].
18. Sourabh Kushwaha, Lucknow University, Uttar Pradesh, “Understanding the multi-wavelength variability in blazars”, from July 2024 to Sep 2024, [Supervisor: Sunil Chandra].
19. Nandini N Menon, St. Albert’s College Ernaculam, Kerala, “Photometry of FOC data of BL Lac and S5 0716+714: a step to a photometric pipeline for the FOC instrument”, from Dec 2024 to Mar 2025, [Supervisor: Sunil Chandra].
20. Parshwa Shah, Indus University, Ahmedabad, “Development of a Python based housekeeping software for astronomical instrumentation”, from Jan 2025 to May 2025, [Supervisor: Deekshya R Sarkar].
21. Praful Choudhary, Jamia Millia Islamia University, New Delhi, “Mechanical design of SIRIS instrument”, from Jan 2025 to May 2025, [Supervisor: Deekshya R Sarkar].
22. Dhanvi Desai, L D College of Engineering, Ahmedabad, “Design of mechanical parts for interfacing various components in an astronomical instrument”, from Jan 2025 to May 2025, [Supervisor: Alka].
23. Ameya Gokhale, VIT Vellore, “Design of mechanical parts for interfacing various components in an astronomical instrument”, from Jan 2025 to May 2025, [Supervisor: Alka].
24. Vandan Kachhadiya, St. Xavier’s College(Autonomous), Ahmedabad, “Optical test bench setup for characterization of astronomical instruments”, from Sep 2024 to May 2025, [Supervisor: Shashikiran Ganesh].
25. Kishan Solanki, St. Xavier’s College(Autonomous), Ahmedabad, “Optical test bench setup for characterization of astronomical instruments”, from Sep 2024 to May 2025, [Supervisor: Shashikiran Ganesh].
26. Sneha Srivastava, Chandigarh University, Mohali, “Static structural, Buckling and Modal analysis of Cryostat for

Astronomical instrumentation", from Jan 2025 to May 2025, [Supervisor: Prashanth K Kasarla].

27. Rishit Tiwari, NIT Surat, "Interpreting/predicting periodic structures in the lightcurves using AI/ML", from Aug 2024 to April 2025, [Supervisor: Sunil Chandra].
28. Himani Jeevan Janve, Chandigarh University, "Simulation of Plasmoid motion in the astrophysical jets using PLUTO", from Jan 2025 to April 2025, [Supervisor: Sunil Chandra].

**Solar Physics**

29. Abhishek Sharad Potdar, Fergusson College (Autonomous),Pune, "Type III Radio Bursts and Their Association With X-Class Solar Flares", from Feb 2025 to Apr 2025, [Supervisor: Anshu Kumari].
30. Parthib Banerjee, IISER Berhampur, "Understanding the Kinematics of CMEs", from Aug 2024 to Mar 2025, [Supervisor: Nandita Srivastava].
31. Shweta Ghare, Fergusson College (Autonomous),Pune, "Understanding the Properties of ICMEs Observed During 2009 to 2019", from Aug 2024 to Mar 2025, [Supervisor: Nandita Srivastava].

**Planetary Sciences**

32. Nikunj Dimri, Physics Department, IISER Mohali, "Wind flow study in Martian Craters", from May 2024 to July 2024, [Supervisor: Varun Sheel].
33. Jalormi Brahmachari, Physics Department, IISER Bhopal, "Effect of Solar Radiation on Martian Atmosphere", from May 2024 to July 2024, [Supervisor: Varun Sheel].
34. Aswini K P, Cochin University of Science and Technology, Cochin, "Noble gases Ar, Kr and Xe in carbonaceous chondrites", from Jan 2024 to April 2024, [Supervisor: Ramakant R. Mahajan].
35. Subhadeep Mandal, Indian Institute of Science Education and Research, Berhampur, "Chemical analysis of Planetary samples", from May 2024 to June 2024, [Supervisor: Amit Basu Sarbadhikari].
36. Aadithya S, Geology, Central University of Kerala, "Chemical analysis of Planetary samples", from May 2024 to July 2024, [Supervisor: Amit Basu Sarbadhikari].
37. Manya S, Central University of Kerala, "Sri Lankan serpentine deposit: A Martian analog", from Dec 2024 to April 2025, [Supervisor: Amit Basu Sarbadhikari].
38. Aadithya S, Geology, Central University of Kerala, "Sri Lankan serpentine deposit: A Martian analog", from Dec 2024 to April 2025, [Supervisor: Amit Basu Sarbadhikari].
39. Kunal C. Suvagiya, Shree Swaminarayan Institute of Technology, Bhat, Gandhinagar, "Detection of Pyroclastic Deposits using Machine Learning", from Jan 2024 to May 2024, [Supervisor: Megha Bhatt].
40. Niti Singh, NISER Bhubaneshwar, "Monte Carlo RT Approach to determine BRDF for airless planetary surfaces", from May 2024 to July 2024, [Supervisor: Megha Bhatt].
41. Siddhanta Mondal, ECE - Vellore Institute of Technology, "Development of IoT-Based Sensor Nodes for Monitoring Weather Parameters for Space Missions", from Jan 2024 to May 2024, [Supervisor: K. Durga Prasad].
42. Mahesh Divakaran Namboodiri, ECE - Vellore Institute of Technology, "Variable Sinusoidal Waveform Generation using FPGAs for Future Space Missions", from Jan 2024 to May 2024, [Supervisor: K. Durga Prasad].
43. Mihir Baldaniya, ECE - Vellore Institute of Technology, "Internet of Things for Space Applications", from Jan 2024 to May 2024, [Supervisor: K. Durga Prasad].
44. MANASA M. J, ECE - Mangalore University, "LOCAL METEOROLOGY ON MARS", from May 2024 to July 2024, [Supervisor: K. Durga Prasad].
45. Rajana Jai Sainath, ECE - Mangalore University, "Development of IoT-based Sensor Nodes to Monitor Weather Parameters for Space Missions", from May 2024 to July 2024, [Supervisor: K. Durga Prasad].
46. Adelowo Abraham, National Agency for Science and Engineering Infrastructure, Abuja, Nigeria, "Modelling of Lunar Seismic Events Using Apollo Seismic Data", from Jan 2024 to May 2024, [Supervisor: K. Durga Prasad].
47. Dhiraj Shende, S.S.S.M.V. Pimpalkhuta, Amravati, Maharashtra, India, "Reanalysis of Apollo Seismic Data for interpretation of data from ILSA on board Chandrayaan-3 lander", from Jan 2024 to May 2024, [Supervisor: K. Durga Prasad].
48. Pallabi Das, Amity University, Mumbai, Maharashtra, "Perseverance Mars Environmental Dynamics Analyzer (MEDA) Variations along Rover's Traverse in Jezero Crater, Mars", from May 2024 to Aug 2024, [Supervisor: Rishitosh Kumar Sinha].
49. Esha Sree M, Department of Geology, University of Madras, "A comparative study of volcanic cones on Earth and Mars", from May 2024 to July 2024, [Supervisor: S. Vijayan].
50. Shashank Singh, IISER Berhampur, "Exploring Lunar Landing Sites: Emphasis on the Amundsen Crater", from May 2024 to June 2024, [Supervisor: S. Vijayan].
51. Darshana D, Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur, "Sedimentology study of pont bars in Jezero crater, Mars", from May 2024 to July 2024, [Supervisor: S. Vijayan].
52. Divya K, Anna University, Chennai, "Craters in the Mare-Highland boundary", from March 2024 to Aug 2024, [Supervisor: S. Vijayan].
53. Nehavarthini, Anna University, Chennai, "Impact craters in the south polar region of the Moon", from Aug 2024 to April 2025, [Supervisor: S. Vijayan].
54. Roshan Nath, IISER Bhopal, Madhya Pradesh, "Classification of meteorites from spectral reflectance data using Deep Learning", from May 2024 to July 2024, [Supervisor: Neeraj Srivastava].
55. Soham Mali, IIST, Trivandrum, "Estimation of Mineral Abundance in Meteorites using Reflectance Spectroscopy", from May 2024 to July 2024, [Supervisor: Neeraj Srivastava].
56. Tarushi Bhatnagar, VIT Bhopal, "Predicting Sub-Classes of Ordinary Chondrites from Reflectance Spectra", from May 2024 to July 2024, [Supervisor: Neeraj Srivastava].

57. Aneesha Lekshmi B S, IISER Mohali, “Isotopic Fractionation in star-forming Regions”, from July 2024 to April 2025, [Supervisor: Kinsuk Acharyya].
58. Khushi Yadav, NIT, Kurukshetra, “Study of impact plasma due to dust impact”, from Jan 2024 to May 2024, [Supervisor: Jayesh Pabari].
59. Kriti Shrivastava, Institute for Excellence in Higher Education, Bhopal, “Characteristics of electric and magnetic fields in whistler waves”, from Dec 2023 to May 2024, [Supervisor: Jayesh Pabari].
60. Pankaj Kumar, Chandigarh University, Mohali, “Study of dust ablation in planetary atmosphere and associated chemistry”, from Jan 2024 to June 2024, [Supervisor: Jayesh Pabari].
61. Tejaswi Kondhiya, PRL, Ahmedabad, “Study of streamer during lightning”, from March 2024 to Sept 2024, [Supervisor: Jayesh Pabari].
62. Amandeep Kaur, PRL, Ahmedabad, “Data Analysis of Magnetic Field Measurements of Mars”, from June 2024 to July 2024, [Supervisor: Jayesh Pabari].
63. Harshita, PRL, Ahmedabad, “Image Analysis of dust ring in the orbit of Venus”, from May 2024 to July 2024, [Supervisor: Jayesh Pabari].
64. Kiran Jadhav, Vellore Institute of Technology, “Modelling of Crater Formed Upon Hypervelocity Impact of Interplanetary Dust Particles”, from Jan 2024 to April 2024, [Supervisor: Srirag N Nambiar].
65. Hiya Pokharna, St. Xaviers College, Mumbai, “Study on Estimation of Interplanetary Dust Particle Flux in Space Under Different Scenarios”, from May 2024 to July 2024, [Supervisor: Srirag N Nambiar].
66. P. Sai Ganesh, IISER Mohali, “Estimation of Interplanetary Dust Flux on Lunar Surface”, from May 2024 to July 2024, [Supervisor: Srirag N Nambiar].
67. Sreelekshmi, Women’s Christian College, Chennai, “Study On Dust Detectors and Characterisation of Metal Target Detectors”, from May 2024 to July 2024, [Supervisor: Srirag N Nambiar].
68. Teki L V S Sai Meghana, PRL, Ahmedabad, “Design and Development of DC Voltage Booster Circuit”, from May 2024 to July 2024, [Supervisor: Sonam Jitarwal].
69. Siddhant Abhyankar, PRL, Ahmedabad, “Sensor Interfacing for Lightning station”, from May 2024 to July 2024, [Supervisor: Sonam Jitarwal].
70. Sourabh Singh, PRL, Ahmedabad, “Development of a Data Acquisition System for Lightning Station”, from May 2024 to July 2024, [Supervisor: Sonam Jitarwal].
71. Vaishvi Tyagi, IIT, Roorkee, “Clay mineralogy from the basaltic hosted impact craters and implication for Mars”, from May 2024 to July 2024, [Supervisor: Dwijesh Ray].
72. Aniket Kumar, IIST, Trivandrum, “Mineralogy and spectroscopy of ordinary chondrite and the asteroid connection”, from May 2024 to May 2024, [Supervisor: Dwijesh Ray].
73. Aditya Ray, Presidency University, Kolkata, “Archean Banded Iron Formation and its relevance to Mars”, from Aug 2024 to Sept 2024, [Supervisor: Dwijesh Ray].
74. Gopika Mohan, Central University of Kerala, Trivandrum, “Clay sulfate transition and its relevance to Mars”, from Jan 2025 to March 2025, [Supervisor: Dwijesh Ray].

#### Space and Atmospheric Sciences

75. Prudhvi Teja A, Sardar Vallabhbhai National Institute of Technology, Surat, “Ionospheric and thermospheric changes during varying solar and geophysical conditions”, from May 2024 to July 2024, [Supervisor: Duggirala Pallamraju].
76. Abhishek, PRL JRF, “Study of the formation of ionospheric layers and interpretation of ionograms”, from August 2024 to November 2024, [Supervisor: Duggirala Pallamraju].
77. Samarpan Dutta, PRL JRF, “Dispersing elements in Optics and Spectrographs”, from Jan 2025 to Apr 2025, [Supervisor: Duggirala Pallamraju].
78. Ajay Kumar Yadav, IISER Tirupati, “Investigations on the fluctuations in the solar wind alpha-proton ratio using wavelet techniques”, from July 2023 to May 2024, [Supervisor: Dibyendu Chakrabarty].
79. Kush Shah, Devang Patel Institute of Advance Technology and Research (DEPSTAR), CHARUSAT, “Python-based GUI for Reading and Writing Analog/Digital Signals through USB Communication”, from Dec 2024 to April 2025, [Supervisor: Aaditya Sarda].
80. Sahajabin Parbin, Banasthali Vidyapith, Rajasthan, “The storage of the data from CMOS in SRAM and interface it through FPGA”, from May 2024 to July 2024, [Supervisor: Rahul Pathak].
81. Nishika Jitu Desai, Pandit Deendayal Energy University, Gandhinagar, “Front end electronics card development for CMOS”, from May 2024 to July 2024, [Supervisor: Rahul Pathak].
82. Tuhina Bhuniya, Vellore Institute of Technology, Vellore, “Scientific CMOS interfacing through FPGA to control the input and output”, from May 2024 to July 2024, [Supervisor: Rahul Pathak].
83. Krishang Dalal, Dharmsinh Desai University (DDU), Nadiad, Gujarat, “Establishing communication between FPGA and flash memory and store the data coming from CMOS detector”, from December 2024 to March 2025, [Supervisor: Rahul Pathak].
84. Shivam Yadav, Sardar Vallabhbhai National Institute Of Technology (NIT), Surat, “Development of front-end and processing electronics for a detector (CCD/SCMOS) for space mission instruments”, from Dec 2024 to April 2025, [Supervisor: Rahul Pathak].
85. Dev Kumar Nayak, LD College of Engineering, Ahmedabad, “Design a Motor Driver Circuit for the Shutter Mechanism Used in Future Space-Borne Instruments”, from Dec 2024 to April 2025, [Supervisor: Rahul Pathak].
86. Ajay Kumar Yadav, IISER Tirupati, “Design a Motor Driver Circuit for the Shutter Mechanism Used in Future Space-Borne Instruments”, from Dec 2024 to April 2025, [Supervisor: Rahul Pathak].
87. Pransu Changela, Charotar University of Science and Technology (CHARUSAT), Changa, Anand, “Estimates of Ozone and secondary organic aerosol formation potentials”, from Jan 2025 to April 2025, [Supervisor: Lokesh Kumar Sahu].

88. Vedkumar Patel, Charotar University of Science and Technology (CHARUSAT), Changa, Anand, “Analysis of atmospheric trace gas data measured at different locations of India using several state-of-art instruments”, from Jan 2025 to Apr 2025, [Supervisor: Lokesh Kumar Sahu].
89. Anupriya Bhardwaj, Banasthali Vidyapith, Rajasthan, “Lidar Development and Its Application”, from January 2024 to June 2024, [Supervisor: Som Sharma].
90. Saloni Ratanlal Teli, Dharmsinh Desai University, Nadiad, “Remote Sensing Devices and Their Application in the Study of Atmospheric Cloud and Boundary Layer Dynamics”, from January 2024 to April 2024, [Supervisor: Som Sharma].
91. Aastha Nareshkumar Bhatt, V.V.P. Engineering College, Rajkot, “Remote Sensing Devices and Their Applications in the Study of Atmospheric Clouds and Boundary Layer Dynamics”, from January 2024 to April 2024, [Supervisor: Som Sharma].
92. Deepak Kumar Kar, NIT Rourkela, “Atmospheric Changes During Natural Disasters: A Case Study of a Dust Storm and a Volcanic Eruption Using Space and Ground-Based Instruments”, from May 2024 to July 2024, [Supervisor: Som Sharma].
93. Chirag Mahinda, ISTAR, CVM University, Gujarat, “Atmospheric Changes During Natural Disasters: A Case Study of a Dust Storm and a Volcanic Eruption Using Space and Ground-Based Instruments”, from May 2024 to July 2024, [Supervisor: Som Sharma].
94. Aklesh Kumar Nayak, Central University of Rajasthan, “Investigation of the Atmospheric Boundary Layer Over Ahmedabad Using Ground-Based Lidar, Radiosonde, and Reanalysis Datasets”, from May 2024 to July 2024, [Supervisor: Som Sharma].
95. Yug M. Thosar, Maharaja Sayajirao University of Baroda, “Lidar and Satellite-Based Study of Atmospheric Clouds and Boundary Layer Over the Indian Region”, from May 2024 to July 2024, [Supervisor: Som Sharma].
96. Nupoor A. Chotaliya, St. Xavier’s College, Ahmedabad, “Seasonal Variations in Ozone and Oxygen and the Global Impact of Mt. Ruang Volcanic Eruptions on Atmospheric Composition Across Altitudes”, from May 2024 to July 2024, [Supervisor: Som Sharma].
97. Minakshi Singh, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, “Study of Atmospheric Dynamics Using Ceilometer and Automatic Weather Station”, during May-July 2024”, from May 2024 to July 2024, [Supervisor: Som Sharma].
98. Simanta Kalita, Banaras Hindu University, “Estimation of Atmospheric Boundary Layer Height Using Radiosonde, Machine Learning, and Image Processing”, from May 2024 to July 2024, [Supervisor: Som Sharma].
99. Shailja Srivastava, Banasthali Vidyapith, Rajasthan, “Algorithm Development for the detection of Atmospheric Cloud Base Height and Signal Delay Correction Due to Rain: Using LIDAR and Satellite Observations”, from May 2024 to July 2024, [Supervisor: Som Sharma].
100. Alfred Genuwin, Dept. of Atmos. Sci., Central University of Rajasthan, “Radiative forcing for different aerosol types using radiative transfer model”, from May 2024 to July 2024, [Supervisor: Harish Gadhavi].
101. Haripriya H., Cochin University (Through Academy Fellowship), “Radiative forcing for different aerosol types using radiative transfer model”, from May 2024 to July 2024, [Supervisor: Harish Gadhavi].
102. Saksham Yadav, University of Arizona, Arizona, USA, “Error correction for black carbon measurements using an aethalometer”, from May 2024 to July 2024, [Supervisor: Harish Gadhavi].
103. Dhruvi Janasariya, Gujarat University, “Atmospheric Methane removal - a survey of technologies”, from May 2024 to July 2024, [Supervisor: Harish Gadhavi].
104. Sachin Kori, Gujarat University, “Atmospheric Methane removal - a survey of technologies”, from May 2023 to April 2024, [Supervisor: Harish Gadhavi].
105. Naima Pathan, Govt. Polytechnic for girls, Ahmedabad, “Sunphotometer Optics and Data Transfer”, from Dec 2024 to May 2025, [Supervisor: Malaidevan P].
106. Shifa Pathan, Govt. Polytechnic for girls, Ahmedabad, “Sunphotometer Electronics”, from Dec 2024 to May 2025, [Supervisor: Malaidevan P].
107. Madhulikha Vutti, Srinivasa Ramanujan Institute of Technology, Ananthapur, Andhra Pradesh, “Elevation tracking of Suntracker”, from Dec 2024 to Mar 2025, [Supervisor: Malaidevan P].
108. Sanika Kanere G, Govt. College of Engineering, Karad, Maharashtra, “Atmospheric Methane removal - a survey of technologies”, from Dec 2024 to April 2025, [Supervisor: Malaidevan P].
109. Geist Raj, Shankersinh Vaghela Bapu Institute of Technology -Gandhinagar, Gujarat, “Automated Pressure based Air Sampling System”, from Jan 2025 to April 2025, [Supervisor: Malaidevan P].
110. Darshan Harshadbhai Jotaniya, Dharmsinh Desai University, Nadiad, “Shutter Mechanism for Optical System”, from May 2024 to July 2024, [Supervisor: Ravindra Pratap Singh].
111. Bhavya A. Madhavani, Dharmsinh Desai University, Nadiad, “Airglow Image processing using ML/DL techniques”, from Dec 2024 to March 2025, [Supervisor: Ravindra Pratap Singh].
112. Hetvi Bhadani, Devang Patel Institute of Advance Technology and Research, CHARUSAT, Changa, Gujarat, “Airglow Image Processing using ML/DL Techniques and Data Visualization”, from December 2024 to March 2025, [Supervisor: Ravindra Pratap Singh].
113. Dibyani Singh, PRL, “Derivation of Rotational Temperatures Using Spectroscopic Measurements of OH and O2 Nightglow Emissions in the MLT Region”, from January 2025 to March 2025, [Supervisor: Ravindra Pratap Singh].
114. Sanjana Joshi, Sardar Patel University, Anand, “The Influence of Meteorological on Ambient Aerosol Concentration”, from January 2024 to April 2024, [Supervisor: T. A. Rajesh].
115. Tanisha purohit, Sardar Patel University, Anand, “The Influence of Meteorological on Ambient Aerosol Concentration”, from January 2024 to April 2024, [Supervisor: T. A. Rajesh].
116. Shayan Makwana, New LJ Institute of Engineering and Technology, Ahmedabad, “Development of a Python-based data acquisition, control, and processing software for aerosol monitoring instruments”, from January 2024 to April 2024, [Supervisor: T. A. Rajesh].

117. Kashish Bindran, New LJ Institute of Engineering and Technology, Ahmedabad, “Development of a Python-based data acquisition, control, and processing software for aerosol monitoring instruments”, from January 2024 to April 2024, [Supervisor: T. A. Rajesh].
118. Sqn. Ldr. Harjot Singh Virdi, Indian Air Force, Air HQ (VB), New Delhi, “GNSS positioning accuracy evaluation over the Indian sector”, from March 2024 to May 2024, [Supervisor: K. Venkatesh].
119. Sayanee Haldar, National Institute of Technology, Rourkela, “Asymmetries in the structural features of Equatorial Ionization Anomaly in the Indian sector”, from March 2024 to May 2024, [Supervisor: K. Venkatesh].
120. Ranjita Andrapiya, Maharaja Sayajirao University of Baroda, Vadodara, “Study of night time TEC enhancements over Geomagnetic equator using GPS observations”, from June 2024 to July 2024, [Supervisor: K. Venkatesh].
121. Samarpan Dutta, JRF, PRL, “Investigations on the association of various solar proxies with ionospheric F-layer peak density over Ahmedabad”, from August 2024 to December 2024, [Supervisor: K. Venkatesh].
122. Divyani Singh, JRF, PRL, “Study of Ionospheric Total Electron Content (TEC) during geomagnetic storm conditions”, from August 2024 to December 2024, [Supervisor: K. Venkatesh].
123. Nribarai Sankar, North-Eastern Hill University, Shillong, “Evaluation of IRI modelled bottom-side and top-side ionospheric TEC over Ahmedabad”, from January 2025 to February 2025, [Supervisor: K. Venkatesh].
124. Yaswanth O. S., IISER, Thiruvananthapuram, “Machine learning of atmospheric variability”, from May 2024 to July 2024, [Supervisor: Narendra Ojha].
125. Archisman Chakraborty, HRI, Prayagraj, “Machine learning of atmospheric variability”, from May 2024 to July 2024, [Supervisor: N. Ojha].

**Geosciences**

126. Rupa Mukherjee, Rajendra College, Chhapra, “ocean chlorophyll trends”, from July 2024 to Oct 2024, [Supervisor: Arvind Singh].
127. Balaji Naik, IISER, Bhopal, “ocean deoxygenation”, from May 2024 to July 2024, [Supervisor: Arvind Singh].
128. Anamika Das, IISER, Bhopal, “ocean time-series analysis”, from May 2024 to July 2024, [Supervisor: Arvind Singh].
129. Krishnadev G., Central University of Kerala, “Application of radiogenic isotopes to understand sediment provenance”, from Dec 2024 to April 2025, [Supervisor: Vineet Goswami].
130. Md. Asif Raza, BHU, Varanasi, “Geochemical tools to understand the rock genesis.”, from May 2024 to June 2024, [Supervisor: Vineet Goswami].
131. Rupshee Upadhyay, MLSU, Udaipur, “Understanding the 14C geochronology and Nd isotopic stratigraphy of authigenic component: Implications for assessing the depositional history and past ocean circulation.”, from May 2024 to June 2024, [Supervisor: Vineet Goswami].
132. Muhammed Mehafus Thannani, IISER, Pune, “Depositional Flux of 10Be in Southern, India”, from Jun 2024 to Mar 2025, [Supervisor: Amzad Hussain Laskar].
133. Nanditha Narendran, Manipal Academy of Higher Education, Manipal, “Radiocarbon in unsaturated zone soil water and soil carbonate: implications to groundwater dating”, from Jan 2025 to May 2025, [Supervisor: Amzad Hussain Laskar].
134. Akancha Tripathi, Central University of Gujarat, “Greenhouse gas emissions from wetlands: Insights from radiocarbon and stable isotope analyses”, from Jan 2025 to May 2025, [Supervisor: Amzad Hussain Laskar].
135. Sonia Tyagi, St John’s College, Agra, “Study of Aerosol Composition: Implication from Air Quality to Climate Change”, from March 2024 to June 2024, [Supervisor: Neeraj Rastogi].
136. Shasya, Central University of Gujarat, “Study of Environmental Microplastics”, from Jan 2025 to Apr 2025, [Supervisor: Neeraj Rastogi].
137. Mr. Khirod Kumar Das, BBAU, Lucknow, “Geochemical and chromium isotopic composition of suspected melt fragments from the Luna Crater”, from Jan 2025 to Apr 2025, [Supervisor: Yogita Kadlag].
138. Mr. Rumanshu Hazarika, BBAU, Lucknow, “Geochemical Analysis of glassy melt rock samples from the Luna Structure, Kachchh District, India: Implications for Origin of the Luna Structure”, from Jan 2025 to Apr 2025, [Supervisor: Yogita kadlag].
139. Shivraj Dhanabhai Naghera, Birla Vishvakarma Mahavidyalaya, “Developing Python Script for geoscientific data analysis: chronology”, from Dec 2024 to Apr 2025, [Supervisor: Shubhra Sharma].
140. Utkarsh, Kumar, Madhav Institute of Technology & Science, Gwalior, “Developing Python Script for geoscientific data analysis: lab management”, from Jan 2025 to May 2025, [Supervisor: Shubhra Sharma].
141. Chelsei Kothari, Netaji Subhas University of Technology, “Developing Python Script for geoscientific data analysis: luminescence dating”, from Dec 2024 to Apr 2025, [Supervisor: Shubhra Sharma].
142. Palaash Kartik Vachharajani, IISER Mohali, “Mathematical Modelling and Constraints on Geological Processes Using Trace Elements”, from May 2024 to July 2025, [Supervisor: Shivansh Verma].
143. Debasish Maji, IISER Pune, “Development of Fe Isotopes Systematics for MC-ICPMS Analysis”, from May 2024 to July 2024, [Supervisor: Shivansh Verma].
144. Akashar Ratanapara, Indus University, Ahmedabad, “Data acquisition and processing software for coincidence gamma-gamma ($\gamma$-$\gamma$) spectrometry”, from Feb 2025 to May 2025, [Supervisor: P R Adhyaru].
145. Akashdeep Sodhi, Netaji Subhas University Of Technology, Delhi, “Electronics and Communication with Artificial Intelligence and Machine Learning”, from Jul 2024 to Jan 2025, [Supervisor: Akash Ganguly and Shivansh Verma].
146. Aryan Dave, Devang Patel Institute of Advanced Technology and Research, Charusat University, “Transformers: Harnessing Attention for Superior Sequence Prediction”, from Jan 2025 to May 2025, [Supervisor: Akash Ganguly and Shivansh Verma].

147. Harit Tarwani, Charotar University of Science and Technology, Charusat University, “Transformers: Harnessing Attention for Superior Sequence Prediction”, from Jan 2025 to Jun 2025, [Supervisor: Akash Ganguly and Shivansh Verma].

148. Deval Shah, Symbiosis Institute of Technology, Pune, “HV DC DC Converter for Space Payload”, from Jan 2024 to June 2024, [Supervisor: Manan Shah].

149. Dev Soni, Desai University, Nadiad, “Data frame structure and generation using HDL”, from Dec 2024 to Apr 2025, [Supervisor: Manan Shah].

150. Sunil Lakhera, Vellore Institute of Technology, Chennai, “HV DC DC Converter: Design and Validation”, from Dec 2024 to Apr 2025, [Supervisor: Manan Shah].

151. Ojas Patkar, B.V.M. Engineering College, Anand, “HV DC DC Converter: Design and Validation”, from Jay 2025 to May 2025, [Supervisor: Manan Shah].

152. Netri Trivedi, Vishwakarma Government Engineering College, Ahmedabad, “Data frame structure and generation using HDL”, from Jan 2025 to Apr 2025, [Supervisor: Manan Shah].

**Theoretical Physics**

153. Ms. Anantshree Bhatt, Doon University, Uttarakhand, “Study of neutrino Oscillations in 2 and 3 flavour framework”, from 01/01/24 to 11/03/24 (online) to 12/03/24 to 11/05/24 (offline), [Supervisor: Srubabati Goswami].

154. Ms. Ankita Acharjee, National Institute of Technology, Silchar, “Neutrino Cosmology”, from 23/05/2024 to 19/7/2024, [Supervisor: Srubabati Goswami].

155. Ms. Tammana Pathan, SVNIT, Surat, “Exploring the universe through Astrophysical Neutrinos”, from 08/08/2024 to 02/05/2025, [Supervisor: Srubabati Goswami].

156. Ms. Safana Shaji, IISER Mohali, “Atmospheric and Solar Neutrinos”, from 23/08/24 to 11/12/24 (online) to 12/12/24 to 22/04/25 (offline), [Supervisor: Srubabati Goswami].

157. Mr. Sanjit Kumar Mahto, NIT Jamshedpur, “Probing Properties of Neutrinos”, from 09/01/2025 to 05/05/2025, [Supervisor: Srubabati Goswami].

158. Mr. Divyanshu Gola, Doon University, Dehradun, “Dark Matter probe with Radio data”, from 10/02/2024 to 09/07/2024, [Supervisor: Partha Konar].

159. Mr. Bhavya Thacker, IIT Guwahati, “Probing Inert doublet model in Muon Collider”, from 01/11/2024 to 31/03/2025, [Supervisor: Partha Konar].

160. Mr. Aritra Roy, MSU, Baroda, “Introduction to General Relativity”, from 10/06/2024 to 08/08/2024, [Supervisor: Namit Mahajan].

161. Ms. Diya K. S., Cochin University of Science and Technology, Cochin, “Gershgorin Interpretation of Flavour Problem”, from 08/05/2024 to 04/07/2024, [Supervisor: Ketan M. Patel].

162. Mr. Arpan Dey, St. Xaviers’ College, Kolkata, “Investigations on the fundamental domain of the Modular group”, from 03/06/2024 to 28/07/2024, [Supervisor: Ketan M. Patel].

163. Ms. Jeelben B. Kothadiy, Indian Institute of Technology, Roorkee, “Superconducting diode effect”, from 10/05/2024 to 05/07/2024, [Supervisor: Paramita Dutta].

164. Mr. Ganesh Arvindh Ramanan, Indian Institute of Space Science and Technology, Thiruvananthapuram, “Graphene: Physics of different layers”, from 27/05/2024 to 19/07/2024, [Supervisor: Paramita Dutta].

165. Mr. Tijare Mandar Rajesh, IISER Kolkata, “Modern Amplitude Methods”, from 06/05/2024 to 05/06/2024, [Supervisor: Satyajit Seth].

166. Ms. Sarwangi S. Patel, IIT Bhubaneswar, “Tools and techniques used in multi-loop multi-leg scattering processes”, from 06/05/2024 to 05/06/2024, [Supervisor: Satyajit Seth].

**Atomic, Molecular and Optical Physics**

167. Aayushi Raval, Dept of Physics, MSU Baroda, “Laboratory astrophysics”, from March 2024 to September 2024, [Supervisor: B. Sivaraman].

168. Ganapathy Srinivasan, Dept of Physics, NIT Puducherry, “VUV and IR spectra of simple astrochemical ices”, from September 2024 to May 2025 (Ongoing), [Supervisor: B. Sivaraman].

169. Aleena George, Dept of Physics, St Paul’s College, Kalamassery, Kerala, “Searching the spritzer spectra for PAH in asteroids and comets”, from January 2025 to April 2025, [Supervisor: B. Sivaraman].

170. Mrs. Shivani Kamdi, Indira Gandhi National Tribal University, “Basics of luminescence dating”, from March 13, 2025 to April 09,2025, [Supervisor: Naveen Chauhan].

171. Ningnung Jakoinao, IISER Mohali, “Basics of luminescence dating and processing of samples”, from Feb 09, 2025 to Feb 28,2025, [Supervisor: Naveen Chauhan].

172. Ms. Snigdha Choudhury, Tezpur University, Assam, “Basics of luminescence dating”, from Dec 23,2024 to Jan 13, 2025, [Supervisor: Naveen Chauhan].

173. Ms. Shaina Kapoor, IIT Gandhinagar, “Luminescence dating and worked on her Ph.D. Samples”, from Aug 01 2024 to 31 Jan 2025 to Mar 10, 2025 to Sep 10, 2025, [Supervisor: Naveen Chauhan].

174. Shilpa Shaju, Christ College, Kerala, “Basics of luminescence dating”, from July 02, 2024 to Aug 06, 2024, [Supervisor: Naveen Chauhan].

175. Madhusoothanan R, Department of Physics, Indian Institute of Technology, Hyderabad, “Study of Third Harmonic Generation in Air using Femtosecond Filamentation”, from May 06, 2024 to July 29, 2024, [Supervisor: Rajesh Kumar Kushwaha].

176. Mr. Mehta Bhavik Rajeshbhai, Pandit Deendayal Energy University Gandhinagar, “Simulation and Analysis of Low Energy Neutral Atoms Imaging Detector”, from March 05, 2024 to July 29, 2024, [Supervisor: Rajesh Kumar Kushwaha].

177. Ms. Sangeerthana, Cochin University of Science and Technology (CUSAT), Kerala, “Understanding Detection Limits in Laser-Induced Breakdown Spectroscopy”, from xx to xx, [Supervisor: Prashant Kumar].

178. Ms. Anukritii Dutta, Birla Institute of Technology, Mesra, Ranchi, “A Comparative Study of Solar Wind Particles Using WIND and SWIS-ASPEX Data”, from xx to xx, [Supervisor: Prashant Kumar].

179. Mr. Adityadhar Dwivedi, IISER Mohali, Punjab, “Polarimetry in Quantum Domain”, from May, 2024 to July, 2024, [Supervisor: Shashi Prabhakar].

180. Ms. Aastha Tripathi, SVNIT, Surat, “Experiments on Continuous Variable Quantum Key Distribution”, from May, 2024 to July, 2024, [Supervisor: Shashi Prabhakar].
181. Ms. Bhabana Sarma, IISER, Thiruvananthapuram, “Polarimetry in Quantum Domain”, from May, 2024 to July, 2024, [Supervisor: Shashi Prabhakar].
182. Mr. Risabh Paul, Vellore Institute of Technology, Vellore, “Raman Scattering Studies of Quantum Materials (PdTe2)”, from June 03, 2024 to July 15, 2024, [Supervisor: Satyendra Nath Gupta].
183. Mr. Vikas Vishwakarma, V. E. S. College of Arts, Science and Commerce Mumbai, “Quantum Dots and Their Applications”, from May 06, 2024 to July 05, 2024, [Supervisor: Satyendra Nath Gupta].
184. Mr. Kushagra Srivastav, A&A Div. PRL, “Search for First Hydrostatic Core Candidates in the Orion B Region”, from June, 2024 to October, 2024, [Supervisor: Dipen Sahu].
185. Mr. Vimalraj R, Research Associate, PRL, Ahmedabad, “Exploring Protoplanetary Disk Structures: Planet Formation and Ice Lines”, from Feb, 2025 to Ongoing, [Supervisor: Dipen Sahu].

# Division Visitor Details

#### Astronomy and Astrophysics

1. Prof. Devendra Ojha, Tata Institute of Fundamental Research, Mumbai, “Collaborative discussion”, from 30-01-2025 to 31-01-2025.
2. Dr. Suman Bala, USRA Huntsville, Alabama, USA, “Collaborative discussion”, from 05-03-2025 to 07-03-2025,[Seminar : “Gamma-Ray Bursts (GRBs) as electromagnetic (EM) counterparts of Gravitational Wave (GW) sources”].
3. Dr. Biswajit Mondal, NASA Marshall Space Flight Center, USA, “Collaborative discussion”, from 10-02-2025 to 14-02-2025,[Seminar : “Solar Coronal Phenomena: Imaging X-ray Spectroscopy”].
4. Prof. Kunal P. Mooley, IIT Kanpur, “Collaborative discussion”, from 10-10-2024 to 11-10-2024,[Seminar : “Gravitational wave and multi-messenger signals from compact binary mergers”].
5. Prof. Varun Bhalerao, IIT Bombay, “Collaborative discussion on Daksha”, from 15-04-2024 to 16-04-2024,[Seminar : “Daksha: Indian Eyes on Transient Skies”].
6. Dr. Priyanka Chaturvedi, Tata Institute of Fundamental Research, Mumbai, “Collaborative discussions”, from 04-03-2025 to 07-03-2025.
7. Dr. Bhargav Vaidya, Indian Institute of Technology, Indore, “Collaborative work and discussions”, from 09-01-2025 to 12-01-2025.
8. Dr. Kirit Makwana, Indian Institute of Technology, Hyderabad, “Collaborative work and discussions”, from 09-01-2025 to 13-05-2025.
9. Dr. Supratik Banerjee, Indian Institute of Technology, Kanpur, “Ccollaborative work and discussions”, from 09-01-2025 to 14-01-2025.
10. Prof. Mathias Schultheis, Observatoire de la Cote d’Azur, Nice, France, “Collaborative work and discussions”, from 04-02-2025 to 06-02-2025,[Seminar : “Diffuse Interstellar Bands in the Milky Way as seen by GAIA”].
11. Prof. Agnes Fienga, Observatoire de la Cote d’Azur, Nice, France, “Collaborative work and discussions”, from 04-02-2025 to 06-02-2025.
12. Dr. Govind Nandakumar, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, “Collaborative work and discussions”, from 03-02-2025 to 07-02-2025,[Seminar : “Detailed exploration of the near infrared spectra of M giant stars to chemically characterise the inner Milky Way”].

#### Solar Physics

13. Dr. Pietro Zucca, ASTRON (Netherlands Institute for Radio Astronomy), “Research interaction, collaborative work with LOFAR and GMRT observations and seminar”, from 16-01-2025 to 17-01-2025,[Seminar: “Radio Eyes for the Sun, Heliosphere and Ionosphere: Status and Plans for the LOFAR2.0 Era”].
14. Dr. Nariaki Nitta, Lockheed Martin Solar and Astrophysics Laboratory (LMSAL), USA, “Research discussion and collaboration”, from 16-01-2025 to 17-01-2025.
15. Dr. Anna Jadwiga Kepa, Space Research Centre, Polish Academy of Sciences, Solar Physics Division, Wroclaw, Poland, “Research collaboration and interaction”, from 23-11-2024 to 28-11-2024.
16. Dr. Marek Jerzy Steslicki, Space Research Centre, Polish Academy of Sciences, Solar Physics Division, Wroclaw, Poland, “Research collaboration and interaction”, from 23-11-2024 to 28-11-2024,[Seminar: “PROBA-3 Mission”].
17. Dr. Tomasz Maciej Mrozek, Space Research Centre, Polish Academy of Sciences, Solar Physics Division, Wroclaw, Poland, “Research collaboration and interaction”, from 23-11-2024 to 28-11-2024,[Seminar : “Understanding Solar Eruptions: Ongoing and Future Research Programs at Space Research Centre of Polish Academy of Sciences”].
18. Dr. Alexander Warmuth, Leibniz-Institut für Astrophysik Potsdam (AIP), Germany, “Scientific collaboration and exchange during Indo-German DAAD project”, from 01-12-2024 to 12-12-2024,[Seminar : “Studying Solar Flares with the X-ray Telescope STIX on Solar Orbiter”].
19. Dr. Jake Arthur Jack Mitchell, Leibniz-Institut für Astrophysik Potsdam (AIP), Germany, “Scientific collaboration and exchange during Indo-German DAAD project”, from 01-12-2024 to 12-12-2024.
20. Mr. Timothy John Purdy, GONG Program, National Solar Observatory, Boulder, USA, “Technical visit for inspection, maintenance, and upgradation of GONG instrumentation at USO, PRL”, from 18-03-2025 to 30-03-2025.
21. Mr. Stephen Edwin Bounds, GONG Program, National Solar Observatory, Boulder, USA, “Technical visit for inspection, maintenance, and upgradation of GONG instrumentation at USO, PRL”, from 18-03-2025 to 30-03-2025.
22. Mr. Detrick Demond Branston, GONG Program, National Solar Observatory, Boulder, USA, “Technical visit for inspection, maintenance, and upgradation of GONG instrumentation at USO, PRL”, from 18-03-2025 to 30-03-2025.
23. Ms. Shruti Bhatporia, University of Cape Town, South Africa, “Collaborative Research interaction”, from 29-11-2024 to 29-11-2024,[Seminar : “Fast Radio Bursts, a Recent Discovery in the Field of Transients”].
24. Ms. Ketaki Deshpande, Royal Observatory of Belgium (ROB) and KU Leuven, Belgium, “Collaborative research discussion”, from 09-01-2025 to 10-01-2025,[Seminar : “Electron Density Mapping: Insights from Radio and In-Situ Observations & EUHFORIA Modeling”].

### Space and Atmospheric Sciences

25. Prof. Paulo Roberto Fagundes, Professor de Física e Astronomia, Universidade do Vale do Paraiba (UNIVAP), "for collaborative discussion", from 05-03-2025 to 14-03-2025,[Seminar : "Ionospheric disturbances due to Solar Flare and Coronal Mass Ejection - Space Weather impacts"].
26. Prof. Aroh Barjatya, Embry-Riddle Aeronautical University, USA, "for collaborative discussion", from 10-03-2025 to 11-03-2025,[Seminar : "Distributed high-cadence plasma measurements from Langmuir probes in planetary ionospheres"].

### Geosciences

27. Prof. Chris Clark, Curtin University, Perth, Australia, "To deliver talk", from 03-09-2024 to 03-09-2024,[Seminar : "Progress in the Development of Integrated Petrochronological and Geodynamic Models of High- Grade Metamorphic Systems"].
28. Prof. Stephen Tooth, Aberystwyth University, Wales, UK, "To deliver talk", from 08-01-2025 to 08-01-2025,[Seminar : "Are humans now the dominant geological agent?"].
29. Rani Maurya, Gujarat National Law University, "To discuss research project and sample analysis", from 11-03-2025 to 18-03-2025.
30. Sushma Prasad, Potsdam University, "To disucuss collaboration work", from 26-03-2024 to 30-03-2025.
31. Swati Joshi, Delhi University, "Analysis of the samples collected at Delhi as a part of collaboration", from 15-04-2024 to 14-05-2024.
32. Hazel Vernier, Universite de Reims Champagne-Ardenne, France, "Analysis of the samples collected from upper tropospheric lower stratospheric (UTLS) region as a part of CEFIPRA project", from 07-08-2024 to 20-08-2024.
33. Gwenael Berthet, CNRS, France, "Scientific discussion on the data came from CEFIPRA project", from 13-05-2024 to 17-05-2024.
34. Dr. D. K. Aswal and Dr. manish Joshi, Bhabha Atomic Research Center, Mumbai, "To discuss for a project", from 12-06-2024 to 12-06-2024.

### Theoretical Physics

35. Dr. Anirban Das, Seoul National University, South Korea, "Academic discussion", from 17-04-2024 to 19-04-2024,[Seminar : "Dark Matter: the Enigma of our Cosmos and New Ways to Detect Light Dark Matter"].
36. Mr. Divyanshu Gola, Doon University, Dehradun, "Academic discussion", from 10-02-2024 to 09-07-2024,[Seminar : "Radio searches of Dark Matter in Dwarf Galaxies"].
37. Ms. Anantshree Bhatt, Doon University, Dehradun, Academic discussion, "Academic discussion", from 12-03-2024 to 11-05-2024,[Seminar : "Study of neutrino Oscillations in 2 and 3 flavour framework"].
38. Dr. R. Thiru Senthil, INO from IMSc, Chennai, "Visitor", from 25-05-2024 to 19-06-2024.
39. Dr. Chandrodoy Chattopadhyay, North Carolina State University, USA, "Academic discussion", from 31-07-2024 to 02-08-2024,[Seminar : "(a) "Heavy-ion collisions and hydrodynamics", (b) "Beyond standard hydrodynamics: Maximum-Entropy theory and the dynamics of critical fluctuations"."].
40. Ms. Tamanna Pathan, SVNIT Surat, "Visitor", from 22-08-2024 to 02-05-2025.
41. Ms. Safana P. Saji, IISER Mohali, "Visitor", from 23-08-2024 to 11-12-2024.
42. Prof. Saurabh Basu, IIT Guwahati, "Academic discussion", from 18-09-2024 to 18-09-2024,[Seminar : "Quasiperiodic potential induced corner states in a quadrupolar insulator: A paradigm for higher-order topology"].
43. Dr. Debashis Banerjee, Saha Institute of Nuclear Physics, "Academic discussion", from 03-10-2024 to 04-10-2024,[Seminar : "Efficient Quantum Field Theories for Quantum Computers"].
44. Ardamon Sten, IIT Kanpur, "Visitor", from 14-10-2024 to 25-10-2024.
45. Dr. Sai Chaitanya Tadepalli, Indiana University, USA, "Academic discussion", from 22-10-2024 to 22-10-2024,[Seminar : "Large Blue Spectral Index from a Conformal Limit of a Rotating Complex Scalar"].
46. Dr. Bhupal Dev, Washington University, "Academic discussion", from 23-11-2024 to 04-12-2024,[Seminar : "(a) "Neutrinos: Dirac or Majorana?", (b) "Introduction to High-Energy Neutrino Astrophysics""].
47. Dr. Sudeep K. Ghosh, IIT Kanpur, "Academic discussion", from 04-12-2024 to 05-12-2024,[Seminar : "Unveiling the mechanism behind sign changes in the thermopower and Hall coefficient of strained Sr2RuO4"].
48. Dr. Adhip Agarwala, IIT Kanpur, "Academic discussion", from 06-12-2024 to 06-12-2024,[Seminar : "Surface Tension of a Topological Phase"].
49. Dr. Saptarshi Mandal, Institute of Physics, Bhubaneswar, "Academic discussion", from 09-12-2024 to 12-12-2024,[Seminar : "A leisurely walk through few exotic manifestation of interacting spin systems"].
50. Prof. Subhendra Mohanty, IIT Kanpur, "Academic discussion", from 19-12-2024 to 19-12-2024,[Seminar : "Effective theories at finite temperature"].
51. Ms. Dharitree Bezboruah, Tezpur University, "visitor", from 07-01-2025 to 28-01-2025.
52. Mr. Sanjit Kumar, NIT Jamshedpur, "Visitor", from 15-01-2025 to 30-04-2025.
53. Dr. Abhishek Samanta, IIT Gandhinagar, "Academic discussion", from 30-01-2025 to 30-01-2025,[Seminar : "Non-Fermi Liquid Transport in Semimetals and Strongly Correlated Systems"].
54. Dr. Ravi Kuchimanchi, AID India, "Academic discussion", from 30-01-2025 to 30-01-2025,[Seminar : "Puzzles and predictions of the left right symmetric model"].
55. Dr. Anshika Bansal, University of Siegen, Germany, "Academic discussion", from 10-02-2025 to 14-02-2025,[Seminar : "LCSR application to $\mathrm{D}^+ \to \pi^+\ell^+\ell^-$"].

56. Prof. Sourin Das, Indian Institute of Science Education and Research, Kolkata, “Academic discussion”, from 21-03-2025 to 21-03-2025,[Seminar : “From Monopole-Induced Berry Phase to Quadrupolar Berry Phase”].
57. Dr. Aabhaas Vineet Malik, Birla Institute of Technology and Science Pilani, KK Birla Goa campus, “Academic discussion”, from 25-03-2025 to 25-03-2025,[Seminar : “Hidden magnetism and a mechanism for it”].
58. Dr. Indrakshi Raychowdhury, Birla Institute of Technology and Science Pilani, KK Birla Goa campus, “Academic discussion”, from 25-03-2025 to 25-03-2025,[Seminar : “Towards Quantum Simulating QCD”].
59. Dr. Sadashiv Sahoo, INO from IOP Bhubaneswar, “Visitor”, from 25-03-2025 to 25-05-2025.

**Computer Networking and Information Technology (CNIT) Division**

60. 27 Police Officers from Rashtriya Raksha University, Rashtriya Raksha University, Lavad-Dehgam, Gandhinagar, “Rashtriya Raksha University, Lavad-Dehgam, Gandhinagar, organized a field visit of CNIT Division and Param Vikram-1000 HPC at Physical Research Laboratory (PRL) on 07/March/2025. This visit involved 27 Police Officers from various states across India accompanied by the RRU staff members.”, from 07-03-2025 to 07-03-2025.

**Atomic, Molecular and Optical Physics**

61. Dr. Namrata Rani, Department of chemistry and Astronomy, Universidad de Concepción, Chile, “Research discussions”, from 23-02-2025 to 03-03-2025,[Seminar : “Reaction Mechanisms and Binding Energies of Interstellar Molecules: From Sulfur-Containing Species to Amides on Icy Grains”].
62. Prof. Nigel Mason, School of Physics and Astronomy, University of Kent, United Kingdom, “Research discussions”, from 09-11-2024 to 23-11-2024,[Seminar : “”].
63. Dr. Ragav Ramachnadran, Institute of Astronomy, Space and Earth Sciences (IASES), Kolkata, India, “Experiments in SALT and HISTA”, from 01-04-2024 to 31-03-2025.

# Astronomy and Astrophysics

**Chandrayaan-3 APXS elemental abundance measurements at lunar high latitude**

The elemental composition of lunar soil and rocks from different parts of the Moon is key to understanding the evolutionary history of the Moon. The chemical composition of lunar regolith has so far been precisely measured using the samples collected by the Apollo, Luna, and Chang'e 5 missions, which are from equatorial to mid-latitude regions; lunar meteorites, whose location of origin on the Moon is unknown; and the in situ measurement from the Chang'e 3 and Chang'e 4 missions, which are from the mid-latitude regions of the Moon. For the first time, measurements of abundances of the lunar soil in lunar high latitude region has been made by the Alpha Particle X-ray Spectrometer (APXS) of the Pragyan rover of Chandrayaan-3 mission. The APXS conducted scientific observations at 23 locations along the rover's path in the lander's vicinity, which had diverse morphologies. X-ray spectra recorded by the APXS showed the presence of all major and minor rock-forming elements, and abundances of elements were obtained from the analysis of the spectra.

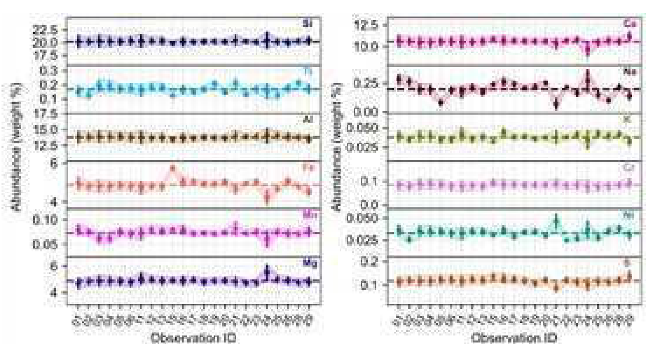



Figure 1 : Abundances of elements at each observation location as measured by Chandrayaan-3 APXS. Error bars represent one-sigma uncertainty; each panel's dotted line corresponds to the mean abundance.

(see Figure 1) shows the measured abundances at all observing locations, showing that the abundances of the lunar soil in the vicinity of the landing site are fairly uniform. From the elemental composition, it is inferred that the regolith primarily comprises Ferroan Anorthosite (FAN), a product of the Lunar Magma Ocean crystallization. However, observation of relatively higher magnesium abundance with respect to calcium in APXS measurements suggests the mixing of additional mafic material. The compositional uniformity over a few tens of meters around the Chandrayaan-3 landing site provides an excellent ground truth for remote sensing observations.

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This work was done in collaboration with Shyama Narendranath, Netra S. Pillai (SAG/URSC), Arup Kumar Hait, Aaditya Patinge (SAC), Abhishek Kumar, Neeraj Satya, Vivek R. Subramanian, Sonal G. Navle, R. G. Venkatesh, Lalitha Abraham (URSC), K. Suresh, Amitabh (SAC).

**(Santosh V. Vadawale, N. P. S. Mithun, M. Shanmugam, Amit Basu Sarbadhikari, Rishitosh K. Sinha, Megha Bhatt, S. Vijayan, Neeraj Srivastava, Anil D. Shukla, S. V. S. Murty, Anil Bhardwaj, Y. B. Acharya, Arpit R. Patel, Hiteshkumar L. Adalaja, C. S. Vaishnava, B. S. Bharath Saiguhan, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, Yash Srivastava, Varsha M. Nair, Tinkal Ladiya, Shiv Kumar Goyal, Neeraj K. Tiwari)**

**Discovery and characterization of a dense sub-Saturn TOI-6651b**

We have discovered and characterized a transiting sub-Saturn exoplanet TOI-6651b using the PARAS-2 spectrograph. The host star, TOI-6651 ($m_{\rm V} \approx 10.2$), is a sub-giant, metal-rich G-type star with $[\rm Fe/H] = 0.225^{+0.044}_{-0.045}$, $\rm T_{\it eff} = 5940 \pm 110$ K, and $\log g = 4.087^{+0.035}_{-0.032}$. Joint fitting of the radial velocities from PARAS-2 spectrograph and transit photometric data from Transiting Exoplanet Survey Satellite (TESS) reveals a planetary mass of $61.0^{+7.6}_{-7.9}\rm M_{\oplus}$ and radius of $5.09^{+0.27}_{-0.26}\rm R_{\oplus}$, in a $5.056973^{+0.000016}_{-0.000018}$ days orbit with an eccentricity of $0.091^{+0.096}_{-0.062}$. TOI-6651b has a bulk density of $2.52^{+0.52}_{-0.44} g/cm^3$, positioning it among the select few known dense sub-Saturns and making it notably the densest detected with TESS (see Figure 2).

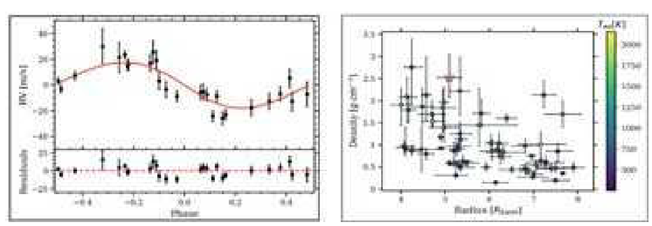

Figure 2 : Left : TOI-6651 RVs plotted with orbital phase and the best-fit RV model with EXOFASTv2 is represented by the red line. Lower panel is showing the residuals. Right : Bulk density of known sub-Saturns plotted against their radius with TOI-6651b being the second-highest density among them shown as star in the plot.

TOI-6651b is consistent with the positive correlation between planet mass and the host star's metallicity. We find that a considerable portion $\approx 87\%$ of the planet's mass consists of dense materials such as rock and iron in the core, while the remaining mass comprises a low-density envelope of H/He. TOI-6651b lies at the edge of the Neptunian desert, which will be crucial for understanding the factors shaping the desert boundaries. The existence of TOI-6651b challenges conventional planet formation theories and could be a result of merging events or significant atmospheric mass loss through tidal heating, highlighting the complex interplay of dynamical processes and atmospheric evolution in the formation of massive dense sub-Saturns. This is the first exoplanet discovery from the PARAS-2 spectrograph and the PRL 2.5m telescope. For the first time in the country, we have done speckle imaging of TOI-6651 using the PRL 2.5m telescope to rule out the very close companions around the host star.

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This work was done in collaboration with Boris S. Safonov, Ivan A. Strakhov (SAI, Lomonosov Moscow State University, Russia), Marco Montalto (INAF – Osservatorio Astrofisico di Catania, Italy), Jason D. Eastman, David W. Latham and, Allyson Bieryla (CFA, Harvard & Smithsonian, USA).

**(Sanjay Baliwal, Rishikesh Sharma, Abhijit Chakraborty, Akanksha Khandelwal, K. J. Nikitha, Neelam J. S. S. V. Prasad, Kapil K. Bharadwaj, Kevikumar A. Lad, Shubhendra N. Das and Ashirbad Nayak)**

### TOI-6038Ab : A Dense Sub-Saturn in the Transition Regime between the Neptunian Ridge and Savanna

We have discovered and characterized another sub-Saturn exoplanet, TOI-6038Ab, using the PARAS-2 spectrograph. The planet orbits a bright ($m_{\rm V} = 9.9$), metal-rich late F-type star, TOI-6038A, with $\mathrm{T}_{eff} = 6110 \pm 100$ K, $[\mathrm{Fe/H}] = 0.124^{+0.079}_{-0.077}$ dex, and $\log g = 4.118^{+0.015}_{-0.025}$. The system also contains a wide-orbit binary companion, TOI-6038B, an early K-type star at a projected separation of $\approx 3217$ AU. We combined radial velocity data from PARAS-2 with photometric data from the Transiting Exoplanet Survey Satellite (TESS) for joint modelling. Along with that, we have also acquired and analyzed the speckle imaging data using the speckle imager attached with the PRL 2.5m telescope. We found that TOI-6038Ab has a mass of $78.5^{+9.5}_{-9.9}\mathrm{M}_{\oplus}$ and radius of $6.41^{+0.20}_{-0.16}\mathrm{R}_{\oplus}$, orbiting in a circular orbit with a period of $5.8267311^{+0.0000074}_{-0.0000068}$ days (see Figure 3).

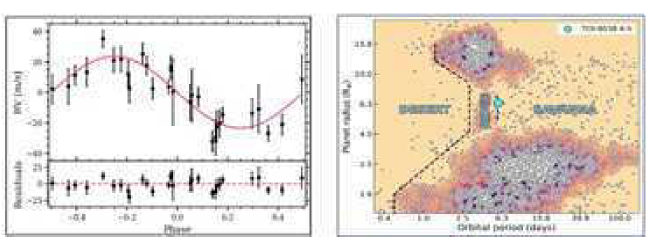

Figure 3 : Left : TOI-6038A RVs plotted with orbital phase and the best-fit RV model with EXOFASTv2 is represented by the red line. Lower panel is showing the residuals. Right : TOI-6038Ab in the period-radius diagram of close-in exoplanets with radii constrained to a precision better than 20%. The boundaries of the Neptunian desert, ridge, and savanna (Castro-Gonzalez et al. 2024a) are indicated with black dashed lines.

Internal structure modelling suggests that $\approx 74\%$ of the planet's mass is composed of dense materials, such as rock and iron, forming a core, while the remaining mass consists of a low-density H/He envelope. TOI-6038Ab lies at the transition regime between the recently identified Neptunian ridge and savanna. Having a density of $\rho_{\rm P} = 1.62^{+0.23}_{-0.24} g/cm^3$, TOI-6038Ab is compatible with the population of dense ridge planets ($\rho_{\rm P} \simeq 1.5$–$2.0 g/cm^3$), which have been proposed to have reached their close-in locations through high-eccentricity tidal migration (HEM). First-order estimates suggest that the secular perturbations induced by TOI-6038B may be insufficient to drive the HEM of TOI-6038Ab. Therefore, it is not clear whether HEM driven by a still undetected companion or early disk-driven migration brought TOI-6038Ab to its present-day close-in orbit. Interestingly, its bright host star makes TOI-6038 A b a prime target for atmospheric escape and orbital architecture observations, which will help us to understand its overall evolution better.

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This work was done in collaboration with A. Castro-González (Centro de Astrobiología, CSIC-INTA, Spain), Vincent Bourrier (Geneva Observatory, Switzerland), Hareesh G. Bhaskar (Technion—Israel Institute of Technology, Israel), Jason D. Eastman, David W. Latham and, Allyson Bieryla (CFA, Harvard & Smithsonian, USA).

**(Sanjay Baliwal, Rishikesh Sharma, Abhijit Chakraborty, K. J. Nikitha, Akanksha Khandelwal, Neelam J. S. S. V. Prasad, Kapil K. Bharadwaj, Kevikumar A. Lad, Ashirbad Nayak, and Vishal Joshi)**

### Linear polarization study of open clusters in the anticenter direction: Signature of the spiral arms

Dust in the ISM is responsible for the partial linear polarization of starlight due to dichroic extinction. Combining the star-light polarization measurement with the accurate distance information provides observational constraints on the number of dust clouds along the line of sight, thereby enabling a comprehensive understanding of 3D dust distribution in the Galactic plane. Motivated by the idea of tracing the spiral arms from the dust distribution, we chose to study several clusters in a similar line of sight that lie at different distances in the direction of the anticenter. In contrast to the direction of the Galactic center, the anticenter direction is less crowded and has less dust extinction, providing a unique opportunity to perform polarization observations of open clusters at distant locations of the disk. We observed five open clusters, Kronberger 1, Berkeley 69, Berkeley 71, King 8, and Berekeley 19, situated at distances ranging from 2-6 kpc using the AIMPOL instrument mounted on the 104 cm Sampurnanand telescope operated by ARIES, Nainital, during October 19 to 23, 2022. We analyzed the polarization measurements and information on the distance to the observed stars using both qualitative and quantitative methods to disentangle the number of dust clouds along the line of sight. Our analysis revealed multiple (two or more) foreground dust layers in all observed cluster directions. The distances of these layers were approximated from the jump in the degree of polarization, polarization angle, and extinction as a function of distance to the individual stars toward the corresponding clusters. Berkeley 69 and Berkeley 71 reveal a dust layer at approximately 2 kpc, coinciding in the distance with the Perseus arm. On the other hand, Berkeley 19 and King 8 have distant dust layers that are likely associated with the Outer arm in the direction of the anticenter. The absence of a discernible Perseus arm signature in the higher latitude clusters ($|b| > 3^\circ$) suggests that the Perseus arm could be thinner than the Outer arm of our Galaxy due to the flaring disk of the Milky Way.

However, it could also be related to local structures within the Perseus arm. In any case, our results highlight the dust distribution over Galaxy's small- and large-scale structures.

We, furthermore combined our polarization measurements in the anticenter with the literature, spanning approximately a radius of $4^{\circ}$. Our analyses revealed a consistent rise in the degree of polarization and a gradual stabilization of the polarization angle with increasing distance. This uniform trend suggests a homogeneous dust distribution along this line of sight characterized by a consistent alignment of the dust grains and the plane-of-sky component of the magnetic field with distance. Overall, our findings indicate that the anticenter direction is a low extinction direction with somewhat uniform orientation of the plane-of-the-sky magnetic field component. Any observed changes in the polarization or extinction along the line of sight are primarily caused by the global features of the Galaxy such as the spiral arms.

doi : `https://doi.org/10.1051/0004-6361/202449537`

This work was done in collaboration with Vincent Pelgrims of the Universite Libre de Bruxelles, Brussels, Belgium, and Santosh Joshi and Mrinmoy Sarkar of ARIES, Nainital, India.

**(Namita Uppal and Shashikiran Ganesh)**

**Cloud-Cloud Collision: Formation of Hub-filament Systems and Associated Gas Kinematics. Mass-collecting Cone - A New Signature of Cloud-Cloud Collision**

Massive stars, with masses exceeding eight solar masses, significantly influence their host galaxies through intense radiative and mechanical feedback. Hub-filament systems have been identified as promising environments for massive star formation. In these systems, molecular gas and dust are funneled through filaments toward the central hub, which becomes the densest region, ideally forming massive stars. Despite their significance, the origins of hub-filament systems remain elusive. Interestingly, recent observational studies of some massive star-forming regions suggest a possible connection between the collision of molecular clouds and the formation of hub-filament systems. To explore this aspect, an analysis of magneto-hydrodynamic (MHD) simulation data has been conducted, where a spherical turbulent molecular cloud collides with a plane-parallel sea of denser gas at about 10 km/s. The collision leads to shock compression, forming filaments mostly perpendicular to the magnetic field. These filaments, shaped into a cone, evolve through non-gravitational initially, followed by gravitational gas attraction to form the hub-filament system. The formation process involves turbulence, shock compression, magnetic fields, and gravity. Position-velocity diagrams reveal gas flow toward the cone's vertex, where high-density objects collapse, with the magnetic field curving toward the collision, providing key signatures of cloud-cloud collisions.

doi : `https://doi.org/10.3847/1538-4357/ad7098`

This work was done in collaboration with T. Inoue (Konan Univ., Japan), Y. Fukui (Nagoya Univ., Japan), H. Sano (Gifu Univ., Japan), R. I. Yamada (Nagoya Univ., Japan), and K. Tachihara (Nagoya Univ., Japan).

**(A. K. Maity, L. K. Dewangan, N. K. Bhadari, O. R. Jadhav)**

**G321.93-0.01: A Rare Site of Multiple Hub-filament Systems with Evidence of Collision and Merging of Filaments**

Molecular clouds host elongated dense structures called filaments, which often converge at junctions known as hubs, forming hub-filament systems. In hub-filament systems, gas and dust flow through filaments into the hub, enabling the formation of massive stars ($>$ 8 $M_{\odot}$) that significantly impact their host galaxies through radiative and mechanical feedback. Despite their importance in massive star formation, the origins and evolution of hub-filament systems remain poorly understood. This study investigates the massive star-forming molecular cloud G321.93-0.01 (G321, distance $\sim$1.98 kpc) to explore the origin and evolution of hub-filament systems. The major outcome of this study is detecting multiple hub-filament systems in G321. This is a unique result, considering that such complex sites are rare in the literature. Two hub-filament systems exhibit high mass accretion rates ($> 10^{-3}$ solar mass per year). A significant difference in the evolutionary stages of hub-filament systems is observed in G321 based detecting ionized (HII) regions. n the central hub of a hub-filament system in G321, the analysis of Atacama Large Millimeter/sub-millimeter Array (ALMA) Band-7 continuum data revealed several high-mass branches (M $\sim$8–33 $M_{\odot}$), which further fragment into smaller branches and leaves. The computed masses of these leaves/cores ($\sim$1–9 $M_{\odot}$) align with the thermal Jeans mass of the central hub with subsonic/transonic turbulence. This hub-filament system shows the signature of collision with a filamentary cloud about 1 Myr ago, suggesting that the collision event may have triggered its formation. In the remaining cases, the constituent filaments exhibit relative velocities ($\sim$1 km/s), indicating possible formation through the merging or overlapping the filaments.

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This work was done in collaboration with Y. Fukui (Nagoya Univ., Japan), A. Haj Ismail (Ajman Univ., United Arab Emirates), Saurabh Sharma (ARIES, India), and H. Sano (Gifu Univ., Japan).

**(A. K. Maity, L. K. Dewangan, N. K. Bhadari, O. R. Jadhav)**

**JWST-ALMA study of a hub-filament system in the nascent phase**

Massive stars (M $>$ 8 $M_{\odot}$) influence their surroundings through radiative and mechanical energy. Hub-filament systems, which consist of dense filaments converging into a central hub, are found to be crucial for massive star formation. However, these systems' processes driving mass accumulation are not yet fully understood. Observing these systems in their primordial state, before newborn stars disrupt them with intense energy, is rare but essential for understanding how massive stars gain their mass. This study, using images from the James Webb Space Telescope (JWST) and data from the Atacama Large Millimeter/submillimeter Array (ALMA) telescope revealing gas kinematics, confirms the existence of a compact, early-stage hub-filament system nurturing the high-mass protostar G11P1 (distance $\sim$2.92 kpc). This work mainly used the $N_2H^+$(1–0) line data from the ALMA Band-3 observations. This study reveals several gas streams flowing toward the central hub, primarily driven by gravity. It introduces a new observational signature of early hub-filament systems: a wiggled, funnel-shaped structure in position-position-velocity (PPV) space. Overall, the work presents new observational proxies to trace pristine hub-filament systems and sheds light on the intricate processes involved in the early stages of massive star formation.

doi : https://doi.org/10.1051/0004-6361/202452189

This work was done in collaboration with A. Hoque (SNBNCBS, India), L. E. Pirogov (IAP RAS, Russia), P. F. Goldsmith (JPL, USA), Saurabh Sharma (ARIES, India), A. Haj Ismail (Ajman Univ., United Arab Emirates), and T. Baug (SNBNCBS, India).

**(N. K. Bhadari, L. K. Dewangan, O. R. Jadhav, A. K. Maity)**

### Mon R2: A Hub-Filament System with an Infrared Bubble at the Hub Center

The formation process of massive stars (M $>$ 8 $M_\odot$) is not yet fully understood. It is thought that the formation of such stars is intricately linked to accretion through filaments in hub-filament systems. In these systems, gas and dust are funneled through filaments into the central hub, establishing the necessary conditions for the birth of massive stars. The target of this study is an evolved-stage hub-filament system in Monoceros R2/Mon R2 characterized by active star formation and the presence of massive stars, which is one of the nearest hub-filament systems located at a distance of $\sim$830 pc. To probe the mass accumulation process and the impact of massive stars formed in the Mon R2 hub-filament system, the study examined gas kinematics across various physical scales using multi-scale and multi-wavelength continuum and line data sets from the Atacama Large Millimeter/sub-millimeter Array (ALMA), along with near-infrared data from the Hubble Space Telescope (HST). The Mon R2 hub-filament system displays a spiral structure, with the central hub containing more mass than its filaments. ALMA $C^{18}O$(1–0) emission reveals several filaments connected to a molecular ring (size $\sim$0.18 pc $\times$ 0.26 pc). Analysis of the ALMA $C^{18}O$(1–0) line data uncovers a V-shaped velocity feature and an anti-correlation between the radial distributions of column density and radial velocity, indicating mass accretion toward the molecular ring along the filaments. The molecular ring surrounds the infrared ring (size $\sim$0.12 pc $\times$ 0.16 pc), which is not usually observed. The infrared ring encircles infrared dark regions and a population of embedded near-infrared sources, including the massive stars. The infrared and the dense molecular rings are likely shaped by feedback from massive stars. Overall, the derived outcomes support that the Mon R2 hub-filament system transitioned from infrared-quiet to infrared-bright, driven by the interaction between gas accretion and feedback from massive stars.

doi : https://doi.org/10.3847/1538-3881/ad9b22

This work was done in collaboration with A. Haj Ismail (Ajman Univ., United Arab Emirates) and Saurabh Sharma (ARIES, India).

**(L. K. Dewangan, N. K. Bhadari, A. K. Maity, O. R. Jadhav)**

### Uncovering the Hidden Physical Structures and Protostellar Activities in the Low-metallicity S284-RE Region: Results from ALMA and JWST

Studying star formation in low-metallicity clouds provides valuable insights into how stars form under distinct physical conditions. Unlike regions with higher metal content, low-metallicity environments exhibit unique characteristics influencing gas cooling, heating, and star formation processes. These differences offer an opportunity to understand better the mechanisms driving star formation in such environments. Previously reported research shows that in low-metallicity environments, gas tends to remain warmer due to less efficient cooling, creating conditions that favor the formation of massive stars (M $>$ 8 $M_\odot$). In this context, the low-metallicity region S284-RE (distance $\sim$5.5 kpc), containing only one-fifth of the Sun's metal content, has been analyzed using multi-wavelength data from the Spitzer Space Telescope, Herschel Space Observatory, James Webb Space Telescope (JWST) and Atacama Large Millimeter/submillimeter Array (ALMA). A filamentary structure in S284-RE, with a mass of $\sim$2402 $M_\odot$ and a length of $\sim$8.5 pc, is investigated using the Herschel column density map. It is classified as a thermally supercritical filament (i.e., $\mathrm{M}_{l,crit} < \mathrm{M}_{l,obs}$). The Planck 850 $\mu$m polarization data suggest that the magnetic field lines appear to be perpendicular to this filament. The study has uncovered multiple molecular outflows and clear indicators of active star formation. These outflows are driven by young stars embedded in dense gas and dust, some exhibiting periodic bursts of accretion (or episodic accretion). The driving sources of the outflows are identified based on outflow geometry, ALMA continuum peaks, and positions of young stars. Interestingly, a massive young star is also discovered driving an outflow that stretches about 2.7 parsecs (5.5 $\times$ $10^5$ AU).

doi : https://doi.org/10.3847/1538-4357/ada388

This work was done in collaboration with A. Verma (ARIES, India), Saurabh Sharma (ARIES, India), and Mamta (ARIES, India).

**(O. R. Jadhav, L. K. Dewangan, N. K. Bhadari, A. K. Maity)**

### Peering into the Heart of the Giant Molecular Cloud G148.24+00.41: A Deep Near-infrared View of the Newly Hatched Cluster FSR 655

A star cluster is a group of stars gravitationally bound to one another. It is hypothesized that most, if not all, stars form within clusters in molecular clouds.

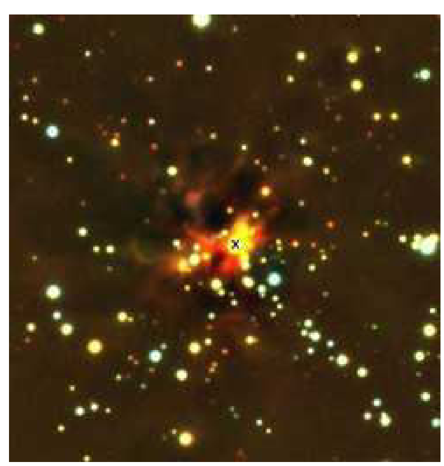

Figure 4 : Near Infrared color-composite image (red: Ks band; green: H band; and blue: J band) of the newly hatched cluster, FSR 655, taken with the TANSPEC camera mounted on the 3.6m Devasthal Optical Telescope.

These clusters' dense and dynamic environment plays a critical role in shaping both the stellar and likely planetary properties of the constituent stars. In this study, we examined the filamentary hub of the giant molecular cloud G148.24+00.41, which has a total mass of approximately $10^5$ $M_\odot$. Observations of the central 2 pc × 2 pc region of the hub were conducted using the near-infrared TANSPEC camera on the 3.6 m Devasthal Optical Telescope, focusing on the J, H, and Ks bands (Figure 4).

The Ks-band luminosity function (KLF) was employed to estimate the cluster's age by comparing it with the KLF of synthetic clusters, yielding an age of approximately 0.5 Myr. Our analysis indicates that the current mass of the cluster is approximately 180 $M_\odot$ and is forming stars at a rate of approximately 330 $M_\odot$ per Myr, with a star formation efficiency of about 20%. This efficiency is significantly higher than the typical star formation efficiency of around 3% observed in molecular clouds. Given that the cluster is connected to an extended gas reservoir through a filamentary network, we estimate that, at the current star formation rate, the cluste can evolve into a more massive system, potentially exceeding 1000 $M_\odot$ within a few million years. We discuss the importance of studying such young clusters to gain insights into the early evolution and growth processes of star clusters.

doi : https://doi.org/10.3847/1538-3881/ad630d

This work has been done in collaboration with Devendra Ojha (TIFR, Mumbai), Sourbha Sharma (ARIES, Nainital), Jessy Jose (IISER, Tirupati), Ram Sagar (IIA, Bangalore) and international collaborators.

**(Vineet Rawat and Manash Samal)**

**Search for protostellar jets with UWISH2 in the molecular cloud complexes Vulpecula and IRDC G53.2**

Jets and outflows serve as key indicators of stellar formation, playing a crucial role in facilitating the loss of angular momentum from young stellar objects (YSOs), thereby preventing them from spinning excessively as they grow. In this study, we utilized near-infrared shock tracer emissions at 2.12 micron to identify 127 outflows within the molecular cloud complexes Vulpecula OB1 and IRDC G53.2, spanning 12 square degrees of the Galactic plane. A significant majority (79%) of the outflow driving sources were classified as Class 0/I protostars, while 17% were Class II YSOs, and the remaining 4% were Class III YSOs. Analysis of knot spacings revealed a characteristic ejection frequency of approximately 1.2 kyr, suggesting that the outflow activity represents an intermediate eruption type, falling between the FU Ori and EX Ori classes, for both cloud complexes. Radiative transfer models were employed to infer the stellar and disk properties of the driving sources, indicating that intermediate-mass protostars drive the majority of the observed jets. The study also identified and discussed several noteworthy trends between outflow properties and their corresponding driving sources. These findings highlight the potential of the identified jet-driving protostellar sample to enhance the understanding of outflow dynamics, particularly with future high-resolution observations.

doi : https://doi.org/10.1093/mnras/stae846

This work has been done in collaboration with Manish Chauhan and Anandmayee Tej (IIST, Thiruvananthapuram) and Dirk Froebrich (University of Kent UK).

**(Manash Samal)**

**A Phenomenological Study of the Evolution of Shock-Induced O i Emission Lines in the Spectrum of Nova V2891 Cygni**

The eruption of Nova V2891 Cygni in 2019 offers a rare opportunity to explore the shock-induced processes in novae ejecta. The spectral evolution shows noticeable differences in the evolution of various oxygen emission lines such as O i 7773 Å, O i 8446 Å, O i 1.1286 $\mu$m, O i 1.3164 $\mu$m, etc. Here, we use the spectral synthesis code `Cloudy` to study the temporal evolution of these oxygen emission lines. Our photoionization model requires the introduction of a component with a very high density ($n \sim 10^{11}\,\mathrm{cm}^{-3}$) and an enhanced oxygen abundance (O/H $\sim 28$) to produce the O i 7773 Å emission line, suggesting a stratification of material with high oxygen abundance within the ejecta. An important outcome is the behaviour of the O i 1.3164 $\mu$m line, which could only be generated by invoking the collisional ionization models in `Cloudy`. Our phenomenological analysis suggests that O i 1.3164 $\mu$m emission originates from a thin, dense shell characterized by a high density of about $10^{12.5}$–$10^{12.8}\,\mathrm{cm}^{-3}$, most likely formed due to strong internal collisions. If such is the case, the O i 1.3164 $\mu$m emission presents as a tracer of shock-induced dust formation in V2891 Cyg. The collisional ionization models have also been successful in creating the high-temperature conditions ($\sim 7.07$–$7.49 \times 10^5$ K) required to reproduce the observed high ionization potential coronal lines, which coincide with the epoch of dust formation and evolution of the O i 1.3164 $\mu$m emission line.

doi : https://doi.org/10.1093/mnras/stae1719

This work has been done in collaboration Gargi Shaw of Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Mumbai.

**(Ruchi Pandey, Mudit K Srivastava, Gargi Shaw)**

**The Gaia Ultracool Dwarf Sample–IV: GTC/OSIRIS Optical Spectra of Gaia Late-M and L Dwarfs**

As part of our ongoing, in-depth investigation of the low-mass end of the main sequence within the Solar neighbourhood, we conducted optical spectroscopic observations of 53 late-M and L-type ultracool dwarfs using the OSIRIS instrument on the 10.4 m Gran Telescopio Canarias. The data include low-resolution ($\mathrm{R} \approx 300$) and mid-resolution ($\mathrm{R} \approx 2500$) spectra. While most of these objects were previously identified, many remained poorly studied and lacked comprehensive kinematic information. We measured spectral indices and assigned spectral types—six newly classified in this work. By fitting BT-Settl synthetic spectra, we estimated effective temperatures and surface gravities for all targets. Radial velocities were determined for 46 objects using line centre fitting and cross-correlation techniques, including 29 sources without prior radial velocity data. Combined with *Gaia* DR3 astrometry, these measurements allowed us to compute Galactocentric space velocities. Kinematic analysis revealed two candidates likely associated with populations outside the thin disc and four members of known young stellar moving groups. Additionally, we identified two young field ultracool dwarfs: 2MASSW J1246467+402715 (L4$\beta$), which shows a possible weak lithium absorption feature, and G 196-3B (L3$\beta$), whose youth is supported by previous studies of its primary companion.

doi : https://doi.org/10.1093/mnras/stae2102

Gaia UltraCool Dwarf Sample Project (GUCDS) consortium.

**(A. S. Rajpurohit)**

### Dust Formation and Destruction in the Ejecta of Nova V959 Monocerotis

We analyzed the infrared observations of the classical nova V959 Mon, which underwent an eruption in 2012. By combining archival and ground-based IR data spanning 100-4205 days post-outburst, we examine the system's dust formation, ejecta dynamics, and the properties of its secondary star. Analysis of the pre-eruption near-infrared spectral energy distribution reveals that the secondary star has an effective temperature of 5660 K, consistent with a G5 main-sequence classification. This finding revises earlier studies that suggested a K-type star.

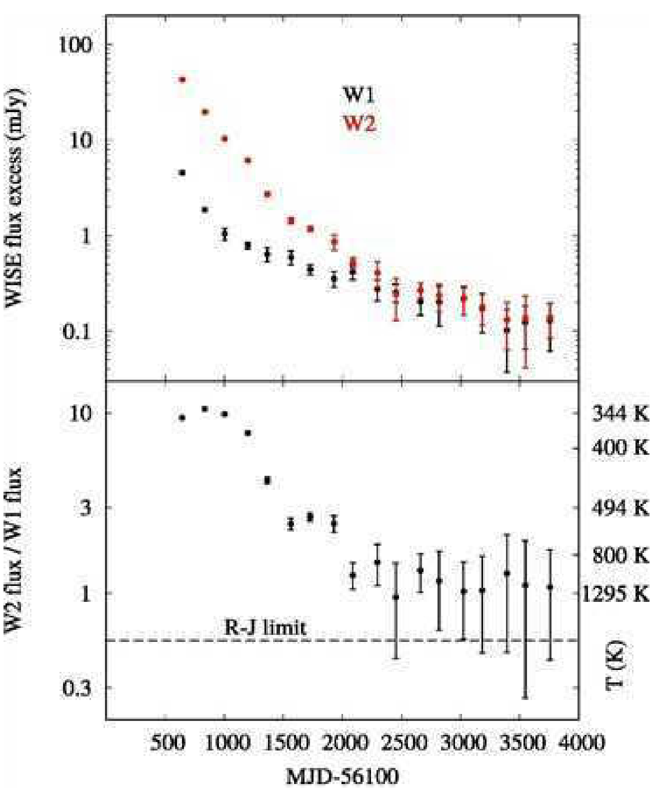


Figure 5 : Top: Variation of the NEOWISE W1 and W2 fluxes from the 2012 ejecta, i.e. the quiescent WISE fluxes have been subtracted from the NEOWISE data; the excess fluxes have been dereddened by $\mathrm{E(B-V)} = 0.7$ Bottom: Variation of the flux excess ratio $\mathrm{W2/W1}$ flux excesses are dereddened. The error bars are derived from the errors in the W1 and W2 fluxes. The temperature scale on the right-hand axis corresponds to that of the black body having the $\mathrm{W2/W1}$ flux ratio on the left-hand axis. The broken horizontal line is the Rayleigh-Jeans limit.

NEOWISE observations detected unexpected late-time (2600 days) dust emission at W1 and W2 bands (3.4 and 4.6 $\mu$m, respectively), inferred from the variation of the flux excess ratio $\mathrm{W2/W1}$ (See Figure 5). Contrary to standard nova dust formation models-where temperatures typically decrease over time-the dust in V959 Mon exhibited a steady rise in temperature from $\sim$370 K to $\sim$1300 K. Concurrently, the dust mass declined from $\sim 2 \times 10^{-8}$ M$_\odot$ to $\sim 10^{-12}$ M$_\odot$, indicating gradual destruction as the material spiraled inward. We propose that this dust originated in pre-existing circumbinary material, likely remnants from the system's common envelope phase. When the 2012 ejecta collided with this reservoir, Rayleigh-Taylor instabilities fragmented the dust into clumps that subsequently "rained" toward the central binary. The observed temperature increase and mass loss align with theoretical models of dust destruction via chemisputtering by hydrogen atoms in the ejecta. Notably, V959 Mon was the first nova detected in gamma rays by Fermi LAT, a phenomenon linked to its oxygen-neon (ONe) white dwarf composition. This suggests that gamma-ray emission may be a common feature of ONe novae. Our findings challenge conventional theories of nova dust formation, demonstrating that interactions with pre-existing circumbinary material can produce unique infrared signatures and dynamical behaviour. This work underscores the importance of revisiting archival NEOWISE data to identify similar late-time dust emissions in other novae, potentially reshaping our understanding of dust production and destruction in cataclysmic variables.

doi : https://doi.org/10.1093/mnras/stae1240

This work has been done in collaboration with Prof. Anurin Evans (Keele University, UK) and Prof. Watson Varricatt (UKIRT Observatory, USA).

**(D. P. K. Banerjee & Vishal Joshi)**

### Foreground Dust Properties toward the Cluster NGC 7380

We analyze the multiband polarimetric observations to derive the properties of foreground dust toward the open star cluster NGC 7380, located within the H ii region Sh 2-142. The cluster, associated with the binary O-type star DH Cep, lies at a distance of approximately 2.5 kpc and exhibits variable extinction, making it an ideal target for studying interstellar dust dynamics. The polarization vectors of stars align predominantly with the Galactic magnetic field, indicating that dust grains are aligned by the large-scale Galactic field rather than local sources. The study identifies a dense dust structure in the southeast region of the cluster, supported by extinction maps and infrared emission, which correlates with higher polarization degrees. The color composite image of the observed region of the cluster NGC 7380 contains IR images, and the distribution of the dust extinction and Polarization vectors in the V band is shown in Figure 6.

A key finding is the presence of a foreground dust layer at approximately 1.2 kpc, inferred from the increase in polarization and extinction with distance. The average maximum polarization $\mathrm{P}_{max}$ and peak wavelength $\lambda_{max}$ are measured as $1.71 \pm 0.57\%$ and $0.56 \pm 0.07$ $\mu m$ respectively, suggesting grain sizes similar to those in the diffuse interstellar medium. The polarizing efficiency decline at higher extinctions implies reduced grain alignment in denser regions. The Stokes parameter analysis reveals three distinct groups of stars, reflecting variations in dust properties and magnetic field orientations along the line of sight.

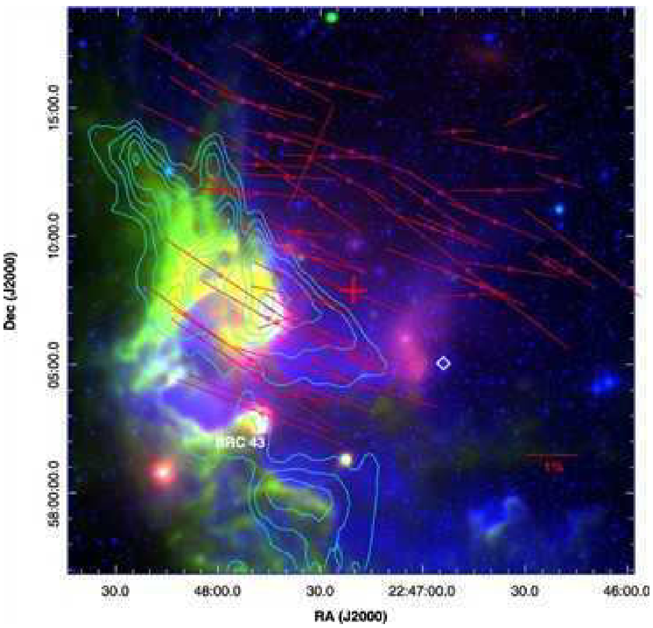


Figure 6 : The colour composite image of the observed region of the cluster NGC 7380 (red: WISE-W4; green: WISE-W3; blue: DSS2-R). Cyan contours represent the distribution of the dust extinction in the region. Polarisation vectors in the V band are overplotted.

We also identified eight stars with potential intrinsic polarization, likely due to circumstellar effects, though most polarization arises from interstellar dust. The alignment mechanisms and dust properties are consistent with RAT theory, particularly in how grain size and radiation fields influence polarization efficiency. The research underscores the role of Galactic magnetic fields in dust alignment. It highlights the complex interplay between dust distribution, extinction, and local radiation environments in star-forming regions. These findings contribute to a deeper understanding of interstellar dust dynamics and its impact on starlight polarization in clusters.

doi : `https://doi.org/10.3847/1538-3881/ad36c3`

This work has been done in collaboration with Prof. Jeewan C. Pandey and Dr. Neelam Panwar (ARIES, India), Dr. Biman J. Medhi (Gauhati University, India) and Dr. Thiem Hoang (Korea Astronomy and Space Science Institute, Republic of Korea.

**(Sadhana Singh, Vishal Joshi and Shashikiran Ganesh)**

### Optical and X-ray studies of the Be/X-ray binary IGR J06074+2205

Be/X-ray binaries (BeXRBs), the largest group within the high mass X-ray binaries (HMXBs), typically host a neutron star as the compact object, coupled with a massive non-supergiant star of mass 10-20 $M_\odot$), orbiting around their common center of mass. The neutron stars within these binary systems derive their energy by accreting mass from the circumstellar disc of the Be stars. Notably, the companion Be stars in BeXRBs frequently display distinct emission lines such as H I, He I, and Fe II at certain stages of their evolution. BeXRBs exhibit two distinct categories of X-ray activities: normal (Type I) and giant (Type II) X-ray outbursts. Normal outbursts manifest as periodic or quasi-periodic events, typically occurring near the periastron passage of the neutron star. These outbursts last for a fraction ($\sim$20%) of the orbital period, reaching peak luminosities up to $10^{37}$ erg $s^{-1}$. In contrast, giant X-ray outbursts are rare and irregular, and their infrequent occurrences lack orbital modulation. They persist for multiple orbital periods, showing peak luminosities equal to or exceeding $L_X \geq 10^{37}$ erg $s^{-1}$. IGR J06074+2205 was discovered by the JEM-X telescope onboard INTEGRAL in 2003. Subsequently, the optical counterpart of IGR J06074+2205 is suggested to be a Be star, as indicated by the presence of the H$\alpha$ emission line. Coherent X-ray pulsations were detected from the X-ray source using the XMM-Newton observation on 29 September 2017. Detection of a cyclotron absorption line at $\approx$51 keV allowed to estimate the neutron star's magnetic field of the neutron star as $4\times10^{12}$ G.

We carried out X-ray studies of the Be/X-ray binary IGR J06074+2205 during X-ray outbursts in 2023 October and December using NuSTAR and NICER pulsar observations. NuSTAR observed the source twice during the 2023 October outburst, while NICER provided coverage across various epochs during both outbursts. Coherent X-ray pulsations from the neutron star are detected at 374.60 s. The pulse profiles of the pulsar exhibit a strong correlation with both luminosity and energy, revealing the intricate characteristics of the emitting region. The NuSTAR spectra unveil an iron emission line at 6.4 keV during the brighter state, corresponding to a luminosity of $\sim$5.56 $\times$ $10^{36}$ erg $s^{-1}$. Additionally, a cyclotron absorption line at 50.7 keV, indicative of a magnetic field strength of 5.69 $\times$ $10^{12}$ G, is detected solely during the brighter observation. We utilized the long-term MAXI/GSC light curve to estimate the potential orbital period of IGR J06074+2205, which is predicted to be approximately 80 days or 80/n days (n = 2, 3, 4). We showed results from optical spectroscopic analysis of observations taken between 2022 and 2024 using the MIRO and IAO. We observed variable $H_\alpha$ and Fe II emission lines (see Figure 7), with an increase in equivalent width, indicating a dynamic circumstellar disc. The appearance of additional emission lines, such as He I (5875.72 Å), He I (6678 Å), and He I (7065 Å) from the post-outbursts observation in 2024 February suggests the growth of a larger or denser circumstellar disc. This disc continues to grow without noticeable mass-loss, even during the 2023 X-ray outbursts, potentially leading to a future giant X-ray outburst.

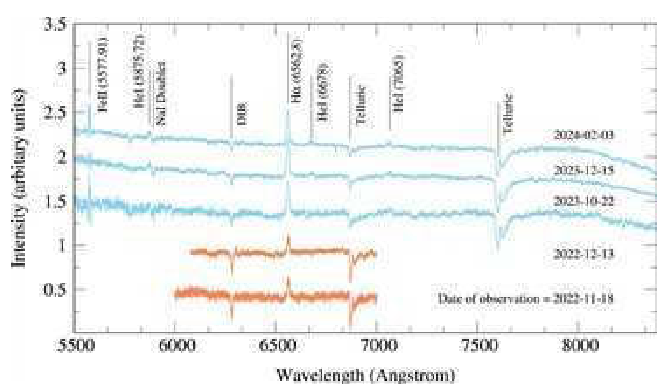


Figure 7 : Evolution of the optical spectrum of Be/X-ray binary IGR J06074+2205 as seen with the MFOSC-P (orange) & HFOSC (blue) instruments. The observation dates are annotated on each spectrum. The spectra are plotted with certain offsets for clarity.

doi : `https://doi.org/10.1093/mnras/stae2282`

This work has been done in collaboration with G. K. Jaisawal of Technical University of Denmark, Denmark.

**(Birendra Chhotaray, Goldy Ahuja and Sachindra Naik)**

### A Long-term Study of Mrk 50: Appearance and Disappearance of Soft Excess

Active Galactic Nuclei (AGNs) are among the most luminous and energetic sources in the universe. The extremely high luminosity of the AGNs is understood to arise from the accretion of matter onto the supermassive black hole (SMBH) residing at the center of the host galaxies. The SMBH typically has a mass ranging from $10^5$ to $10^9$ $M_\odot$. The AGNs emit radiation across the entire range of the electromagnetic spectrum, from radio waves to high energy $\gamma-$rays. According to the standard accretion disk theory, the thermal emission from the disk is mostly emitted in the ultraviolet (UV) band of the electromagnetic spectrum. Viscous dissipation in the disk generates heat, which is then radiated in the optical/UV regime for black hole masses typical of AGNs. The X-ray emission from the AGN serves as an important tool for investigating physical processes in extreme gravity, as it is thought to originate from the innermost region of the accretion disk.

The X-ray spectrum of AGN is primarily dominated by a power-law continuum produced through the inverse Compton scattering of the seed optical/UV photons from the accretion disk by a hot corona located near the black hole. In addition to the power-law continuum with exponential cut-off, the other spectral features, such as reflection, low energy absorption, and often an excess in the soft X-ray ranges (below 2 keV), are also present. The reflection features consist mainly of two components, such as a Compton hump, visible in the 15 to 50 keV range and an iron $K_\alpha$ emission line at $\sim$ 6.4 keV. The low energy absorption is typically significant in Seyert 2 AGNs. In contrast, the Seyfert 1s are usually not absorbed or only marginally absorbed with absorption column density, $N_H \leq 10^{22} cm^{-2}$. The absence of strong absorption allows us to see an additional featureless spectral component, known as soft X-ray excess over the hard X-ray power-law continuum in many Seyfert 1s. However, the origin of this spectral component has been a topic of research over the last $\sim 40$ years. Markarian 50 (Mrk 50) is a Seyfert 1 galaxy at a redshift of $z = 0.0065$. Optical observations revealed that Mrk 50 exhibited significant variability in its nuclear region between 1985 and 1990, without any evidence of a disk structure in the system. Mrk 50 is very bright in the X-ray range and known to be an unabsorbed Seyfert 1 galaxy with a soft excess and no detectable iron line. We carried out an extensive temporal and spectral study of the Seyfert 1 AGN Mrk 50 using 15 years (2007–2022) of multiwavelength observations from XMM-Newton, Swift, and NuSTAR for the first time. From the temporal analysis, we found that Mrk 50 was variable during the 2007 observation. After that, Mrk 50 became non-variable throughout the observational period from 2009 to 2022. Our spectral analysis show that the observed spectra are almost unaffected by intrinsic hydrogen column densities, indicating that Mrk 50 has a 'bare' nucleus at its centre. From the $\sim 15$ year (2007–2022) long observations of Mrk 50, we observe that the source moved from a comparatively soft state in 2007 to a comparatively hard state in 2013, and then back to a soft state in 2022.

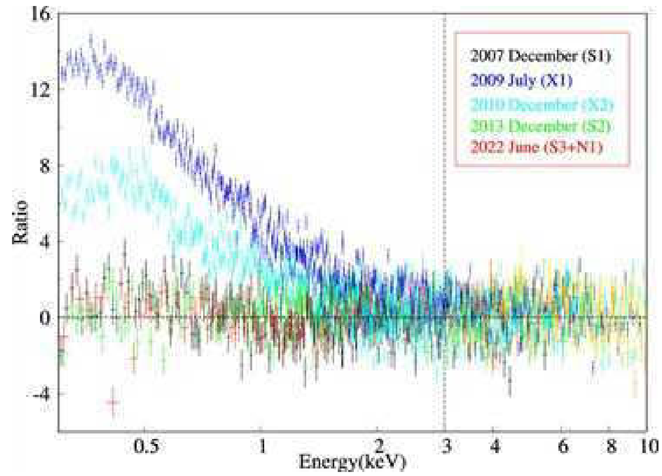


Figure 8 : Ratio plot of the observed spectra over a power-law model, fitted to the 3-10 keV band and extrapolated to lower energies, showing the presence of variable soft excess in Mrk 50.

The observed variation in the spectral slope can be attributed to the dynamics of the accretion flow surrounding the central SMBH and the characteristics of the Compton cloud. Our analysis reveals that the normalized accretion rate decreases from $-0.87$ to $-1.77$, while photon index $\Gamma_{PC}$ changes from $1.88$ to $1.54$. During these spectral transitions of Mrk 50, the warm corona, as described by the warm Comptonization model, and the inner disk boundary, as described by the blurred reflection model, change accordingly. During our spectral analysis, the soft excess component varies throughout the observational period (Figure 8). In the 2009 observation, we found the strongest presence of this component in the observed spectrum. However, before and after 2009, this component gradually faded. The appearance and disappearance of the soft excess component can be explained by the dynamics of accretion and the properties of the Compton cloud.

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This work has been done in collaboration with P. Nandi of Indian Centre for Space Physics, Kolkata, India, and A. Jana of Universidad Diego Portales, Chile.

**(Narendranath Layek and Sachindra Naik)**

### Accretion properties of a low-mass active galactic nucleus: UGC 6728

Active galactic nuclei (AGNs) are among the most luminous sources which are powered by the process of accretion of matter from the host galaxy onto the supermassive black holes (SMBHs) located at their center. The AGNs are generally characterized by their complex spatial and temporal variabilities over the entire range of the electromagnetic spectrum, starting from radio to very high energy $\gamma-$rays. The X-ray photons are believed to have originated from a region closer to the central SMBH. Thus, X-ray spectroscopy is a powerful tool to probe the innermost regions of the accretion disc around the SMBHs. It allows us to determine the physical conditions of the plasma surrounding the central X-ray source. By observing these X-ray photons, we can characterize the fundamental parameters of the black hole, such as its mass, spin, etc. These parameters play a crucial role in understanding the physical nature of the central engine and its cosmological evolution. Our knowledge of the physical processes in AGNs is mostly based on the galaxies which harbour a SMBH of mass greater than $10^6$ M$_\odot$. However, the low mass AGNs $(\mathrm{M_{BH}} < 10^6\mathrm{M_\odot})$ are yet to be explored. One can explore the missing link to probe whether the accretion mechanism is independent of the mass of the black hole.

UGC 6728 is a relatively less explored nearby ($z$=0.0065 Seyfert 1 AGN, which shows broad emission lines in the optical band. This AGN is a late-type galaxy and contains an SMBH of mass M$_{\mathrm{BH}} = 7.1 \times 10^5$ M$_\odot$. The X-ray observation of UGC 6728 reported that it has a 'bare nucleus,' i.e., little or no obscuration along the line of sight to the nucleus. We conduct a comprehensive analysis of X-ray observations spanning approximately 15 years (2006-2021) for UGC 6728. Throughout this period, we observed significant variations in the X-ray luminosity of the source. The X-ray luminosity exhibits fluctuations on a yearly timescale, with a factor of $\sim$2.4 variations observed in the 2016-2017 observations. Our investigation is focused on the broadband X-ray spectra covering the energy range of 0.3-79.0 keV. We find this source retains its 'bare'-nature throughout the observational period. Based on our spectral analysis, we determine that the variations in luminosity are not dependent on the hydrogen column density ($\mathrm{N_H}$). Throughout the 15 years of observations, the spectral slopes of UGC 6728 exhibit significant variations. Notably, this undergoes a systematic transition from a comparatively harder state $(\Gamma \sim 1.39)$ to a comparatively softer state $(\Gamma \sim 1.85)$ from 2006 to 2021. The observed variation of $\Gamma$ can be attributed to the accretion flow dynamics surrounding the central supermassive black hole and the characteristics of the Compton cloud. The intensity of the soft excess component varies throughout our observational period. The 2006 and 2009 observations displayed profound soft excess, compared with the diminished presence of soft excess observed in the 2016 and 2017 epochs. The variation in the strength of soft excess could be explained by the variation of the accretion dynamics. By performing X-ray spectral fitting using the `TCAF` model, we determine the mass of the SMBH to be $\mathrm{M_{BH}} \sim 7.13 \times 10^5$ M$_\odot$ with a high spin at $a > 0.9$ and inclination angle of 49.5 degree.

doi : `https://doi.org/10.1093/mnras/stae1529`

This work has been done in collaboration with A. Chatterjee and S. Safi-Harb of University of Manitoba, Canada, and S. K. Chakrabarti of Indian Centre For Space Physics, Kolkata, India.

**(P. Nandi, N. Kumari, N. Layek and S. Naik)**

**X-ray spectral properties of dust-obscured galaxies**

By performing X-ray spectral study we unveiled a new population of active galactic nuclei (AGN) hosted in high-redshift (0.59 $\leq z \leq$ 4.65) dust-obscured galaxies (DOGs) lying in an extragalactic deep field namely XMM-Large Scale Structure (XMM-LSS). To improve the spectral quality of individual sources, we combined all the multi-epoch spectra of an individual source obtained from the `XMM − Newton` and `Chandra` observatories. This study reveals that the X-ray spectra of our DOGs can be fitted with a simple absorbed power-law or with a physically motivated model considering a torus-like geometry of obscuring material around AGN.

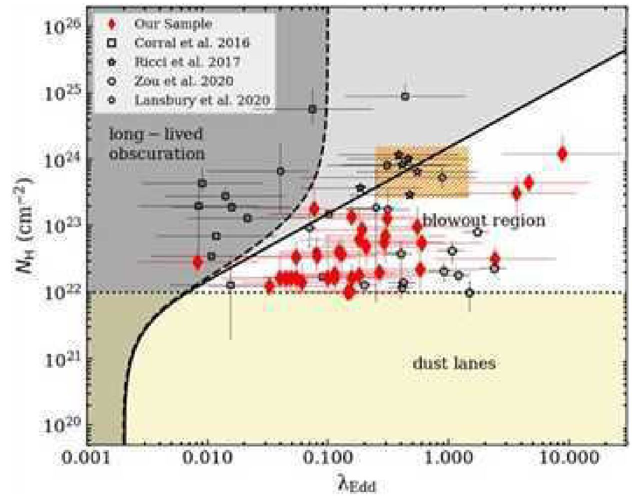



Figure 9 : The $\mathrm{N_H}$ versus Eddington ratio plot. The grey-shaded region represents a region for long-lived obscuration. The solid curve and dashed curve segregating long-lived obscuration and short-lived obscuration. The yellow-shaded region with low absorption represents obscuration caused by host galaxy dust lanes.

The line-of-sight column densities ($\mathrm{N_H}$) in our sources span across a wide range (1.02 $\times$ 10$^{22}$ cm$^{-2}$ $\leq \mathrm{N_H} \leq$ 1.21 $\times$ 10$^{24}$ cm$^{-2}$), with a substantial fraction (18 per cent) of them being heavily obscured ($\mathrm{N_H}$ $\geq$ 10$^{23}$ cm$^{-2}$). We also identified one new Compton-thick (CT)-AGN candidate ($\mathrm{N_H}$ $\geq$ 1.5 $\times$ 10$^{24}$ cm$^{-2}$), yielding CT−AGN fraction of only 3.0 per cent. The absorption−corrected X-ray luminosities of our sources suggest them to be luminous quasars. The $\mathrm{N_H}$ versus Eddington ratio diagnostic plot infers that our sample consists of a heterogeneous population that includes a small fraction (12 per cent) of DOGs belonging to an early phase (Hot DOGs) during which accretion and obscuration peaks. In contrast, the remaining DOGs belong to an intermediate or late phase during which radiative feedback from the dominant AGN blows away surrounding obscuring material (see Figure 9).

doi : `https://doi.org/10.1093/mnras/stae1191`

**(Abhijit Kayal and Veeresh Singh)**

**Broadband Multi-wavelength Properties of M87 during the 2018 EHT Campaign Including a Very High Energy Flaring Episode**

Understanding the location and mechanisms behind high-energy activities (GeV and TeV flares) in jetted AGNs has been one of the major endeavors of the scientific community. Detection of strong and variable TeV emission from radio galaxies, supposedly having a large angle between the line-of-sight and the astrophysical jet axis $(> 15^\circ)$ — consequently implying poor boosting in the emission we receive on Earth — indicates exotic acceleration processes at work. The TeV emission is generally explained using two varieties of models 1) Up-scattering of low-energy photons of different origins (synchrotron photons in the jet, disk, BLRs, corona, CMBR, torus, etc.) by ultra-relativistic leptons (electrons/positrons) in the jet. 2) through hadronic processes (proton synchrotron, $p$-$\gamma$, $p$-$p$, $\gamma$-$\gamma$ interactions). However, the location of the TeV emission is very poorly understood.

The high-energy $\gamma$-rays, being highly interactive with ambient photons and particles, should not be able to leave the jet interiors. On the other hand, modeling efforts to explain these emissions (broad spectral energy distribution; SED) suggest a large boosting factor and BLR contribution (in FSRQs), hinting at a close-by dissipation region.

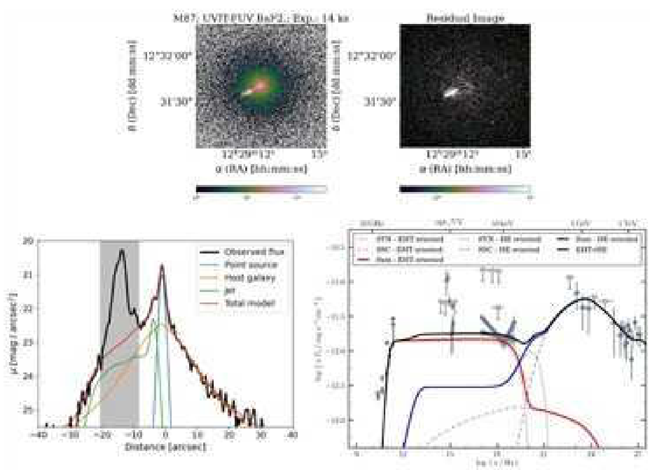



Figure 10 : The first two images are AstroSat-UVIT (BaF2) observations and the residual of the 2D image decomposition model. The bright patch in the residual reflects the irregular downstream hotspots (A, B,C etc) which were not included in our models. Bottom left: The surface brightness profile obtained from the decomposition, depicting the constraints of core, HST-1, jet etc. Bottom Right: Various multi-wavelength data (SED) used for modelling.

The observing campaigns of the Event Horizon Telescope (EHT) consortium, organized every spring, enable a unique platform where various observational facilities jointly cover almost the entire observable energy spectrum with unprecedented simultaneity and resolution for two main objects — Sgr A*, M87 — and many other AGNs as calibrators. The observing campaign in 2018 revealed a TeV flare as detected by H.E.S.S., MAGIC, and VERITAS jointly, that was also covered by facilities like Chandra, NuSTAR, AstroSat, HST, phased ALMA + other EHT partners simultaneously or quasi-simultaneously. Utilizing such a noble dataset, it was tried to impress on both 1) the location of the emission region and 2) modelling the physical mechanisms behind, responsible for the TeV flare.

The contributions of various subcomponents (host, core, HST-1, extended jet) were estimated using techniques such as spectral and image decomposition, informed by past monitoring of M87 with HST and Chandra. A short (three-day) very high energy (VHE) $\gamma$-ray flare — the first since 2010 — was detected, with spectral hardening observed using H.E.S.S., MAGIC, and VERITAS ($\mathrm{E} > 100$ GeV). Fermi-LAT recorded a simultaneous high energy (HE; $\mathrm{E} = 100$ MeV–300 GeV) $\gamma$-ray flux increase. Chandra X-ray data showed a likely longer-term core flux enhancement with a harder spectrum, similar to the 2017 campaign.

While radio and millimeter core fluxes were comparable to or lower than 2017 levels, VLBA revealed an annual shift in the jet position angle. EHT millimeter data also showed a change in the ring asymmetry's position angle, suggesting a link between small- and large-scale jet orientation changes.

Combined, these results could help us constrain the size of the emission region but no concrete constraints on the location of the TeV emission in the jet. However, it revealed a detailed insight into the M87 jet combined using a similar study in 2017, sampling the $\gamma$-ray quiet state (EHT-MWL, 2021, ApJL, 91, L11) — as a reference.

The SED modelling confirmed that a one-zone model cannot explain M87 broadband emission; at least a second or even third component is required to explain the emission from Radio to TeV regimes.

These findings underscore the importance of coordinated MWL observations. Future EHT-MWL campaigns, including those from 2021 and 2022, will refine our understanding of M87*, its disk-jet connection, and $\gamma$-ray emission mechanisms. The public dataset from this campaign provides a valuable resource for testing general relativity and advancing AGN studies. Figure 10 depicts some of the key contributions of the AstroSat-UVIT (first three panels) to this collaborative work and showcases the strength of such a global campaign in constraining simultaneous SED (last panel).

The combined EHT-MWL SED, the most extensive broadband spectra to date, complementing EHT observations of M87, having detected day-scale TeV flare ($\tau \sim 1.88 \pm 0.27$ days), no major changes in core VLBI fluxes, an indication of elevated X-ray emission though not on a similar timescale, presenting best possible dataset till date presents a unique asset for the complex modelling of the M87 jet emission.

doi : `https://doi.org/10.1051/0004-6361/202450497`

This work, led jointly coordinated by various principle authors and contributed by several focussed task teams from across many international organizations as EHT-MWL partners. The contribution of the AstroSat-UVIT uniquely highlights the instruments' imaging capability and in deciphering the complex contributions of the subcomponents.

**(Sunil Chandra)**

**Cosmic dipoles of active galactic nuclei display much larger amplitudes than the cosmic microwave background dipole**

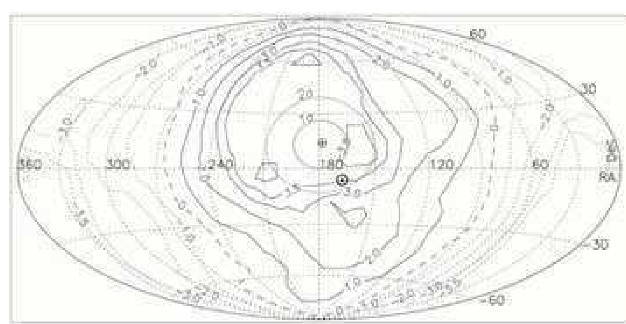



Figure 11 : A contour map of the dipole amplitudes, estimated for various directions in the sky, from the QUAIA data. The contour values depict components of the estimated peculiar velocity, in units of the CMB value of 370 km s$^{-1}$, in various directions of the sky. The symbol $\oplus$ indicates the optimum pole position while $1\sigma$ and $2\sigma$ errors are indicated by grey ellipses around it. The symbol $\odot$ indicates the CMB pole position.

The QUAIA sample, comprising 1.3 million quasars, has been investigated by computing the dipole from asymmetries observed in the source number counts. A dipole 3-4 times as large as the cosmic microwave background (CMB) dipole, although in the same direction, is found (Figure 11). The amplitude of the source dipole being significantly larger than that of the CMB dipole is inconsistent with the cosmological principle, the basic tenet of the standard model in modern cosmology.

doi : `https://doi.org/10.1093/mnrasl/slae039`

**(Ashok K. Singal)**

**Horizon, homogeneity and flatness problems – their resolutions do not depend upon inflation**

The horizon problem encountered in cosmology, is derived as such for world models based on the Robertson-Walker metric where homogeneity and isotropy of the Universe is assumed to begin with and is guaranteed for all epochs. The only thing that happens in this scenario is that in such a universe, described by a single, time-dependent scale factor, which may otherwise be independent of spatial coordinates, the light signals in a finite time might not cover all the available space. Further, the flatness problem, as it is posed, is not even falsifiable. The usual argument offered in the literature is that the present density of the Universe is very close to the critical density value and that the Universe must be flat since otherwise, in the past at $\sim 10^{-35}$ second (near the epoch of inflation) there will be extremely low departures of density from the critical density value (of the order $\sim 10^{-53}$), requiring a sort of fine tuning. It is shown that even if the present value of the density parameter were very different, still at $10^{-35}$ seconds it would differ from unity by the same fraction. Thus a use of fine tuning argument to promote $k = 0$ model amounts to *a priori* rejection of all models with $k \neq 0$. Without casting any aspersions on the inflationary theory, which after all is the most promising paradigm to explain the pattern of anisotropies observed in the cosmic microwave background, we argue that one cannot use homogeneity and flatness to support inflation.

doi : `https://doi.org/10.1140/epjc/s10052-024-12740-7`

**(Ashok K. Singal)**

**Enigmatic factor of 4/3 in electromagnetic momentum of a moving spherical capacitor**

The electromagnetic momentum of a moving charged spherical capacitor computed directly from electromagnetic fields yields an extra factor of 4/3, similar to that encountered in the classical electron model (Feynman Lectures Vol. 2, Ch. 28), where this enigmatic factor has been a source of confusion for more than a century. There have been attempts to eliminate this 'unwanted' factor by even a modification in electromagnetic field energy-momentum definition that has entered even standard textbooks (Jackson 1999, Classical Electrodynamics, Ch. 16). Here it is shown that in a moving charged spherical capacitor, such a factor of 4/3 in the electromagnetic momentum arises naturally from electromagnetic forces inthe system, implying there is no justification in modifying the standard definition of electromagnetic energy-momentum.

doi : `https://doi.org/10.1088/1361-6404/ad7ae4`

**(Ashok K. Singal)**

**A summary of instruments proposed for observing pulsating variables from the Mt. Abu Observatory**

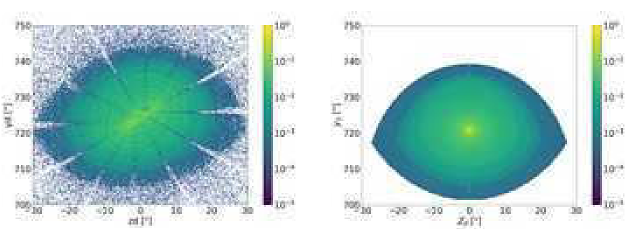
Telescopes of the 50cm to 2.5m aperture range operating at PRL Mt. Abu Observatory are useful for studying pulsating variable stars and other time-domain astronomical targets. A study of various detector systems and optics was carried out to have photometric and spectroscopic capabilities for bright sources in the optical and infrared wavebands. In the present work, designs are explored for spectroscopy using two different detectors covering the entire optical window in one shot. Multi-band photometry are envisaged with CMOS and InGaAs detector arrays providing wide-field coverage in the optical and infrared bands, respectively. Suitable optical components for matching the seeing limited PSF to the small pixels of the detectors are suggested, providing a wide field-of-view on the corresponding telescopes. Some initial observational results with existing instruments at the Mt Abu observatory are also presented.

doi : `https://doi.org/10.1007/s12036-024-10019-7`

**(Anwesh Kumar Mishra, Deekshya Roy Sarkar, Prachi Prajapati, Alka Singh, Prashanth K. Kasarla & Shashikiran Ganesh)**

**DarsakX: A Python package for designing and analyzing imaging performance of X-ray telescopes**

The imaging performance and sensitivity of an X-ray telescope when observing astrophysical sources are primarily determined by its optical design, geometrical uncertainties (such as figure errors, surface roughness, and mirror alignment inaccuracies), and the reflectivity properties of the X-ray reflecting mirrors.



(a) Chandra Ray Tracer (b) DarsakX

Figure 12 : (a) PSF simulated by Chandra Ray Tracer (ChaRT), (b) PSF simulated by DarsakX. Source position: $\phi = 0^{\circ}$, $\theta = -0.2^{\circ}$, energy=4.5 keV and pixel size=10 $\mu$m

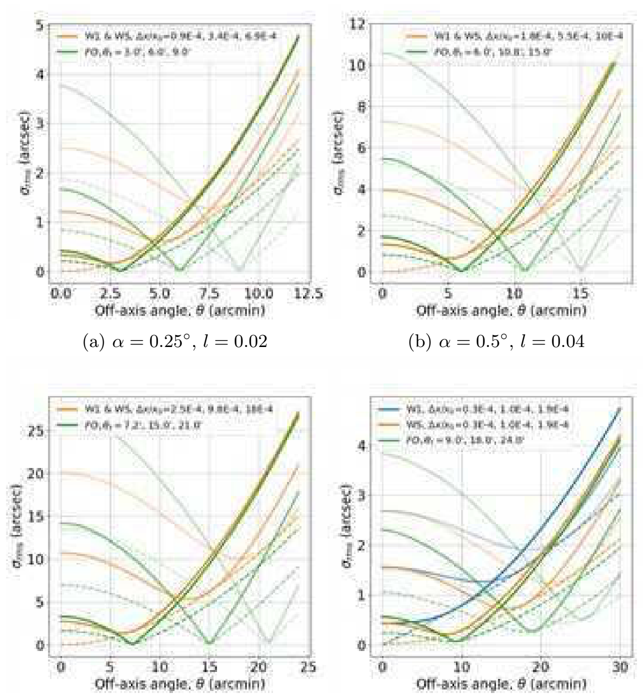
To thoroughly evaluate the imaging performance of an X-ray telescope with an optical design similar to Wolter-I, which consists of multiple shells with known geometrical uncertainties and mirror reflectivity properties, appropriate computational tools are essential. In addition to estimating the angular resolution and effective area for various source energies and locations, such tools are also essential for assessing the impact of figure errors on the telescope's imaging performance. Furthermore, they can be utilized to optimize the optics geometry by modifying it relative to the Wolter-I design to minimize optical aberrations. We have developed DarsakX, a Python-based ray tracing tool specifically designed to estimate the imaging performance of a multi-shell X-ray telescope. DarsakX can simulate the impact of figure errors along the axial direction of a mirror shell, with the geometrical shape of the mirror shells defined by a combination of the base optics (such as Wolter-I or conical optics) and the figure error. Moreover, DarsakX can be used to explore new optical designs that incorporate two reflections similar to Wolter-I optics but offer improved angular resolution for wide-field telescopes. DarsakX has been validated by simulating the Chandra telescope's effective area and angular resolution with its ideal configuration; see Figure 12 for a Point Spread Function (PSF) comparison. Developed using an analytical approach, DarsakX ensures computational efficiency and fast processing.

doi : `https://doi.org/10.1016/j.ascom.2024.100829`

**(N.K. Tiwari, S.V. Vadawale, N.P.S. Mithun, C.S. Vaishnava, B. Saiguhan)**

**A novel optical design for wide-field imaging in X-ray astronomy**

Over the decades, astronomical X-ray telescopes have utilized the Wolter type-1 (W1) optical design, which provides stigmatic imaging in the axial direction but suffers from coma and higher order aberrations for off-axis sources.




(a) $\alpha = 0.25^\circ$, $l = 0.02$ (b) $\alpha = 0.5^\circ$, $l = 0.04$

(c) $\alpha = 0.75^\circ$, $l = 0.08$ (d) $\alpha = 1^\circ$, $l = 0.01$

Figure 13 : $\sigma_{rms}(\theta)$, geometrical rms image radius, is plotted for W1, WS, and FO for four sets of values of $\alpha$ (on-axis incident angle) and $l$ (mirror length to focal length ratio). For W1 and WS, $\sigma_{rms}(\theta)$ is plotted at three axial positions with a flat focal surface and at one position with a curved focal surface. For FO, $\sigma_{rms}(\theta)$ is plotted for three values of $\theta_t$, evaluated at both flat and curved focal surfaces. Solid lines represent $\sigma_{rms}(\theta)$ evaluated at a flat focal surface, and dashed lines represent $\sigma_{rms}(\theta)$ evaluated at a curved focal surface. For W1 and WS at a flat focal surface, an increment in the displacement of the focal plane ($\Delta x/x_0$) is indicated by increasing the transparency of the curves. Similarly, for FO, an increment in $\theta_t$ is represented by increasing the transparency of the curves.

The Wolter-Schwarzschild (WS) design, with stigmatic imaging in the axial direction while suffering from higher-order aberrations, is corrected for coma, thus performing better than the Wolter type-1. Both designs provide high angular resolution along the axial direction; however, the angular resolution degrades continuously with increasing field angle, resulting in an overall reduction when averaged over the entire field of view (weighted by the area covered). An optical design that maximizes angular resolution at the edge of the field of view rather than at the center is more suitable for wide-field X-ray telescopes required for deep sky astronomical surveys or solar observations. The Hyperboloid–Hyperboloid optical design, which reduces its axial resolution to improve field angle resolution, provides an improved area-weighted average angular resolution compared to the Wolter–Schwarzschild design, but only for fields of view exceeding a specific size. We have introduced a new optical design, which we name the Field-angle Optimized (FO) design, that is free from coma aberration and capable of maximizing angular resolution at any desired field angle (see Figure 13). This design consistently outperforms the Wolter 1, Wolter–Schwarzschild, and Hyperboloid–Hyperboloid designs when averaged over any field of view size, and its performance remains stable despite variations in telescope parameters such as diameter, focal length, and mirror lengths. By utilizing the FO design, a full-disk imaging solar X-ray telescope is also designed.

doi : `https://doi.org/10.1007/s10686-025-09992-w`

**(N.K. Tiwari, S.V. Vadawale, N.P.S. Mithun)**

**Development of Fabry-Perot based wavelength calibrator**

The detection of smaller planets around Sun-like stars requires a precision of at least 10 cm/s on-sky, which is currently constrained by several limitations, both on-sky and off-sky. One key limitation is wavelength calibration. At present, we use a UAr hollow cathode lamp (HCL) as the wavelength calibrator. However, due to aging and the uneven distribution of spectral lines across the spectrograph's order, the UAr HCL cannot achieve the required precision. In contrast, the Fabry-Perot (FP) wavelength calibrator, with its uniform and extensive distribution of spectral lines, serves as an ideal replacement for the UAr HCL. The FP instrument (see Figure 14), designed and fabricated at PRL's Thaltej and Navrangpura campuses, is now installed on the PARAS-2 spectrograph. Since the FP is not an active device like the UAr HCL, it requires an external white light source, which is provided by a Xenon arc lamp. This Xenon arc lamp setup (see Figure 15), also designed and fabricated at PRL, powers the FP. Currently, the characterization of the FP's data is underway and is expected to be completed by May 2025.

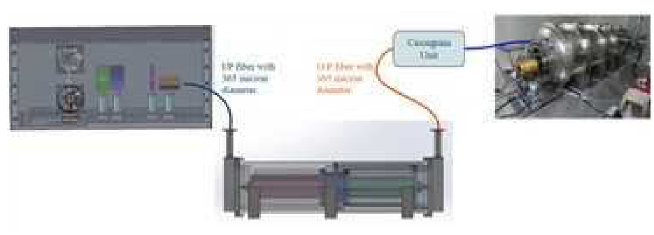


Figure 14 : Schematic diagram of the FP and the Xenon arc lamp set up with PARAS-2

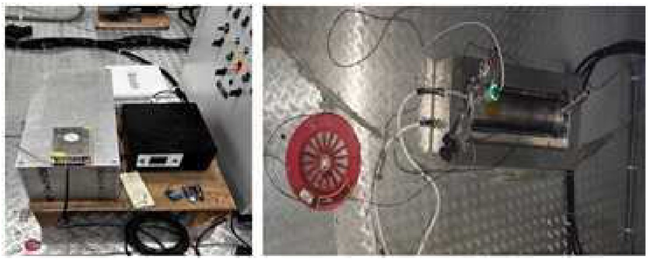


Figure 15 : Left : Xenon arc lamp set up, Right : Fabry-Perot optics inside the vacuum chamber which is kept in a thermally stable water bath.

**(Subhendra Nath Das, Kapil K. Bharadwaj, Neelam J.S.S.V. Prasad, Kevikumar A. Lad, K. J. Nikitha, Rishikesh Sharma, Abhijit Chakraborty)**

**Cryogenic Dewar development for PARAS-2 under MII**

We have been actively working on the in-house development of a Liquid Nitrogen (LN2) based cooling system designed to maintain the PARAS-2 spectrograph detector at a highly stable cryogenic temperature of $-120 \pm 0.1^{\circ}$C throughout observation periods. This precise thermal control is essential for ensuring minimal detector noise and optimal performance in high-precision spectroscopic measurements. The entire design and engineering of the cooling system have been carried out in-house. The thermal design ensures the stringent temperature stability requirements. The fabrication of the cryogenic dewar (see Figure 16) has been expertly handled by Aditya High Vacuum, Ahmedabad, ensuring high-quality materials and precise manufacturing standards. One of the critical performance parameters of the system is the hold time of the LN2 dewar, which is approximately 20 hours. This hold time is crucial for uninterrupted observations, reducing the frequency of LN2 refills and ensuring consistent operational efficiency. Through rigorous testing and optimization, we are working to further refine the system to achieve even greater efficiency and reliability, reinforcing its capability to support long-duration astronomical observations.

Figure 16 : The PARAS-2 cryogenic dewar in the lab for testing and verifications.

**(Kapil K. Bharadwaj, Neelam J.S.S.V. Prasad, Kevikumar A. Lad, Rishikesh Sharma, Abhijit Chakraborty)**

**Double Scrambler Implementation in PARAS-2**

Achieving the precision required to detect Earth- to super-Earth-sized planets via radial velocity (RV) measurements demands an accuracy range of 10–30 cm/s, which necessitates exceptional long-term instrument stability in high-resolution Doppler spectroscopy. We have developed a double scrambler (see Figure 17) for the the high resolution spectrograph (PARAS-2; $\mathrm{R} \sim 110,000$) indigenously. The optical and optomechanical design is done inhouse and the fabrication is done by Luma Optics Pvt. Ltd. Baroda. Coupled with octagonal fibers, this scrambler is anticipated to provide significant scrambling gains (SGs) in terms of the long term uniform illumination of the slit position of the spectrograph. Its use will effectively minimize the impact of input illumination variations on the fiber output, thereby enhancing the stability of the spectrograph's instrument profile and thus improving the Doppler measurement precision. Additionally, the output becomes remarkably insensitive to the variations in input pupil, effectively isolating the spectrograph from fluctuations in telescope illumination and changes in atmospheric seeing conditions up to an extent.

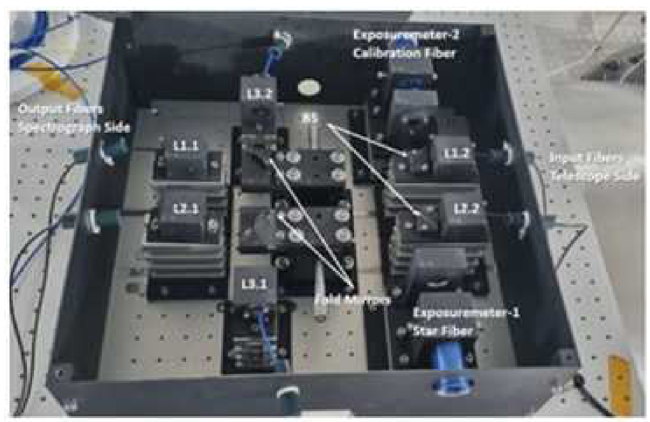



Figure 17 : Double Scrambler Implementation

**(Kapil K. Bharadwaj, Neelam J.S.S.V. Prasad, Kevikumar A. Lad, Rishikesh Sharma, K. J. Nikitha, Abhijit Chakraborty)**

**BOSE Space Telescope**

We have put forward the proposal for the Bhaskaracharya Observatory for the Search of Exoplanets (BOSE) mission which will be the first of its kind discovery-legacy space telescope mission from India, with its primary aim of finding Earth 2.0 (see Figure 18 (left)), which is defined as 'an exoplanet with mass less than 3 times the Earth mass lying in the habitable zone of the host star' using the transit method of differential photometry with unprecedented photometric and spatial accuracy till date.

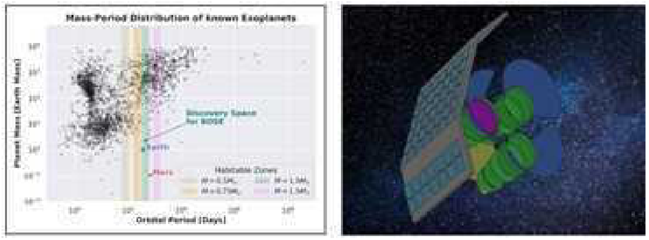



Figure 18 : Left : The Mass-Period distribution of known exoplanets along with the discovery space (indicated by the arrow in teal) of the BOSE mission. Right: An artistic picture of the BOSE in space.

BOSE will have three 60 cm clear aperture refractive optical (working in $600$–$1000$ nm wavelength range) telescopes (see Figure 18 (right)) on a single platform at L2 for continuous staring at a particular field of $\sim 500deg^2$ to detect transiting exoplanets. Each telescope will have a mosaic array of 2 $\times$ 2 of 14K $\times$ 14K sCMOS of latest technology which will have minimal intrinsic detector noise, thereby aiding the further enhancement of the photometric precision of $\sim$20 ppm on a 11th magnitude star and 35 ppm on 12th Magnitude star in 1 hour of effective exposure. This sensitivity is expected to yield discovery of $\sim 1000$ Earth-like/Super-Earth planets if we survey 600,000 stars in two separate fields for a period of 3 years per field. The resolution per pixel of BOSE will be about 3 arcseconds which is better than any other similar telescopes in the past, present and future (Kepler, TESS, and PLATO missions respectively). Apart from exoplanet studies the ultra precise photometry data from BOSE will be useful in studying asteroseismology, transients, detection of exomoons, exorings and exocomets, etc.

**(Abhijit Chakraborty, Neelam J.S.S.V. Prasad, Kapil K. Bharadwaj, Rishikesh Sharma, Churchil Dwivedi, Kevikumar A. Lad, Vishal Joshi, Arvind Singh Rajpurohit, K. J. Nikitha, Aveek Sarkar, Manash Samal, Lokesh Dewangan, Shashikiran Ganesh)**

**Development of Liquid Nitrogen Generation Plant**


Figure 19 : The LN2 plant at Mount Abu Observatory, Gurushikhar, Rajasthan.

At PRL Mount Abu Observatory, Liquid Nitrogen (LN2) is required to cool the detector of different back-end instruments of the 1.2m and 2.5m telescopes. In order to meet the rising demand for LN2, a new liquid nitrogen plant (see Figure 19) with a liquid nitrogen capacity of 120 liters per day has been installed at the observatory. The plant became operational this year. The plant extracts and liquifies the nitrogen from the atmosphere. At the PRL Mount Abu Observatory, liquid nitrogen is used to cool the detectors of various back-end instruments on the telescope.

**(Kevikumar A. Lad, Vivek Kumar Mishra, JSSV Prasad Neelam, Ashirbad Nayak, Nafees Ahmed, Kapil K. Bharadwaj)**

**Development of Data Reduction Pipeline for Speckle Imaging at PRL**

Ground-based astronomical observations are significantly affected by atmospheric turbulence, which degrades image quality. Speckle imaging is a powerful technique that mitigates these effects by capturing rapid, short-exposure images, effectively freezing atmospheric distortions, and enabling near-diffraction-limited resolution.

A speckle imager is deployed on Side Port #1 of the PRL 2.5m telescope at Mount Abu Observatory. We have developed a dedicated Python-based data reduction pipeline at PRL to process speckle images obtained from this camera. The algorithm computes a mean Power Spectral Density (PSD) from the Fourier Transforms of multiple short-exposure frames ($\sim 5-10$ milliseconds). This PSD is then analyzed to identify potential companions, and if detected, the binary system's parameters are extracted from the PSD.

This pipeline has been instrumental in the study of exoplanet host stars and binary systems. Notably, it enabled for the first time in the country the application of speckle imaging for exoplanet host star follow-up. We have used the pipeline in analyzing host stars, including TOI-6651 – the host star of the first exoplanet discovered with the PRL 2.5m telescope – and TOI-6038A (see Figure 20). These observations confirmed their isolation, hence enhancing exoplanet detection reliability by eliminating contamination from nearby stars. Additionally, we were able to resolve known binary systems (see Figure 21) down to 0.25 arcseconds using this pipeline, with extracted parameters closely matching literature values, demonstrating its accuracy in high-resolution stellar imaging.

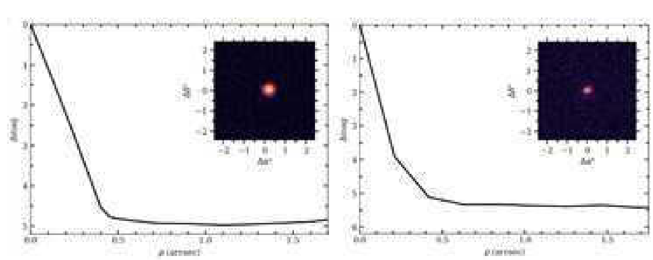


Figure 20 : Speckle Imaging of Exoplanet Host Stars: The curves correspond to the $5\sigma$ contrast curve in the V-band of the host stars of the first two exoplanet systems discovered using the PRL 2.5m telescope with the PARAS-2 spectrograph (left: TOI-6651, right: TOI 6038A). No stellar companions were detected for these stars, thus confirming their isolation and validating the planetary nature of the detected signals.

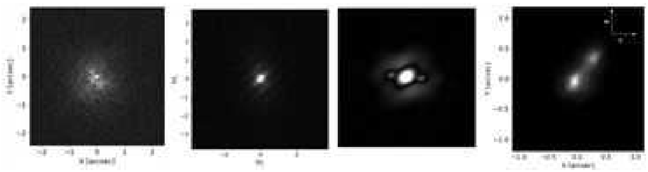


Figure 21 : Speckle Interferometry of a known binary star. (From left to right): A single 10 ms exposure speckle image, the average power spectral density (PSD) of the star, the resultant autocorrelation function (ACF) of the binary system, and the final reconstructed image.

**(K.J. Nikitha, Kevikumar Lad, Neelam JSSV Prasad, Rishikesh Sharma, Abhijit Chakraborty)**

**On-Sky Characterization of ProtoPol: A medium resolution echelle Spectro-polarimeter for PRL Telescopes**

ProtoPol is a medium-resolution echelle spectro-polarimeter initially conceived as a prototype instrument to evaluate the development methodology of the spectro-polarimetric arm of currently under development M-FOSC-EP (Mt. Abu Faint Object Spectrograph and Camera-Echelle Polarimeter) instrument - a two-channel multimode instrument which is currently being designed for PRL 1.2m and 2.5m telescopes at Mt. Abu. However, it was later elevated to the level of a full-fledged back-end instrument for PRL telescopes. Developed completely with commercially available off-the-shelf components, ProtoPol was designed on the concept of echelle and cross-disperser gratings having a wavelength range from 400 to 960 nm with a resolution $(\lambda/\delta\lambda)$ in the range of 7000–8000. In addition to an echelle grating, ProtoPol employs two plane reflection gratings as cross-disperser elements. One for the bluer wavelength (Blue CD) from 400–600 nm and another for redder wavelength (Red CD) from 600–960$\sim$nm.

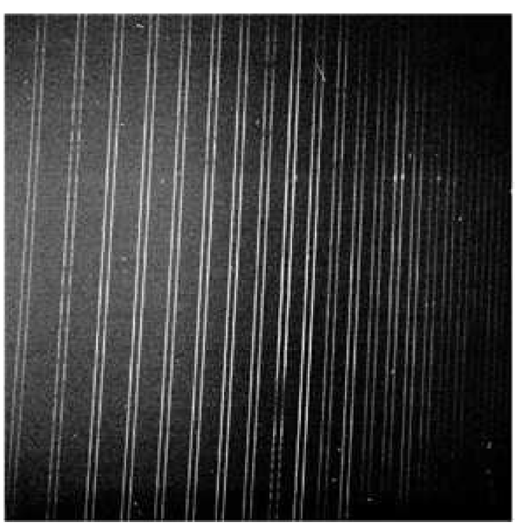


Figure 22 : A raw CCD data frame of ProtoPol in Red CD for an M-Dwarf Wolf 47 (V band magnitude  14) in 30 minutes exposure time. Spectra recorded in multiple spectral orders can be seen. Each spectrum is bifurcated in its O and E polarizing beams to compute the polarization in each band.

The instrument was successfully developed and subsequently commissioned firstly on PRL 1.2m telescope since December, 2023 and later shifted to PRL 2.5m telescope on February, 2024. A variety of observations were carried out for instrument characterization purposes. The total throughput of the instrument was determined to be 6-7% without accounting for slit-loss. Figure 22 shows a raw CCD data frame of ProtoPol in Red CD for an M-Dwarf Wolf 47 (V band magnitude $\sim$ 14) in 30 minutes exposure time.

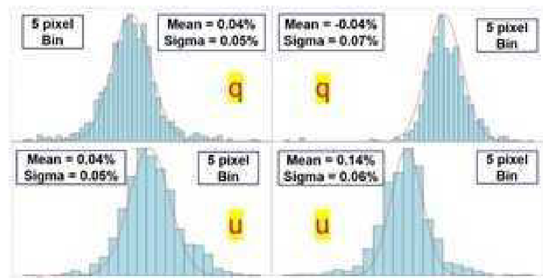



Figure 23 : Instrumental polarisation of ProtoPol with the PRL 2.5 m telescope is shown for the Stokes $q$ and $u$ parameters. Multiple standard unpolarised stars were observed repeatedly over a period of nearly one year, and statistical results are presented. An instrumental polarisation error with a standard deviation ($\sigma$) of 0.05–0.07% is obtained for the $q$ and $u$ parameters, which translates into an overall instrumental polarisation error of approximately 0.1%.

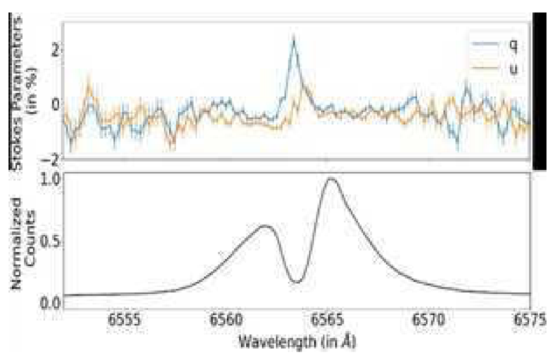



Figure 24 : Spectro-polarimetric observation of H-alpha profile of Herbig star MWC 158. Clear polarization spike is seen at the H-alpha trough. The typical errors in Stokes parameters are around 0.2% at H-alpha peaks and 0.3–0.4% at the trough and the wings.

Observations of standard unpolarized stars reveal instrumental polarization of $\sim 0.1\%$ as shown in Figure 23. Spectro-polarimetric observations reveal a polarization accuracy ($\sigma_p$) of $0.1\% - 0.2\%$ per pixel was achieved for 8 magnitude (V band) with total 1 hour of integration time. A typical signal-to-noise ratio (SNR) of 10 per pixel was achieved for a 14 magnitude (V band) source in 30 minutes exposure time on the 2.5 m telescope. Figure 24 shows the polarization measured across the H$\alpha$ emission profile of a Herbig star MWC 158. A variation of Stokes parameters $q$ and $u$ are seen across the emission line profile. A large sample of science targets were also observed catering to various science goals like Symbiotic stars, Herbig stars, AGB stars, etc. A dedicated fully automated echelle spectro-polarimetric data reduction pipeline has also been developed to help in the analysis of spectro-polarimetric/spectroscopic data.

**(Arijit Maiti, Mudit K. Srivastava, Bhaveshkumar Mistry, Ankita Patel)**

**Mechanical Design of Mt Abu Faint Object Spectrograph and Camera- Echelle Spectrometer (M-FOSC-EP)**

Mt. Abu Faint Object Spectrograph and Camera – Echelle Polarimeter (M-FOSC-EP) is an under-development instrument which has been designed for visible wavelengths for the PRL 2.5 m telescope. M-FOSC-EP is designed to provide seeing-limited imaging as well as low-resolution (resolution $\sim 500$–$800$) spectroscopy in its low-resolution spectroscopy (LRS) arm and intermediate-resolution spectro-polarimetry (resolutions $\sim 10000$–$15000$) in another optical arm. Both these units utilize a common collimator optics and calibration unit. The two separate optical arms have two separate detector systems: (1) for low-resolution spectroscopy and band-limited imaging, and (2) for intermediate-resolution spectro-polarimetric mode. The optical design and other instrument parameters were discussed in the previous year's annual reports. We have now completed the mechanical design of the instrument, which is shown in Figure 25. The opto-mechanical system of the instrument has been designed with a modular approach, wherein each of the sub-systems can be built and assembled independently before being integrated into the complete instrument envelope. These sub-systems can be transported independently and can be reassembled on the telescope floor. The instrument's mechanical systems are divided into five such modules: 1. The Collimator Module, which interfaces with the telescope beam and hosts slits, collimator optics, and a motorized fold mirror to direct the beam into the polarimeter unit or into the low-resolution spectroscopy (LRS) arm; 2. A Polarimeter Unit, which hosts a rotational half-wave plate, Wollaston prism, and the polarimeter camera optics, which breaks the incoming beam into two orthogonal polarized O and E beams that are to be fed to the echelle spectrometer; 3. The Echelle Spectrometer, which uses an echelle grating and two cross-disperser gratings in addition to a collimator-camera optical system to record spectra on a $2\text{K} \times 2\text{K}$ CCD detector system; 4. A Calibration Unit, hosting spectral lamps and additional optics to simulate the telescope beam and pupil, which is fed to the instrument for spectral calibration purposes; and 5. The Low-Resolution Spectroscopy (LRS) Arm, which accepts the collimated telescope beam from the collimator section, and hosts imaging filters, spectroscopy grisms, and a camera optics to focus the beam onto a $1\text{K} \times 1\text{K}$ EMCCD detector. In addition to all these modules, arrangements are also provided to couple a prototype Integral Field Unit (IFU) to the LRS arm, which is currently under design. All these modules are integrated within a cage-structure mechanical mount that couples the instrument to the telescope.

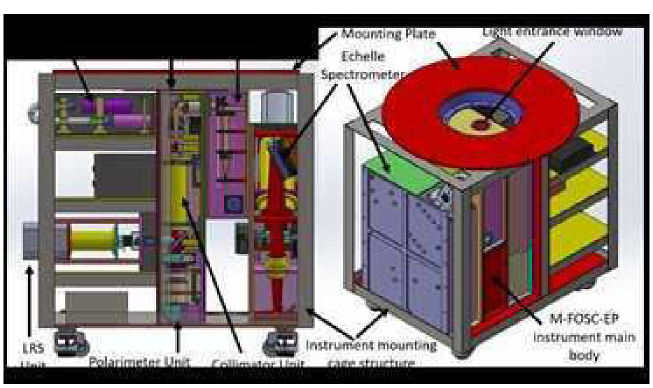



Figure 25 : Mechanical Design and CAD model of M-FOSC-EP along with its mounting structure. Various sub-systems of the instrument can be identified in the figure.

**(Bhaveshkumar Mistry, Mudit K. Srivastava, Arijit Maiti, Jay Chitroda, Ankita Patel)**

**Development of Adaptive Optics (AO) Testbench: Characterization of the optical turbulence generator (OTG)**

Atmospheric turbulence significantly degrades the image quality of celestial sources by distorting the incident wave-front. Adaptive Optics (AO) is an established technique to compensate for this wave-front distortion. An AO testbench was set up to study and develop the methodology for AO correction to the atmospheric induced turbulence in the laboratory, where the turbulence was induced with an in-house designed hot-air optical turbulence generator (OTG). The OTG simulates the atmospheric seeing conditions at the Mt. Abu site in the laboratory. Its input parameters such as temperatures of hot and cool air, wind speed, etc., can be measured and controlled by an in-house developed electronics control unit. The design of this OTG and associated electronics has been detailed in previous annual reports.

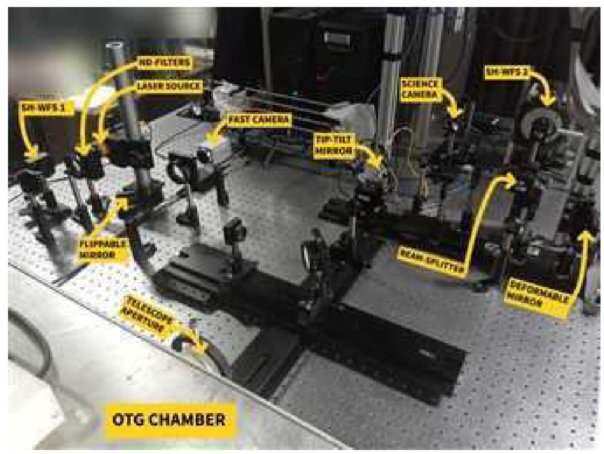



Figure 26 : The Adaptive Optics (AO) test bench set-up consisting of optical turbulence generator (OTG).

The Test bench setup is shown in Figure 26. The simulated telescope beam through the OTG is incident on the telescope aperture and subsequently propagates through the AO wave-front detection and correction arm consisting of a tip-tilt correcting mirror (TTM), deformable mirror (DM), a Shack-Hartmann wave-front sensor, and a science camera along with pupil-mapping optics with appropriate magnification. A fold mirror can be placed after the telescope to direct the beam into a characterization arm consisting of another Shack-Hartmann sensor and a high-speed fast camera to characterize the turbulence properties of the induced turbulence. A collimated laser beam, expanded to a diameter of 50 mm, is made to pass through the OTG. Inside the OTG, air from the cold-intake and hot-intake are mixed in a homogeneous fashion using off-the-shelf fans to introduce turbulence to the beam. This perturbed wavefront/beam is de-magnified to around 6 mm diameter using pupil-mapping optics, after which it reaches a fold mirror. This mirror, when placed into the light path, folds the beam towards the turbulence characterization arm. Another flip mirror is used here to direct the beam onto a Shack-Hartmann wave-front sensor (SH-WFS) from Thorlabs (Model No. WFS20-5C) or on a fast high-speed camera from M/S DITECT (Model HAS-U1). Measurements of phase variations across the pupil using the SH-WFS are used to estimate the spatial characteristics of turbulence, like the Fried parameter ($r_0$). Measurements of the centroid locations of the beam at a very high speed are used to estimate the temporal characteristics of turbulence, like the coherence time ($\tau_0$). We can control the turbulence strength inside the OTG chamber by varying the temperature difference ($\Delta$T) between the cold-intake and the hot-intake and by adjusting the fan speed. For a sample case of 'LOW fan speed; $\Delta \mathrm{T} = 80\,\mathrm{K}$', we estimated $\mathrm{D}/r_0 = 8.3$ and $\tau_0 = 55\,\mathrm{ms}$. The distribution of centroid displacements at the detector of the fast camera is shown in Figure 27, while the Temporal Power Spectrum along with a broken power-law fit is shown in Figure 28.

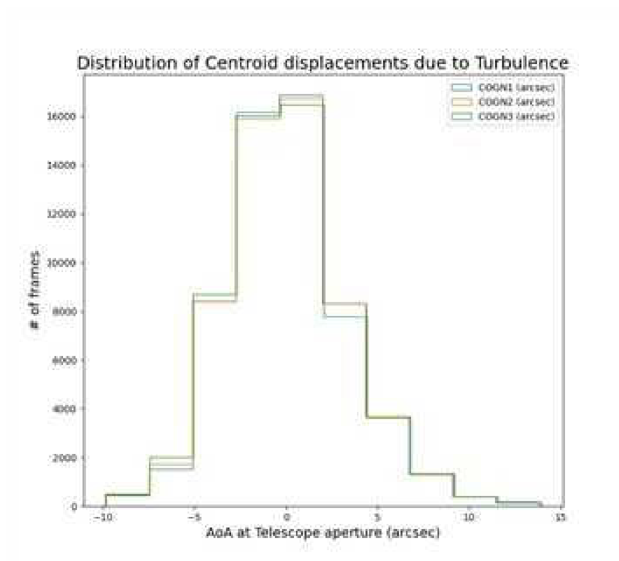



Figure 27 : Distribution of Centroid displacements due to atmospheric turbulence.

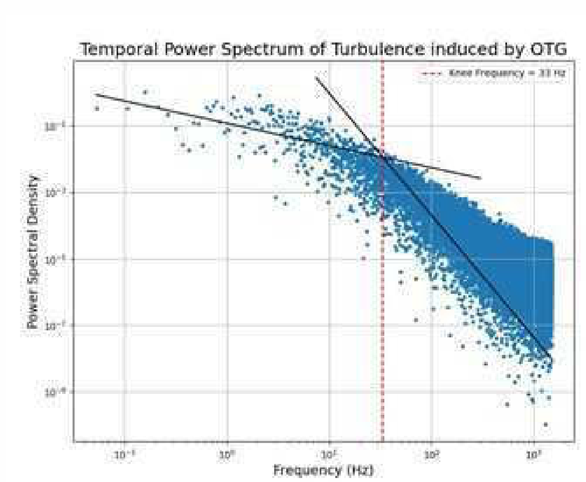



Figure 28 : Temporal power spectrum of turbulence induced by OTG.

**(Jay Chitroda, Ankita Patel, Bhaveshkumar Mistry, Mudit K. Srivastava)**

**Opto-Mechanical Development, Laboratory Characterization, Installation, and On-Sky Alignment of the Low-Resolution Spectrograph (LRS)**

The Low-Resolution Spectrograph (LRS) has achieved several critical milestones in its development this year. All optical components have been mounted and aligned, and the spectrograph enclosure-complete with a calibration unit-has been assembled. Additionally, the telescope-instrument interface flange and housing for electronics components have been successfully implemented. To meet the telescope's balance requirements, a dedicated counterweight structure was designed and fabricated. A manual shutter was installed near the telescope-instrument flange to safeguard the instrument during non-operational periods.

The Assembly, Integration, and laboratory characterization phases have been completed, culminating in the successful installation of the LRS on the side port of the PRL 2.5-meter telescope (Figure 29). The instrument achieved first light on February 13, 2025, followed by initial on-sky alignment and characterization, both of which were executed successfully. The resolving power of the spectrograph was determined using arc lamp spectra and sky airglow lines, confirming a resolution of $\sim$2000 across its full operational wavelength range of 400 nm to 700 nm. This performance aligns precisely with the design specifications, marking a significant achievement in the instrument's development.

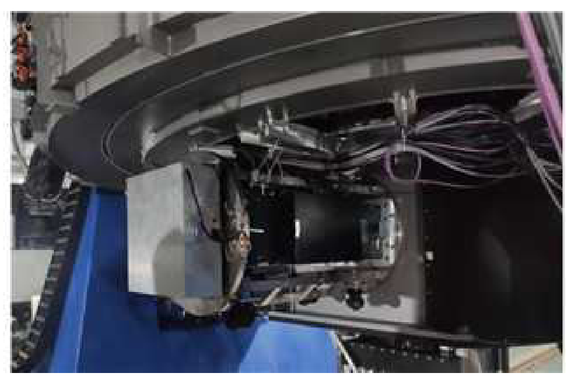


Figure 29 : The Low-Resolution Spectrograph on the side port of the 2.5m telescope.

**(Vishal Joshi, Kapil K. Bharadwaj, Neelam J.S.S.V. Prasad, Kevikumar A. Lad, Nafees Ahmed, Abhijit Chakraborty)**

**Development activities for the NISP instrument**

The upcoming NISP instrument for the 2.5m telescope at Mt Abu will feature five cryo-wheels mounted on a cold bench. They will be rotated by smart stepper motors controlled through software. These wheels will switch between various operational modes of NISP. A test wheel was fabricated by the PRL workshop as per the NISP team's design. The NISP team characterized the test cryogenic filter wheel constructed from brass material containing four sockets for 50mm circular filters (Figure 30).

Figure 30 : Four position cryo filter wheel

To transmit motion between the motor (outside the cryostat) and the wheel (inside the cryostat), two bevel gears and a thermally isolating coupler were used with a feedthrough connecting the wheel to the motor shaft. For absolute position encoding, SmCO magnets and reed switches, operating at cryogenic temperatures were used. A limit switch assembly and groove were used to lock each position. The functional test of the Cryo Wheel assembly showed a smooth operation of the filter wheel between 5-15 rpm inside the Ln2 cooled test dewar with repeatability over many cycles (Figure 31).

Fabrication and testing of cryo-wheel assembly.

Figure 31 : Cryo filter wheel box mounted inside test dewar with smart motor mounted outside the dewar

**(Prashanth Kasarla, Alka Singh, Deekshya R Sarkar, Hitesh L. Adalja, Sachindra Naik, Shashikiran Ganesh)**

**Cryogenic testing of BaF2 flexure mount assembly**

Cryogenic testing of BaF2 flexure mount assembly was carried out to validate the flexure mount design. The vendor has manufactured Invar flexure mount with six flexures based on the design provided by PRL. BaF2 lens with 38mm diameter was glued to six flexures of flexure mount using 3M epoxy adhesive 2216 (showed in Figure 32). BaF2 flexure mount is assembled in an Aluminium mount and mounted to the cold bench of NISP Test Dewar. Cryogenic test was carried out at two different maximum cooling rates (3K/min and 14K/min). Temperature profiles and cooling rate profiles of the cryogenic test with a maximum cooling rate of 14K/min are shown in Figure 33. After both tests, BaF2 flexure mount was removed from the chamber and inspected for damages. BaF2 lens and glue contact were intact. This shows that this flexure mount design can withstand the thermal stress produced due to cooling down to cryogenic temperatures.

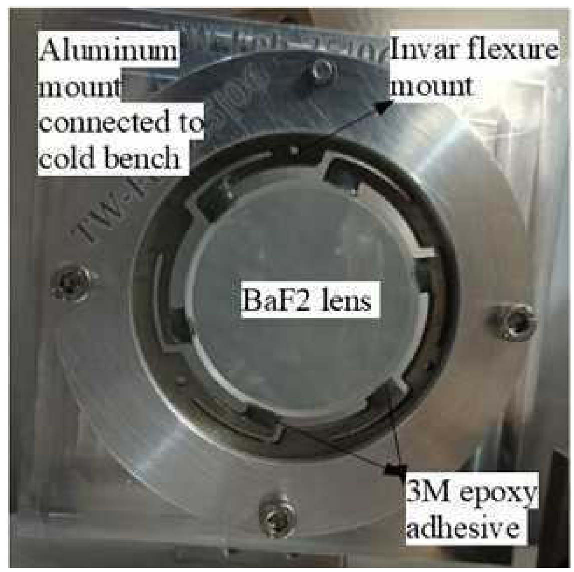



Figure 32 : BaF2 lens in flexure mount

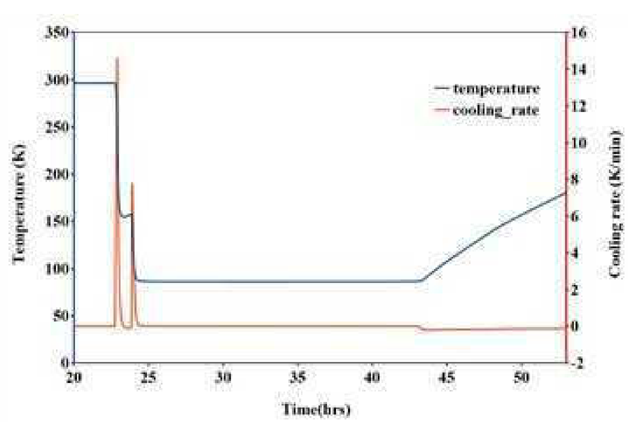



Figure 33 : Temperature profile and cooling rate for the BaF2 lens flexure mount test

**(Prashanth Kasarla, Alka Singh, Deekshya R Sarkar, Hitesh L. Adalja, Sachindra Naik, Shashikiran Ganesh)**

**NISP optics calibration and characterization setup**

An optical setup (shown in Figure 34) is designed to produce a collimated beam. The collimated beam will be used to characterize the performance of the NISP collimator assembly. The experimental setup consists of a light source such as an LED or a LASER, a focuser lens, elliptical flat mirror, and a Parabolic Mirror. To quantify the performance of the setup, interferometer technique is used. A perfectly collimated beam, when passed through shear-plate, would produce fringes parallel to the smaller axis of the elliptical image. Diverging and converging beam would produce fringes at angles to the short axis, in opposite directions (shown in Figure 35). This setup will be used to create a perfectly collimated beam by adjusting the distance between the parabolic mirror and the elliptical flat mirror. Since we have used only reflecting optics, the alignment, once completed at optical wavelengths, can be used for the infrared wavelength tests by just changing the illuminating LED. This setup has been used to characterize a few different imaging arrays at optical and infrared wavelengths. This setup would be utilized to verify the performance of the collimator and camera barrel assemblies for NISP in the laboratory at infrared wavelengths. The collimator and camera assemblies are presently being fabricated by an Indian vendor under the Make-in-India initiative.

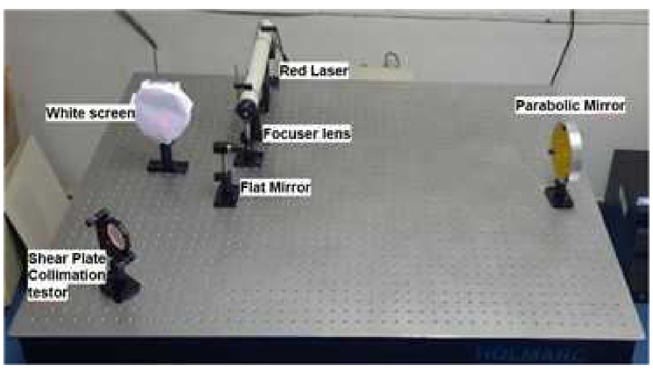



Figure 34 : NISP optics test setup for generating a collimated beam.

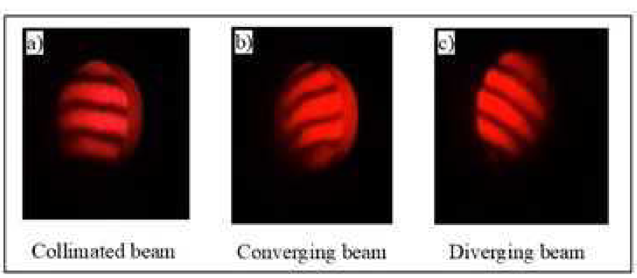



Figure 35 : Images from shear plate test for NISP optics test setup.

(Prashanth Kasarla, Alka Singh, Deekshya R Sarkar, Hitesh L. Adalja, Sachindra Naik, Shashikiran Ganesh)

**Large Area Imager for Mt Abu telescopes**

The Large Area Imager with wavelength range 400-900 nm is an imaging system primarily for use with the 50 cm telescope at PRL Mt Abu Observatory. It has a 33 $\times$ 44 arcmin$^2$ field of view on the 50 cm telescope and a 9 $\times$ 8 arcmin$^2$ field of view on the 1.2 m telescope. It is equipped with 50 $\times$ 50 mm$^2$ optical broadband (U, B, V, R, I) and a few narrowband filters. Six filters can be mounted at a time in a filter wheel placed before the detector. The camera and filter wheel can be controlled through software from Windows or Linux OS running on a compact mini PC. The detector is an $11\mathrm{K} \times 8\mathrm{K}$ front-illuminated CMOS sensor with 3.76 $\mu$m pixel size and has a dark current of 0.003 e/pix/sec at $0^\circ$C and a readout noise of approximately 1 e. On-sky calibration of the instrument was carried out on the PRL 1.2m telescope (Figure 36) and results of photometry of the region of the sky around Ru 149, a standard star field, are shown in (Figure 37). It shows that the instrument can reach 18 magnitudes with an error below 0.1 mag in a reasonable exposure time. This instrument is expected to be very useful for wide-field imaging and photometry addressing various science topics on astronomical sources ranging from Near-Earth-Objects (NEOs) to distant quasars.

Figure 36 : Imager mounted on the PRL 1.2m telescope at Mt Abu.

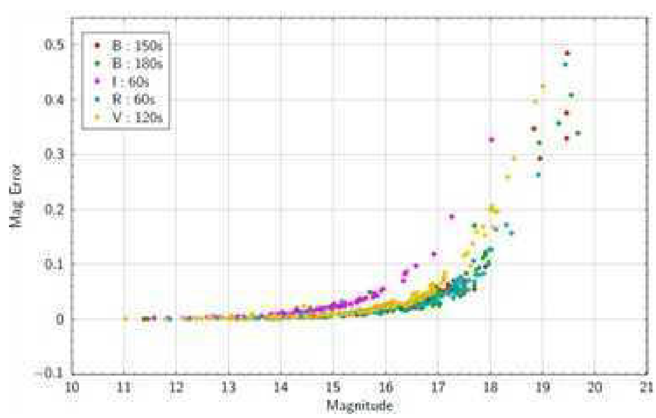



Figure 37 : Photometric magnitudes and error limits with the Imager on the 1.2m telescope calibrated in Ru 149 standard star field.

(Deekshya R Sarkar, Goldy Ahuja, Ranjan Kumar, Vivek Mishra, Sunil Chandra, Shashikiran Ganesh)

**Upgrade of EMPOL instrument for observing faint astronomical targets**

EMPOL is an EMCCD-based imaging polarimeter that was developed in-house at PRL. It comprises a rotating half-wave plate as a modulator, and a wire-grid polarizer as the analyzer.

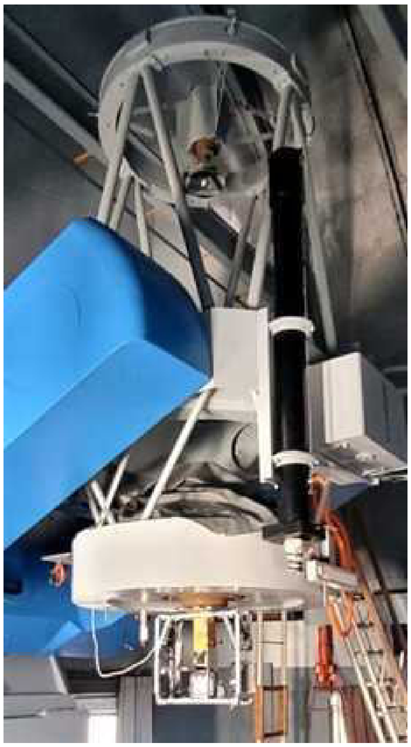


Figure 38 : EMPOL instrument mounted on PRL 1.2m telescope.

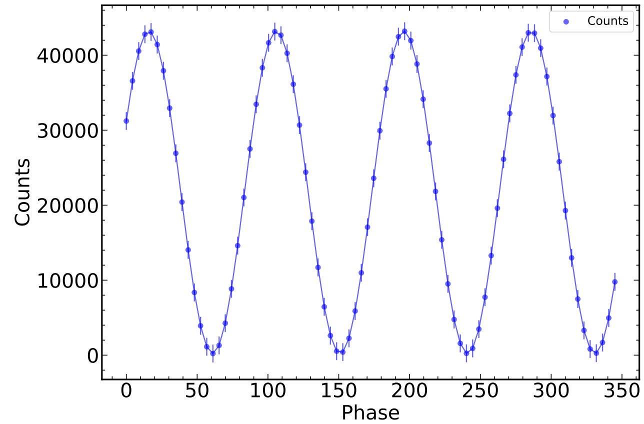



Figure 39 : Modulation curve obtained for 100% polarized light for a star through a Glan prism.

In the instrument's earlier mode of operations, a fixed exposure of 0.5 sec was used at every step of the continuously rotating half-wave plate. This restricted the use of the instrument to relatively bright objects. In order to reach fainter limits, we have now replaced the continuously rotating motor driving the rotating half-wave plate by a new stepper motor with software control. This allows us to implement variable exposure mode of data acquisition. This motorized rotator can be operated via Python using the Astrolib Package. Python scripts are called by EMPOL's acquisition camera software to rotate the motor in coordination with the end of the exposure. This mode of operation has allowed us to measure polarization for 16 mag sources compared to the earlier limit of about 13 mag. Figure 38 shows the upgraded EMPOL mounted at the Cassegrain focus of the PRL 1.2m telescope. To check the instrument performance, we observed a zero polarization standard through a Glan prism. Light passing through the Glan prism gets fully polarized (100% polarisation). The results of the observation are shown in figure 39. The observations show 99% $\pm$ 1% for a star observed through the Glan prism.

**(Alka, Goldy Ahuja, Deekshya R Sarkar, Shashikiran Ganesh)**

# Solar Physics

**Study of magnetic relaxation in Magneto Hydro Dynamic (MHD) simulations of energetically different flares**

Solar flares on the Sun release magnetic energy. The energy varies depending on the strength of the flares. This energy release is expected to relax the magnetic field to a state characterized by lesser energy. Therefore, the extent of relaxation is expected to vary for flares of different classes. Toward such exploration, data-based simulations of three flares, identified as B6.4, C4.0, and M1.1 in the GOES (Geostationary Operational Environmental Satellites) classification scheme, are carried out using the Param Vikram-1000 High Performance Computing Cluster of the Physical Research Laboratory (PRL). Notably, the B6.4 flare is the weakest while the M1.1 flare is strongest, as per expectations. The estimation of dissipated magnetic energy from simulations amounts to 7%, 16.8%, and 33% of the initial magnetic energy available for dissipation, which is in concurrence with the general energy relation between the classes of chosen flares (Fig 1). Further, an analysis of the magnetic reconnection sites corresponding to these flares reveals a parameter which has potential future application in predicting the strength of solar flares. Therefore, this parameter may have utility in space-weather applications.


Figure 1: Panels (a) and (b) show magnetic null point morphologies constituted by the fan (pink) surfaces and spines (yellow) in B6.4 and C4.0 flares, respectively. Panel (c) is depicting the HFT in M1.1 flare. The background map bottom boundary in each panel is overlaid with the SDO/AIA observation near peak time of flares and the vertical magnetic field along with its corresponding color bar at the time of extrapolation.

doi : DOI:https://doi.org/10.1063/5.0206697

**(Satyam Agarwal and Ramit Bhattacharyya)**

**Data-Constrained MHD Simulations of a Confined X-Class Flare in NOAA Active Region 11166**

The study of solar flares is mostly focused on eruptive flares. However, observations have also shown the existence of confined flares where an erupting magnetic structure is not present. The studies on confined flares are limited, and further investigations are needed to understand their underlying physics. Toward such exploration, data-based MHD simulations are carried out for a confined X-class flare in NOAA active region 11166 that occurred on March 9, 2011. The extrapolated non-force-free field identified 3D nulls and quasi-separatrix layers (QSLs, characterised by a drastic change in the magnetic field line connectivity), which were found to be spatially coinciding with the brightenings seen in multi-wavelength observations. The magnetic reconnections at these sites lead to the development of flare ribbons (fig. 2). Importantly, the anchored spine of the 3D null and the complete absence of flux rope in the flaring region are congruent with the confined nature of the flare. Furthermore, the simulation also suggests the role of reconnections at the 3D null with an open spine in the onset of a jet away from the flaring site.

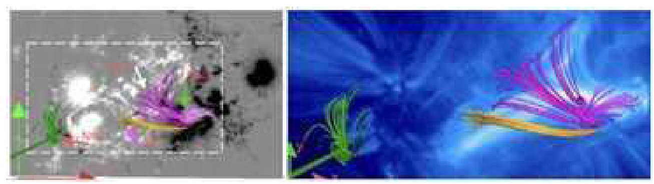


Figure 2: The left panel shows extrapolated field lines with vertical magnetic field on the background map in grayscale. The presence of 3D nulls is marked by red and green arrows. QSLs are indicated by white and pink arrows. The panel on the right shows the field lines for the boxed part over-plotted with observations in the 131 Åchannel of SDO/AIA.

doi : DOI:https://doi.org/10.1007/s11207-025-02426-y

This work is done in collaboration with Sanjay Kumar, Pawan Kumar, Sadashiv of Patna University, India; Avijeet Prasad of University of Oslo, Norway; Sushree S. Nayak of University of Alabama, Huntsville, USA; and Ramesh Chandra of Department of Physics, Kumaun University.

**(Satyam Agarwal and Ramit Bhattacharyya)**

**Exploring the generation and annihilation of three-dimensional nulls through MHD simulations in an initially chaotic magnetic field devoid of nulls**

Three-dimensional (3D) magnetic nulls are the points in space where the magnetic field is zero. They are common in the Sun's atmosphere, as confirmed by recent observations, extrapolations and simulations. 3D nulls play a crucial role in solar events like jets and circular ribbon flares. However, how they are created in the Solar atmosphere is not well-known and remains a mystery. Recent MHD simulations have shown that magnetic reconnection—the process where magnetic field lines break connection and then reconnect to a different field line—can both create and destroy these 3D nulls. However, these simulations started with magnetic fields that already had null points, leaving an open question: Can magnetic reconnection generate nulls in a magnetic field that initially has none? A previous study briefly explored this idea using an initially chaotic magnetic field, but it had limitations. It did not pinpoint the exact locations, process, or types of nulls, and it didn't properly track how the magnetic field changed over time. In this paper, we take a fresh look at the problem using modern tools that allow us to precisely identify and track 3D nulls and their evolution (fig. 3). By following magnetic field lines over time, we showed that the magnetic reconnection is creating and annihilating the nulls in chaotic magnetic fields which have no nulls initially. In this work, it is also explored the role of chaoticity in the null generations and found that, with the increase in the chaoticity level, more numbers of nulls are generated and also earlier in time.

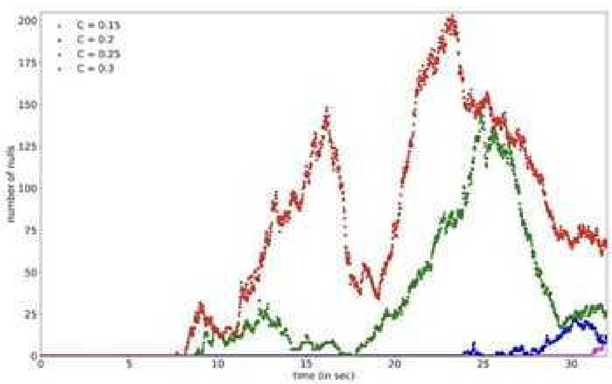



Figure 3: The plot shows an increase in the number of nulls at a given instant and its maximal value over the temporal range with an increase in chaoticity level (C). The vertical axis represents the number of nulls, and the horizontal axis represents time. The plots in different colors (pink, blue, green, and red) represent the variation in the number of nulls for a particular value of the chaoticity (0.15, 0.20, 0.25, and 0.30) respectively. Generation of nulls occurs earlier in time as the chaoticity C increases, i.e., $t = (31, 23, 9, 8)$ s for C $= (0.15, 0.20, 0.25, 0.30)$.

doi : DOI:https://doi.org/10.1063/5.0217951

This work is done in collaboration with David Pontin of the University of Newcastle, Callaghan, Australia, and Sanjay Kumar of Patna University, India.

**(Yogesh Kumar Maurya and Ramit Bhattacharyya)**

**Generation and annihilation of three-dimensional magnetic nulls in extrapolated solar coronal magnetic field: data-based Implicit Large Eddy simulation**

Three-dimensional (3D) magnetic nulls are locations in space where the magnetic field is zero. These points are important because they can host magnetic reconnection, which isa process where magnetic energy is rapidly converted into heat, motion, and high-energy particles and alters the magnetic field lines connectivity. This process is ubiquitous, starting from Laboratory plasmas to Astrophysical plasmas. On the Sun, magnetic reconnection plays a key role in explosive solar events like solar flares, coronal mass ejections, and solar jets—many of which occur near these 3D null points. These nulls are often found in regions of the Sun with complex magnetic polarity regions, making them a subject of great interest, especially when it comes to the understanding of their initial formation. Recent MHD simulations have suggested that magnetic reconnection itself might be responsible for creating these nulls. However, the simulation was started with a pre-existing null and the initial analytical magnetic field. Therefore, it is natural to ask how these nulls are created in the real solar atmosphere. To answer this, we studied a C6.6 class solar flare that occurred in an active region of the Sun (NOAA 11977). Using non-force-free extrapolation and data-based MHD simulations, we confirmed that 3D magnetic nulls can spontaneously appear in pairs through magnetic reconnection (fig. 4).

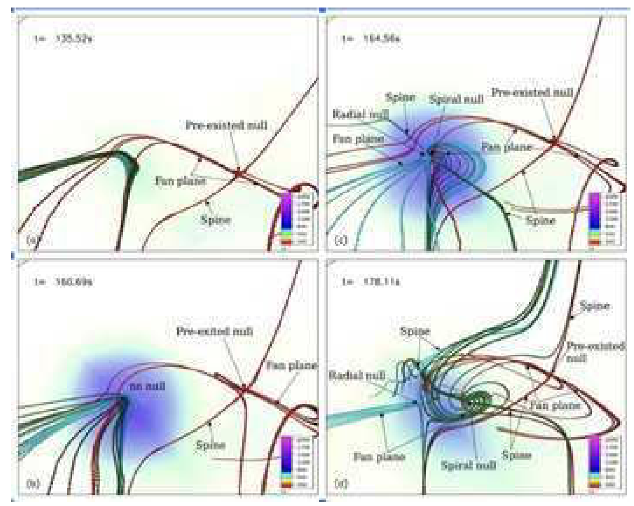



Figure 4: The figure panels show how pairs of 3D magnetic nulls are created near a pre-existing null. Panel (a) highlights the initial setup, with red field lines around the existing null and sky-blue and green field lines are drawn in the areas where new nulls will appear. Panel (b) shows these lines bending into an elbow shape (t $\approx$ 160.69 s), along with an increase in current intensity ('cs'). Panel (c) depicts the generation of a radial and a spiral null (t $\approx$ 164.56 s). Panels (c)–(d) track their evolution: the nulls separate, with the spiral null drifting toward the pre-existing one and later-on they annihilate (please refer to the article).

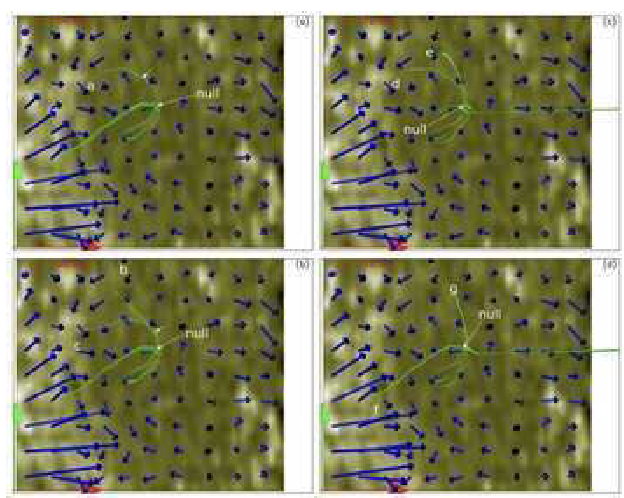



Figure-5: The panels show footpoint brightening linked to slip reconnection of fan field lines of a spontaneously generated radial null in a spiral-radial null pair. Panel (a) (t $\approx$ 164.35 s) marks the radial null ('null') and local plasma flows (blue arrows) near the z = 0 plane. The green field lines (marked by white arrow) are initially anchored at point a. Panel (b) illustrates how its footpoints shift to b, c, and later to d, e, f, and g due to slip reconnection. The overlaid AIA channel spans$\sim 21.75\ \mathrm{Mm} \times 21.75\ \mathrm{Mm}$ in the x and y directions.

Interestingly, the spontaneously created 3D nulls also show the brightening associated with slip-reconnection—a process in which the foot-points of the fan field lines slip through plasma,a typical phenomenon observed in 3D nulls (fig. 5). This discovery is exciting because it offers a new perspective on how energy is released in the

Sun's atmosphere. The spontaneous creation and disappearance of these magnetic nulls could be a missing piece in understanding why the Sun's outer atmospheric layers are so incredibly hot.

doi : `DOI:https://doi.org/10.48550/arXiv.2404.12034`

This work is done in collaboration with David Pontin of The University of NewCastle, Callaghan, Australia.

**(Yogesh Kumar Maurya and Ramit Bhattacharyya)**

**Propagation Characteristics of Acoustic Waves in the Quiet-Sun Lower Solar Atmosphere: MAST Observations**

The solar atmosphere provides a conducive environment for the generation, propagation, and dissipation of various mechanical waves. These waves are considered to play an important role in the heating and dynamics of the solar atmosphere. Acoustic waves are generated by turbulent convection inside the convection zone of the Sun. These waves, trapped inside acoustic cavities, are formed due to the high temperature inside the Sun and the sharp fall in density at the photosphere. The acoustic cutoff frequency of the quiet-Sun photosphere is 5.2 mHz, and waves with frequencies below this value ($<$ 5.2 mHz) are evanescent in the solar atmosphere. In contrast, high-frequency acoustic waves ($>$ 5.2 mHz) propagate into the higher solar atmosphere with increasing amplitude.

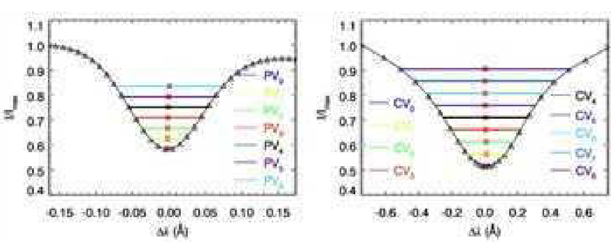



Figure-6: Sample Fe I (left panel) and Ca II (right panel) spectral line profiles reconstructed from the average intensity over full FOV, where triangles denote the locations where line profiles have been scanned, respectively. The horizontal lines connect the blue and red wings with bisector points.

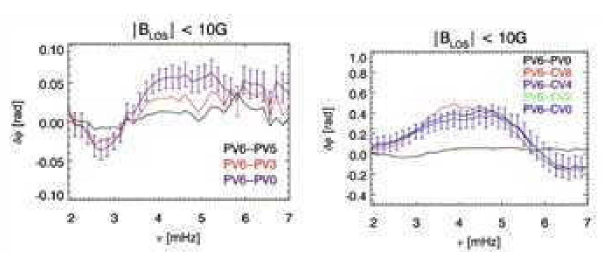



Figure-7: Left panel: Phase shifts measured within photosphere, displayed as a function of frequency integrated over the pixels having —BLOS— $<$ 10 G and coherence greater than 0.5 over the full FOV. Right panel: Same as left panel, but phase shifts estimated within the chromosphere of the Sun.

Exploiting the full potential of the Narrow Band Imager (NBI) instrument installed on the Multi-Application Solar Telescope (MAST), operational at Udaipur Solar Observatory (USO), Physical Research Laboratory (PRL), Udaipur, India, we observed a quiet-Sun region located near the disk center for a duration of 1h50m. The photospheric Fe i 6173Å spectral line was scanned at 35 wavelength positions, while the chromospheric Ca ii 8542Å line was scanned at 27 positions. Utilizing the bisector method on the observed spectral line profiles, we derived seven height-dependent line-of-sight velocities within the Fe i line and nine within the Ca ii line.

The fast Fourier transform (FFT) was applied at each pixel across the full field-of-view observed by NBI/MAST to compute the phase shift and coherence. The frequency- and height-dependent phase shifts, integrated over regions with an absolute line-of-sight magnetic field strength less than 10G, indicate the non-evanescent nature of low-frequency acoustic waves within the photosphere and the photosphere-chromosphere interface region. We also report that this non-evanescent behavior persists beyond the photosphere, encompassing the entire photospheric-chromospheric height range. Additionally, our observations reveal downward propagation of high-frequency acoustic waves, suggesting their refraction from higher layers in the solar atmosphere.

This study contributes valuable insights into the complex dynamics of acoustic waves in the lower solar atmosphere, highlighting both the non-evanescent nature and the downward propagation of acoustic waves.

doi : `DOI:10.3847/1538-4357/ad5d60`

This work is done in collaboration with S.P. Rajaguru, Indian Institute of Astrophysics, Bengaluru, India.

**(Hirdesh Kumar, Brajesh Kumar, Shibu K. Mathew, and A. Raja Bayanna)**

**On the Response of the Transition Region and the Corona to Rapid Excursions in the Chromosphere**

Spicules are thin hair/grass-like structures prominently observed at the chromospheric solar limb. It is believed that the fibrils and rapid blue-shifted and red-shifted excursions (RBEs and RREs, collectively referred to as REs) correspond to on-disk counterparts of type I spicules and type II spicules, respectively. The focus of the study is on observing the response of these REs alongside similar spectral features in the chromosphere, transition region (TR), and corona, using multi-wavelength observations from the Swedish 1 m Solar TelescopeH$\alpha$, Interface Region Imaging Spectrograph (IRIS), and Solar Dynamics Observatory employing space-time plots. The study reveals up-flowing REs promptly reaching temperatures characteristic of the TR and corona, and the down-flowing REs exhibit spectral signatures corresponding to the plasma motion from the corona to chromospheric temperatures, demonstrating a multi-thermal nature. In addition to distinct up-flows and down-flows, sequential up-flow and down-flow along the same path has been observed, depicting a distinctive parabolic trajectory in space–time plots of observations sampling the transition region and various coronal passbands. Similar to isolated up-flows and down-flows, these REs also exhibit a multi-thermal nature throughout their trajectory. Furthermore, our results reveal a more intricate motion of the REs in which both up-flow and downflow coexist at the same spatial location. On a different note, this study shows spatiotemporal red-shifts/down-flows in both the TR and chromosphere. These observations suggest that at least subsets of the strong red-shifts/down-flows observed in TR temperature spectra result from the return from the upper atmosphere flow of plasma in the form of bundles of spicules or features exhibiting similar spectra.

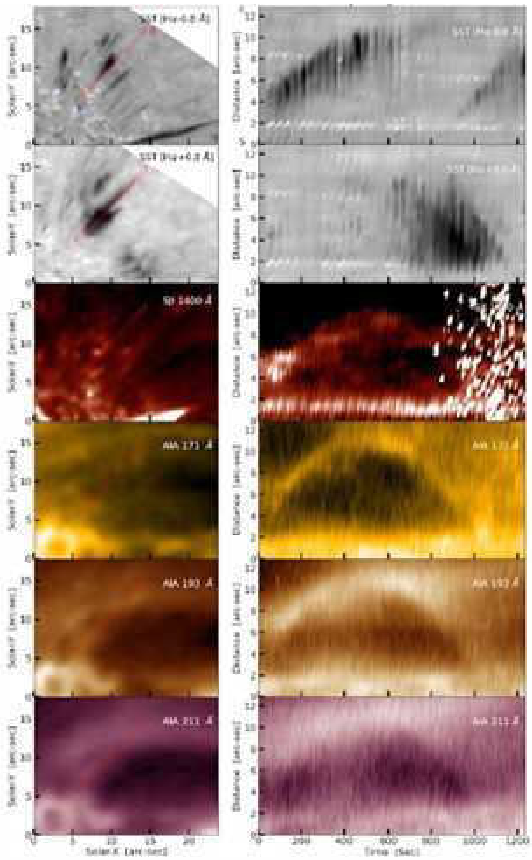


Figure 8: The left column shows the images of the RBEs/RREs at various temperature passbands sampling different heights in the solar atmosphere, and the right column depicts the corresponding space-time plots of the observed RBEs/RREs. The top two images show the upward and downward motion one after the other obtained from the chromospheric observations, and the remaining sub-images show the parabolic path observed in TR and coronal passbands. It shows evidence of REs (spicule) heating corresponding to coronal and Transition Region (TR) temperature with parabolic paths in space-time plots. At a given time, the spicule is visible in all the passbands and thus has a plasma contribution from various temperatures, essentially exhibiting a multi-thermal nature in the solar atmosphere.

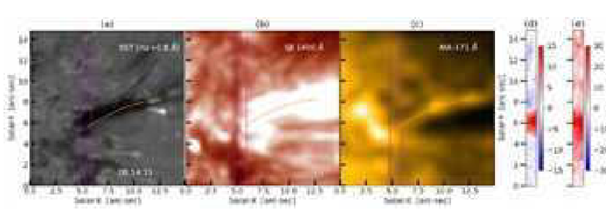


Figure 9: Snapshot of the (a) H$\alpha$ +0.8Å, (b) TR (Si 1400Å), and (c) corona (AIA 171Å), with each of these regions exhibiting a common feature highlighted by an orange dashed line, illustrating the descent of bundles of spicules from coronal passbands down to the chromosphere. The purple parallel lines represent the coverage of the slit, spanning approximately 1 arcsec. The extreme right color bars show Doppler maps corresponding to the region covered by the slit both in the chromosphere and the TR. These Doppler maps show dominant redshifts at the locations corresponding to the down-flowing feature seen in H$\alpha$ -0.8Å, indicating at least a subset of the strong redshifts observed in TR result from the upper atmosphere flow of plasma reaching to the chromosphere in the form of bundles of spicules.

doi : `https://doi.org/10.3847/1538-4357/ad50d5`

This work is done in collaboration with Tiago M. D. Pereira Rosseland Centre for Solar Physics, University of Oslo, Norway.

**(Ravi Chaurasiya, Raja Bayanna, Rohan E Louis, and Shibu K Mathew)**

**Observational study of the atmospheric gravity waves in the lower solar atmosphere**

The solar chromosphere exhibits a variety of waves originating from the photosphere and deeper layers, causing oscillations at different heights with distinct frequencies. This study identifies and analyses atmospheric gravity waves (AGWs) and acoustic waves at various height pairs within the solar atmosphere utilizing imaging spectroscopic observations in spectral lines H$\alpha$, Ca II IR, and Fe I 6173Åfrom the Swedish 1-m Solar Telescope. For the study, we derived the multi-height velocities using filtergram difference and bisector methods.

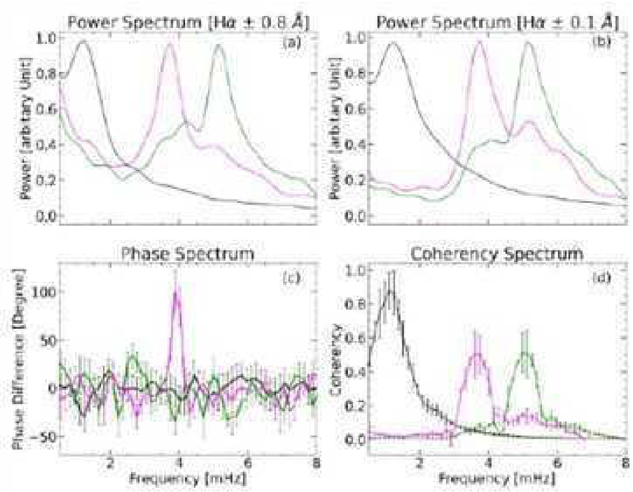



Figure 10: Average power spectrum of the detected pixels in the three frequencies bands in near-photosphere (H$\alpha$ $\pm$ 0.8 Å) and upper chromosphere (H$\alpha$ $\pm$ 0.1 Å) of the solar atmosphere are shown in panels (a) and (b). Panels (c) and (d) show the average phase difference and coherency spectrum of the detected pixels between these two heights. The black, magenta, and green curves are corresponding to the 1.5, 3.3, and 5.5 mHz frequency waves, respectively. The vertical lines over the average phase difference and the coherency spectrum are the $1-\sigma$ error bars. The strong negative phase difference, high coherency, and high power at two heights corresponding to 1.1 mHz frequency are typical signatures of upward-propagating AGWs in the solar atmosphere.

Our analysis shows a consistent increase in power with height in the solar chromosphere and negative phase difference at low-frequencies (around 1.5 mHz) and high coherency, indicating the propagation of AGWs. In addition to this, AGWs are detected within or near-magnetic flux concentration regions, where spicules are also predominant, exhibiting significant power in the chromosphere. These regions also feature inclined magnetic fields, which might be contributing to the propagation of these low-frequency AGWs in the chromosphere. Examining average power maps at spicule locations reveals significant power at AGWs frequency across different chromospheric heights. We speculate that these AGWs propagate upward along spicular structures and were not previously detected employing space–time map due to their limited lifetime. This study provides insights into the complex dynamics of solar chromospheric waves influenced by the magnetic field, contributing to our understanding of AGWs and acoustic waves propagation across different layers of the solar atmosphere.

doi : `https://doi.org/10.1093/mnras/staf045`

**(Ravi Chaurasiya and Raja Bayanna)**

**Effect of area divergence and frequency on damping of slow magnetoacoustic waves propagating along umbral fan loops**

Waves play an important role in the heating of the solar atmosphere. However, observations of wave propagation and damping from the solar photosphere to the corona through the chromosphere and transition region are very rare. Recent observations have shown 3-min slow magnetoacoustic waves (SMAWs) propagation along fan loops (magnetic structures at the edge of the active regions typically rooted in sunspots) from the solar photosphere to the corona.

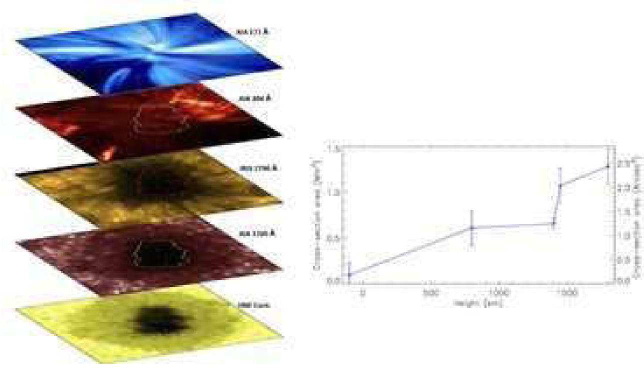


Figure 11: Left panel: Images of the sunspot observed from different passbands sensitive to different temperatures as labeled. The fan loop system is clearly visible in the AIA 171 Å image. Identified loop foot-points in the corona and lower atmosphere are marked with asterisks and small circles, respectively. PRL scientists have also drawn the traced coronal loops in the AIA 171 Å image for visualization purposes. The contours on the images represent the umbra-penumbra boundary. Right panel: Variation of cross-sectional area with height for loop 6. The vertical bars represent errors in the cross-sectional area.

In this work, PRL scientists investigated the role of area divergence and frequencies on the damping of SMAWs propagating from the photosphere to the corona along several fan loops rooted in the sunspot umbra. They have obtained simultaneous sunspot images from the Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory (SDO) at 193 Å AIA 171 Å AIA 304 Å IRIS 2796 Å AIA 1700 Å and HMI continuum passbands along with HMI Dopplergram and IRIS 2796 Å spectroscopic data (fig. 11). Images in these passbands provide insights into different layers of the solar atmosphere, revealing coronal temperatures of 1.6 MK and 0.7 MK, transition region temperature of 50,000 K, chromospheric temperature of 10,000 K, temperature minimum region of 5000 K, and photospheric temperature of 6000 K, respectively. It is evident from the images that the appearance of sunspots varies significantly across different atmospheric layers, which emphasizes the complexities involved in their dynamics. They studied the Fourier power spectra of oscillations along fan loops at each atmospheric height, which showed significant enhancements in 1–2 min, 2.3–3.6 min, and 4.2–6 min period bands. The amplitude of intensity oscillations in different period bands and heights were extracted after normalizing the filtered light curves with the low-frequency background. They found damping of SMAW energy flux propagating along the fan loop 6 with damping lengths $\approx$ 170 km and $\approx$ 208 km for 1.5-min and 3-min period bands, respectively. They also showed the decay of total wave energy content with height after incorporating the area divergence effect and presented the actual damping of SMAWs from the photosphere to the corona. Actual damping lengths, in this case, increased to $\approx$ 172 km and $\approx$ 303 km for 1.5-min and 3-min period bands, respectively (fig. 12). All the fan loops showed such an increase in actual damping lengths, which indicates that the waves are losing energy faster (i.e., the damping length is short) when the area divergence effects are not considered. This is due to the fact that wave energy is getting redistributed across the loop cross-sections due to the effect of area divergence. This clearly demonstrates the importance of the area divergence effect while studying the damping of waves. Their results also showed some frequency-dependent damping of SMAW energy fluxes with height, where high-frequency waves are damped faster than low-frequency waves.

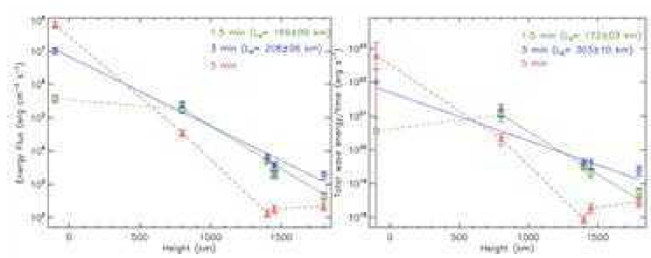


Figure 12: Variation of average wave energy fluxes (left panel) and total wave energy content (right panel) within the loop cross-sectional areas with atmospheric heights.

doi : `https://doi.org/10.1093/mnras/stae1889`

**(Ananya Rawat and Girjesh Gupta)**

**Umbral flashes and their association with running penumbral waves: a study using MAST Ca II 8542 Å narrow-band observations**

Umbral flashes (UFs) are one of the most dynamic phenomena observed in sunspot umbra at the chromospheric heights. In this paper, we utilised the Ca II 8542 line scan observations from the narrow band imager (fig. 13) of the Multi-Application Solar Telescope (MAST), complemented with the data products of Helioseismic Magnetic Imager (HMI) onboard SDO, to investigate the chromospheric UFs and their association with the running penumbral waves (RPWs). Over an approximate observation window of 1 hour, several UFs were observed at different locations inside the umbral boundary of the sunspot. An intensity enhancement of up to 30% or more was observed at the location of UFs, with an approximate periodicity of 3 minutes, the typical period with which the umbral chromosphere oscillates. The line-of-sight (LOS) velocity of UFs was estimated using bisector application to the emission profile resulting from the removal of the mean umbral and the mean quiet Sun (QS) line profiles. The emission profiles resulting from removing the mean umbral profile were observed to better represent the emission component of the UF line profile (fig. 14). Both up-flows and down-flows of the order of $5$ km/s were associated with the UFs, with an average up-flow of $1$ km/s. Out of all UFs analysed, 31% were observed to be associated with down-flows in the case of the removal of the mean umbral profile from the UF line profile. We observed multiple radially propagating LOS velocity disturbances ($20$–$40$ km/s) in the penumbra, which might be associated with the UFs, even though we could not establish a one-to-one correspondence. The horizontally propagating LOS velocity disturbances could produce the visual effect of running penumbral waves, which produce intensity fluctuations when observed at the line-centre wavelength. The simultaneous photospheric HMI observations showed no distinct intensity or velocity signatures corresponding to the UFs observed in the chromospheric Ca II 8542 Å line.

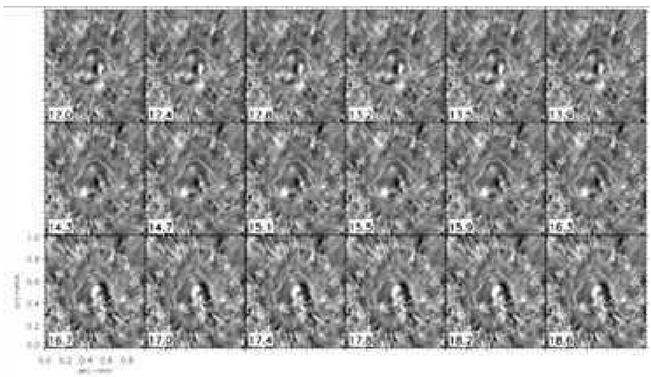


Figure 13: Temporal evolution of the Ca II 8542 line centre difference image, showing several UFs as white patches inside the umbral contour of the sunspot. The time stamp on the respective panel is in minutes.

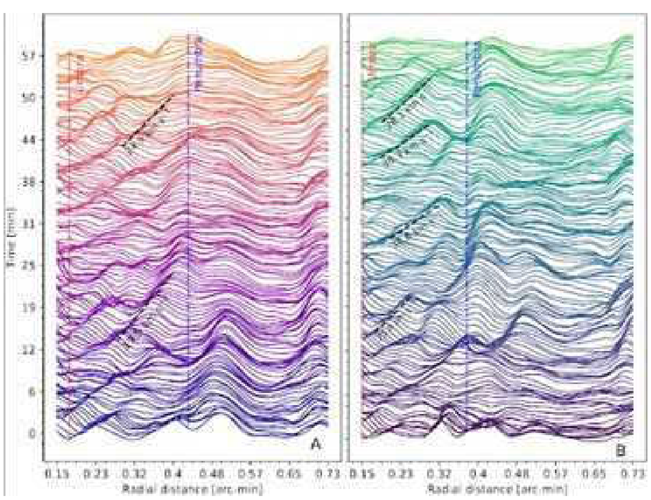


Figure 14: Multiple running penumbral waves with propagation speeds ranging from 20-40 km/s were observed in the angular stack of the LOS velocity. Velocity stacks in panels A and B are separated by 10 degrees. Umbral and penumbral boundaries are shown with vertical lines on both panels.

doi : `https://doi.org/10.1093/mnras/stae2426`

**(Sandeep K. Dubey, Shibu K. Mathew and A. Raja Bayanna)**

**Source Region and Launch Characteristics of Coronal Mass Ejections Driven by Homologous Compact-flare Blowout Jets**

Blowout jets are a type of solar coronal jet characterized by spires that have widths similar to their bright base. The discovery of blowout jets has led to increased focus on understanding the physical processes that control the relationship between jets and coronal mass ejections (CMEs).

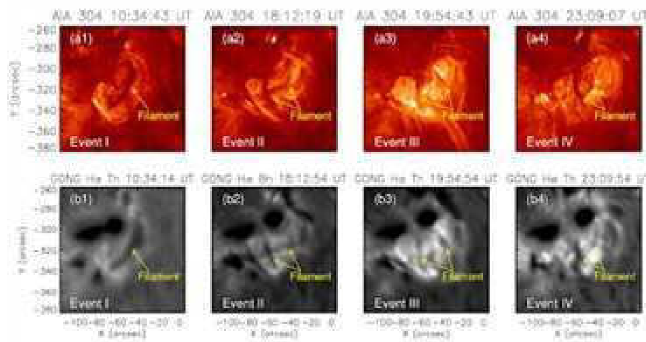



Figure 15: Panels (a1)-(a4): AIA 304 Å channel images of the flaring region before each flare. Panels (b1)-(b4): Corresponding $H_\alpha$ images of the flaring region, recorded by the GONG station indicated in the title of each panel as Th (Teide Observatory, Canary Islands), Bh (Big Bear Solar Observatory, USA). The yellow arrows point to the filaments before the flares.

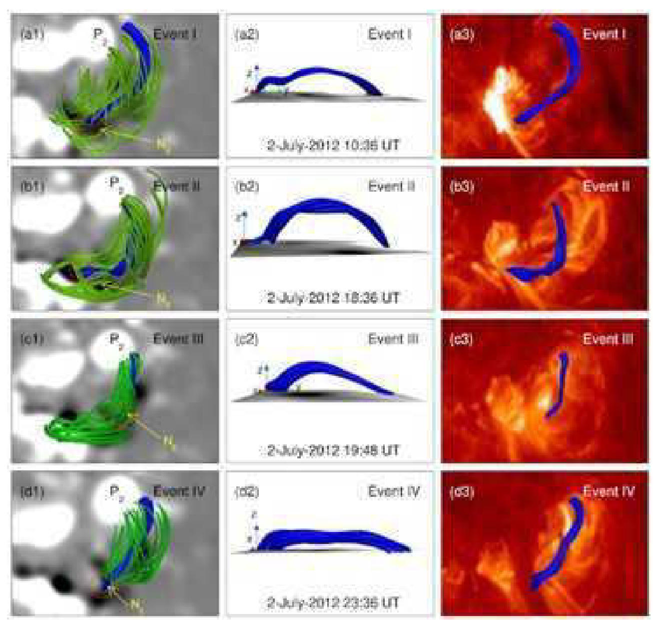



Figure 16: (a1)–(d1) Pre-eruptive coronal magnetic field configurations of the source region obtained from the NLFFF extrapolations using HMI vector magnetograms before events I–IV. We show the flux rope in blue color in each panel. The source region consists of closed bipolar field lines (green), which constrain the underlying flux rope. The flux rope is formed between emerging negative flux (NE) and positive polarity flux in the leading part of the AR. The red circles mark the southeastern footpoint location of the flux rope in each panel, which is rooted in the rapidly changing $N_E$ region. (a2)–(d2) The flux ropes are shown from side views before events I–IV. (a3)–(d3) An AIA 304 Åimage before the respective event is plotted in the background of the flux ropes.

This study investigates the formation of four CMEs originating from homologous blowout jets. All of the blowout jets originated from NOAA active region (AR) 11515 on 2012 July 2, within a time interval of $\approx$ 14 hr. All of the CMEs were wide (angular widths $\approx$ 95-150 degrees) and propagated with speeds ranging between $\approx$ 300–500 km $s^{-1}$ in LASCO coronagraph images. Observations at various EUV wavelengths in Solar Dynamics Observatory/Atmospheric Imaging Assembly images reveal that in all cases, the source region of the jets lies at the boundary of the leading part of AR 11515. Figure 15 presents images of the flaring region in AIA 304 Å and GONG $H_\alpha$. In both AIA 304 Å and GONG $H_\alpha$ images, a filament is identified prior to each jet-flare event, which implies that either the filament did not totally erupt in each of the events or the filaments recursively formed in the filament channel between the positive polarity sunspot and the negative polarity flux.

Coronal magnetic field modeling based on nonlinear force-free extrapolations also indicates that in each case, the filament is contained inside of a magnetic flux rope that remains constrained by overlying compact loops shown. The southern footpoint of each filament is rooted in the negative polarity region where the eruption onsets occur. This negative-polarity region undergoes continuous flux changes, including emergence and cancellation with opposite polarity in the vicinity of the flux rope, and the EUV images reveal brightening episodes near the filament's southeastern footpoint before each eruption. Therefore, these flux changes are likely the cause of the subsequent eruptions. These four homologous eruptions originate near the adjacent feet of two large-scale loop systems connecting from that positive-polarity part of the AR to two remote negative-polarity regions, and result in large-scale consequences in the solar corona.

doi : `https://doi.org/10.3847/1538-4357/ad4995`

This work is done in collaboration with Alphonse C. Sterling of the NASA/Marshall Space Flight Center, Huntsville, USA and Ronald L. Moore of the Center for Space Plasma and Aeronomic Research, University of Alabama in Huntsville, Huntsville, USA.

**(Binal D. Patel and Bhuwan Joshi)**

**On the Influence of the Solar Wind on the Propagation of Earth-impacting Coronal Mass Ejections**

Coronal mass ejections (CMEs) are subject to changes in their direction of propagation, tilt, and other properties as they interact with the variable solar wind. PRL scientists investigated the heliospheric propagation of 15 Earth-impacting CMEs observed during 2010 April to 2018 August in the field of view (FOV) of the Heliospheric Imager (HI) on board the STEREO. About half of the 15 events followed self-similar expansion up to 40 $R_\odot$. The remaining events showed deflection either in latitude, longitude, or a tilt change. Only 2 events showed significant rotation in the HI1 FOV. The authors also use toroidal and cylindrical flux rope fitting on the in situ observations of interplanetary magnetic field and solar wind parameters to estimate the tilt at L1 for these 2 events. This study suggests that CME rotation is not very common in the heliosphere. Their study shows that CME rotation is a rare phenomenon observable in HI1 images. This rarity can be partially attributed to the special conditions required for CME rotation. Although CME rotation appears to be more commonly observed in the lower corona where the ambient magnetic field dominates, it requires conducive conditions of both the magnetic field (fig. 17) and the solar wind to favor a persistent rotation of the CME throughout the heliosphere.

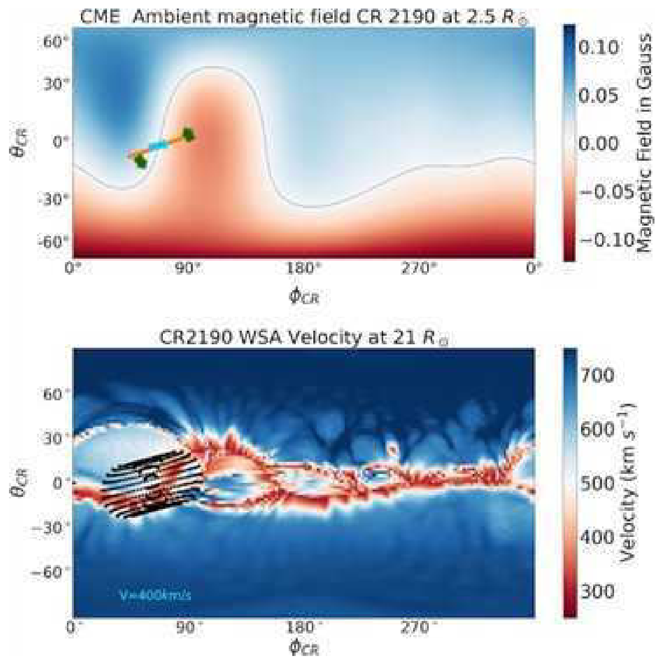



Figure 17: Radial magnetic field (top) and solar wind velocity (bottom) environment of the 2017 May 23 CME.

We attributed the observed deflections and rotations of CMEs to a combination of factors, including their interaction with the ambient solar wind and the influence of the ambient magnetic field. These findings contribute to our understanding of the complex dynamics involved in CME propagation and highlight the need for comprehensive modeling and observational studies to improve space weather prediction. In particular, HI observations help scientists to connect observations near the Sun and near the Earth, improving our understanding of how CMEs move through the heliosphere.

doi : `https://doi.org/110.3847/1538-4357/ad8e63`

This work is done in collaboration with Nat Gopalswamy of NASA/Goddard Space Flight Center, USA and Ashutosh Dash of Central University of Haryana, Jant-Pali, Mahendergarh Haryana, India.

**(Sandeep Kumar and Nandita Srivastava)**

**Modelling the Magnetic Vectors of Interplanetary Coronal Mass Ejections at Different Heliocentric Distances with INFROS**

One of the key challenges in space weather forecasting is reliably predicting the strength of the southward component (Bz) of the magnetic field within an Earth-impacting interplanetary coronal mass ejection (ICME). The Interplanetary Flux Rope Simulator (INFROS) is an observationally constrained analytical model designed to forecast the magnetic field vectors of ICMEs in near-real time. Utilizing the modelling framework of INFROS, the authors investigated six ICMEs sequentially observed by two radially aligned spacecraft positioned at different heliocentric distances. The six selected ICMEs in this study comprise cases associated with isolated coronal mass ejection (CME) evolution as well as those interacting with high-speed streams (HSSs) and high-density streams (HDSs). For the isolated CMEs, their results show that the INFROS model outputs at both spacecraft are in good agreement with in-situ observations (fig. 18).

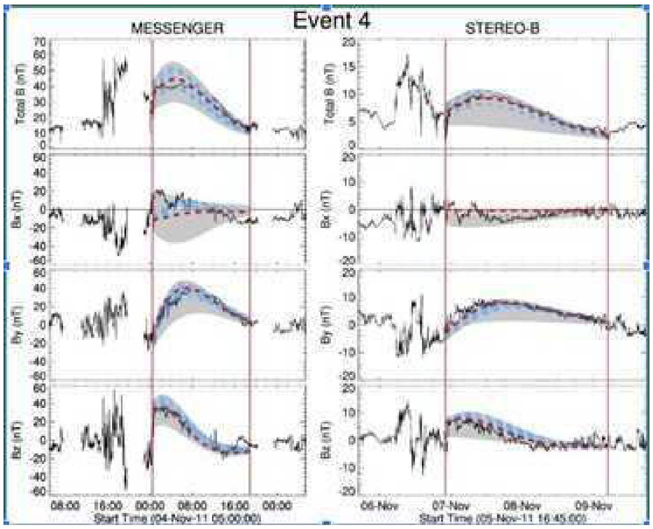



Figure 18: The magnetic field profiles of the ICME sequentially detected by MESSENGER and STEREO-B for the CME of November 4, 2011. The black solid lines denote the observed magnetic vectors of the ICME while the grey-shaded regions are the ensemble results obtained from the model predictions. The cyan dashed lines represent the ensemble model results corresponding to the lowest impact distance at STEREO-B. The red curves mark the best fit of the magnetic vectors at MESSENGER.

However, for most of the interacting events, the model correctly captures the CME evolution only at the inner spacecraft. Due to the interaction with HSSs and HDSs, which in most cases occurred at heliocentric distances beyond the inner spacecraft, the ICME evolution no longer remains self-similar. Consequently, the model underestimates the field strength at the outer spacecraft. The findings indicate that constraining the INFROS model with inner-spacecraft observations significantly enhances the prediction accuracy at the outer spacecraft for the three events undergoing self-similar expansion, achieving a 90% correlation between observed and predicted Bz profiles. This work also presents a quantitative estimation of the ICME magnetic field enhancement due to interaction which may lead to severe space weather. PRL scientists conclude that the assumption of self-similar expansion provides a lower limit to the magnetic field strength estimated at any heliocentric distance, based on the remote-sensing observations.

doi : `10.3847/1538-4365/ad5835`

This work was done in collaboration with Ranadeep Sarkar, Emilia Kilpua of University of Helsinki, Finland, Nat Gopalswamy of NASA/Goddard Space Flight Center, USA.

**(Nandita Srivastava)**

# Space and Atmospheric Sciences

### Change in monoterpene concentrations during winter-to-summer transition period and impact of COVID-19 lockdown at an urban site in India

The ambient concentrations of two monoterpenes ($\alpha - pinene$ and $\beta - pinene$) measured at an urban site in western India during January to May 2020 were investigated to understand the impact of the winter-to-summer transition and COVID-19 pre-lockdown to lockdown conditions. The average mixing ratios of $\alpha - pinene$ and $\beta - pinene$ showed strong day-to-day variations with higher and lower values associated with calm and strong wind conditions, respectively. The monthly mixing ratios of $\alpha - pinene(15 - 28ppt)$ and $\beta - pinene(8 - 14ppt)$ during the study period do not show a clear winter-summer trend, rather show lowest in May.

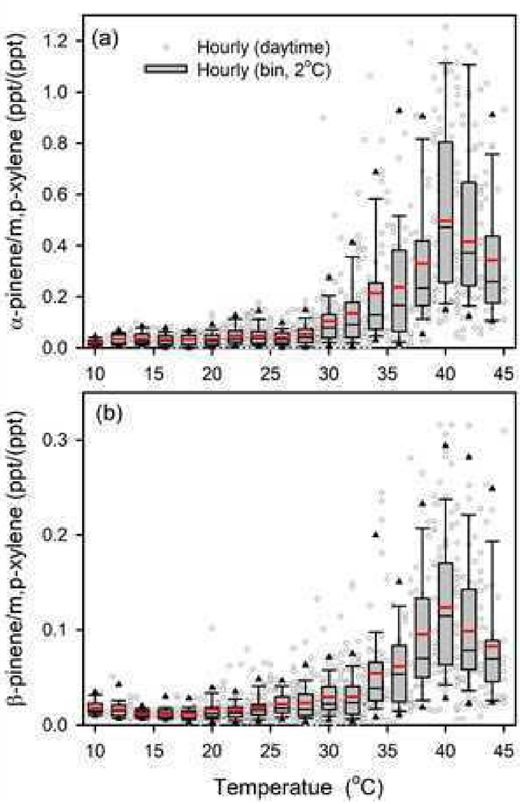



Figure 1.: Dependencies of the $\alpha$- and $\beta$-pinene to m,p-xylene ratios (ppt ppt$^{-1}$) on ambient temperature (hourly data) during the daytime. The box plots (in a bin of 2.0 $^{\circ}$C) represent the percentile, mean (red line) and median values.

The sharp increase in the $\Sigma\alpha + \beta - pinene/\Sigma\beta\mathrm{TEX}$ ratios during the strict COVID-19 lockdown phases from the pre-lockdown values could be due to the reductions of anthropogenic emissions in addition to increased biogenic contributions. The $\alpha$ and $\beta - pinene$ mixing ratio showed a slight increase with the temperature, but the $\alpha - pinene/m,p - xylene$ and $\beta - pinene/m,p - xylene$ increased exponentially till $40^{\circ}$C (Figure 1). As estimated, the daytime average relative biogenic contributions of $\alpha - pinene$ and $\beta - pinene$ increased from $\sim 66$ and $56\%$ in January to $88$ and $70\%$ in May, respectively. This study suggests that the elevated biogenic contributions of monoterpenes along with other BVOCs in the tropical urban region can have significant implications on regional atmospheric chemistry and air quality related to the formation of ozone and SOA in summer. However, further studies are required to investigate the plant-specific emission of BVOCs in urban regions, particularly in developing countries of the tropics.

doi : `https://doi.org/10.1016/j.atmosenv.2025.121141`

**(T.G. Malik, M. Gupta, N. Tripathi, L.K. Sahu)**

### A review on air–sea exchange of reactive trace gases over the northern Indian Ocean

Air–sea exchange is the dominant process controlling the distribution of several important trace gases over remote marine regions. Although the ocean–atmosphere interface covers $\sim$70% of the Earth's surface, the quantitative air–sea exchange of reactive trace gases are estimated over the limited oceanic regions. The production and air–sea exchange of trace gases are controlled by physical conditions at both sides of the interface and ocean biogeochemistry. The northern Indian Ocean experiences strong seasonal monsoon winds and intense tropical cyclones. Consisting of the Arabian Sea and Bay of Bengal, it is one the most biologically productive regimes of the world ocean and home to the intense oxygen minimum zone of the Arabian Sea with dissolved oxygen concentrations (<5 $\mu$M). So far, most of the studies of air–sea exchange of trace gases were focused on the Atlantic and Pacific Oceans, while studies over the northern Indian Ocean are very limited wherein reports exist mainly for $CH_4$, $CO_2$ and $N_2O$. Although progress has been made in recent years, studies of air–sea exchange of reactive trace gases such as non-methane hydrocarbons, oxygen-, sulfur- and halogen-containing hydrocarbons remains scarce.The comparative study of the available data, so far reported, reveal higher air–sea fluxes of DMS and isoprene over the northern Indian Ocean than from other oceanic regions of the world. Therefore, intensive scientific investigation of the biogeochemical cycling of reactive trace gases in the surface seawater, and the response of flux to the dominant physical processes over the basins are necessary.

doi : `https://doi.org/10.1007/s12040-024-02268-5`

**(M. Gupta, N. Tripathi, T.G. Malik, L.K. Sahu)**

**Atmospheric clouds and boundary layer dynamics during a dust storm over Ahmedabad**

This study investigated how a sudden dust storm affected clouds and the lower atmosphere over Ahmedabad, an urban city in western India, on May 13, 2024, during the pre-monsoon season. The storm was caused by strong winds from weather systems in southwest Gujarat and southeast Rajasthan, along with a deepening thermal low core over Ahmedabad. Satellite images from INSAT-3D and NASA's Aqua and Terra (MODIS) captured the event. Ground-based Lidar showed that the dust storm suddenly reduced the height of the mixed air layer from about 2.5 km to just 250 meters due to heavy dust blocking the signal. Before the storm, the air layer was about 2 km high, but it dropped to 800 meters the day after, showing more dust in the air. Visibility also fell to between 340 and 660 meters. Humidity near the ground rose from 29% to 48%, and wind speeds reached 6–10 m/s. After the storm, deep, rainy clouds formed, reaching up to 11 km high and causing about 19 mm of rain, most of it falling within an hour, pointing to the interaction between dust and clouds. This study shows how dust storms, driven by moist weather systems, can result in cloud formation and affect the lower atmospheric conditions.

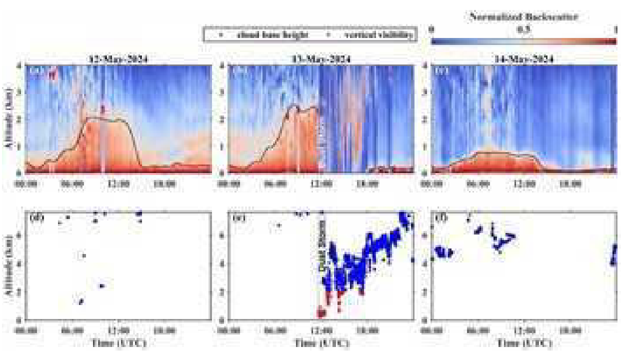



Figure 2.: (a–c) Boundary layer profile derived from the backscatter signal received from the Ceilometer Lidar at the Physical Research Laboratory, Ahmedabad, during 12–14 May 2024. (d–f) shows the cloud base height (blue circle) and vertical visibility (red circle). The dust storm event is marked between the two white dotted lines in (e) and (f).

doi : https://doi.org/10.1016/j.rsase.2024.101442

This work was done in collaboration with Prashant Kumar (SAC, Ahmedabad), Kondapalli Niranjan Kumar (NCMRWF, Noida), Sourita Saha (Scripps Institution of Oceanography, San Diego), and Hassan Bencherif (University De la Réunion, France).

**(Som Kumar Sharma, Dharmendra Kumar Kamat, Aniket)**

**Cloud characteristics over an urban city, Udaipur, in the Aravalli Range of western India**

Clouds play a vital role in the water cycle and influence global weather systems. This study investigated cloud base height (CBH), cloud top height (CTH), and vertical visibility over Udaipur, a city in the Aravalli hills of western India. The study used data from a ground-based Lidar (Ceilometer), satellites (MODIS), and weather models (ERA5) during 2021–2022. The study found that cloud presence peaked during the southwest monsoon, especially in July and August, with frequent multi-layered clouds during this season. CBH was lower during the monsoon and higher in the pre-monsoon months. Cirrostratus clouds were the most common cloud type, making up about 36% of observations. The satellite-derived CBH matched the Lidar observations for a few instances, but the overall correlation between them was weak. The ERA5 model also showed seasonal differences in how well it captured CBH. These findings help improve our understanding of cloud behavior over hilly regions and provide valuable insights for enhancing regional weather modelling and forecasting.

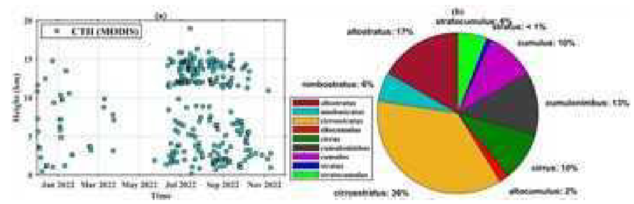


Figure 3.: (a) Cloud Top Height (CTH) observed by MODIS over the Udaipur region during the study period; (b) Percentage of occurrence of different cloud types (classification as per ISCCP on the basis of cloud top temperature and cloud optical thickness).

doi : https://doi.org/10.1007/s42865-024-00075-w

This work was done in collaboration with Kondapalli Niranjan Kumar (NCMRWF, Noida), Prashant Kumar (SAC, Ahmedabad), and Sourita Saha (Scripps Institution of Oceanography, San Diego).

**(Som Sharma, Dharmendra Kamat)**

**Carbon Monoxide Pollution has Gone Down in Ahmedabad in Recent Years**

Carbon monoxide (CO) is a harmful gas found in city air, mostly from cars and other sources that burn fuel. It's bad for our health and also affects the Earth's atmosphere. In a study, scientists looked at CO levels at Ahmedabad, India, over 8 years — from 2014 to 2021— using an advanced measuring device at PRL. They found that CO levels stayed about the same during the afternoon, but in the evening, when local traffic is heavier, the CO levels have declined since 2018—even before the COVID-19 lockdowns started. This decline likely happened because India introduced stricter pollution rules for vehicles (called Bharat Stage IV standards). During the 2020 lockdown, with fewer vehicles on the road, evening CO levels dropped even more—by about 29% compared to earlier years. Interestingly, the observed long-term changes in CO concentrations didn't align with estimates of CO emission fluxes in various inventories, suggesting that those estimates might need to be improved. Overall, the study shows there is huge potential in reducing CO in urban air. These measurements help us see what's working and what needs to be done to keep our air clean.

doi : https://doi.org/10.1007/s11356-024-33813-w

This work was done in collaboration with N. Chandra and Prabir Patra from Research Institute for Global Change, JAMSTEC, Yokohama, Japan.

**(Shyam Lal, S. Venkataramani, Akanksha Arora, Harish Gadhavi)**

**Long-term characteristics and trends in atmospheric black carbon aerosols**

Black carbon (BC) is a primary aerosol that is produced in the atmosphere due to the incomplete combustion of fossil fuels and biomass burning. BC is a significant light-absorbing species and a potential climate warming species after carbon dioxide, with a climate forcing of +1.1 Wm$^{-2}$, higher than that of methane. The characteristics of BC aerosol, its source apportionment into fossil fuel and biomass (wood fuel) components in order to infer their contribution to the total black carbon emission, and their trends measured using a multi-wavelength aethalometer over an urban location (Ahmedabad) in India covering a 14-year period (2006–2019) are comprehensively investigated. Ahmedabad is a densely populated city, and the human population density has increased by 41% between 2006 and 2019. Due to rapid urbanization, the number of registered total vehicles has increased by 222% during 2006–2019 in Ahmedabad.

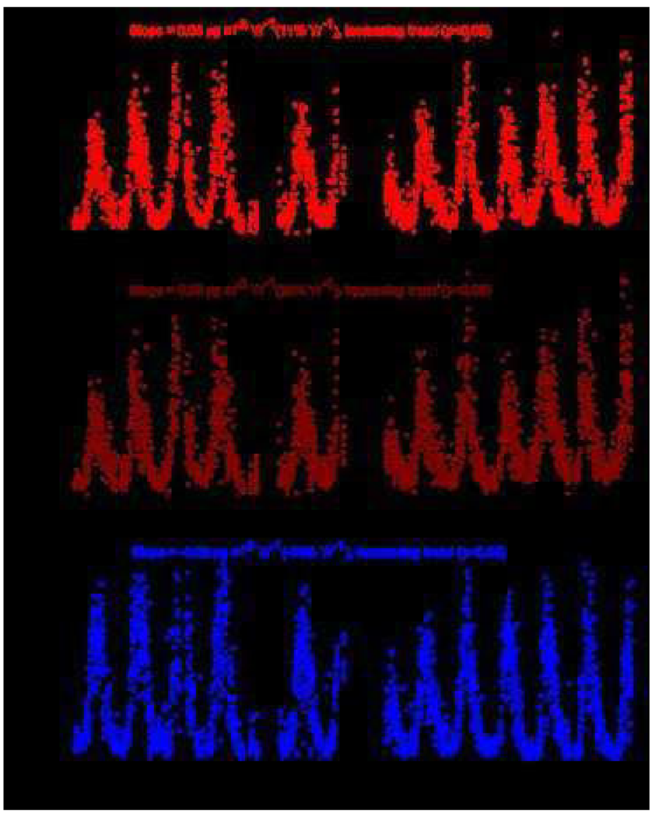


Figure 4.: Long-term trends in (a) eBC, (b) eBCff, and (c) eBCwf mass concentrations over Ahmedabad during the period 2006–2019. The symbols represent the daily mean data in a year and the dotted lines correspond to linear fits. The slope, the rate of increase/decrease along with %, nature of the trend, and the statistical significance are given in each graph.).

The BC mass concentrations exhibit a bimodal distribution, with the morning and evening peaks occurring during 6–9 and 19–22 hours, respectively. The morning peak occurs due to the combined effect of the significant increase in emissions from anthropogenic activities (such as household, road traffic, and roadside cafes and food stalls) and the atmospheric boundary layer height (BLH) dynamics. The evening peak occurs due to a decrease in BLH accompanied by a significant increase in vehicular emissions. The average contributions of BC from fossil fuel combustion and wood fuel burning to total BC are 80% and 20%, respectively, which highlights the dominance of emissions from fossil fuel combustion processes. A statistically significant increasing trend is detected in BC mass concentration at the rate of 11% yr$^{-1}$. The contribution of BC from fossil fuel combustion to total BC reveals a statistically significant increasing trend at the rate of 29% yr$^{-1}$, whereas a decreasing trend in the contribution of BC from wood fuel burning at the rate of 36% yr$^{-1}$ is detected. The study reveals a significant decrease in biomass (wood fuel) burning emissions over the past decade, attributed to the adoption of cleaner household cooking fuel and an increase in emissions from fossil fuel combustion. However, the rate of change in BC emissions from fossil fuel combustion and wood fuel burning is different; the rate of decrease in BC emissions from wood fuel burning is higher than that of the increase in fossil fuel emissions due to rapid urbanization and the consistent increase in usage of non-polluting fuel. Across the globe, several countries are adopting various strategies and mitigation policies on air quality; however, significant gaps exist in their implementation towards achieving cleaner air. This comprehensive study is relevant for understanding the impact of urbanization and devising better BC emission control policies.

doi : `https://doi.org/10.1016/j.scitotenv.2024.172928`

**(T. A. Rajesh and S. Ramachandran)**

**Influence of changes in anthropogenic and natural sources on global aerosol optical depth during COVID-19 lockdowns**

For the first time, multi-source data including high-quality ground-based observations (Aerosol Robotic Network (AERONET)) and satellite (Moderate Resolution Imaging Spectroradiometer (MODIS) and Ozone Monitoring Instrument (OMI)) data in combination with two high resolution model (Modern-Era Retrospective Analysis for Research and Applications-2 (MERRA-2) and Copernicus Atmosphere Monitoring Service (CAMS)) outputs, are analysed to examine the changes in aerosol optical depth (AOD) across the globe during CoronaVirus Disease-2019 (COVID-19) lockdown (2020) period. AERONET AODs decreased by 20-40% during peak lockdown period in spring and summer of 2020 in most locations across the globe, and these changes are statistically significant (Figure 1). The observed magnitude of changes (increase/decrease) are consistent between AERONET and MODIS (Figure 2). The observed changes in AOD were well-captured by both the global models (MERRA-2 and CAMS). OMI absorbing aerosol index captures increases in carbonaceous aerosols due to wildfires and dust. Global analysis reveals that changes in total AOD and species AODs are highest during spring over the Middle East, South and East Asia. Among all the regions, the change in dust AOD was maximum over South Asia during spring ($> 75\%$; -0.04 decrease in dust AOD in -0.05 change in total AOD). Black carbon (BC) and sea salt contribute $\leq 10\%$ to AOD across the globe. Decrease in BC AOD was maximum over South Asia (50%) during spring 2020 providing evidence for the impact of applied restrictions on anthropogenic activities. Decrease in AOD over North America, Europe, Russia, Middle East, South Asia, East Asia, and South East Asia led to global decrease in AOD. This quantitative documentation of changes in AODs due to reduction in aerosol components/species, their regional and seasonal variations are crucial in planning and supporting future mitigation efforts.

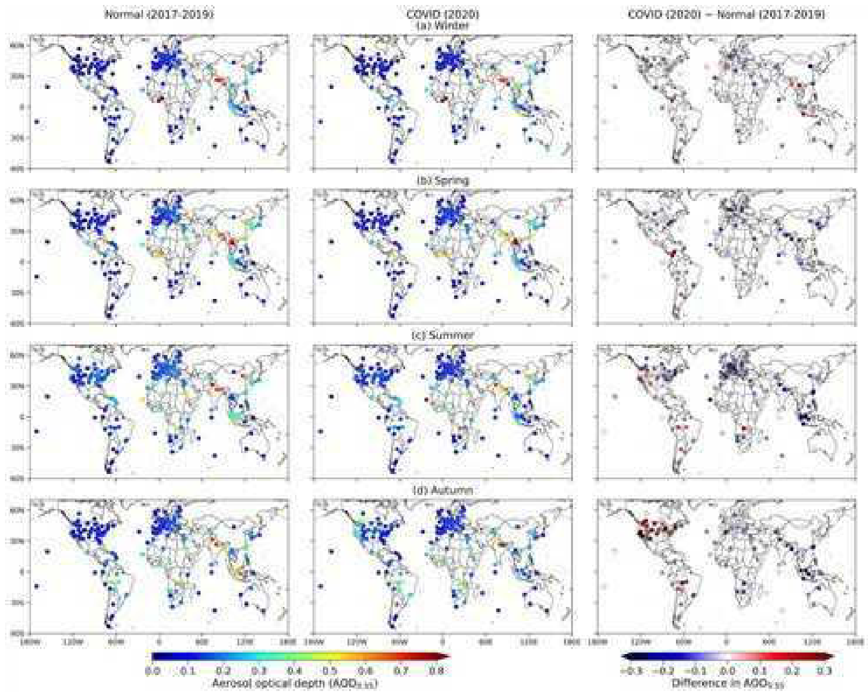



Figure 5.: Aerosol optical depth (AOD) from Aerosol Robotic Network (AERONET) locations corresponding to normal (2017–2019 mean) (1st column), COVID (2020) period (2nd column), and the difference between COVID (2020) and normal (2017–2019) period (3rd column) over the globe as a function of season: (a) winter (DJF), (b) spring (MAM), (c) summer (JJA) and (d) autumn (SON). The symbol "x" over the AOD difference (3rd column) over a location represents the change in AOD which is statistically significant at 95% confidence level (CL) ($p$-values $\leq$0.05) calculated using Student's $t$-test.

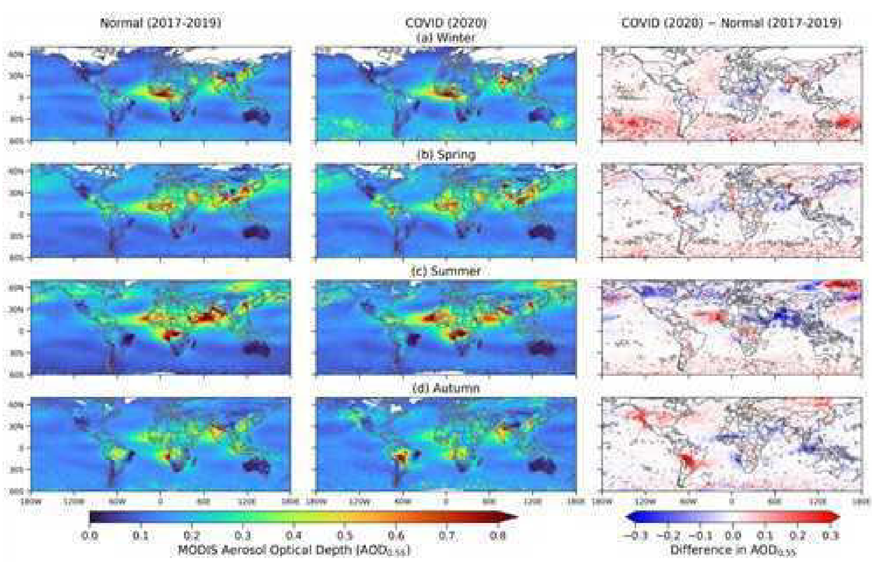



Figure 6.: Moderate Resolution Imaging Spectroradiometer (MODIS) retrieved AOD for normal (2017–2019 mean) (1st column), COVID (2020) period (2nd column), and the difference between COVID (2020) and normal (2017–2019) period (3rd column) at a spatial resolution of $1^\circ \times 1^\circ$ over the globe during (a) winter, (b) spring, (c) summer and (d) autumn. The hatched area represents changes which are statistically significant at 95% Confidence Level ($p$-values $\leq$0.05) determined by Student's $t$-test.

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**(S. Ramachandran and Kamran Ansari)**

**Global insights on aerosol absorption characteristics**

comprehensive analysis of aerosol absorption parameters—**single scattering albedo (SSA)** and **absorption aerosol optical depth (AAOD)**—using high-quality **AErosol RObotic NETwork (AERONET)** observations, and space-time collocated validation of **Modern-Era Retrospective Analysis for Research and Applications-2 (MERRA-2)** simulations over the globe, is conducted on a seasonal scale, for the first time. AERONET SSA is lower in Central (0.86) and South Asia (0.90) than East (0.93) and Southeast Asia (0.94). Over Asia, annual mean AAOD is higher over South Asia (~0.07) and it is ~50% lower over Southeast and East Asia. Globally, AAOD (>0.1) is highest over central Africa in winter because of high AOD and lower SSA which arise due to intense biomass burning and dust aerosols. Seasonal variabilities in spectral SSA and AAOD over North America, South America, Europe, and Middle East are not statistically significant which reveals no significant variations in aerosol composition and size distribution throughout the year over these regions (Figure 3). Bias in MERRA-2 SSA is lower with high **Global Climate Observing System (GCOS)** fraction (>50%) for moderately absorbing aerosols ($0.90 \leq$ SSA $< 0.95$) as the distribution of simulated SSA is narrow in this SSA range as compared to less absorbing (SSA $\geq 0.95$) and more absorbing (SSA $< 0.90$) aerosols (GCOS fraction: <50%). Bias in MERRA-2 AAOD is less (0.003) for low AAOD ($\leq 0.025$) conditions, and higher (-0.05) for high AAOD ($\geq 0.075$) conditions. During peak fire seasons over biomass-burning dominated sites, MERRA-2 overestimates SSA (mean bias error (MBE): ~0.04) with low GCOS fraction (<50%), and underestimates AAOD (MBE>0.03, in magnitude) with <50% data points lying within the expected error. Our findings provide critical global insights for better understanding the characteristics and variabilities of aerosol absorption, and for improving model simulated aerosol absorption on seasonal and global scales, which are useful to substantially reduce uncertainties in global assessment of radiative and climate impact of aerosols.

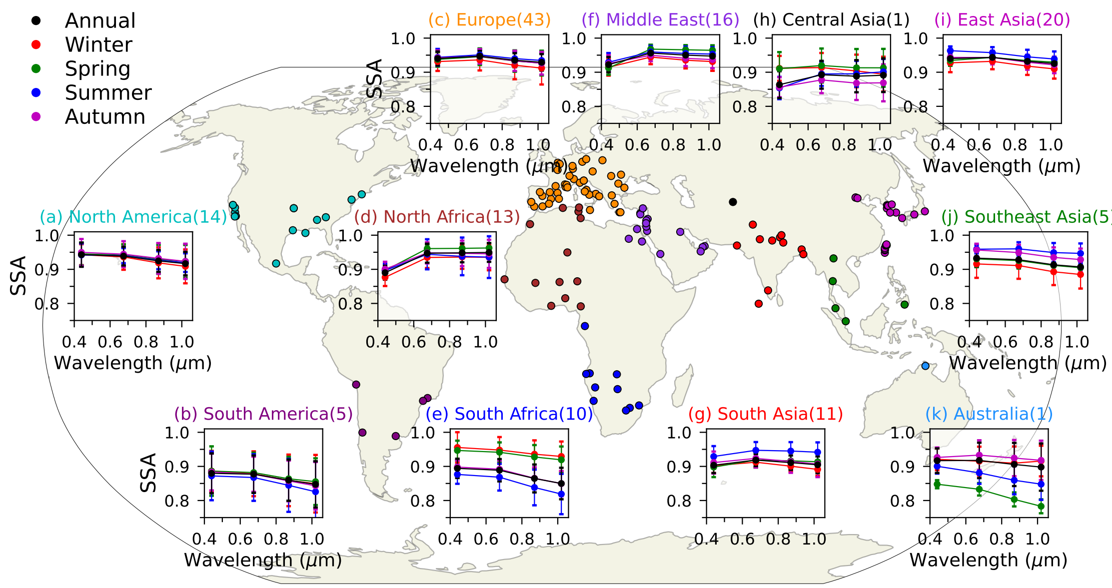


Figure 7.: Spectral variation of regional mean **single scattering albedo (SSA)** in the wavelength range of 0.44–1.02 $\mu$m on annual and seasonal scales over (a) North America, (b) South America, (c) Europe, (d) North Africa, (e) South Africa, (f) Middle East, (g) South Asia, (h) Central Asia, (i) East Asia, (j) Southeast Asia, and (k) Australia. Total number of AERONET observational sites in each region are given in brackets.

doi : https://doi.org/10.1016/j.scitotenv.2024.178178

**(Kamran Ansari and S. Ramachandran)**

**Aerosol single scattering albedo (SSA) changes during COVID-19**

A comprehensive global investigation on the impact of reduction (changes) in aerosol emissions due to Coronavirus disease-2019 (COVID-19) lockdowns on **aerosol single scattering albedo (SSA)** utilizing satellite observations and model simulations is conducted for the first time. The absolute change in SSA retrieved from **Ozone Monitoring Instrument (OMI)**, and two highly-spatially resolved models (**Modern-Era Retrospective Analysis for Research and Applications-2 (MERRA-2)** and **Copernicus Atmosphere Monitoring Service (CAMS)**) simulated SSA is <4% (<0.04-0.05) globally during COVID (2020) compared to normal (2015-2019) period. Change in SSA during COVID is not significantly different from long-term and year-to-year variability in SSA (Figure 4). A small change in SSA indicates that significant reduction in anthropogenic aerosol emissions during COVID-19 induced lockdowns had a negligible effect in changing the net contribution of aerosol scattering and/or absorption to total aerosol extinction. Changes in species-wise **aerosol optical depth (AOD)** are examined to explain the observed changes in SSA. Model simulations show that total AOD decreased during COVID-19 lockdowns, consistent with satellite observations. The respective contributions of sulfate and **black carbon (BC)** to total AOD increased, which resulted in a negligible change in SSA during spring and summer seasons of COVID over South Asia. Europe and North America experience a small increase in SSA (<2%) during summer of COVID due to a decrease in BC contribution. Change in SSA (2%) is the same for a small change in BC AOD contribution (3%), and for a significant change in sulfate AOD contribution (20%) to total AOD. Since, BC SSA is 5-times lower than that of sulfate SSA, the change in SSA remains the same. For a significant change in SSA to occur, BC AOD contribution needs to be changed significantly

(4 to 5 times) compared to other aerosol species. A sensitivity analysis revealed that the change in aerosol radiative forcing during COVID depends primarily on change in AOD rather than SSA. These quantitative findings can be useful to devise more suitable future global and regional mitigation strategies aimed at regulating aerosol emissions to reduce environmental impacts, air pollution, and public health risks.

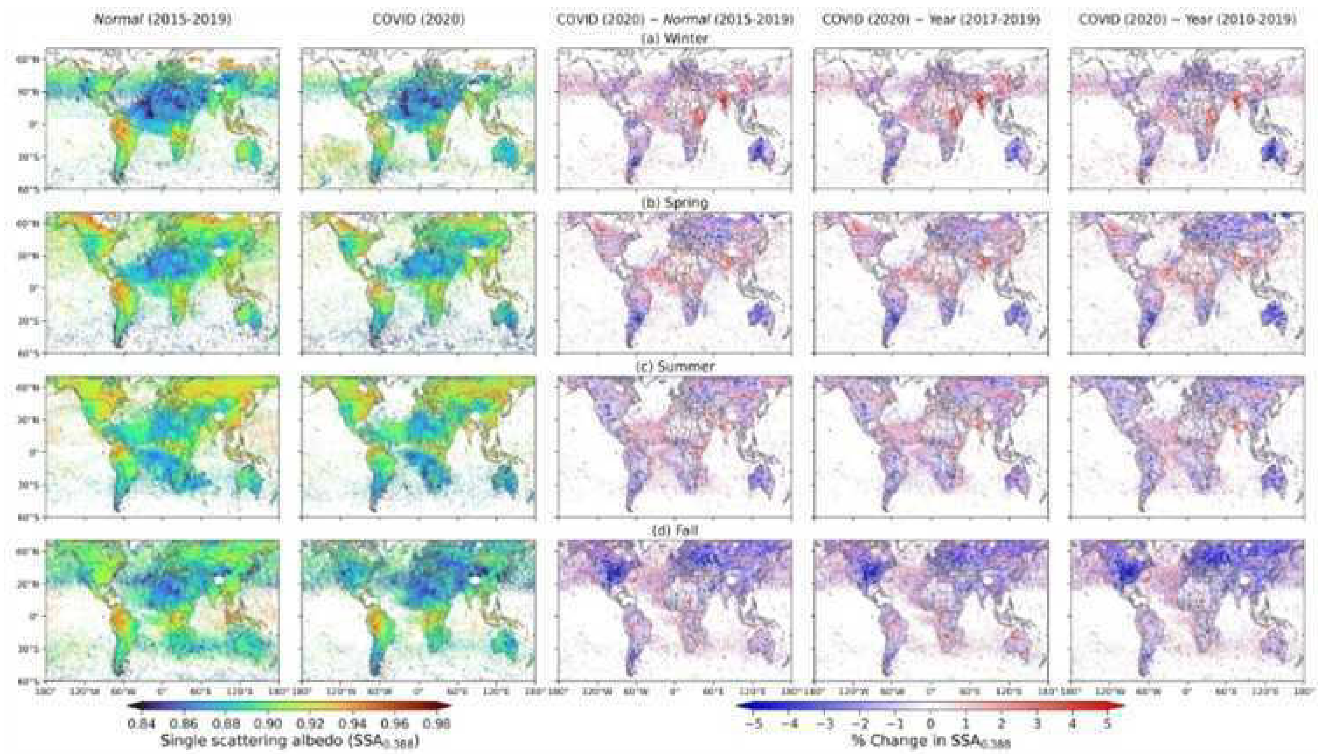


Figure 8.: Ozone Monitoring Instrument (OMI) retrieved single scattering albedo at 0.388 $\mu$m (**SSA**$_{0.388}$) during normal (2015-2019 mean) (1st column), COVID (2020) period (2nd column), and the percentage change in SSA$_{0.388}$ during COVID relative to the normal period (3rd column), recent 3 years (2017-2019 mean) (4th column) and last decade (2010-2019 mean) period (5th column) for four seasons of (a) winter, (b) spring, (c) summer, and (d) fall. The positive and negative values (right 3 columns) indicate the increase and decrease in SSA during COVID, respectively. Significant changes in SSA$_{0.388}$ (corresponding to 95% confidence level) are represented by black dots.

doi : https://doi.org/10.1016/j.atmosenv.2024.120649

**(Kamran Ansari and S. Ramachandran)**

**Optical and Physical Characteristics of Aerosols over Asia: AERONET, MERRA-2 and CAMS**

A comprehensive study on regional and spatial distributions of aerosol columnar optical and physical characteristics utilizing high-quality **AERONET** datasets over Asia (Central, South, South-East, and East Asia), along with spatiotemporal collocated validation of two high-spatially resolved models (**MERRA-2** and **CAMS**) simulated **aerosol optical depth (AOD)** and **Ångström exponent (AE)** on annual and seasonal scales, was conducted for the first time. AOD is the highest over South Asia in each season, followed by South-East, East, and Central Asia. Annual regional average AOD at 0.50 $\mu$m over South Asia is 0.61. Combined influence of both fine anthropogenic aerosol emissions from biomass burning and fossil fuel combustion, and coarse mode dust aerosols from seasonal transport lead to higher AOD and total volume concentration (TVC) with their significant spatiotemporal variations. Coarse volume fraction and effective radius (**R**$_{eff}$) are higher over Central Asia due to dominance of coarse dust aerosols. East and South-East Asia are dominated by fine aerosols and have higher fine volume concentration, AE, fine mode fraction (FMF) (Figure 5), and lower R$_{eff}$. Compared to other regions of globe (except Africa), AOD is higher over Asia, with higher spatiotemporal variabilities in AOD, AE, FMF, and TVC. Over Asia, CAMS performs better than MERRA-2 for AOD (Figure 6). For high AOD conditions, underestimation in model AODs is higher and lower fraction of model AODs satisfy **Global Climate Observing System (GCOS)** requirement over all regions, and these are more pronounced over Asia. Biases in model AODs are higher over Asia compared to other regions of the globe, and lower over North America, Europe, and Australia. Higher bias in model AEs compared to AODs over all regions shows substantial challenges in simulating spectral AOD and appropriate contributions of fine and coarse aerosols. These findings over a global aerosol hotspot region, Asia, along with other regions of the globe are crucial for accurate simulation and fine-tuning of aerosol characteristics by regional and global models, and for reducing uncertainties in assessment of radiative and climatic impact of aerosols.

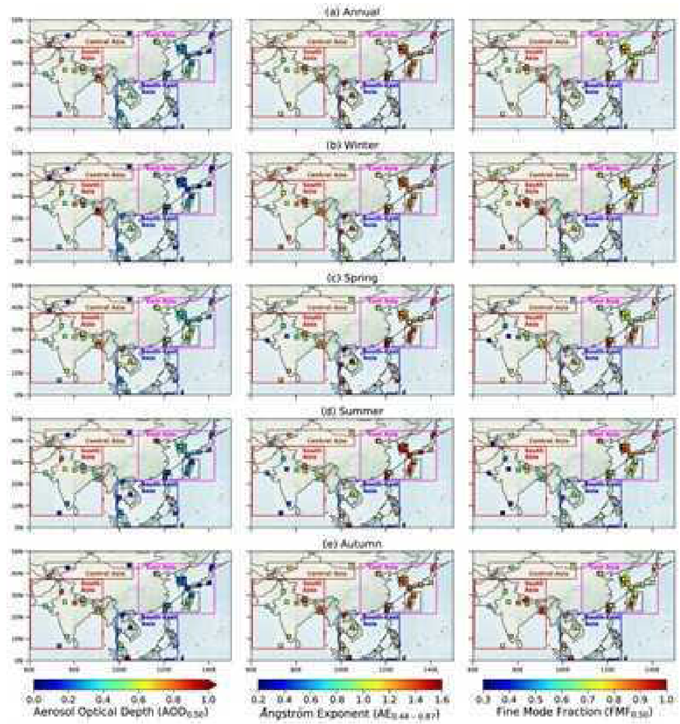


Figure 9.: The spatial distribution of aerosol optical depth (AOD) (1st column), Ångström exponent (AE) (2nd column), and fine mode fraction (FMF) (3rd column) over all the selected AERONET observational sites in Asia on (a) annual and seasonal scales during (b) winter, (c) spring, (d) summer, and (e) autumn. Boxes correspond to different regions in Asia: Central, South, South-East, and East Asia.

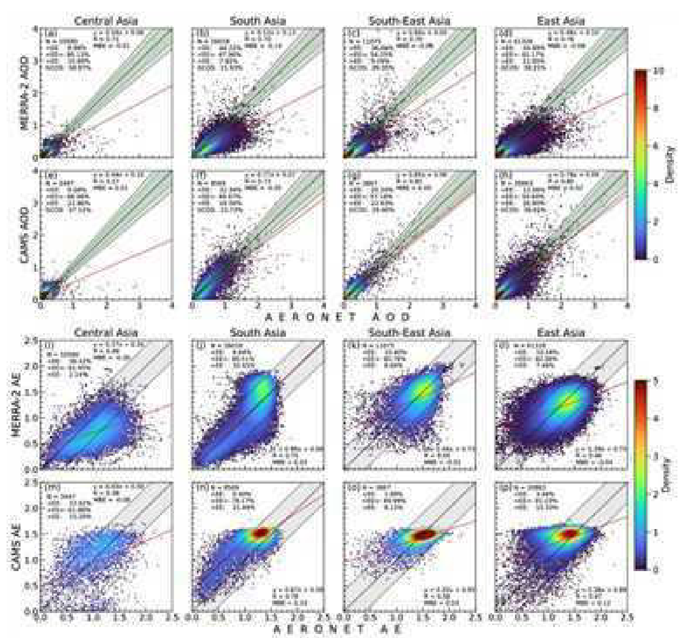


Figure 10.: Collocated validation of **Modern-Era Retrospective Analysis for Research and Applications-2 (MERRA-2)** (a-d, i-l) and **Copernicus Atmosphere Monitoring Service (CAMS)** (e-h, m-p) simulated **aerosol optical depth (AOD)** and **Ångström exponent (AE)** with AERONET measured AOD and AE, respectively, over Central, South, South-East, and East Asia. The solid red and black lines correspond to linear fitted line and 1:1 line, respectively. The dashed black lines and grey shaded region indicate the range of expected error (EE) of AOD ($= \pm(0.05 + 0.15 \times \text{AOD}_{\text{AERONET}})$) and AE ($= \pm 0.4$). The green shaded region in (a)-(h) represents the range of **Global Climate Observing System (GCOS)** requirement for AOD ($= \max(0.04 \text{ or } 0.1 \times \text{AOD})$) and the data points that satisfy the GCOS requirement are given as GCOS fraction (%). Total number of collocated data points (N), percentage of data points below EE (<EE), within EE (<EE>), and above EE (>EE), statistics of fitted line and mean bias error (MBE) are also shown in each panel. Color bars indicate the probability density function derived from the kernel density estimation.

doi : `https://doi.org/10.1016/j.atmosenv.2024.120470`

**(Kamran Ansari and S. Ramachandran)**

**Size resolved particle contribution to vehicle induced ultrafine particle number concentration in a metropolitan region**

The concentration and behavior of nanoparticles (10 to 1000 nm) in Delhi, a densely populated megacity, in different seasons (winter, spring, summer, monsoon, and autumn) were examined, for the first time. Concentration of particles is classified into four different sizes as $N_{nuc}$ (10 to 30 nm, nucleation), $N_{satk}$ (30 to 50 nm, small Aitken), $N_{latk}$ (50 to 100 nm, large Aitken), and $N_{acc}$ (100 to 1000 nm, accumulation mode), and the total (10 to 1000 nm) particle number concentration (PNC) as $N_{total}$. PNC ranges between $10^4$ $cm^{-3}$ and $10^6$ $cm^{-3}$ over Delhi during the year, and the highest concentration occurs in winter. Winter concentration was 2, 1.6 and 1.3 times higher than monsoon, summer, autumn and spring concentrations, respectively. $N_{nuc}$, $N_{satk}$, and $N_{latk}$ and their respective contributions to total PNC exhibit significant seasonal variations. During winter $N_{latk}$ and $N_{acc}$ contribute more to total due to coagulation, with $N_{acc}$ alone contributing $>$40% to total PNC. $N_{nuc}$, $N_{satk}$, and $N_{latk}$ are higher in spring and summer during mid-day due to nucleation and/or ultrafine particle burst events. The direct primary emissions from engine exhaust produce a prominent double hump structure during morning and evening peak hours in winter and autumn. PNC and their contributions exhibit day-night variations as they are influenced by emission sources and variations in meteorological parameters (wind speed, relative humidity, temperature, solar radiation and boundary layer height) between day and night. Carbon monoxide correlates positively with $N_{acc}$ in all seasons ($R^2 \geq 0.5$) as fossil fuel emission is the predominant source for gases and particles in environments considered in this study. These quantitative results on seasonal variations of air pollutants together with the knowledge on seasonal variations in meteorological parameters and atmospheric dynamics provide a foundation which can positively contribute to the planning and devising mitigation measures aimed at improving air quality and public health.

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This work was done in collaboration with K. Rajagopal and R.K. Mishra of Delhi Technological University, Delhi.

**(S. Ramachandran)**

**Seasonal variation of particle number concentration in urban area with exposure assessment and deposition in human respiratory tract**

Ultrafine particles (UFP) associated with air quality and health impacts are a major concern in growing urban regions. Concentrations of UFP (particles of size between 10 to 100 nm) and accumulation mode ($N_{acc}$) (particles of size $>$100 and up to 1000 nm), were analyzed over a highly polluted megacity, Delhi, in conjunction with vehicular flow density, during peak (morning, and evening) and non-peak hours. UFP contributes $\geq$60% to total particle concentration during autumn and monsoon. UFP concentrations are about 50,000 particles per $cm^3$ in winter which reduces to about 25,000 particles during monsoon. $N_{acc}$ are about 20,000 (winter) and 10,000 (monsoon) particles per $cm^3$. UFP concentration and $N_{acc}$ during peak hours are at least twice higher than those obtained in non-peak hours, confirming the dominant influence of emissions from vehicular exhaust in study region. Seasonal analysis of UFP size distribution reveals that direct emissions dominate the concentrations during winter and autumn, whereas new particle formation contributes the highest in spring and summer. Assessment of inhalable particle number concentration and particle deposition in the human respiratory tract using Multiple Path Particle Dosimetry model, performed for the first time, shows that order of deposition goes as alveoli $>$ bronchiole $>$ bronchus. The deposition ranges between 10 and 18 million nanoparticles during different hours of day, whereas estimated inhalable particle concentration (IPN) varies between 0.5 and 1 billion. Results on IPN during activities classified from light (walking), medium, heavy, very heavy to severe (long-distance running) provide insights into health effects on vulnerable populations. These quantitative results obtained over a megacity on hourly and seasonal variations of nanoparticles along with IPN and deposition rates for different activities are important and are invaluable inputs for developing mitigation policies aimed to improve air quality and public health, both of which are major concerns in South Asia.

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This work was done in collaboration with K. Rajagopal and R.K. Mishra of Delhi Technological University, Delhi.

**(S. Ramachandran)**

**Influence of local meteorology and gaseous pollutant emissions on atmospheric nanoparticle concentrations in urban region**

The roadside environment is one of the major sources of nanoparticle emission in the urban regions. The complex mixture of different pollutants makes it hard to understand the dynamics and behavior of nanoparticles. The dynamics of atmospheric nanoparticles ranging from 10 to 1000 nm along with local meteorological conditions and gaseous pollutants in a pedestrian way at a busy street in Delhi, a megalopolis in India, during all five major seasons of the study area, were analysed. Nucleation mode particles were higher during the spring season, whereas the contribution of Aitken mode particles dominated the total particle number concentrations in the rest of the seasons. Due to the influence of vehicular sources, rush hour concentrations were higher than during non-rush hours. Thus, the diurnal pattern in particle concentration strongly coincided with emissions associated with the vehicular flow. During the winter season, the average total particle number concentration was observed to be maximum ($4.1 \times 10^4$ $cm^{-3}$) with a higher surface area of particles of $3.5 \times 10^{-3}$ $mm^2m^{-3}$. Compared to the monsoon season, the concentration of $NO_X$ was 5 times higher in winter. The boundary layer height in the study region ranged from 600 to 2400 m during different seasons, and the maximum ventilation coefficient was observed to be $>$3000 $m^2s^{-1}$ during summer. Precipitation reduced the concentration of particles by half, from $2.2 \times 10^4$ to $1.1 \times 10^4$ $cm^{-3}$, due to wet scavenging. The study revealed that the concentrations of particles depend not only on primary emissions but also are influenced by local meteorology and other co-emitted pollutants. Understanding the dynamics of atmospheric nanoparticles in urban roadside environments as outlined in this study is crucial to devise necessary mitigation measures for people residing near the road in order to reduce health impact and improve air quality.

doi : https://doi.org/10.1016/j.apr.2024.102358

This work was done in collaboration with K. Rajagopal and R.K. Mishra of Delhi Technological University, Delhi.

**(S. Ramachandran)**

**Signature of a zonally symmetric semidiurnal tide during major sudden stratospheric warmings and plausible mechanisms**

Sudden Stratospheric Warming (SSW) is a winter phenomenon initiated primarily by the enhanced stationary planetary waves (SPWs), characterized by an increase in polar stratospheric temperature by a few tens of kelvin for a few days. Wave-wave nonlinear interaction can produce secondary waves, with frequency sum and difference of the primary wave frequencies.

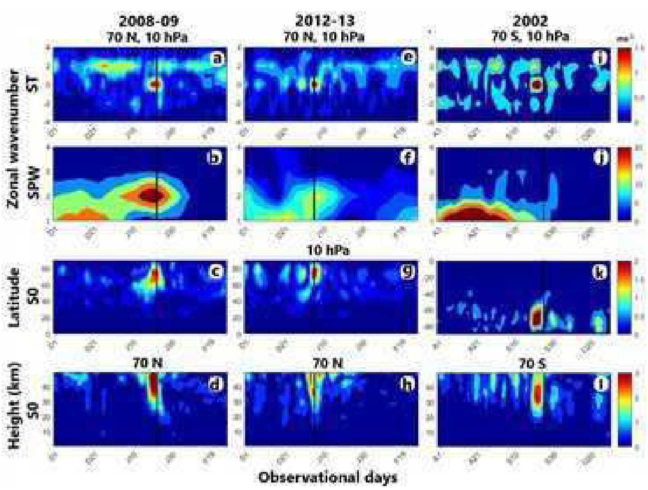

Figure 11.: Enhancement in S0 during SSW. Temporal variability of different ZWN components of (a) ST, (b) SPW utilizing U at 10 hPa, 70°N from MERRA 2 during 2008–2009 observational days (December 1–February 28). (c) Latitude profile at 10 hPa of S0. (d) Altitude profile at 70°N of S0. (e–h) The same as (a–d), but during 2012–2013. (i–l) The same as (a–d), but during 2002 (August 1–October 31). The black solid vertical line represents the peak warming day. Please note the change of scale in the color bars corresponding to each subplot while comparing. The letters D, J, F, and A, S, O on the x axis denote December, January, February, and August, September, October; the subsequent number indicates the day of the given month.

The sun-synchronous semidiurnal tide is a major component at mid and high latitude middle atmosphere, which non-linearly interacts with the dominant SPW in the stratosphere to produce the zonally symmetric Semidiurnal Tide (ST) component ($S_0$), as observed during the Northern Hemisphere SSWs. The zonally symmetric distribution of ozone has also potential to excite the S0 component by absorption of solar UV radiation as evident during the rare Southern Hemisphere SSW. Overall, the present study sheds light on the possible generation mechanism involved in the S0 enhancement (Figure 11).

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This research work was done in collaboration with I. Paulino [Department of Physics, Federal University of Campina Grande, Campina Grande, Brazil]

**(G. Mitra and A. Guharay)**

**On the vertical wave characteristics in the MLT region and its seasonal variations**

The characteristics of vertically propagating waves are derived using simultaneous observations of OH(3-1) airglow brightness and corresponding rotational temperature data. These data were obtained from an in-house PAIRS (PRL Airglow Infrared Spectrograph) over Ahmedabad (23°N, 72.6°E) for the year 2023. Krassovsky's ratio method is employed to derive the vertical wave characteristics: periods ($\tau$), vertical wavelengths ($\lambda_z$), and vertical phase speeds ($C_z$), using the simultaneously obtained brightness and temperature data. Complementary data from SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) and the Horizontal Wind Model (HWM-14) were also utilized to explain our findings.

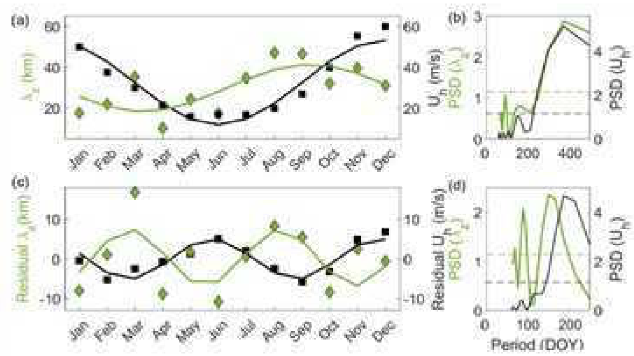

Figure 12.: (a) Monthly mean $U_h$ (black squares) and monthly mean $\lambda_z$ (green diamonds) for the year 2023. The annual variations of $U_h$ and $\lambda_z$ are derived using sine fitting and are shown by black and green lines, respectively. (b) The Lomb-Scargle spectral analysis shows periodicities of around 365 days in monthly mean $U_h$ and $\lambda_z$. The horizontal dashed lines show 99% FAL. (c) Residuals in the monthly mean $U_h$ and $\lambda_z$ obtained by subtracting the sine-fitted curve with the observed AO from their respective monthly mean. (d) Lomb-Scargle spectral analysis shows the presence of around 162 days and 182 days of oscillations in the residuals of $\lambda_z$ and $U_h$, respectively.

In 2023, PAIRS data were obtained for 304 nights, of which 116 nights confirmed upward propagation of waves, for which $\lambda_z$ values were derived. Seasonal variations in the derived $\lambda_z$ are analyzed using daily calculated $\lambda_z$ values for the year 2023. HWM-14 obtained horizontal wind data, with zonal and meridional components, are used for 2023 to observe the annual and semi-annual oscillation (AO and SAO) behavior of the resultant horizontal wind. Annual variations of nightly mean $\lambda_z$ and horizontal winds ($U_h$) and their residuals showed an anti-correlation between the observed AO and SAO in both parameters (Figure 18). A sine fitting model is proposed, accounting for the observed AO and SAO, to provide a first-order estimate of the $\lambda_z$ as a function of the day of the year. The interplay between the SAO in zonal winds, AO in zonal, meridional, and horizontal winds, and their filtering effect collectively shape the presence and characteristics of the waves in the Mesosphere-Lower Thermosphere (MLT) region. This interaction significantly impacts atmospheric dynamics and circulation patterns. Such systematic investigation of the vertical wave characteristics in the MLT region reveals insights into the dynamics of wave propagation in the MLT region.

doi : https://doi.org/10.1016/j.asr.2025.01.017

**(Kiran and Ravindra Pratap Singh)**

### Role of F-layer peak height variations on the estimation of ionospheric TEC over the low latitudes

In the equatorial and low latitude sectors, special configuration of the mutually perpendicular electric and magnetic fields leads to several unique dynamical phenomena. Estimating the realistic values of F-layer peak density (NmF2) and the peak height (hmF2) is one of the important requisite for arriving at accurate predictions of Total Electron Content (TEC) in ionospheric modelling. Ionospheric empirical models estimate the TEC values by integrating the empirically constructed vertical electron density profiles, where-in, the primary task is to estimate the NmF2 and hmF2. Any uncertainties in the modelled NmF2 and hmF2 significantly hinder the accuracy of modelled TEC. Three different hmF2 estimation methods in the International Reference Ionosphere (IRI) model are exploited in an assimilative approach to explore the sensitivity of modelled TEC to hmF2 variations. Simultaneous observations of digisonde and GPS over Trivandrum and Ahmedabad are analyzed. It is observed that the electron density distribution as seen in hmF2 variations are not effectively reproduced in the density profiles in the existing model outputs. This study highlights the need for modifications in the empirical formulations for accurate predictions of TEC over the equatorial and low latitude sectors like India.

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This work is done in collaboration with T.K. Pant, Space Physics Laboratory, VSSC, Trivandrum, India

**(K. Venkatesh, D. Pallamraju, Dalsania P Kelvy and D. Chakrabarty)**

### Effects of storm time ionospheric irregularities on GPS positioning accuracy

Ionospheric irregularities remain a challenging concern as it can pose severe threats to satellite-based services by introducing amplitude and phase scintillations in the trans-ionospheric radio signals. The scintillations may cause degradation of the positioning, navigation, and timing (PNT) services or even complete system failure under extreme conditions. The characteristics of equatorial plasma bubbles during an intense geomagnetic storm of 12 May 2021 are studied. Onset of this storm coincides with the local sunset in the Indian longitudes. The storm time Rate of TEC Index (ROTI) fluctuations and scintillations at L-band are enhanced over the equator than the low latitudes which is opposite to the quiet time behaviour. A strong agreement between the ROTI pattern with the positioning errors from equatorial to low latitudes is reported. In order to model the amplitude of the scintillation index against the position error observations, the linear, quadratic, and cubic regression curve fittings are utilized that indicate the cubic polynomial manifesting the best fitted SNR measurements with the weak as well as moderate scintillation index. The attempt in this work is aligned with the efforts towards reliable PNT operations over equatorial and low latitudes.

doi : https://doi.org/10.1016/j.asr.2023.04.041

This work is done in collaboration with K. Ansari, S.K. Panda (Koneru Lakshmaiah Education Foundation, India) and P. Jamjareegulgarn (King Mongkut's Institute of Technology Ladkrabang, Thailand).

**(K. Venkatesh)**

### Quasi-two-day wave amplification through interhemispheric coupling during the 2010 austral summer

A quasi-two-day wave (QTDW) event during January-February 2010 is investigated using the MERRA-2 reanalysis dataset. MERRA-2 data reveals the growth of the QTDW westward propagating wavenumber 3 preceded by a weak westward wavenumber 4. The diagnostic analysis suggests that the QTDW growth near tropical stratopause is mainly supported by barotropic (BT) instability in the presence of the summer easterly jet. BT instability during this event is suggested to be linked to the planetary wave breaking (PWB) in the winter hemisphere. The connecting link between the two appears to be the inertial instability (II) supported by the cross-equatorial transport of potential vorticity in association with PWB in the winter hemisphere which is consistent with the previous studies. Signatures of II are evident from the MERRA-2 temperature and wind anomalies in the vicinity of cross-equatorial transport of potential vorticity. One important observation brought out in this study is that the strength of meridional wind anomalies in the regions of the II appears to control the meridional curvature of the zonal mean zonal wind and, hence, BT instability of the jet. Overall, the temporal evolution of the QTDW at tropical stratopause during this event is consistent with the episodes of PWB, strength of meridional wind anomalies around the II and meridional curvature of zonal mean zonal wind. The latitude-altitude growth of the QTDW W3 in the zonal wind conforms to the location of critical layers and region of negative meridional gradient of potential vorticity.

doi : https://doi.org/10.1016/j.asr.2023.06.044

This work is done in collaboration with S. Gurubaran, Indian Institute of Geomagnetism, Navi Mumbai.

**(Dupinder Singh, Gourav Mitra, Amitava Guharay, and Duggirala Pallamraju)**

### Estimation of downward heat flux into the F-region from the inner-magnetosphere during stable auroral red (SAR) arc events in the daytime obtained using OI 630.0 nm red-line emissions

The mid-latitude upper atmosphere connects to the outer plasmasphere through closed geomagnetic field lines. During geomagnetic disturbances, interactions between cold plasmaspheric particles and hot ring current ions generate heat, which is conducted along field lines to the mid-latitude ionosphere, leading to electron temperature (Te) enhancements. The excitation of ambient oxygen atoms by these heated electrons produces Stable Auroral Red (SAR) arcs. This downward flow of energy primarily occurs as electron heat flux or soft particle precipitation (¡10 eV), which is challenging to measure directly and is often estimated through theoretical modeling. This study estimates the downward heat flux into the F-region during daytime SAR arc events using OI 630.0 nm red-line emissions. During disturbed periods, high-resolution ground-based measurements from Boston (71°W, 42.36°N) revealed enhanced emissions exceeding model predictions, corroborated by Defense Meteorology and Satellite Program Te measurements ( 800 km) within ±2° of the observational magnetic latitude. Forward modeling (FM) estimates indicate that the daytime Te required to generate these emissions range from 3000-4500 K. By analyzing FM-computed Te variations during these events, the estimates of electron heat flux indicated values of $\sim 10^{10}$ eV cm$^{-2}$ s$^{-1}$, with deposition rates three times higher at 500 km than at 300 km, suggesting that most energy is dissipated in the upper F-region (Figure-11). Therefore, by using the ground-based 630.0 nm emission measurements and ionospheric observations, this study provides critical constraints on heat flux estimates and its role in mid-latitude upper atmospheric dynamics during daytime conditions.

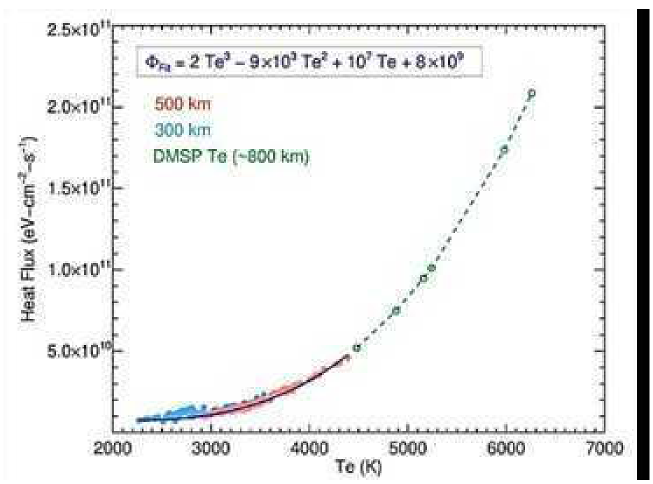


Figure 13.: Estimated electron heat flux in the ionospheric F-region at 300 km (blue dots) and 500 km (red dots) during daytime. The best polynomial fit ($\Phi_{Fit}$) through the estimated values is shown by the blue solid line. Open green circles represent DMSP $T_e$ measurements at ∼800 km, with the green dashed line representing the extrapolated fit to these values. A nonlinear relationship between the estimated heat flux and $T_e$ is observed.

doi : https://doi.org/10.1029/2024JA032694

This work was done in collaboration with Prof. Supriya Chakrabarti of University of Massachusetts, Lowell, MA, USA.

**(Kshitiz Upadhyay and Duggirala Pallamraju)**

**Determination of electron heat flux in the topside ionosphere and its impact on the vertical profile of OI 630.0 nm emission rate during nighttime SAR arcs for different solar activity conditions**

The downward electron heat flux from the overlap region of the outer plasmasphere with the inner ring current serves as the primary energy source for the generation of stable auroral red (SAR) arcs over mid-latitudes. SAR arcs, characterized by enhanced monochromatic oxygen red-line emissions, serve as an optical signature of plasmasphere–ionosphere coupling. This study examines variations in the estimated electron heat flux for multiple SAR arc conjunction events with respect to different solar activity conditions at nighttime. The nighttime electron heat flux was derived by using the ground-based measurements of SAR arc emission intensities, simultaneous in-situ measurements of electron temperature ($T_e$) enhancements in the topside ionosphere, and the physics-based model, GLOW. The results indicate that estimated heat flux values are significantly higher (about an order of magnitude) during high solar activity compared to low solar activity, with a strong positive correlation (R = 0.7) between heat flux and solar flux variations. Furthermore, solar activity was found to influence the peak emission altitude of SAR arcs, with their occurrence below 300 km during low solar activity periods or near solar minimum (Figure 12). Therefore, these results present the critical influence of solar cycle variation on electron heat flux and its role in the mid-latitude upper atmospheric dynamics for nighttime conditions.

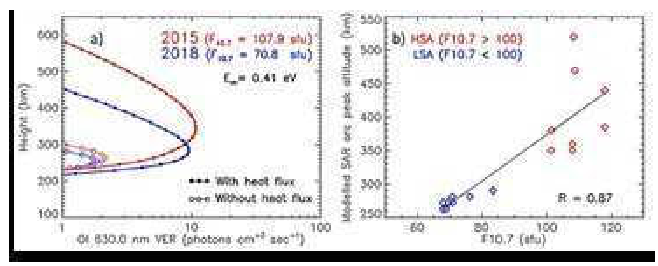

Figure 14.: a) The modelled volume emission rates (VER; photons cm$^{-3}$ sec$^{-1}$) for typical OI 630.0 nm nightglow (without heat flux) is shown by open circles and for SAR arc case (with heat flux) is shown by filled dots at nearly same characteristic energy ($E_M$ = 0.41 eV). b) The variation in peak altitude of modelled SAR arc emissions with respect to solar activity variation is shown. Red color indicates high solar activity (HSA), and blue color indicates low solar activity (LSA) periods.

doi : https://doi.org/10.1016/j.asr.2024.12.046

This work was done as a part of under the SCOSTEP SVS fellowship to Kshitiz Upadhyay in collaboration with Prof. Kazuo Shiokawa, Nagoya University, Japan and Dr. Artem Gololobov, Yakutsk University, Russia,

**(Kshitiz Upadhyay and Duggirala Pallamraju)**

**Latitudinal Distribution of Thermospheric Nitric Oxide (NO) Infrared Radiative Cooling During May and October 2024 Geomagnetic Storms**

The infrared emissions by Nitric oxide (NO) serve as a significant heat sink for the thermosphere and facilitate its recovery from the enhanced density during geomagnetic storms. During geomagnetic storms, the increased precipitation of energetic electrons and ions facilitate the production of NO in the high latitude regions. The investigations were carried out during the two recent severe geomagnetic storms (10–11 May, and 10–11 October 2024). During the May 11 event, the peak NO infrared radiative cooling events shifted from the high-latitudes (30–83 °N) to low-latitude (10 °S–30 °N) regions (Figure 3(a)) in early morning, which is favorable for storm-induced equatorward meridional winds. The FPI (Fabry–Perot Interferometer) measured wind intensity in lower thermosphere captured the storm induced equatorward meridional wind on May 11 (Figure (b)). The strength of the equatorward meridional wind on May 11 (red colored line, Figure 13(b)) increased significantly up to about 290 $ms^{-1}$. It is interpreted that this strong wind brought the NO-rich air toward low latitudes, causing an increase in the NO IRF (Infrared Radiative Flux) in equatorial regions as observed in Figure 13(a). For the October 11 event, most of the enhanced emissions were observed in solar noon and located in 70–180 °E and 5–40 °S. The southern magnetic pole is also located between the same longitude region, where equatorward meridional winds are more enhanced compared to other longitude regions during geomagnetic storms. The effect of storm induced meridional winds on enhanced thermospheric NO radiative cooling were further confirmed by observation of depleted O/$N_2$ ratio in the same region. The contribution of energetic solar radiation to the post storm NO radiative cooling in low latitude regions was also discussed in this study.

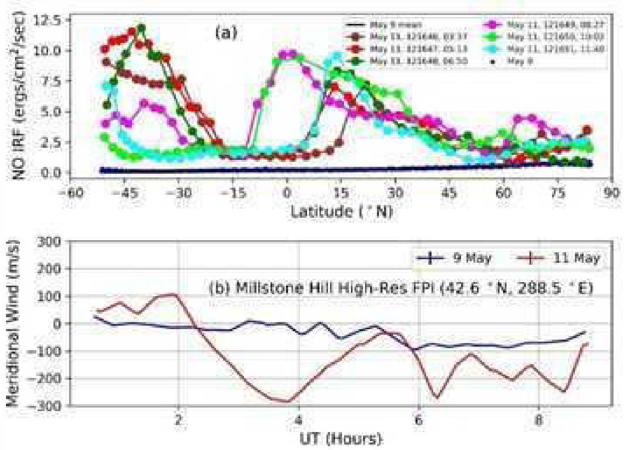


Figure 15.: (a) SABER observed orbital variation of NO IRF in early morning on May 9 (geomagnetic quiet day), and May 11, (b) The meridional wind measurements by FPI on May 9 and May 11, 2024. The 6-digit number (e.g., 121,646) in figure (a) shows the orbit number in northern hemisphere, and time (e.g., 03:37) shows UT (hours) near the equator.

doi : https://doi.org/10.1029/2024JA033559

**(Alok K. Ranjan and Duggirala Pallamraju)**

**Origins of Very Low Helium Abundance Streams in Solar Wind**

The helium abundance in solar wind is defined as $A_{He}$ = $N_a/N_p$ ×100 where $N_a$ and $N_p$ are the alpha ($He^{2+}$ or often termed as Helium) and proton ($H^+$ or often termed as Hydrogen) concentrations respectively. $A_{He}$ in the solar wind typically varies in the range of 2 – 5% with respect to solar cycle and solar wind velocity. In interplanetary coronal mass ejection structures, $A_{He}$ can go as high as 30%. Interestingly, there are instances (Figure 14) where the observed $A_{He}$ has been found exceptionally low ($<$ 1%). These low-$A_{He}$ occurrences are detected both near the Sun and at 1 au are mostly observed near the heliospheric current sheet. In order to understand the origin of low $A_{He}$ events, 28 cases observed by the Wind spacecraft and 4 by Parker Solar Probe are investigated. Based on the ADAPT-WSA model, it is shown that the low-$A_{He}$ events originated from the boundaries of coronal holes, primarily from large quiescent helmet streamers. It is argued that the cusp above the core of the streamer can produce such very low helium abundance events. The streamer core serves as an ideal location for gravitational settling to occur as demonstrated by previous models, leading to the release of this plasma through interchange reconnection near the cusp, resulting in low-$A_{He}$ events. Ulysses observations provide credence to this proposition.

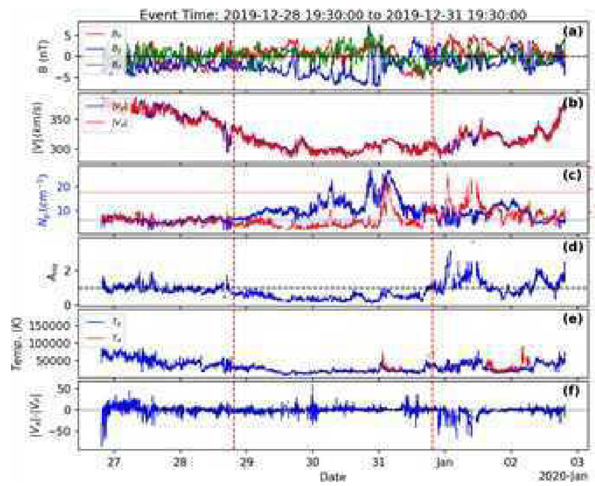


Figure 16.: Example of a low helium abundance event (third panel, $A_{He}$) marked by the two dashed red vertical lines. $A_{He}$ is expressed as $N_{Alpha}/N_{Proton}$ × 100. The panels from the top includes magnetic field components ($B_x$, $B_y$ and $B_z$), velocity of protons (denoted by $V_p$) and alphas (denoted by $V_a$), proton ($N_p$) and alpha ($N_a$) densities, $A_{He}$, proton temperature and alpha proton differential velocity.

doi : https://doi.org/10.3847/1538-4357/ad84d6

This work is done in collaboration with N. Gopalswamy, Seiji Yashiro and Leon Ofman [NASA Goddard Space Flight Center, Greenbelt, USA] and Parisa Mostafavi [Johns Hopkins University, Applied Physics Lab. Laurel, USA]

**(Yogesh, D. Chakrabarty, Nandita Srivastava)**

**Anomalous responses of Low Latitude Ionosphere during two geomagnetic storms**

It is, in general, assumed that stronger geomagnetic storm (parameterized by magnetospheric ring current strength) driven by Interplanetary Coronal Mass Ejections (ICMEs) should generate stronger effects on the low latitude ionosphere than during weaker geomagnetic storm. In direct contradiction to this, it is shown that a weaker geomagnetic storm on 31 October, 2021 caused a much stronger ionospheric response (Figure 16) over low latitudes (Ahmedabad) than a stronger storm on 04 November, 2021 that occurred a few days later. The ionospheric response is evaluated by the total electron content (TEC) measurements by India's NavIC (Navigation with Indian Constellation) satellites that showed significant increase on 31 October in contrast to 04 November 2024. The investigation suggests that the steady southward interplanetary magnetic field condition (IMF $B_z$) is more effective than the fluctuating IMF $B_z$ condition in generating sustained penetration electric field influence over the low latitudes. This, when combined with the favourable meridional (north-south) wind conditions, can bring out a stronger ionospheric response. This investigation is important to understand the low latitude ionospheric response during geomagnetic storm events.

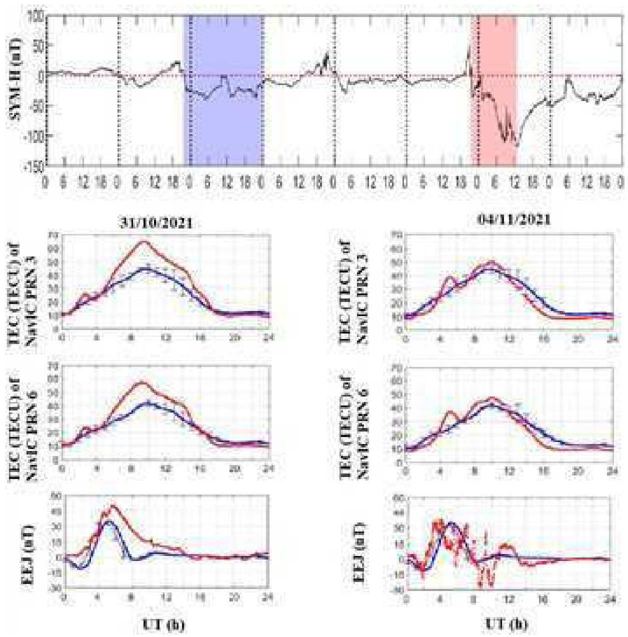


Figure 17.: SYM-H (nT) variation (top panel) from October 29 through November 05, 2021. The purple shaded region indicates the presence of Magnetic Cloud (MC) while the peach shaded region indicates the presence of Sheath. In the bottom panel, TEC (for the two PRNs 3 and 6) along with the EEJ variations are shown for the weak storm (October 31, left panel) and the strong storm (November 04, right panel). The red curves show the observed TEC and EEJ variations while the blue curves show the variation of the average of the three quietest days. The black horizontal bars signify the 1-sigma level. Clear observation of TEC enhancements as well as strong EEJ over the quiet-time variations are seen on the bottom left hand panel during October 31 event due to the influence of the MC. On the contrary, the bottom right hand panel shows no such enhancement in TEC and presence of CEJ is seen under the influence of the Sheath region.

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This work is done in collaboration with Gopi K. Seemala [Indian Institute of Geomagnetism, Navi Mumbai]

**(Sumanjit Chakraborty, Dibyendu Chakrabarty, Anil K. Yadav)**

**Aditya Solar wind Particle Experiment (ASPEX) on-board Aditya L1**

Aditya–L1, the first dedicated Indian solar mission, was launched on 02 September 2023 and was placed in a halo orbit around the first Lagrange point (L1) of the Sun–Earth system on 06 January 2024. Aditya Solar wind Particle EXperiment (ASPEX) is one of the three in situ science experiments on board the Aditya–L1 mission that provides measurements of primarily protons and alpha particles in the solar wind, suprathermal, and energetic particles in the energy range from 100 eV to 6 MeV/nucleon. ASPEX consists of two independent spectrometers: the Solar Wind Ion Spectrometer (SWIS: 100 eV – 20 keV) and Supra Thermal and the Energetic Particle Spectrometer (STEPS: 20 keV/nucleon – 6 MeV/nucleon).

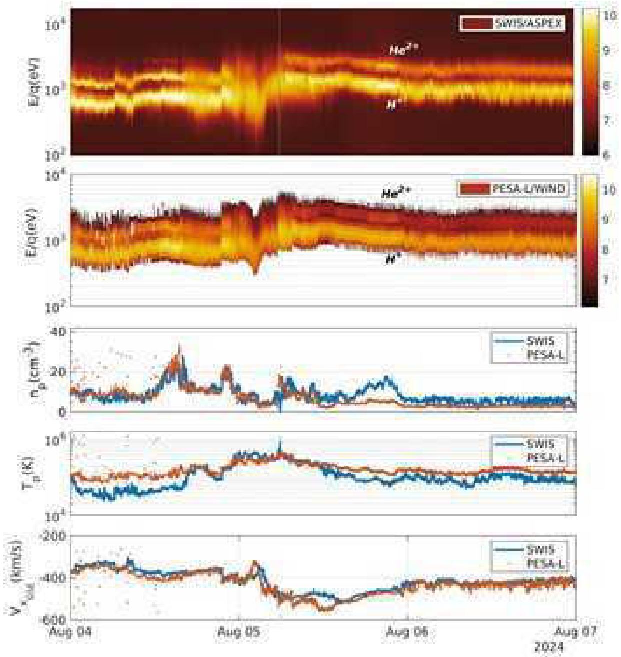


Fig 18: The top two panels show the energy histograms for protons ($H^+$) and alpha ($He^{2+}$) particles obtained from the ASPEX-SWIS and PESA-L instrument in Wind during 04–07 August, 2024. The bottom three panels show the comparisons between the variations in the proton density ($N_p$), Temperature ($T_p$) and X-component of velocity, $V_x$ (in GSE coordinate system) obtained from SWIS and PESA-L.

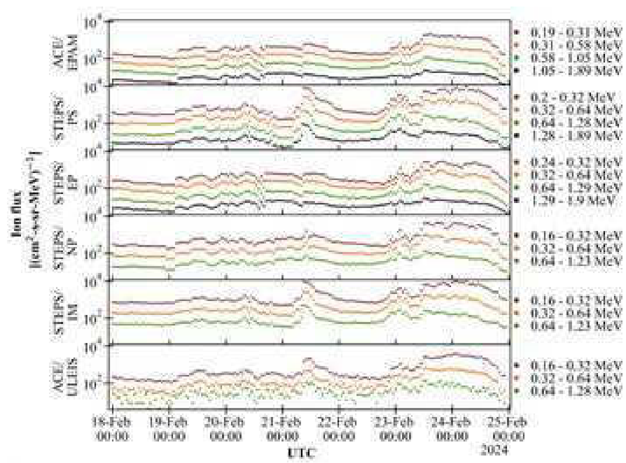


Figure 19.: Comparison of the ion fluxes measured by four ASPEX–STEPS sensors (Parker Sprial or PS, Earth Pointing or EP, North Pointing or NP, and Inter-Mediate or IM) with EPAM (top panel) and ULEIS (bottom panel) instruments on board Advanced Composition Explorer (ACE) satellite from 00.00 UTC on 18 February 2024 to 23.59 UTC on 24 February 2024.

After the launch of Aditya L1, two STEPS units were switched–on during the Earth-bound phase on 10 September 2023. STEPS has carried out measurements in the Earth-bound orbit for altitudes $\gtrsim 8$ $R_E$, and also in the cruise phase from the Earth to the halo orbit, and four sensors of STEPS are continuously operational after insertion to the halo orbit. These measurements are directionally resolved and are expected to provide important clues to the origin, acceleration and anisotropy of suprathermal and energetic ions in the interplanetary medium. Understanding of these energetic ions are important to mitigate the damage to the space assets.

On the other hand, SWIS instrument is a low energy spectrometer and comprises two Top-Hat analysers (THA-1 and THA-2), which have a 360$^\circ$ angular coverage in the ecliptic plane and in the plane perpendicular to the ecliptic plane, respectively. SWIS is primarily designed to separate $H^+$ and $He^{2+}$ that, in turn, provides the time-dependent variation of the all-important helium abundance in the ambient solar wind and in transient structures like interplanetary coronal mass ejections (ICME), stream interaction regions (SIR) passing through the location of the spacecraft. SWIS measurements are expected to throw light on the origin of slow and fast solar wind, suprathermal ions, directional anisotropies and can be extremely important to evaluate the space weather impact on the Earth. Data from SWIS and STEPS are consistent with those obtained from existing international missions and are shown in Figure 18 and Figure 19 respectively.

doi : https://doi.org/10.1007/s11207-025-02441-z, https://doi.org/10.1007/s11207-025-02443-x

This work is done in collaboration with Bhas Bapat [Indian Institute of Science Education and Research, Pune]

**(Shiv Kumar Goyal, Neeraj Kumar Tiwari, Arpit R. Patel, M. Shanmugam, Santosh V. Vadawale, Dibyendu Chakrabarty, Jacob Sebastian, Bijoy Dalal, Piyush Sharma, Aveek Sarkar, Aaditya Sarda, Tinkal Ladiya, Abhishek J. Verma, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, Prashant Kumar, Manan S. Shah, Pranav R. Adhyaru, Hiteshkumar L. Adalja, Swaroop B. Banerjee, K.P. Subramanian, M.B. Dadhania, Abhishek Kumar, P. Janardhan, and Anil Bhardwaj, Prashant Kumar, Manan S. Shah, Hiteshkumar L. Adalja, Arpit R. Patel, Pranav R. Adhyaru, M. Shanmugam, Dibyendu Chakrabarty, Swaroop B. Banerjee, K. P. Subramanian, Aveek Sarkar, Tinkal Ladiya, Jacob Sebastian, Abhishek Kumar, Sushil Kumar, Nishant Singh, M.B. Dadhania, Santosh V. Vadawale, Shiv Kumar Goyal, Neeraj Kumar Tiwari, Aaditya Sarda, Deepak Kumar Painkra, Piyush Sharma, Abhishek J. Verma, Yogesh, P. Janardhan, and Anil Bhardwaj)**

# Planetary Sciences

**I. Modelling of Planetary Atmosphere, Simulations and Interstellar Medium**

ChaSTE onboard Chandrayaan-3 provided first in-situ temperature measurements near southern polar region of the Moon: New Insight about Harboring Water-ice on the Moon

The Moon's surface thermal environment is among the most extreme of any planetary body in the solar system. Lunar near surface temperature and thermophysics are essential parameters that not only dictate the stability of water-ice/volatiles, but also important for lunar geology and geophysics, resource exploration, mission safety and establishing sustainable long-term habitats on the Moon. While global surface temperatures have been mapped through remote sensing, Apollo 15 and 17 missions have provided the only in-situ data and merely for equatorial regions. No in-situ measurement is available from polar regions of the Moon. Chandra's Surface Thermophysical Experiment (ChaSTE) is an experiment onboard Chandrayaan-3's Vikram lander (Figure 1) aimed at investigating the temperature profile and thermophysical properties within the top 10 cm of the lunar surface at a high latitude south polar landing location. After the Vikram lander achieved soft landing at the Shiv Shakti point on the Moon, ChaSTE probe was deployed and successfully penetrated into the lunar soil to carryout measurements for the entire duration of the mission. ChaSTE experiment was jointly developed by PRL and SPL/VSSC and successfully operated on the surface of the Moon for the entire duration of the mission.

Figure 1: Image of the Vikram lander with ChaSTE probe deployed into the lunar surface

Using ChaSTE observations, we have reported the first-ever in-situ temperatures up to a depth of 10 cm inside the lunar surface near the southern polar region of the Moon at 69.37$^{\circ}$ S. The peak surface temperature at Shiv Shakti landing site was measured to be 355 K ($\pm$ 0.5 K), a temperature relatively higher than $\sim$330 K($\pm$3K), predicted by earlier observations. This unexpected higher temperature is due to penetration of ChaSTE on the Sun-ward (equator-ward) facing surface with a slope of $\sim$6$^{\circ}$. Temperatures estimated using 3-D thermophysical model developed by PRL, and appropriately applied for the Chandrayaan-3 landing conditions, is consistent with ChaSTE in-situ measurements (Figure 2). Lunar surface temperature measured on a flat surface, about a metre away from ChaSTE location, was found to be $\sim$332K ($\pm$1 K), which is consistent with orbiter based remote sensing observation ($\sim$330 K). Therefore, ChaSTE observations indicate that the lunar surface temperatures show a significant spatial variability at metre scales at high latitudes, unlike at the equatorial regions. These effects become prominent as we move towards poles, an important aspect that should be considered for future exploration.

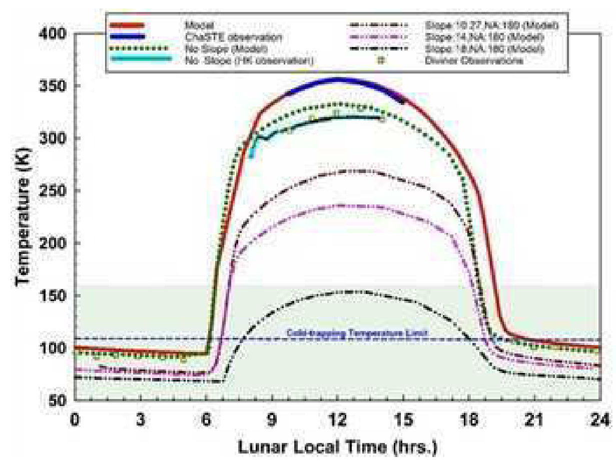


Figure 2: A comprehensive plot showing in-situ observations and model derived diurnal temperatures at ChaSTE penetration point. The green band represents the optimum temperature conditions for water-ice migration and cold trapping.

Using 3D Model calculations based on ChaSTE measurements, a relationship between the local slope and expected surface peak temperature was derived to assess the possibility of water-ice stability within the region. An important outcome of these simulations is that the high latitude sites with local slope higher than 14$^{\circ}$ towards pole might offer similar environment as polar sites for accumulating water ice at shallow depths of few 10s of centimetres. These locations could be promising sites for future lunar exploration and habitation. Such sites are not only scientifically interesting but also pose less technical challenges for exploration in comparison with regions closer to the poles of the Moon.

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This work has been carried out in collaboration with Dinakar Prasad Vajja, Aasik V and ChaSTE Team, SPL/VSSC.

**(K. Durga Prasad, Chandan Kumar, Ambily G, Kalyana Reddy P, Sanjeev K. Mishra, Janmejay Kumar, Tinkal Ladiya, Arpit Patel, Murty S.V.S. and Anil Bhardwaj)**

**Effect of COVID-19 Global Lockdown on Our Moon**

Moon preserves a rich archive of our cosmic past and provides a unique platform to study the changes associated within the Earth-Moon system. As the Moon receives radiation only from Earth (known as Terrestrial radiation (TR)) during night-time, systematic investigation of lunar night-time temperatures can be possibly thought as a stable platform to study Earth's radiation budget and climate change, as indicated by earlier literature. It has been proven that when the COVID-19 pandemic hit the world and lockdowns were imposed in many countries, human activities were reduced significantly. While a strict global lockdown happened during April-May 2020 due to the outbreak of COVID-19 pandemic, the anthropogenic emissions and aerosols, the key source for outgoing TR, were found to be considerably decreased, thereby affecting the lunar nearside night-time temperatures. In this context, we have analysed the night-time temperatures (Local time 22:00-04:00) at six near-side sites on the Moon using brightness temperatures observed by the Diviner Lunar Radiometer (DLRE) instrument on-board LRO mission. Surface temperatures at all six sites exhibited an anomalous dip during the same period (Figure 3). We have also analysed the effect of solar activity and other factors which might affect the night-time temperatures, and found that these parameters did not correlate to the observed temperatures. While other possible factors that may lead to this change are ruled out, this anomalous dip in the observed temperatures are largely attributed to the possible reduced terrestrial radiation due to the global lockdown. Even though COVID-19 pandemic has given us a hard time socially and economically, this unique opportunity has provided a clue that the man-made changes happening on Earth may affect our nearest celestial neighbor Moon.

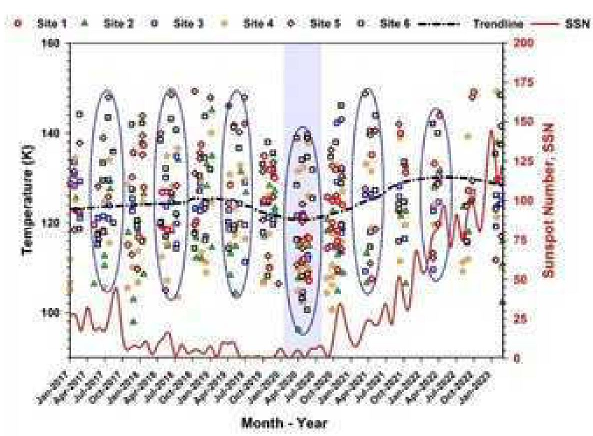


Figure 3: The night-time temperatures observed on various sites on the Moon by Diviner instrument within the period 2017-2023. The red solid line indicates the solar activity during the period and the anomalous decrease in temperatures can be observed during April-May 2020 with the black trend line (strict global lockdown period), which is highlighted.

Therefore, the Moon has possibly experienced the effect of COVID-19 lockdown and this study proposes that Moon-based observatories can become potential tools for observing Earth's environmental changes and needs to be explored extensively.

doi : `https://doi.org/10.1093/mnrasl/slae087`

**(K. Durga Prasad and G. Ambily)**

**Modelling of alpha particle-induced X-ray signals from the lunar surface**

The elemental composition of a planetary surface can be deduced from in situ measurements by either remote sensing techniques, or laboratory analysis of the returned samples. Compositional maps of the moon, Mars and asteroids have been obtained using remote sensing X-ray and gamma-ray spectroscopy, reflectance spectroscopy in the last six decades of planetary exploration. Alpha particle-induced X-ray spectroscopy (APXS) detects characteristic X-ray lines emitted by atoms excited by incident alpha particles and X-ray radiation. A novel method for estimating the anticipated APXS signals from prominent K$\alpha$ lines for various lunar compositions (KREEP basalt and FAN considered here) is presented. Results suggest all major element characteristic K$\alpha$ X-ray lines are well above the background for the high Al basalt composition, with the exception of the Na K$\alpha$ X-ray line. Modelling results show that an alpha-induced X-ray spectrometer on a lunar rover can detect K$\alpha$ X-ray lines of major elements, and can distinguish different lunar compositions.

doi : `https://www.currentscience.ac.in/show.issue.php?volume=126&issue=3`

**(D. Banerjee)**

**First in-situ thermal conductivity of southern polar regolith on the Moon**

In addition to providing in-situ temperature measurements of the surficial layer, ChaSTE experiment onboard Chandrayaan-3's Vikram lander provided the first in-situ thermal conductivity at a depth of $\sim$8 cm of the regolith at the southern polar landing site of the Moon.

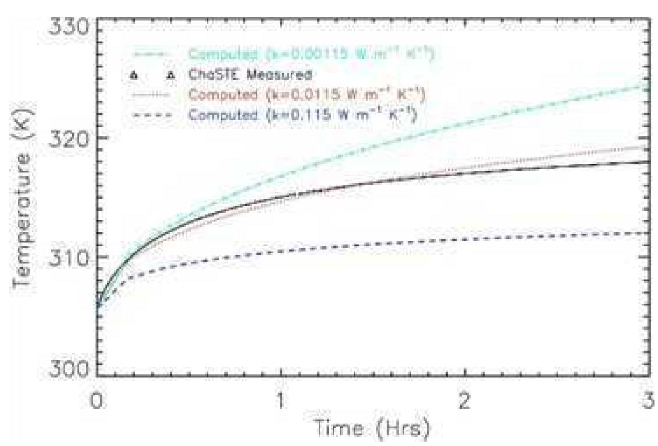


Figure 4: Comparison of numerical model computed and ChaSTE measured temperature rise during active heating experiment.

The ChaSTE experiment was jointly developed by PRL and SPL/VSSC and successfully operated on the surface of the Moon for the entire duration of the mission. Once passive temperature measurements were accomplished, thermal conductivity measurements were carried out by energising the heater provided on the probe. In-situ thermal conductivity of the regolith is estimated by comparing the slopes of the heating curves during actual ChaSTE experiments and corresponding laboratory experiments (Figure 4). Through the two active heating experiments at a depth of 80 mm, the thermal conductivity of the lunar regolith at the Shiv Shakti point is estimated to be 0.0115 $\pm$ 0.0008 and 0.0124 $\pm$ 0.0009 W/mK respectively.

doi : https://doi.org/10.1038/s41598-025-91866-4

This work has been carried out in collaboration with ChaSTE Team, SPL/VSSC.

**(K. Durga Prasad, Chandan Kumar, Ambily G, Kalyana Reddy P, Sanjeev K. Mishra, Janmejay Kumar and Anil Bhardwaj)**

**Electric Fields due to Charged Dust within Martian Dust Devils**

Convective vortices that are dust-laden (dust devils) are common features on Mars and are believed to be an efficient mechanism for dust entrainment in the Martian atmosphere. The dust, which exhibits vertical and lateral size distributions within the dust devils, gets charged due to triboelectric charging. The charge separation in this process and weak atmospheric conductivity might yield a massive charge buildup and large electric fields within the vortex. For certain dust-atmospheric conditions, its magnitude is shown to exceed the atmospheric break-down value, which may trigger lightning in the dust devils on Mars. Considering the importance of such induced fields at local scales, to lander and rover missions on Mars, we have developed a physics insight of the charge and electric field distribution within a dust devil and estimated them quantitatively.

doi : https://doi.org/10.1063/5.0240977

**(Varun Sheel & Sanjay Mishra)**

**Plasma drift in magnetically controlled ionosphere of Mars**

In the previous report we have developed a magnetically controlled ionosphere model for the first time to study the ionopause structures (Haider et al., 394, 115423 (2023)), which explained very well the physical processes for the formation of ionopases. This model is upgraded and used to study the vertical plasma drift effects on Mars' upper atmosphere. This paper is carried out in collaboration with T. Majeed (Majeed et al., 429, 116447, 2025), who used my previous model code for the current study. The new model results are compared with radio occultation measurements of Mars Express (MEX) and Mars Atmosphere and Volatile Evolution (MAVEN). The electron density profiles selected for this study represent the southern high latitude region of Mars where the crustal magnetic field is strong and near vertical in direction. These electron density measurements have shown the topside plasma distribution with unusually large electron density scale heights presumably in response to downward accelerating solar wind electrons along magnetic field lines (see figure 5). We find that the photochemical model of the Martian ionosphere ceases at a height well above the ionospheric peak.

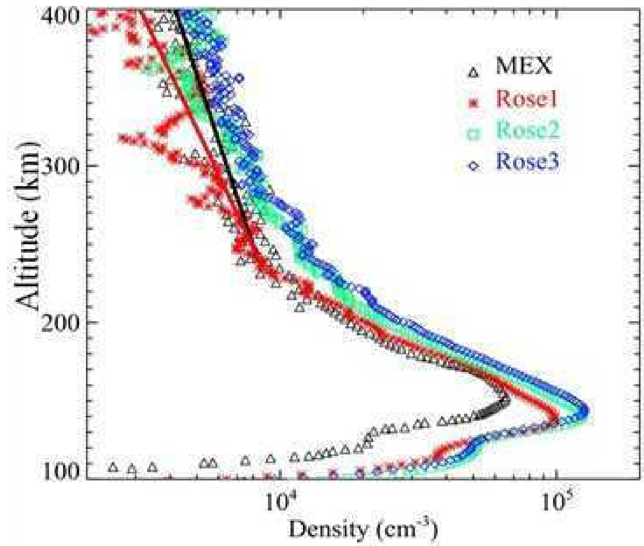


Figure 5: Comparison of daytime electron density profiles observed by Radio Occultation measurements onboard MEX and MAVEN spacecrafts between 100 km and 400 km.

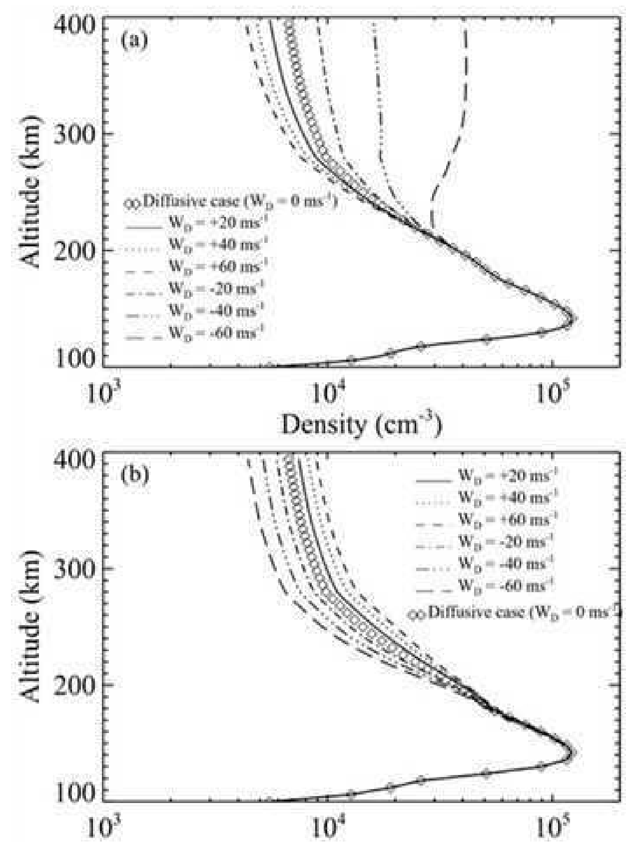


Figure 6: Drift velocity affected daytime electron density profiles in comparison with that calculated with diffusive equilibrium condition: (a) zero ions flux at the upper boundary (b) when the upper boundary condition is modified by imposing $W_d$ to estimate the inflow and outflow plasma.

To interpret the measured ionospheric structures at altitude where plasma transport dominates, we find it is necessary to impose field aligned vertical plasma drift most likely caused by the motion of neutral winds. The upward drift is estimated $\sim$ 30 m/s to -60 m/s and downward drift -12 m/s -to -90 m/s are required to maintain the topside ionosphere comparable with the measurements. The figure 6(a) and 6(b) represents the altitude electron density profile (upper panel) with zero ion flux at the upper boundary $\Phi$ =0 and those calculated when upper boundary condition is modified $\Phi$ = $W_d$ $n_i$, where $W_d$ is the drift velocity and $n_i$ is ion density. In absence of zero boundary condition and zero drift flow, the density is high above 250 km. In presence of diffusive flux boundary and drift velocity the electron density is reduced above 200 km.

doi : https://doi.org/10.1016/j.icarus.2024.116447

This work has been carried out in collaboration with T. Majeed, S. W. Bougher, P. Withers, and A. Morschhauser.

**(S. A. Haider)**

**Comprehensive Analysis of a Chloride Rich Topographic Depression in Terra Sirenum, Mars: A Possible Lost Basin With Astrobiological Significance**

This study is about a region on Mars called Terra Sirenum, a depression on the surface with deposited sediments and water in the past; such landforms are called basins. It is also chloride-rich, which can absorb moisture from its surroundings and be conducive to supporting microbes' survival in harsh conditions. It is important because it provides a framework in which microbes can potentially survive on Mars in the past. Scientists wanted to understand the history of this basin and whether it could have the potential to support life in past. They studied the structure, shape, size, and spatial distribution of landforms in the regions and minerals found in the basin to determine the basin's geological evolution, longevity, and environmental conditions over a period of time. They also looked at the surrounding valleys, which are channels that may have once carried water. These valleys helped scientists understand the water activity in the region. The study found that it is part of a large sedimentary basin that extended beyond its present boundaries and contains evidence that is indicative of different environments. This is interesting because it shows that the region has changed over time. The scientists also found that the basin went through cycles of getting wet and drying out, which could have happened many times. Also, they found that the basin may have held water for several thousands of years. By looking at the minerals in the basin and using models, the scientists found that the area had a mix of chemicals that could have been good for life. This discovery is exciting because it means this region on Mars might be a good place to search for signs of past life, and it could be a good spot for future missions to explore the possibility of life on Mars.

doi : https://doi.org/10.1029/2024JE008311

**(Deepali Singh, Rishitosh K. Sinha and Kinsuk Acharyya)**

**Signature of Vertical Mixing in $H_2$-dominated Exoplanet Atmospheres**

Vertical mixing is a crucial disequilibrium process in exoplanet atmospheres, significantly impacting chemical abundance and observed spectra. While the current state-of-the-art observations detect its signature, its effect varies widely on atmospheric spectra for different planetary parameters such as eddy diffusion, surface gravity, internal and equilibrium temperature, and metallicity. We assess the influence of disequilibrium chemistry across the parameter spaces and the retrieval models' effectiveness in constraining the eddy diffusion coefficient by running a large number of 1D chemical kinetics models. We investigated the impact of vertical mixing on the transmission spectrum and built a custom fast-forward disequilibrium model, which includes vertical mixing using the quenching approximation and calculates the model abundance orders of magnitude faster than the chemical kinetics model. We coupled this forward model with an open-source atmospheric retrieval code and used it on our chemical kinetics model's JWST simulated output data and retrieved eddy diffusion coefficient, internal temperature, and atmospheric metallicity. We find that there is a narrow region in the parameter space in which vertical mixing greatly affects the atmospheric transmission spectrum. In this region of the parameter space, the retrieval model can put high constraints on the transport strength and provide optimal exoplanets to study vertical mixing. In addition, the $NH_3$ abundance can be used to constrain the internal temperature for equilibrium temperature $>$ 1400 K.

doi : https://doi.org/10.3847/1538-4357/ad891f

**(Vikas Soni and Kinsuk Acharyya)**

**The extent of formation of organic molecules in the comae of comets showing relatively high activity**

Ground and space-based observatories have extensively studied comets, reservoirs of complex organic molecules. While their origin is often attributed to the cometary nucleus, some molecules can form in the coma. We used our multifluid chemical hydrodynamical model for the cometary atmosphere to investigate the relative contributions of nuclear and coma origins for various organic molecules in four active comets. The research focused on C-H-O and N-bearing species, including glycine, by employing a multifluid chemical-hydrodynamic model and an updated chemical network. It was found that while some molecules like formic acid (HCOOH), methyl formate ($HCOOCH_3$), acetaldehyde ($CH_3CHO$), acetonitrile ($CH_3CN$), acetic acid ($CH_3COOH$), cyanoacetylene ($HC_3N$), cyanodiacetylene ($HC_5N$), and formamide ($NH_3CHO$) can be partially synthesised in the coma, others like ethanol ($C_3H_5OH$), ethylene glycol ($(CH_2OH)_2$), glycolaldehyde ($CH_2OHCHO$), and glycine primarily originate from the nucleus. The study also showed that factors like initial cometary abundance, reactant ratios, and temperature significantly influence molecular formation in the coma. Coma-synthesized molecules can reach substantial production rates, potentially detectable by future space missions.

doi : https://doi.org/10.1016/j.icarus.2024.116374

**(Sana Ahmed and Kinsuk Acharyya)**

### II. Remote Sensing and Data Analysis

**Geological mapping of Chandrayaan-3 landing area: New insights into provenance of materials, crater chronology and origin of rocks**

This study presents the first detailed geological map of the Chandrayaan-3 landing area using high-resolution remote sensing data. The map shows three main types of terrain: rugged high-relief terrain, smooth plains with high relief, and smooth plains with low relief. The Chandrayaan-3 landing site is located in the low-relief smooth plains. Age estimates, based on crater size analysis, suggest these terrains formed around 3.7 billion years ago during the Imbrian period. Impact crater studies reveal that the landing area has been shaped by secondary craters and debris from nearby large craters. The pattern of secondary craters and ejecta rays indicates that material from the Schomberger crater likely covered the landing area. This matches the similar ages of the geological units and the Schomberger crater floor (∼3.7 billion years). Rock analysis shows that most large rocks (81.5% of those 5 meters or bigger) in the landing area came from a 540-meter-wide fresh crater 14 km south of the site. Additionally, smaller rock fragments, especially to the west, are linked to a 10-meter-wide crater near the landing site. These findings help interpret data from Chandrayaan-3 and provide insights into the geological history of the Moon's southern high-latitude region.

doi : https://doi.org/10.1016/j.asr.2025.01.020

**(Rishitosh K. Sinha, Akash Gautam, Jayanta Laha, Neha Panwar, Vijayan S., Neeraj Srivastava, and Anil Bhardwaj)**

**Deformation of the Gruithuisen region lava tube under compressional stress on the Moon**

Billions of years ago, molten rock flowed on the Moon's surface, known as lava flow. As this hot lava moved, the outer layer would cool and harden, while the inside remained molten and continued to flow. Eventually, the lava inside would drain away, leaving behind hollow tunnels.

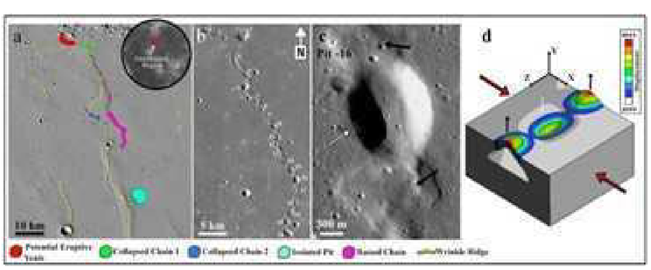


Figure 7: a) Geomorphological map of the Gruithuisen region (35°N, 44°W), displaying collapsed pits, raised features, potential eruptive vents, and wrinkle ridges. b) Close-up view of a chain of collapsed pits and raised features, and c) Collapsed pit-16 and raised features in LROC-NAC images. d) Aligned model 4 with pit 16.

These tunnels are known as lava tubes. There are reported lava tubes on the Moon, one of which is located in the Gruithuisen region (∼35°N, 44°W) (Figure 7). The lava tube in the Gruithuisen region has unique shapes compared to others, ranging from curved channels to ellipses with raised features. This study focuses on the distinctive shapes of the lava tube in the Gruithuisen region. The findings suggest that as the Moon cooled and shrank over time, immense stress was placed on its crust, causing it to crack and fold, forming surface features known as wrinkle ridges. The same stress that created these wrinkle ridges also affected the lava tubes. Additionally, the gravitational pull of Earth contributed to the stress, squeezing and deforming the lava tubes into exceptional shapes. The study of the deformed lava tube offers valuable insights into the powerful stresses that have shaped the Moon lava tube. The journey from a volcanic hotspot to a quieter, cooler body has been marked by numerous physical changes, each leaving its mark on the Moon's surface. This deformed lava tube is one such captivating story of the Moon's dynamic past, offering a glimpse into the processes that have shaped it into the Moon we see today.

doi : https://doi.org/10.1130/G52143.1

This work was done in collaboration with Harish, LASP, Boulder and K. S. Sharini, University of Western Ontario, London.

**(Kimi K. B., Anil Chavan and Vijayan S)**

**Chandrayaan-3 landing site evolution by South Pole-Aitken basin and other impact craters**

The Chandrayaan-3 mission with the Vikram-lander and the Pragyan rover landed in the high latitude highland region near the south pole of the Moon. The landing site is located ∼350 km from the South Pole-Aitken basin rim, an ancient and highly cratered terrain. This site has undergone the complex emplacement sequence of SPA basin ejecta followed by the nearby and distant impact basins and crater ejecta materials.


Figure 8: Chandrayaan-3 mission landed within a buried crater, which is older than the South-Pole Aitken basin

We found that the SPA basin is the major contributor, which deposited nearly ∼1400 m of ejecta materials, and 11 other basins deposited ∼580 m of ejecta. The other complex craters contributed up to ∼90 m of ejecta. Meanwhile, secondary craters of a few km in diameter located adjacent to the landing site contributed to ∼0.5 m ejecta, which are crucial target materials for the Pragyan rover insitu analysis.

Pragyan rover images revealed the landing site is devoid of >1 m boulders along the traverse revealing typical highland terrain. The Pragyan rover Navcam and Orbital High Resolution Camera regional images revealed linear distal ejecta rays possibly from the distant impacts as insitu evidence of foreign material at the CH-3 landing site. We found a semi-circular, heavily degraded structure encompassed around the landing site, which is interpreted as a buried impact crater ∼160 km in diameter probably formed before the SPA basin (Figure 8). The erasure of pre-SPA basin craters is caused by both the direct burial by SPA basin ejecta, high seismic shaking during SPA formation, and then followed by various post-SPA craters and associated some of the degradation processes. Chandrayaan-3 mission landed within an ancient region that hosts some of the most deeply excavated materials on the Moon.

doi : `https://doi.org/10.1016/j.icarus.2024.116329`

This work is done in collaboration with R. Aditi, Anna University, U. Thahira, Bharathidasan University, Trichy, Amitabh, K. V. Iyer, K. Suresh, Ajay Prashar, SAC and G. Rima, URSC.

**(Vijayan S., Kimi, K.B., Chavan, A., Sinha, R.K., Vadawale, S., Shanmugam, M., Mithun, N.P.S., Arpit R. Patel, S. Amit Basu and Anil Bhardwaj)**

### Recent Tectonic Activity in and Around the Posidonius Crater, Moon

The Moon's surface and subsurface have undergone countless changes over time, shaped by powerful internal and external forces. These changes are recorded in geological features such as impact craters, mare deposits from past magmatism, and tectonic structures like wrinkle ridges, lobate scarps, small-scale graben, deformed small craters, and tectonic pits-each revealing different aspects of the Moon's evolving landscape.

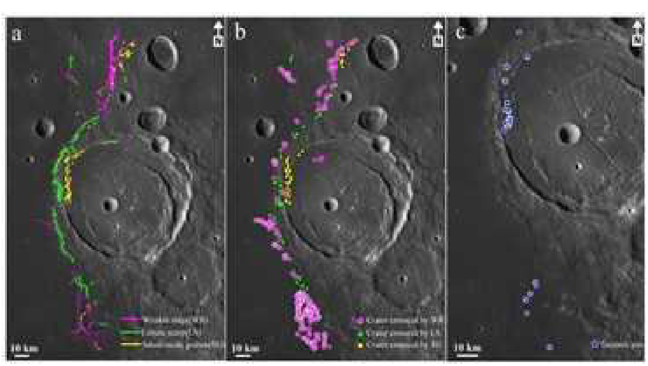


Figure 9: Mapped deformed structures overlaid on the LROC-WAC mosaic. a) Distribution of mapped wrinkle ridges (WRs) (pink), lobate scarps (LSs) (neon green), and small-scale graben (SGs) (yellow). b) Distribution of deformed craters by WRs (pink), LSs (neon green), and SGs (yellow). c) Distribution of tectonic pits (TPs) (blue).

The northeastern Mare Serenitatis basin, specifically the Posidonius crater region (32°N, 30°E), the focus of our study, preserves a rich history of these complex deformations (Figure 9). Our research shows that fractures from the ancient Mare Serenitatis impact basin became active again over time, deforming the western floor of Posidonius crater. This reactivation likely contributed to the formation of younger tectonic features, including wrinkle ridges, lobate scarps, small-scale graben, deformed small craters, and tectonic pits, and may have influenced the way wrinkle ridges and lobate scarps transition into one another. Dating of wrinkle ridges and lobate scarps suggests they formed between ∼29 Ma and ∼120 Ma near the crater, indicating recent tectonic activity in the study area. Additionally, a combination of processes-including magmatism, subsidence, and fractures associated with the basin-may have played a role in shaping Rima Posidonius, a long, sinuous rille that runs across the floor of Posidonius crater. These findings suggest that this region has experienced recent tectonic activity, making it a compelling site for future lunar exploration missions.

doi : `https://doi.org/10.1029/2024JE008446`

This work was done in collaboration with K. S. Sharini, University of Western Ontario, London, Harish, LASP, Boulder, S. Tuhi, Auburn University, USA and R. K. S. Priya, Anna University, Chennai.

**(Kimi K.B., Vijayan S. and Anil Chavan)**

### A case for young igneous volcanism in the Terra Sirenum region, Mars

On Mars, within an unnamed crater nearly 73 cones are situated on the floor which is located at 27.6°S, 156.9°W (Figure 10). This crater has been subjected to detailed investigations by at least three different scientific teams, each supporting various hypotheses like sedimentary and igneous volcanism regarding the cones' origins.

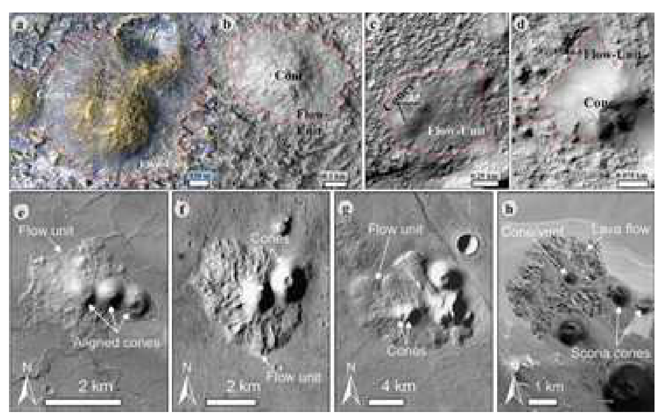


Figure 10: Comparison of cones associated with flow units from various Martian regions with Earth cones.

The cone field is circumferentially distributed around a triad of primary fractures, which have instigated the formation of the graben structure within the crater. The crater floor exhibits a variety of geomorphological and stratigraphic units, suggesting that the crater has undergone a complex history of different episodes of geological events, including volcanism, tectonic activity and potential fluvial processes. Cones display one of two broad morphologies: domical cones and pitted cones. The morphometric analysis of the $W_CR/W_CO$ in relation to the Cone width of pitted cones aligns with the trends observed in both terrestrial and Martian scoria cones. However, the morphometric measurements of domical cones deviate from the discernible trends typically seen in igneous volcanic structures, sedimentary formations on Earth, and Martian edifices. The cumulative Size-Frequency Distribution (CSFD) analysis indicates the formation of the cone field in the crater occurred between ∼1.26 Ga and ∼1 Ga, corresponding to the Mid-Amazonian epoch. Spectral analysis of the crater floor units indicates the presence of kaolinite, along with low-calcium and high-calcium pyroxene minerals, which could potentially be a marker of volcanic as well as aqueous activities. However, the spectral signature of high-calcium pyroxene in the cone-field bearing crater unit suggests a recent igneous volcanic origin. This study highlights the complex geological history of the unnamed crater, with spectral and morphometric analyses suggesting a likely igneous volcanic origin for the cones amidst evidence of tectonic and aqueous activity.

doi : `https://doi.org/10.1016/j.icarus.2025.116512`

This work was done in collaboration with Shreekumari Patel, M.R. El-Maarry, Khalifa University, UAE and Harish, LASP, Boulder.

**(Vijayan S.)**

**Classifying meteorites with MetNet: A deep learning approach using reflectance spectroscopy**

Meteorites hold critical information about the evolution and history of the solar system. The accurate classification of meteorites, typically determined through petrological examination, is crucial before any further analytical steps.

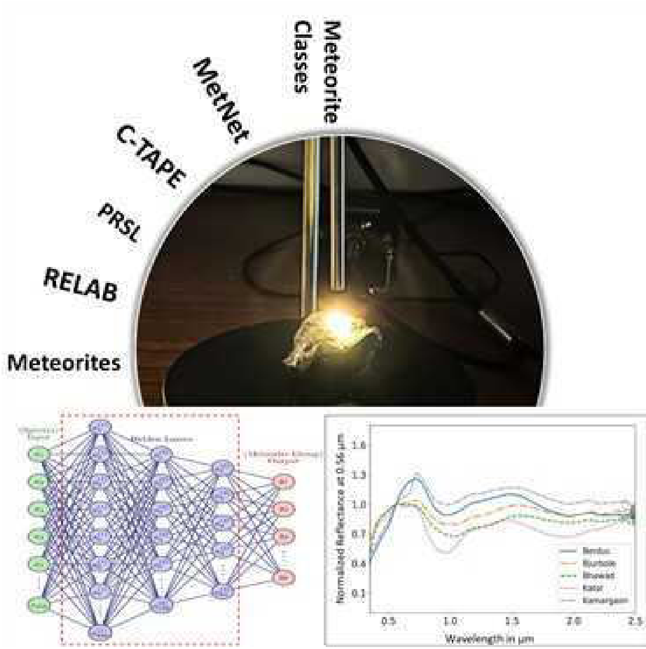


Figure 11: Meteorite classification using Reflectance Spectroscopy and Deep Learning

Traditional methods of analyzing these precious specimens often involve destructive geochemical techniques, which deplete the sample and limit subsequent analyses. Reflectance spectroscopy, which interprets a sample's characteristics by analyzing reflected light, has emerged as a nondestructive alternative with significant potential for meteorite classification. In this study, we employed spectral reflectance data from more than 1700 meteorite samples from RELAB, C-TAPE and Planetary Remote Sensing Laboratory (PRSL) to develop and fine-tune a deep learning model capable of accurate classification of the meteorites (Figure 11). A validation accuracy of 93% has been achieved in the study. These results demonstrate the efficiency of using deep learning and reflectance spectroscopy for meteorite classification, offering a nondestructive and accurate alternative to the traditional methods.

doi : `https://doi.org/10.1111/maps.14342`

**(Neeraj Srivastava, Abhishek J. Verma, R.R. Mahajan, Neha Panwar, Tvisha Kapadia, A.B. Sarbadhikari, Avadh Kumar and Team)**

**III. Meteorite, Analogue and Laboratory Studies**

**Magmatic evolution of KREEP-free lunar meteorite Asuka-881757 inferred from sector-zoned clinopyroxene, pyroxene symplectites, and thermodynamic modeling**

The study of lunar basaltic meteorite A-881757 provides important information on magmatic sources, lunar interior, and distinct magmatic processes, highlighting the differences with the returned lunar samples. The meteorite was sourced away from the mare regions (3.8-2.0 Ga age) of the Apollo, Luna, and Chang'E 5 landing sites. Our study provides insights into the early thermo-chemical evolution of the Moon, and highlights the importance of understanding melting mechanisms in the lunar interior. The lunar meteorite A-881757 likely represents hidden cryptomare basalts present at the lunar surface and subsurface, which are yet to be chemically explored by any missions. Therefore, this study suggests at least a few reasons why there needs to be more sample returns from the unexplored regions of the Moon.

doi : `https://doi.org/10.1111/maps.14257`

This work has been carried out in collaboration with A. Yamaguchi, A. Takenouchi, J.M.D. Day, and T. Ubide.

**(Y. Srivastava and A. Basu Sarbadhikari,)**

**Maskelynite as seen in shocked Lonar target basalt, Indian and martian and lunar meteorites (Geochemistry)**

Feldspars are the most dominant mineral group in Earth's crust and also one of the primary constituents in the crustal rocks of many rocky bodies in our Solar system. However, the studies on shock excursions of feldspar remain challenging due to its complex properties, and post-impact modification due to hydrothermal alteration. The impact-induced shock response on feldspar from Earth, Moon and Mars are different due to their difference in chemical composition and formation mechanism. The apparent morphological similarity (smooth, featureless) of lunar and martian maskelynite corroborates their direct delivery to the Earth from the impact site without undergoing the post-impact brecciation. In contrast, the terrestrial maskelynite suffered prominent post-impact modification during its ejecta emplacement. This study could help to validate the mineralogy and chemical data (e.g. amorphous vs crystalline) acquired through the in-situ analyses by ongoing rovers that are currently operational on Mars and return sample return missions in the future.

doi : https://doi.org/10.1016/j.chemer.2024.126127

This work was done in collaboration with S. Misra, University of KwaZulu-Natal, South Africa, C. Park, Korean Polar Research Institute and H. E. Newsom, E. J. Peterson, University of New Mexico, Albuquerque.

**(D. Ray)**

**Spectroscopic characterisation of fluorite from Amba Donga, Gujarat, India: Linking chemical composition with color**

This study aims at the enduring discussion regarding the sources of color variation in fluorite (CaF2) by employing an innovative quantitative methodology that encompasses fluorite samples exhibiting a range of color hues. The approach integrates chemical compositional analysis with optical spectroscopic characteristics to clarify the connection between elemental composition, concentration, and color differences in fluorite. Various optical spectroscopic techniques, such as UV-visible absorption, emission (including photoluminescence and fluorescence), and Raman spectroscopy, were utilized to identify distinct spectral signatures corresponding to the specific colors of the samples under investigation. The findings reveal a significant correlation between certain elemental concentrations and the spectral features observed, particularly those influenced by alkaline metals, transition metals, and rare earth elements (REEs). This quantitative relationship between elemental composition and spectroscopic properties offers a fresh perspective on the mechanisms behind color variation in fluorite. The thorough analysis presented in this work highlights the complex interactions among mineral composition and elemental concentrations, especially those of alkaline metals, transition metals, and REEs, in relation to the variations in spectral signatures and the visual characteristics of fluorite.

doi : https://doi.org/10.1016/j.saa.2024.124464

This work was done in collaboration with Ali H. Almohammed, Uttam K. Bhui and N. Madhavan, Pandit Deendayal Energy University, Gandhinagar.

**(D. Ray and A. D. Shukla)**

**Characterization of multichannel SDD X-ray spectrometer with ASIC readout**

For soft X-ray spectroscopic observations of astrophysical sources, instruments utilizing Silicon Drift Detectors (SDDs) are particularly advantageous due to their high energy resolution, low noise performance and improved detection efficiency at energies above 10 keV compared to other thin silicon-based detectors. This enables the use of a single detector to cover a broad energy range of approximately 1-25 keV, facilitating the separation of different spectral components in sources such as compact object binaries-without the complications introduced by cross-calibration errors between multiple instruments. For such broadband studies, an energy resolution of <150 eV at 5.9 keV is generally sufficient. However, since the geometric area of an individual SDD is typically too small for observing most astrophysical sources beyond the Sun, deploying an array of SDDs becomes essential. We report results from a multi-channel large area X-ray spectrometer using SDD with ASIC readout for future space and astronomical observations.

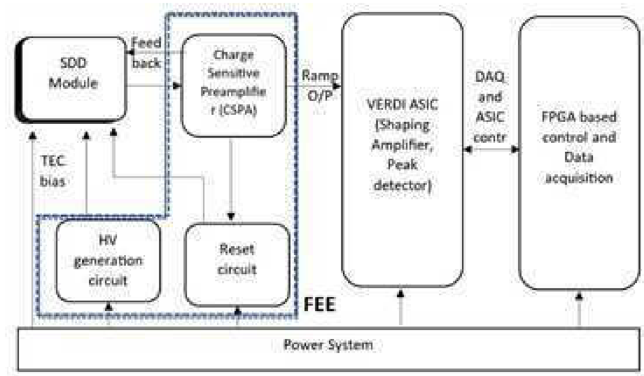


Figure 26: Block Diagram of Spectrometer

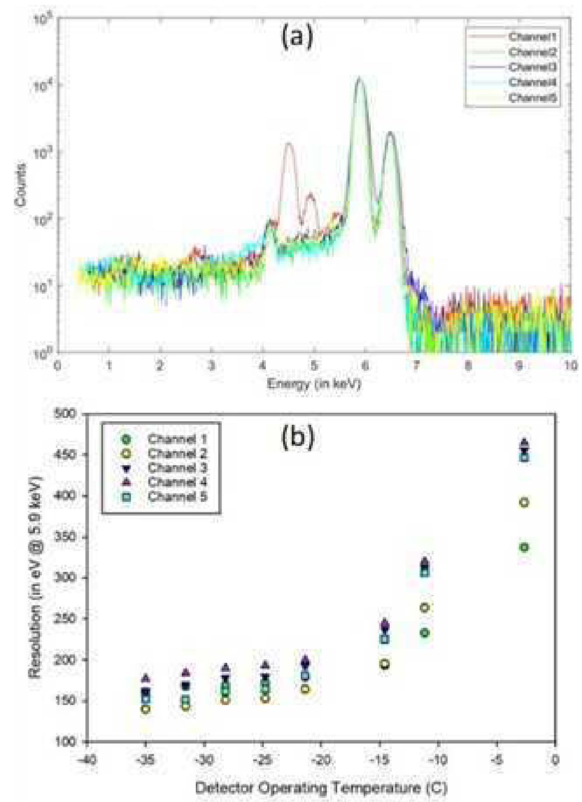


Figure 27: (a) Multichannel Spectrum with Fe-55 (b) Variation in resolution with detector temperature

Discrete electronics-based X-ray spectrometers have been designed for space applications and have provided excellent results. Nevertheless, with the requirement of large area detector with multiple channels readout, it is prudent to minimize the mass, size and the power consumption of the instrument. Hence, we have proposed to adapt the readout ASIC in the spectrometer design. The block schematic of the spectrometer is shown in Figure 26. The spectrometer system consists of an SDD module, a front-end electronics board containing the CSPA circuit, a reset mechanism circuit, as well as the HV generation circuit for the detector, the VERDI ASIC board, and the data acquisition and ASIC control board.

The VERDI-3 ASIC has 8 readout channels, each with a shaping amplifier, a baseline holder, and peak holder circuit with an output buffer. The output of each stage can be given to the output buffer based on chip selector value. Apart from these, VERDI allows programmability of the various parameters such as shaper channel threshold voltage, channel gain, polarity, shaping time, preamplifier compensation, etc. through SPI interface. The ASIC is 3 mm x 3 mm in size and requires the power of $\sim$ 170 mW for its operation.

The spectrometer's performance was evaluated using Fe-55 (X-ray lines at 5.9 keV, 6.49 keV) and Am-241 (X-ray lines at 13.9 keV, 17.8 keV) sources (Figure 27). Single-channel resolution was $\sim$135 eV at 5.9 keV (Mn-K$\alpha$) and 273 eV at 13.9 keV, with a detector temperature of -35$^\circ$C and shaping time of 2 $\mu$s. The spectrometer was characterised for different shaping times, gains, and detector operating temperature to optimise the performance. Multichannel operation showed resolutions of 148-184 eV at 5.9 keV, slightly degraded due to thermal effects from concurrent operation- a scope for future improvement. Below is the multichannel spectrum for the spectrometer and its resolution at different detector temperatures. The compact, lightweight and power efficient design of the spectrometer, along with its high energy resolution and fast response time, makes it suitable for space-based applications.

doi : https://doi.org/10.1016/j.asr.2025.01.019

**(Nishant Singh, M. Shanmugam, Arpit Patel, Sushil Kumar, Deepak K. Painkra, Tinkal Ladiya and S. Vadawale)**

## IV. Developmental Work

### VODEX Development

In the solar system, Interplanetary Dust Particles (IDPs) evolve dynamically and may be captured by a planet on its way. Such IDPs, when passing through the atmosphere, get ablated and leave metallic ions in the lower ionosphere. It is essential to know IDP flux as an input to the ablation process for understanding the meteoroid layer in the electron density profile. There are no measurements of IDPs at and around Venus, except the existence of a few measurements of IDPs at larger distances from Venus. A Venus Orbit Dust Experiment (VODEX) is proposed for future Venus orbiter to study mass, speed and flux of IDPs at and around Venus, and also between Earth and Venus. As a part of the project, DEX was flown in PSLV C-58. The development of the Qualification Model (QM) is ongoing.

**(Jayesh Pabari, S. Nambiar, Rashmi, S. Jitarwal, K. Acharyya, V. Sheel, R. Mahajan, Anil Bhardwaj and Team)**

### Lightning Instrument for Venus (LIVE)

For detection of lightning on Venus, LIVE is being developed at PRL. LIVE incorporates two design approaches, discrete frequency approach similar to Orbiter Electric Field Detector (OEFD) Instrument in Pioneer Venus Orbiter (PVO) mission and wide band approach to cover the entire frequency range from Hz to kHz. In the former, four filters are designed having centre frequency of 100 Hz, 200 Hz, 400 Hz and 730 Hz with bandwidth of 30% of the central frequency. The advantage of using this approach is better signal to noise ratio and also, two additional channels in whistler frequency range which was not there in earlier PVO mission. The wide band filter covers a frequency range of DC to 30 kHz using which one can easily see the dispersion phenomenon using time frequency localization which is the unique characteristic of lightning. Figure 12 represents the LIVE circuit design including Front end electronics, processing electronics and power scheme. To digitize the incoming analog signals from different frequency bands, five Analog to Digital Converters (ADCs) are used at different sampling rates. Further, another multichannel ADC is used for monitoring different voltages and temperatures. In LIVE, Field Programmable gate array (FPGA) is used to control the peripheral devices and also to process the data on board to reduce the high data rate, as shown in Figure 13. FPGA's internal SRAM is used to save and process the data. FPGA reset circuitry is used to reset FPGA when powered on and also based on tele-command. To provide the required power to LIVE payload, a power scheme is designed (Figure 14). The raw bus from the satellite is filtered at the first stage using an EMI filter for removal of high frequency noise. Then, 7 V and 3.3 V DC-DC Converters and positive and negative low dropout voltage regulators (LDOs) are used for providing power to all analog and digital units of the payload.

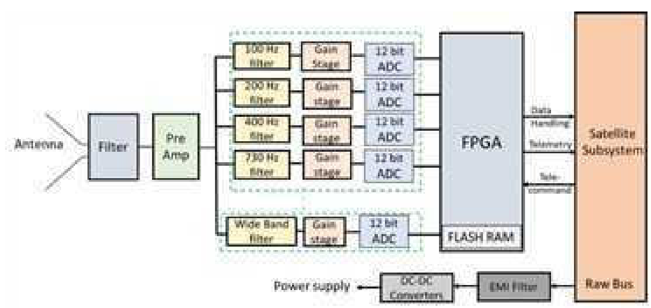


Figure 12: LIVE Schematic Design

The PCB card of the LIVE front-end electronics is being designed and tested in the laboratory as shown in figure 15(a). The testing set up (figure 15(b)) represents all the modules used during the test. For testing the response of individual filter, the output voltage levels are checked for the known input pulse from the function generator. The pulse input of 100 Hz frequency, 10 mV amplitude, 5% duty cycle with rise time of 10 ns and fall time of 160 $\mu$s is applied as an input to the antenna (sensor) and each filter response on the oscilloscope is checked. The responses of discrete filters like 100 Hz (in yellow colour), 200 Hz (in blue colour), 400 Hz (in red colour), 730 Hz (in green colour) at 200 mV/division voltage scale, and the wide band filter (in orange colour) at 1V/division voltage scale are depicted in Figure 16.

Also, we have performed several experiments for identification of lightning event in the presence of noise that are given below:

(i) Experiment for confirmation of RF noise filtering (in the absence of lightning signal): The LIVE antenna along with Front End Electronics (FEE) was tested with a lightning pulse signal generated by Van-de-Graaff generator. As a noise source, a signal generator attached to another smaller antenna was used to radiate high frequency RF noise (at 600 MHz). The experiment setup is shown in Figure 17. To see the presence of high frequency RF noise, output of raw antenna was observed, since the FEE is expected to filter out this frequency. The FEE output of four discrete filter channels at 100 Hz, 200 Hz, 400 Hz and 730 Hz and also a wide band channel of up to 30 kHz pass band were recorded. Figure 18(a) shows the output of a raw antenna showing the RF noise waveform, while Figure 18(b) shows the same noise, filtered out in the output of discrete channels of LIVE.

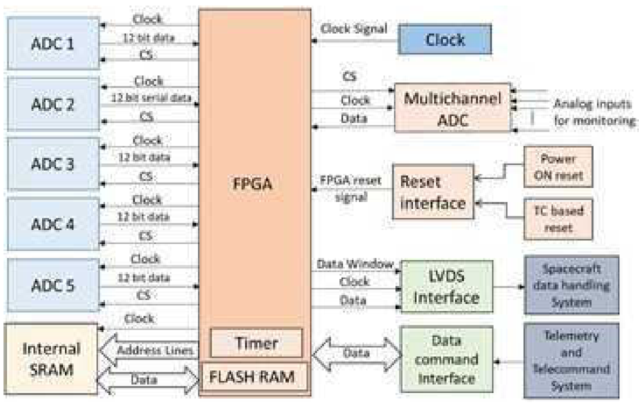


Figure 13: LIVE Processing Block Diagram

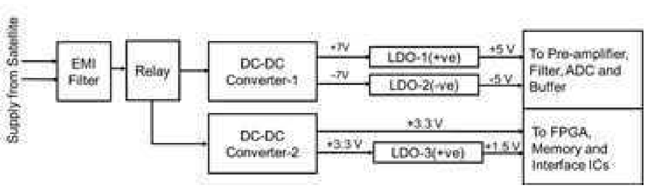


Figure 14: LIVE Power Block Diagram

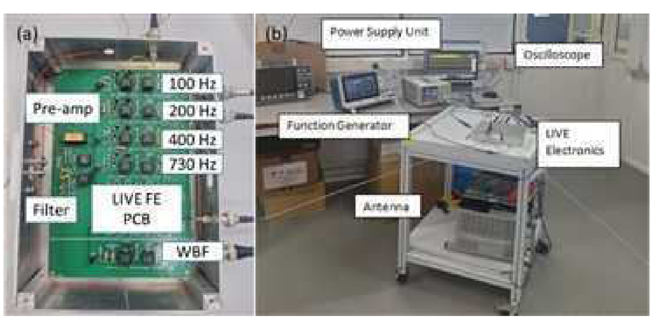


Figure 15: (a) LIVE FE PCB having both design configurations. (b) LIVE Laboratory testing set-up


Figure 16: Testing Results of LIVE FEE different stages

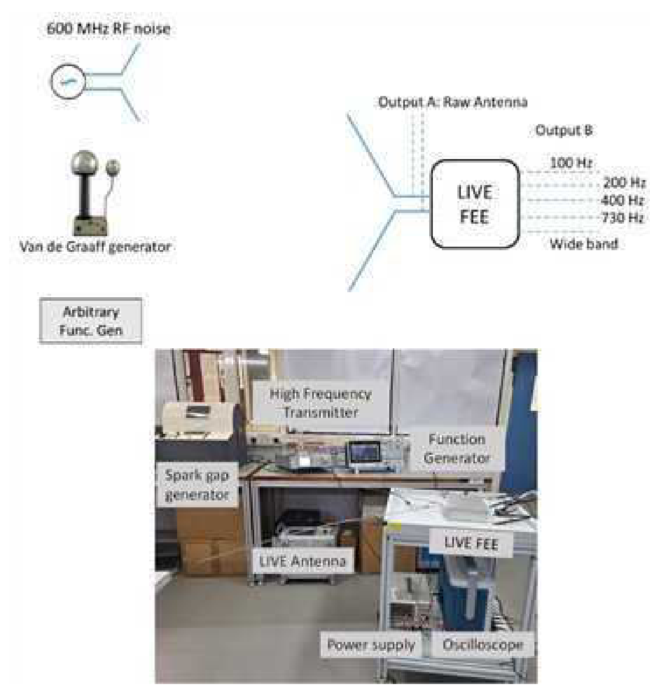


Figure 17: (a) Test setup showing signal and noise sources and LIVE with FEE (top) and (b) Photograph of the experimental set up (bottom)

(ii) Experimental identification of lightning event in the presence of RF noise: In the second experiment, LIVE antenna was fed a lightning discharge pulse generated by Van-de-Graaff (VDG) generator, in presence of RF noise. Figure 19 shows the time domain FEE output in all the channels, lightning pulse in time domain, spectrum of the lightning signal, the time-frequency spectrogram along with its zoomed version. It can be observed from Figure 19(a) that the lightning signal is filtered out at the designed center frequency, as per the bandwidth of each channel and the last channel, i.e., wide band filter provides essentially the lightning pulse up to 30 kHz signal frequency. This demonstrates that the signals are appropriately filtered in the LIVE electronics.

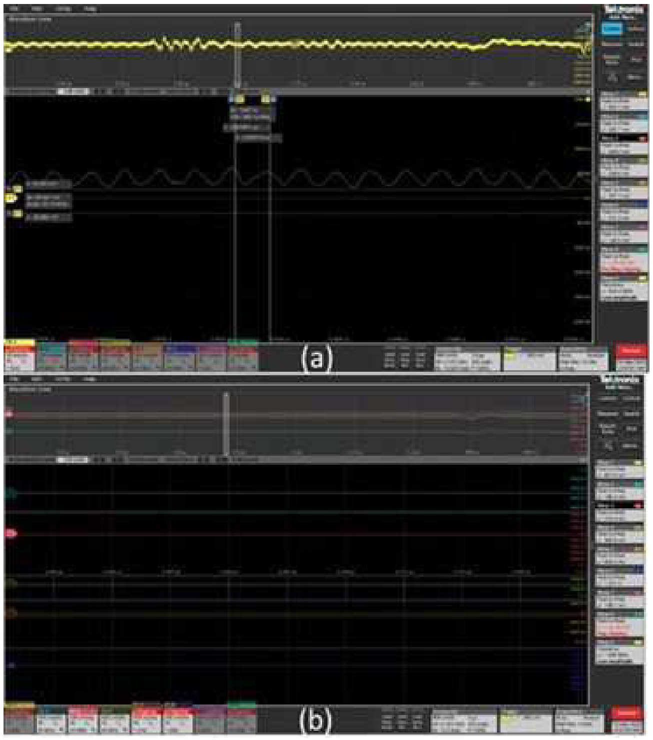


Figure 18: LIVE lab model tested in presence of noise. (a) Raw antenna output showing the 600 MHz noise waveform along with zoomed version and (b) Output of LIVE filter channels, showing the absence of the same noise

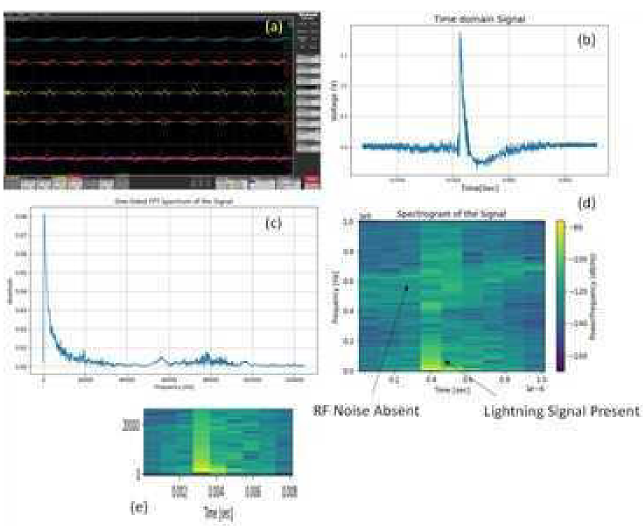


Figure 19: Experimental results related to identification of lightning event in the presence of background RF noise. (a) Time domain FEE output in all the channels, (b) lightning pulse from wide band channel of LIVE shown in time domain, (c) spectrum of the lightning signal, (d) time-frequency spectrogram and (e) zoomed version of time-frequency spectrogram.

Further, to uniquely identify lightning event, the time-frequency localization is used through its spectrogram (incorporating Fast Fourier Transform FFT). Figure 19(d) shows the time-frequency spectrogram of the FEE output in the wide band channel. One can observe from Figure 19(d) that the RF noise corresponding to 600 MHz does not appear in the spectrogram and the lightning signals clearly appear in it (at the lower frequencies). To explain its details, a zoomed version of the spectrogram, covering the lower frequencies, is also shown. The lightning pulse has relatively higher power at lower frequencies.

This is how a lightning pulse will be (uniquely) differentiated in presence of a constant background noise source. The time-frequency localization technique demonstrated here is a standard technique, customarily used for all the past instruments/missions at other planets. In addition, once the Engineering Model (EM) of LIVE is available, we shall conduct a full-scale EMI/EMC test at SAC, to understand the background noise (or frequencies) presence.

**(Jayesh Pabari, S. Jitarwal, Rashmi, S. Nambiar, K. Acharyya, V. Sheel, Anil Bhardwaj and Team)**

**Dust EXperiment (DEX) on-board PSLV C-58 (XPoSAT mission), Its Data Analysis and Results**

Understanding the distribution of Interplanetary Dust Particles (IDPs) in the solar system and their dynamical behaviour, provides us information about the current state and the dynamical behaviour related to the Solar system. Further, these particles are ablated in the Earth's atmosphere, which are responsible for a meteoroid layer in the lower ionosphere. The density of the meteoroid layer is directly dependent on the incoming flux of these particles. Dust EXperiment (DEX), an impact ionization dust detector, was aimed to provide an impact rate of the dust particles in the near-Earth orbit.

| | |
|---|---|
| Mission | PSLV C-58 (XPoSat) |
| Platform | POEM-3 |
| Launch Date | 1st January 2024 |
| Inclination | 9.5° |
| Altitude | ~350 km |
| Total data received | 13.79 Mbytes |
| Total valid data | 10.09 Mbytes |
| Total valid frames | 5.88 Mbytes |

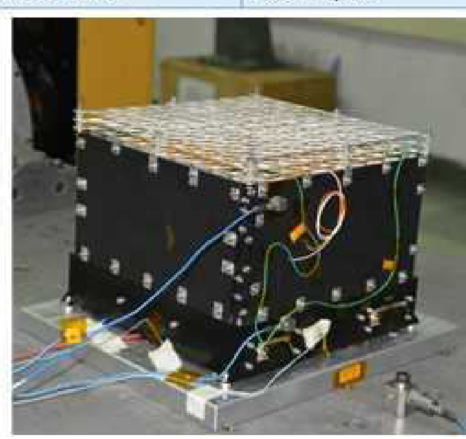

Figure 20: (a) A summary related to the received DEX data (b) Flight model of DEX mounted on shaker for vibration test

DEX (Figure 20(b)) was flown in the Earth orbit on-board PSLV Orbital Experimental Module (POEM-3) of PSLV C-58 (XPoSat mission), launched on $1^{st}$ January 2024. Data has been received till $9^{th}$ February 2024, as per the observation schedule of DEX. A summary of observations made by DEX is given in Figure 20(a). The objectives of DEX payload were

1. To demonstrate its operation in the space environment.
2. To understand dust impact of IDPs in the near-Earth environment.

Operation and Telemetry: DEX took continuous observation whenever it was switched on and the observation period can be seen in Figure 21. All the payloads on POEM were connected to a single RS485 bus. On prompt from the Data Processing Unit (DPU), which is every 16 ms, the DEX replies with two bytes of data as per RS485 protocol. The data is downlinked during the period of visibility and sent to the payload team. Due to limited visibility period and data downlink, actual observation period was quite low compared to mission lifetime (Figure 21). Data for 152 orbits were made available in total.

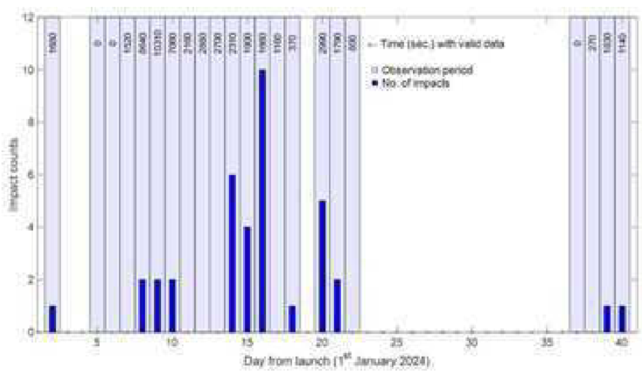


Figure 21: Period of DEX observation is shown with days from the launch. Seconds of data for which validity was ascertained is shown on the respective days.

Data Analysis: The received HEX data (Figure 22) was first converted to decimal format and checked for valid (healthy) bytes and 73.15% were found as the valid data. Next, the valid data was searched to extract the signal after removing headers and footers. Further, the data was filtered using multiple criteria like (i) removal of saturated data, (ii) noisy data removal using mean and standard deviation of signal and signal time series difference and (iii) searching for rise/fall pattern of impact signal to derive final number of genuine impacts. The filtering process is shown in Figure 22. Figure 23 shows a typical dust impact signal, obtained by DEX.

DEX Results: The DEX may be calibrated in near future and at present, data provided by uncalibrated DEX is analyzed to derive the particle flux as follows.

Results Using Impact Rate from DEX: The flux of particles can be derived using the equation

$$f = \frac{\mathrm{N}}{\mathrm{A}_\theta \times t}$$

where N is the number of particles measured by DEX in time t and $\mathrm{A}_\theta$ is the area of the detector given by $\mathrm{A}_\theta = \mathrm{A}_{bt} cos\theta + \mathrm{A}_{st} sin\theta$, in which the parameter $\mathrm{A}_{bt}$ is the bottom target area and the parameter $\mathrm{A}_{st}$ is the lower side target area. The angle $\theta$ is the angle of particle impact with respect to the target normal. The error is computed by propagating the error in the area of DEX seen by the incoming dust particle.

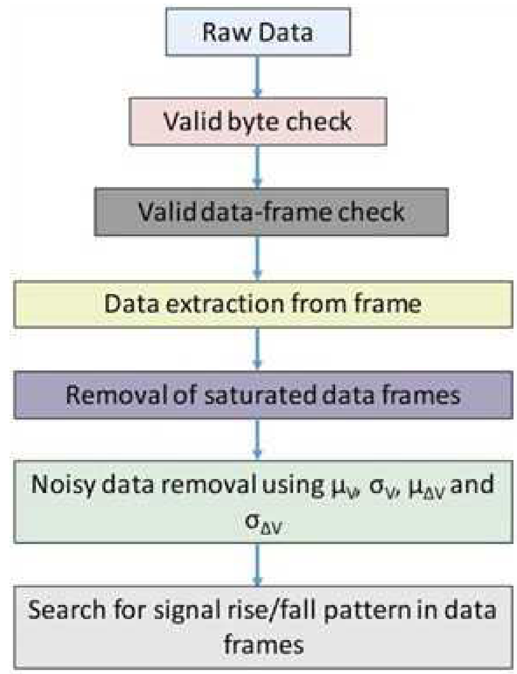


Figure 22: Data processing pipeline for DEX with description for each step

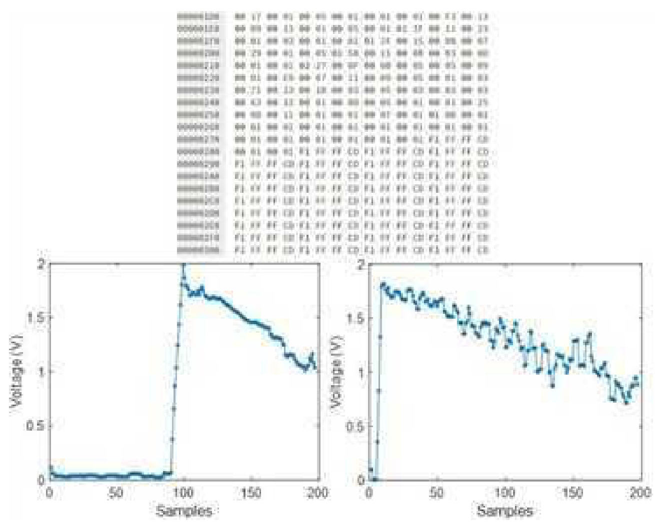


Figure 23: The top pane shows DEX data received in HEX format for Orbit 19. The bottom images show typical dust impact signal provided by DEX. The signal corresponds to orbit 207 ($14^{th}$ January 2024) and 321 ($21^{st}$ January 2024).

Based on the analysis of DEX data, 37 genuine impacts have been identified as unique impacts due to the IDP. Considering the given detector area, a uniform angular distribution for the detector FOV and actual observation time; the flux of IDP measured by DEX is found to be $9.96 \times 10^{-3} [4.55 \times 10^{-3}, 1.54 \times 10^{-2}]\ \# m^{-2} s^{-1}$.

Figure 24 shows the derived flux from DEX measurements, plotted over the flux obtained from the Grun et al. (1985) model, enhanced by the gravitational pull of Earth, for the comparison.

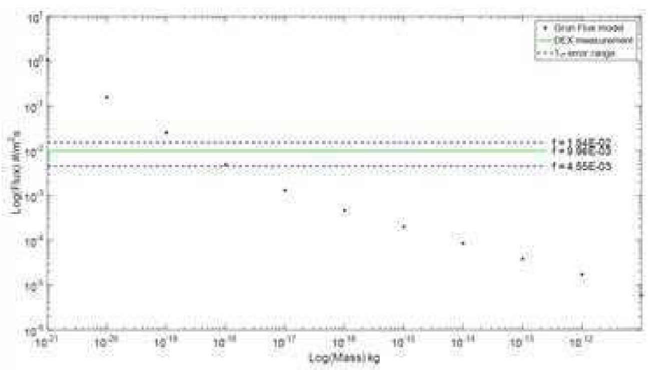


Figure 24: Flux derived from the DEX measurement

Summary: DEX has demonstrated successful operation in the space environment, thereby achieving the first objective of the payload. The IDP flux of $9.96 \times 10^{-3} [4.55 \times 10^{-3}, 1.54 \times 10^{-2}]$ $\# m^{-2} s^{-1}$ is found in the near-Earth environment from the DEX data analysis.

**(Jayesh Pabari, Srirag Nambiar, Sonam Jitarwal, Rashmi, Kinsuk Acharyya, Varun Sheel, Anil Bhardwaj and DEX Team)**

**PRATHIMA payload for ISRO-JAXA LUPEX/Chandrayaan-5 Mission - Developmental Status**

Water-ice is an essential resource on the Moon that enables human expansion to the space. The study of ice helps in understanding the volatile behaviour and their presence on the moon. The remote sensing-based evidences for the existence of water ice on the Moon showed maximum abundance in the polar regions. The next major step forward is to determine the distribution and quantification of water ice using robust in-situ measurements to understand its nature, distribution and process of formation/accumulation. To accomplish these objectives, an experiment called “Permittivity and Thermophysical Instrument for Moon’s Aquatic Scout (PRATHIMA)” is proposed for the LuPEX/Chandrayaan-5 rover. The proposed experiment will enable local investigation of the uppermost 30-50 cm of lunar soil to scout and quantify the abundance of water ice. PRATHIMA experiment consists of three main sub-systems: (a) a permittivity probe that will be deployed into ∼30-50 cm of the lunar surface (in a pre-drilled borehole), (b) an electronics box (on rover/ lander) and (3) a deployment mechanism. PRATHIMA instrument uses the technique of dielectric permittivity for the detection and quantification of water ice in the lunar soil.

The PRATHIMA electronics subsystem consists of 2 pairs of transmitters and two pair of receivers for measurement of dielectric permittivity of the subsurface of the moon. These electrodes are mounted equidistantly on the probe. The probe also has 10 temperature sensors mounted on the probe (Figure 25). The probe will be inserted using a deployment and retraction mechanism. There are other sensors for housekeeping datasets. The transmitter electronics are designed and developed using DAC, and the DDS algorithm is developed using a Look-up Table onboard an FPGA within 10Hz to 10KHz in the range of ±12V with one transmitter in antiphase to another. The receiver electronics involve the signal conditioning of the reflected signals from the Lunar regolith and the difference in the potentials between two receiver electrodes. The temperature sensors, signal conditioning, and digitization take heritage from the ChaSTE payload Front-End electronics, which was on-board Chandrayaan-3. The mechanism electronics is based on a motor-based linear guide system with the endpoints controlled using limit switches, and during flight, the mechanism subsystem is held using a hold-down release mechanism. The lab model of electronics is designed and further iterations in development are in progress. Lab model development of deployment mechanism is in progress. Various approaches / schemes and configurations were evaluated for the design of both the electronics system and deployment mechanism to arrive at the present configuration. Numerical simulations are underway to assess the sensitivity of the received signal strength on the dielectric properties of the medium under different experimental conditions.

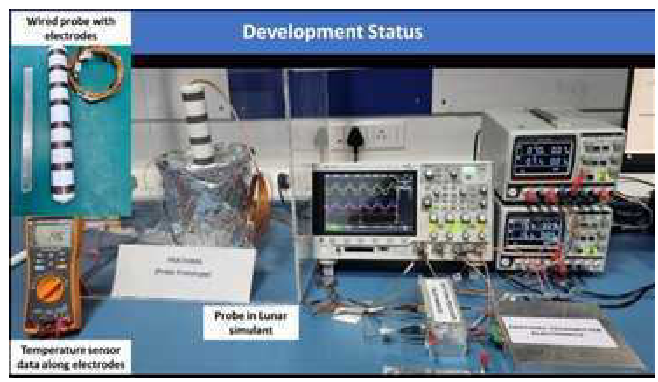


Figure 25: End-to-end testing of PRATHIMA LVM electronics

**(K. Durga Prasad, M. Shanmugam, Chandan Kumar, Sushil Kumar, Sanjeev K. Mishra, Tinkal Ladiya, Nirbhay K. Upadhyay, P. Kalyan Reddy, Janmejay Kumar, Neeraj Srivastava, Megha Bhat, Rajiv R. Bharti, Sanjay K. Mishra, S. Vijayan, Rishitosh K. Sinha, Varun Sheel and Anil Bhardwaj)**

**Development of Digital Pulse Processing based readout electronics for Silicon Detectors**

Silicon detectors are widely used in radiation spectroscopy for detecting charged particles and soft X-rays, due to their high energy resolution and efficiency. Traditional readout electronics of a Silicon detector includes a Charge Sensitive Pre-amplifier (CSPA), a Shaping Amplifier, Peak Detector and an FPGA that increases the size, weight, power when multiple detectors are used. Moreover, analog shaping amplifier and peak detector limits the performance at higher count rate due to its infinite impulse response which creates pile-up & baseline shifts. These limitations can be addressed using Digital pulse processing technique, which digitizes the preamplifier output and processes it in real-time using FPGA-based trapezoidal or triangular filters. Figure 28 shows the basic flow chart of the DPP algorithm which is simulated using MATLAB whose results are shown in Figure 29.

The CSPA signal is digitized using a fast ADC. The digital differencing mimics analog CR (differentiator) to produce a square pulse. This is then further processed with delays and differencing amplifier and finally accumulated, replicating the RC (integrator) stage, to form a triangular or trapezoidal pulse. An FPGA algorithm identifies the pulse peak, which corresponds to the energy of the incident radiation. Digital pulse processing allows multiple detectors to be read using a single FPGA program, significantly reducing instrument size, weight, and power. Figure 30 shows the Lab model of the Digital pulse processor (DPP) that is currently being tested with Si PIN detector for future space mission instruments.

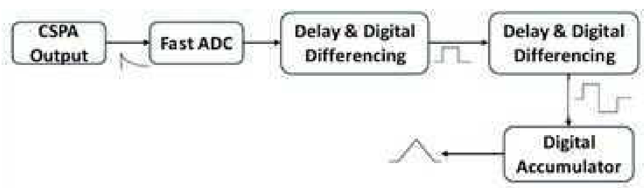


Figure 28: Basic Flow Chart of DPP Algorithm

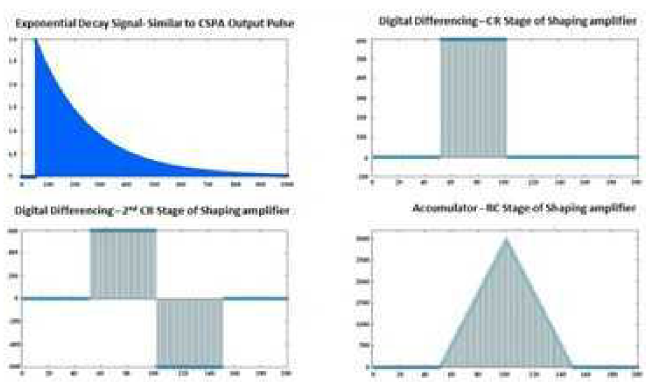


Figure 29: MATLAB Simulation results of DPP Algorithm

Figure 30: Digital Pulse Processor PCB

**(Sushil Kumar, Arpit Patel and M. Shanmugam)**

**Experimental Simulation of Venusian Lightning using Planetary Environment Simulation Chamber**

Lightning is a sudden and violent electrical discharge that occurs in the atmosphere of a planet for a short duration. It produces optical signals, ELF/VLF electromagnetic waves, and acoustic waves. For Venus, it is long understood that the electromagnetic emissions emanating from the clouds might result from momentum transfer and charge dispersion induced by lightning. Although it is very difficult to attribute the signatures received by different sensors to lightning activity with full confidence, earlier studies have shown that the most robust indications of repeated atmospheric electrical activity at Venus appear to be the VLF detections. This work addresses the detection of the electromagnetic waves generated by lightning through instrumentation in the emulated Venusian atmosphere under varied Pressure and Gas Mixtures.

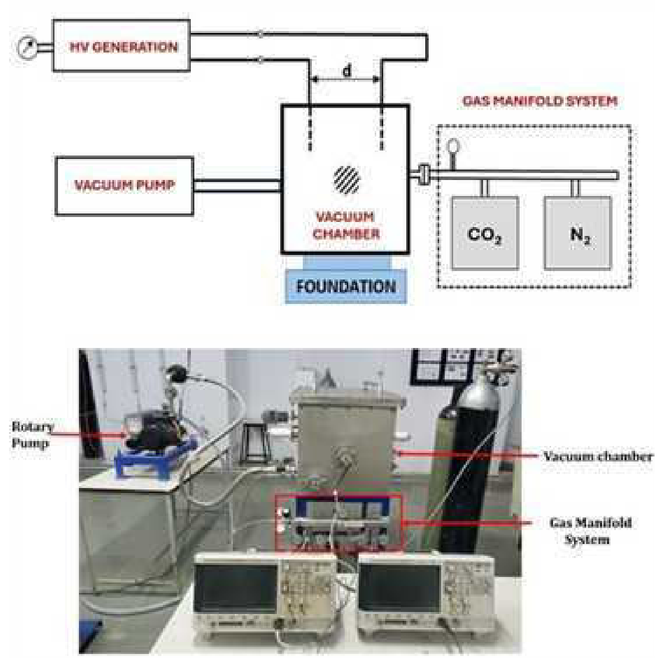


Figure 31: Schematic of testing setup (top) and the image of Testing Setup (bottom) at CHARUSAT

Lightning phenomenon is not fully understood in the case of Venus, therefore there is a need for in-depth understanding of the discharge phenomenon occurring in the Venusian atmosphere. To simulate the Venusian environment, the vacuum chamber needs to be filled with various gases in similar proportion like 96.5 % $CO_2$, 3.5 % $N_2$ etc. Figure 31 depicts the vacuum chamber of the experimental setup with different ports, attached Pirani gauge and the gas manifold system. Further testing is ongoing with different gas mixing proportions using the gas manifold system attached with the chamber. Numerous iterations of experiments were conducted, measuring breakdown voltages and lightning voltages at varied pressure range (Figure 32). The pressure range was decided based on the pressure at Venusian surface of 45 to 70 km in the existence of Venusian cloud. The tests were reiterated for the mixture of $CO_2$ and $N_2$ gases. The detected lightning signals were captured using a Digital Storage Oscilloscope (DSO), and the signal spectrum was analysed using Fast Fourier Transform (FFT). The project experimentations exhibit the capability of the lightning detection of antenna under varying Venusian Environmental conditions which justifies the objective of the project.

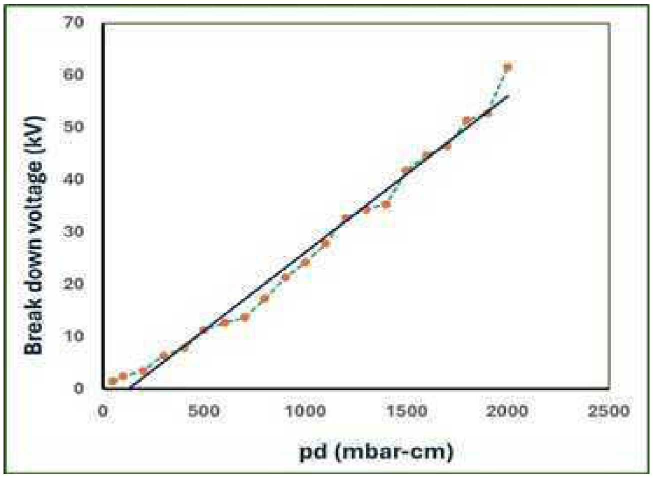


Figure 32: Results for $CO_2$ + $N_2$ mixture

The work has been done in collaboration with Prof. T. Upadhyaya and team, CHARUSAT, Changa.

**(Jayesh Pabari, R. Mahajan, S. Jitarwal, Rashmi, S. Nambiar, K. Acharyya, Anil Bhardwaj and Team)**

**A system and method for performing Lightning characterization and detection for realization of a Planetary Lightning**

A system and method for experimental simulation of Venusian lightning, its characterization and its detection have been designed and developed. The present invention provides a system and method for performing lightning characterization and detection for realization of a planetary lightning. The system comprises, a chamber, a plurality of electrodes, at least one antenna. The system includes an impulse generator and a measurement device. The plurality of electrodes is positioned within the chamber. The impulse generator is configured to generate a high voltage pulse and the high voltage pulse is applied to the plurality of electrodes, which results in generation of an electrical breakdown for a pre-defined time. The antenna is a dipole antenna, that is fixed at an end portion of the plurality of electrodes and the antenna is configured to receive a pre-defined amount of energy from the electrical breakdown. The measurement device processes the pre-defined amount of energy and characterizes a lightning process. The key achievements are analysis of Venusian lightning source strength at the pressure of clouds through its generation, the breakdown of gas mixture present in the clouds and its detection by electrically short antenna. Our results show that majority of Venusian lightning should be due to the $CO_2$ present, superimposed by any conducting ions (like $H^+$ or $SO_4^-$). The results are useful for lightning project at PRL, for Venus Orbiter Mission (VOM).

The work has been done in collaboration with Prof. T. Upadhyaya and team, CHARUSAT, Changa and published in Official Journal of the Patent Office, Issue Number 05/2025, Dated 31/01/2025

**(Jayesh Pabari, Ramakant Mahajan and Anil Bhardwaj)**

# Geosciences

**Phosphate Influx and Dust Deposition Create Zonal and Meridional Biogeochemical Gradients in *Trichodesmium* Abundance**

*Trichodesmium*, being a nitrogen fixing microbe, contributes significantly to nitrogen inputs. Limited availability of data, however, restricts our understanding of environmental parameters in controlling the distribution and abundance of Trichodesmium. To address this, we conducted a comprehensive analysis using large-scale field-based data of *Trichodesmium* abundance to investigate the role of various physical, chemical, and meteorological parameters on the distribution and abundance of *Trichodesmium* along the zonal and meridional transects of the Tropical Atlantic Ocean. It is concluded that *Trichodesmium* distribution is governed by a complex interplay of environmental factors. Along the zonal transect, *Trichodesmium* abundance is primarily governed by the availability of $PO_4^{3-}$ and high sea surface temperatures. Conversely, the inter-hemispheric variability seems to be influenced by dust deposition and high sea surface temperatures. Furthermore, our estimation of high modeled depth-integrated nitrogen fixation rates based on *Trichodesmium* underscores its crucial role in the nitrogen budget. These findings provide valuable insight into the role of environmental factors driving Trichodesmium abundance and its significance toward the global nitrogen budget.

doi : https://doi.org/10.1029/2024GB008182

This work was done in collaboration with Rainer Kiko, Helena Hauss

**(Shreya Mehta, Narendra Ojha, Arvind Singh)**

**Winter convective mixing regulates oceanic C:N:P ratios**

Recent studies challenge the universality of the Redfield ratio, proposing that physical and biogeochemical processes influence C:N:P ratios geographically. Sampling the Arabian Sea during the winter monsoon, the impact of convective mixing, eddies, and $N_2$, fixation on elemental ratios has been examined. Convective mixing enhanced nutrient supply in surface waters, lowering N:P and C:P ratios in the northern region, while ratios increased equatorward, averaging 245:32:1. Temperature changes best explained the variations, with $N_2$, fixation contributing minimally. Denitrifying conditions in subsurface waters significantly reduced N:P ratios. These findings highlight how global elemental ratios are shaped by physical and biogeochemical interactions.

doi : https://doi.org/10.1002/lno.12621

This work was done in collaboration with Sebin John.

**(Deepika Sahoo, Himanshu Saxena, Sipai Nazirahmed, Mohammad Atif Khan, Deepak Kumar Rai, Niharika Sharma, Sanjeev Kumar, A. K. Sudheer, Ravi Bhushan, Arvind Singh)**

**Re-Os geochronology and geochemical evolution of late Cambrian to Middle Ordovician Alum and Tøyen shales, Sweden**

Radiometric dating of sediments is important to establish chronological constraints between different sedimentary sequences. This study provides Re-Os isotopic data to refine early Palaeozoic chronostratigraphy. Shale samples from Sweden yield key age constraints: 497 $\pm$ 28 Ma for Furongian (Cambrian), 488.6 $\pm$ 5.1 Ma for uppermost Cambrian, and 469.7 $\pm$ 1.4 Ma for the Lower–Middle Ordovician boundary. Seawater $^{187}$Os/$^{188}$Os declines through the Ordovician, indicating reduced weathering and global cooling. Geochemical analysis suggests shale deposition under restricted conditions with high organic productivity. Redox-sensitive element relationships indicate that metal drawdown was influenced by euxinic conditions in the latest Cambrian to Early Ordovician. This study has implications for chronological constraints of the late Cambrian to Middle Ordovician strata and environmental conditions through the timeframe.

doi : https://doi.org/10.1016/j.gloplacha.2024.104580

This work was done in collaboration with Judith L. Hannah, Holly J. Stein, Per Ahlberg, Jörg Maletz, Frans Lundberg, Jan Ove R. Ebbestad

**(Vineet Goswami)**

**Paleoenvironmental of the Kashmir Himalaya during the late Holocene**

A study was conducted to decipher changes in paleoenvironmental conditions of the Kashmir Valley using stable isotopic compositions and elemental concentrations of total organic carbon (TOC) and total nitrogen (TN) in a sediment core from the Wular Lake. The Chronology of the core established through radiocarbon dating estimated the age of the core bottom to be 3752 Cal years BP, covering the late Holocene. Using carbon isotopic compositions of TOC, nitrogen isotopic compositions of TN, along with TOC-TN contents, the study identified changes in biology and associated biogeochemical processes in the Wular Lake during the late Holocene. Changes in C and N biogeochemistry of the lake through the last 3752 Cal years BP suggested overall drier condition during 3752–1500 Cal years BP that transitioned into a wetter condition at around 1500 Cal years BP until at least 295 Cal years BP. Evidence for relatively intense drier events were observed within the dry and wet phases at around 2500 and 500 Cal years BP. Observed dry and wet phases in the region might be due to the weakening and strengthening of the precipitation, which was linked to negative and positive phases of the North Atlantic Oscillation, respectively.

doi : https://doi.org/10.1016/j.qsa.2024.100199

**(A. Rahman, R. A. Shah, M. G. Yadava, S. Kumar)**

**Tidal dynamics and estuarine carbon cycling**

Dissolved inorganic carbon (DIC) and particulate organic carbon (POC) dynamics in the world's estuaries have been studied extensively at monthly, seasonal, and annual time scales with particular focus on their concentrations and export fluxes to the coastal oceans. However, given the dynamic nature of the estuaries, the effect of tidal and diel cycles on the processes modulating DIC and POC dynamics remains obscure. To decipher the biogeochemical processes at tidal scale, DIC and POC concentrations and their carbon and nitrogen isotopic compositions were measured across the salinity gradient at every high and low tide for nine consecutive days in the Mahanadi estuary, a tropical estuary at the east coast of India. Showing contrasting differences across salinity gradient in DIC, POC and their isotopic compositions, DIC and POC were significantly different during high and low tide in the mixing zone only during spring duration. This showed the effect of spring-neap tidal cycle owing to water level fluctuations and mixing intensity in the estuarine mixing zone. Linear least-squares regression models indicated carbonate and/or silicate weathering by biogenic $CO_2$ to be the probable DIC source in the freshwater region of the estuary. Deviations of observed DIC concentrations and its isotopic composition from the conservative mixing values suggested pronounced alteration of DIC source signature in the mixing zone. A process-based model approach aimed at delineating possible biogeochemical processes affecting DIC dynamics indicated calcite dissolution during low tide and calcite precipitation during high tide to be dominant processes in the mixing zone. Additionally, signatures of more than one simultaneous biogeochemical process modulating the DIC dynamics were also observed. POC pool in the mixing zone was largely influenced by its removal through rapid remineralisation during both high and low tides.

doi : https://doi:10.1016/j.marchem.2024.104451

**(M. Atif Khan, Sanjeev Kumar)**

**Isotopic evidence for degradation of particulate black carbon in the ocean**

Particulate black carbon (PBC) forms $\sim$12$\pm$5% of the particulate organic carbon pool in aquatic systems. Black carbon has been considered highly recalcitrant and therefore a potent sink for carbon. Paleoenvironmental and biogeochemical studies have been conducted assuming BC as highly stable and its isotopic composition to remain unaltered after formation. However, recalcitrant nature of BC in the environment is under debate. Using the CTO-375 method and by measuring concentrations and isotopic compositions of particulate BC, PRL explored the transformation of PBC along the atmosphere-river-ocean continuum. Significantly high carbon isotopic composition in the ocean compared to rivers and atmospheric particulate matter indicates (i) degradation of PBC, potentially through photodegradation and leaching, and/or (ii) availability of an enriched source other than fluvial or aeolian inputs. This evidence for degradation of PBC in aquatic systems warrants rethinking on its C sequestration potential and role in aquatic C biogeochemistry and further raises concerns regarding the use of sedimentary BC as a paleoenvironmental proxy.

doi : https://doi.org/10.1029/2023GL106050

This work was done in collaboration with P. Ragavan

**(Siddhartha Sarkar, Abdur Rahman, Mohammad Atif Khan, Ajayeta Rathi, Arvind Singh, Sanjeev Kumar)**

**Demystifying the particulate black carbon conundrum in aquatic systems**

Particulate black carbon (PBC) constitutes a notable fraction of riverine particulate carbon (C), and is considered to be a potent sink of C due to its refractory nature in the environment. However, its potential to regulate global climate has been challenged with recent arguments of transformation of BC in the environment. In this study, PRL explored the transport and transformation of PBC along the continuum of six river basins in western India. Using the CTO-375 method and measuring the concentration and stable isotopic composition of the soot fraction of the BC spectrum, the reasons for its variation in the river continuum was examined. The investigation suggested that changes in concentration and isotopic composition were due to allochthonous inputs and degradation, implying that BC may not be as recalcitrant as previously thought. Riverine export fluxes of PBC to the Arabian Sea was also estimated and was found to be a minor fraction of the current global flux estimates.

doi : https://doi.org/10.1088/2515-7620/ad4e0f

**(Siddhartha Sarkar, Ajayeta Rathi, M. Atif Khan, Sanjeev Kumar)**

**Enhancement in primary productivity due to river modification**

Under warming conditions and with increasing human perturbations, rivers across the globe are facing drastic shifts in their hydrologic regime resulting in fragmentation and disconnection from the catchment. Subsequently, a dependency on *in situ* primary productivity as the source of organic matter increases and warrants detailed investigation of the nature of primary production in urbanised river systems. In this study, primary productivity was estimated at multiple locations along the continuum of an engineered (Sabarmati) and a free flowing (Mahi) river systems in India using carbon isotopic tracer incubation method. Significantly enhanced primary productivity in the riverfront (engineered construction along the Sabarmati that holds water supplied by a canal) and polluted downstream of the Sabarmati compared to free flowing Mahi was observed. It was also observed that water stagnancy, temperature, and nutrient availability were the key factors regulating the rates of primary productivity in the urban river system. The study highlights the salient features of riverine primary productivity associated with engineered modifications, that needs to be considered for future river development projects.

doi : https://doi.org/10.1002/rvr2.88

**(Siddhartha Sarkar, Sanjeev Kumar)**

**A hydrous sub-arc mantle domain within the northeastern Neo-Tethyan ophiolites: Insights from cumulate hornblendites**

This study focused on unique rock formations in eastern Arunachal Himalaya, where pieces of ancient oceanic crust (ophiolites) are found. They focused on hornblendite dykes—sheets of rock containing different amphibole minerals—that formed under high temperatures and varying pressures. The chemical clues show these rocks originated from a water-rich, basaltic magma in a volcanic arc setting, revealing important details about the water-rich mantle below these arcs. This research helps us better understand the formation and evolution of the Neo-Tethyan lithosphere.

doi : https://doi.org/10.1016/j.chemer.2024.126122

**(Amrita Dutt, Anil D. Shukla, A. Krishnakanta Singh, Ambili Narayanan)**

**Analysis of sediment provenance using geochemical and isotopic data for a post-LGM sediment core from the western Great Rann of Kachchh, India: Implications for climate control on source regions.**

This study examines a 46.5-meter sediment core from the Nara River bed in the Western Great Rann of Kachchh, India, to understand how sediment sources changed after the Last Glacial Maximum. Initially, most of the sediment was delivered by monsoon-driven rivers from the Western Himalayas. However, during the early Holocene, the source shifted toward sediments from the Indus River—with a brief reversal around 7,000 years ago possibly linked to the reactivation of the Ghaggar-Hakra channel. In the mid- to late Holocene, the Indus River's influence became dominant, and the continued availability of freshwater supported early Iron Age and medieval cultures in the region. A subsequent decline in freshwater input after the medieval period likely contributed to the collapse of these cultures, highlighting how changes in rainfall patterns from different climatic regions control sediment origins.

doi : https://doi.org/10.1016/j.palaeo.2024.112185

This work was done in collaboration with Mamata Ngangom, Jyotsna Dubey

**(Ayushi Bhatnagar, Anil D. Shukla, M.G. Thakkar, Ravi Bhushan)**

**Mid-Holocene climate-glacier relationship inferred from landforms and relict lake sequence, Southern Zanskar ranges, NW Himalaya**

The relationship between glacial dynamics and the lake sedimentation during the mid-Holocene climate variability in the Zanskar Himalaya are inferred using para/peri glacial landforms, elemental geochemistry, and optical chronology. Three minor glacial advances were inferred in Holocene with multiple standstills and intervening deglaciations. Six centennial to millennial-scale climatic phases were deduced from lake sediments and was further used to understand glacier dynamics, where responded to major cooling events. After 2500 years, permafrost conditions degraded implying an increase in air temperature. The climate variability shows a close correspondence with regional climate records suggesting that marginal glacier advancements were triggered by enhanced moisture via atmospheric rivers and cooler winter temperatures.

doi : https://doi.org/10.1016/j.geomorph.2023.108953

**(Shubhra Sharma, Anil D. Shukla)**

**The Beas River Floods 2023: A Watershed Moment for Paradigm Shift Towards Urbanisation and Development in the Higher Himalayan Valleys**

The study in the Beas river (Manali to Mandi town) after the July 2023 flood assessed the geomorphic vulnerability of the terrain and understand the role of human intervention in the disaster. The study indicates that the surfaces proximal to the trunk riverbed and the ephemeral tributary channels suffered maximum damage. Along the upper Beas river, the lateral erosion caused by hyper-concentrated flows saturated with paraglacial sediments partly obstructed the river and increased the erosivity that also led to remobilisation of midchannel bars along with the uprooted trees. In the downstream (southern mountain front), maximum damage was caused by activating seemingly dormant ephemeral tributary channels. The disaster was force amplified when the river was temporarily obstructed by the manmade structures (e.g., suspension bridges), and most importantly, urban settlements (largely hotels) on the flood plain. Also, many public buildings suffered as these were constructed in/along the ephemeral tributary channels, which were temporarily blocked by these structures, as well as by logged tree trunks.

doi : https://doi:10.18520/cs/v127/i1/65-77

Raghuveer Negi, Naresh Rana, Sarswati Prakash Sati

**(Anil D. Shukla, Navin Juyal, Shubhra Sharma)**

**$CO_2$ flux and carbon dynamics in soil and respired $CO_2$ in a semi-arid region of western India :**

Soil releases much more $CO_2$ than human activities, with tropical soils showing large variations in emissions. To understand these emissions, soil $CO_2$ levels, surface fluxes, and carbon isotope signatures have been measured. Soil $CO_2$ concentrations ranged from 13,780 to 26,300 ppm, with emissions strongly influenced by soil moisture. Drier conditions led to higher $CO_2$ flux, while increased moisture reduced emissions. Radiocarbon analysis showed that most $CO_2$ comes from root respiration and fresh organic matter decay, while older soil carbon contributes less than 5%. This suggests that long-stored soil carbon and $CO_2$ emissions are largely separate processes, challenging traditional methods of estimating soil organic carbon turnover. With climate warming, the release of $CO_2$ from semi-arid tropical soils is unlikely to increase significantly because only a small portion of the $CO_2$ emissions ($<$5%) are linked to the older soil carbon pool.

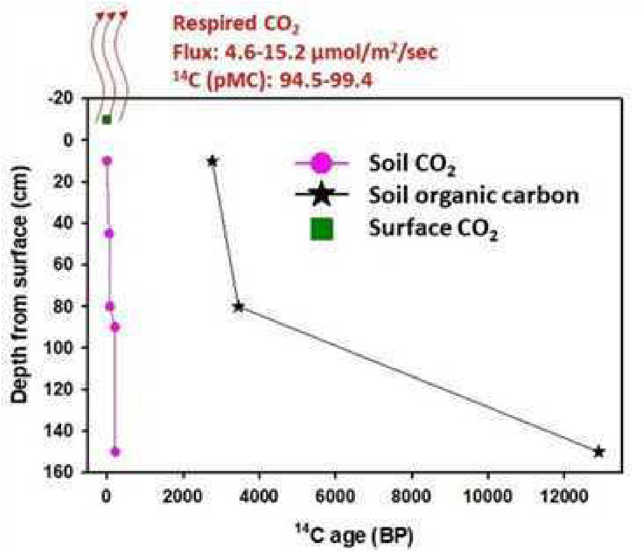


Figure 1. Soil $CO_2$ flux and radiocarbon content (expressed in percent modern carbon pMC, or in years BP) in soil organic carbon, soil pore space $CO_2$ and respired $CO_2$ in a tropical semi-arid farmland.

doi : `https://doi.org/10.1002/saj2.70026`

This work was done in collaboration with Aharna Sarkar

**(Amzad H. Laskar, Ranjan Kumar Mohanty, Rahul Kumar Agrawal, Sanjeev Kumar, A. Shivam)**

### Investigating sources affecting atmospheric $NH_3$ over the northwestern Indo-Gangetic Plain using nitrogen isotope ($\delta^{15}$N)

Ammonia ($NH_3$) is the major constituent among all the reactive nitrogen species present in the atmosphere, and the most essential species for secondary inorganic aerosol formation. Recent satellite-based observations have identified the Indo-Gangetic Plain (IGP) as a major hotspot of global $NH_3$ emission; however, the major sources and atmospheric processes affecting its abundance are poorly understood. Our study aims to understand the wintertime sources of $NH_3$ using species-specific $\delta^{15}$N in $PM_{2.5}$ over Patiala, a semi-urban site located in the IGP. Mixing model results using $\delta^{15}$N-$NH_3$ reveal the dominance of non-agricultural emissions ($NH_3$-slip: 47 $\pm$ 24%) over agricultural emissions (24 $\pm$ 11%), combustion sources (19 $\pm$ 14%), and biomass burning (10 $\pm$ 8%) for atmospheric $NH_3$. Diurnal variability in source contributions to $NH_3$ was insignificant. This study highlights the importance of non-agricultural $NH_3$ emissions over the agriculture-dominated IGP region.


Figure 2. $\delta^{15}$N-based major sources of $NH_3$ over an agriculture dominated site in the Indo-Gangetic Plain

doi : `https://doi.org/10.1016/j.chemosphere.2024.142356`

**(Chandrima Shaw, Neeraj Rastogi, Ajayeta Rathi, Sanjeev Kumar, Rohit Meena)**

### Insights into the formation of secondary organic aerosols from agricultural residue burning emissions: A review of chamber-based studies

Organic aerosols (OA) are a significant component of fine particulate matter in the ambient air and are formed through primary and secondary processes. Primary organic aerosols (POA) are directly released from sources, while secondary organic aerosols (SOA) are formed through the oligomerisation and/or oxidation of volatile organic compounds (VOCs) in the atmosphere. Recently, there has an increasing attention on the SOA budgets, their formation pathways, and photochemical evolution due to their impacts on climate and human health. Biomass burning (BB) is a significant source of OA, contributing around 5-30 % to the SOA burden globally. Agricultural residue burning (ARB) is a type of BB that contributes 10% of total atmospheric OA mass worldwide, whereas it contributes higher in Asian regions like China and India. ARB emits a significant amount of air pollutants, including VOCs, into the atmosphere. However, there is inadequate information on the transformation of ARB emissions to SOA due to limited laboratory studies. In this review, major focuses were on the formation mechanism of SOA from ARB emissions, summarising the current state of the art about ARB precursors and their oxidation products from chamber-based studies, including measurement methods and analytical instrumentation. It also discusses the role of different types of oxidants in OA mass enhancement, factors affecting the overall SOA yield, and the uncertainties involved in the process.

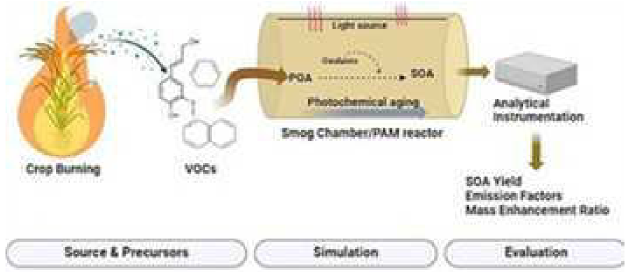


Figure 3. Schematic diagram depicting the process of SOA yields evaluation

doi : `https://doi.org/10.1016/j.scitotenv.2024.175932`

This work was done in collaboration with Swati Joshi, Atinderpal Singh

**(Neeraj Rastogi)**

**Finer Aspects of Spatio-Temporal Variations in Indian Summer Monsoon Rainfall Trend Reversals over the Last 120 Years.**

This study investigates the multidecadal variability and reversal events in Indian summer monsoon rainfall over the past 120 years (1901–2020) using district-level data, revealing significant spatio-temporal heterogeneities.

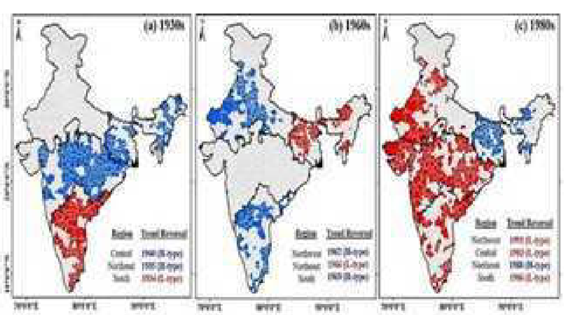


Figure 4. Districts with in the homogeneous rainfall regions underwent the three prominent summer monsoon rainfall trend reversal events around (a) the 1930s, (b) the 1960s, (c) the 1980s

Three major rainfall trend reversal epochs were identified—in the 1930s, 1960s, and 1980s—each characterised by distinct spatial asymmetries. During the 1930s, central and northeast India exhibited a reversal from an increasing to a decreasing trend, whereas the south peninsula reversed from decreasing to increasing trends, leading to a pronounced north–south asymmetry. The 1960s saw the south peninsula and northwest regions transition from rising to falling trends, contrasting with an opposite shift in the northeast, thereby producing an east–west asymmetry. The reversal in the 1980s was the most spatially extensive, with approximately 50% of the study area undergoing a trend change; here, the south peninsula, central, and northwest regions switched from declining to increasing rainfall, while the northeast experienced the reverse. Notably, the 1930s event, although less extensive, manifested the greatest magnitude deviation from long-term averages. Temporal evolution in these spatial patterns suggests that the delineation of homogeneous rainfall regions in India has shifted, underscoring complex interactions between climate drivers and regional monsoon dynamics.

doi : `https://doi.org/10.1007/s10584-024-03780-9`

**(Swagatika Chakra, Harsh Oza, Akash Ganguly, Amit Pandey, Virendra Padhya, R. D. Deshpande)**

**Relative Contribution from Different Water Sources to Supraglacial Runoff in Western Himalaya**

This study presents an integrated analysis of hydrological processes in response to climate variability, employing long-term observational records and advanced modelling techniques. The authors investigate how changes in precipitation patterns, temperature, and land surface conditions have modulated streamflow and groundwater recharge over multiple decades.

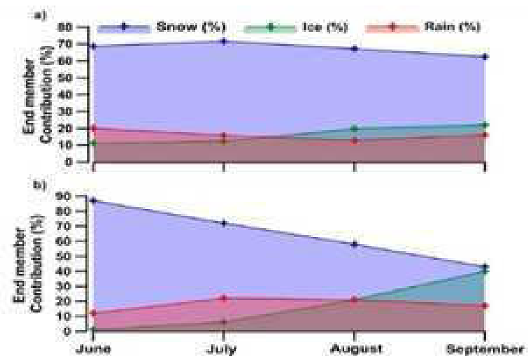


Figure 5. Estimation of end member contribution resulting from : (a) isotope based mixing analysis (b) Glacio- hydrological model from Azam et al.(2019). Error estimate for the end member lie in the range of $\pm$ 7.91 in snow melt, $\pm$ 6.14 in ice melt and $\pm$ 6.35 in rain in isotope –based mixing analysis .

Their analysis reveals that climate-induced alterations in extreme rainfall events and shifting seasonal patterns have significantly impacted water resource availability. Novel statistical approaches and hydrological models are used to capture non-linear responses and critical thresholds within the system. The results underscore that even modest changes in climate variables can lead to disproportionate shifts in hydrological regimes, particularly in regions with complex topography and heterogeneous land use. Importantly, the study identifies distinct spatio-temporal patterns, highlighting areas of vulnerability where water resources are most at risk. These comprehensive findings provide a critical reference for policymakers and water resource managers aiming to implement adaptive strategies in the face of climate change impacts. The work contributes to the broader understanding of climate–hydrology interactions and emphasises the need for integrated water management practices to mitigate adverse impacts on both urban and rural communities

doi : `https://doi.org/10.1016/j.jhydrol.2024.131137`

This work was done in collaboration with Naveen Kumar, Kalyan Biswal, Tirumalesh Keesari

**(Akash Ganguly, Amit Pandey, R.D. Deshpande)**

# Atomic, Molecular and Optical Physics

### Relativistic equation-of-motion coupled-cluster-theory analysis of blackbody radiation shift in the clock transition of Zn I

Equation-of-motion coupled-cluster (EOM-CC) method in the four-component relativistic theory framework was employed to understand the roles of electron correlation effects in the ab-initio estimations of electric dipole polarizabilities of the states engaged in the clock transition of the zinc atom. The roles of basis size, inclusion of higher-level excitations, and higher-order relativistic effects in the evaluation of both excitation energies of a few low-lying excited states and electric dipole polarizabilities are analyzed systematically. Our EOM-CC values are compared with the earlier reported theoretical and experimental results. This demonstrates the capability of the EOM-CC method to ascertain the precision of the blackbody radiation shift in a clock transition, which holds paramount importance for optical clock-based experiments.

doi : https://doi.org/10.1103/PhysRevA.109.063111

This work was carried out in collaboration with Somesh Chamoli, Anmol Mishra and Achintya Kumar Dutta of the Department of Chemistry, IIT Bombay and Richa Sharma Kesarka of Space Applications Centre, Ahmedabad, Gujarat India

**(B. K. Sahoo)**

### Nuclear charge radius differences in the silver isotopic chain

Nuclear charge radius differences in the silver isotopic chain have been reported through different combinations of experiment and theory, exhibiting a tension at the level of two standard deviations.. We investigated isotope shifts in the silver isotopes to address the issue of large differences in the nuclear charge radii of these isotopes from the earlier works. Our calculations predict electronic transition energies in Ag I at the 0.3% level, the highest accuracy achieved in this system so far. We calculated electronic isotope shift factors by employing analytical response relativistic coupled cluster theory, and found that a consistent charge radius difference between $^{107,109}\mathrm{A}g$ was returned when we combined our calculations with the available optical isotope shift measurements.

doi : https://doi.org/10.1103/PhysRevResearch.6.033040

This work was carried out along with B. Ohayon of The Helen Diller Quantum Centre, Department of Physics, Technion-Israel Institute of Technology, Haifa 3200003, Israel and J. E. Padilla-Castillo, S. C. Wright and G. Meijer of Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

**(B. K. Sahoo)**

### High-accuracy nuclear-spin-dependent parity-violating amplitudes in $^{133}\mathrm{C}s$

Relativistic coupled-cluster (RCC) theory at the singles and doubles approximation was developed to estimate nuclear-spin-dependent (NSD) parity-violating (PV) electric dipole transition amplitudes among hyperfine levels in $^{133}\mathrm{C}s$. To validate our calculations, we reproduced the Dirac-Hartree-Fock values and results from the combined coupled-Dirac-Hartree-Fock and random phase approximation (CPDF-RPA) method that were reported earlier. Contributions from the double-core-polarisation (DCP) effects with the CPDF-RPA method were found to be between 3% and 12% among different hyperfine levels. We derived a generalised expression for determining these amplitudes, which helped incorporate both the NSD PV Hamiltonian and electric dipole operator simultaneously in the perturbation approach to account for the DCP contributions. The RCC method subsumes the CPDF-RPA and DCP effects in addition to contributions from the Brueckner pair correlations and normalisation of the wave functions including correlations among them. To improve the accuracy of the PV amplitudes further, we replaced the ab-initio values of the electric matrix elements and energies by their experimental values via a sum-over-states approach.

doi : https://doi.org/10.1103/PhysRevA.110.022812

A. Chakraborty and B. K. Sahoo

**(B. K. Sahoo)**

### Probing the doubly magic character of the $^{100}Sn$ isotope

Understanding the nuclear properties in the vicinity of $^{100}\mathrm{S}n$, which has been suggested to be the heaviest doubly magic nucleus with proton number (Z) equal to neutron number (N), has been a long-standing challenge for experimental and theoretical nuclear physics. In particular, contradictory experimental evidence exists regarding the role of nuclear collectivity in this region of the nuclear chart. In this study, we provided further evidence for the doubly magic character of $^{100}Sn$ by measuring the ground-state electromagnetic moments and nuclear charge radii of indium (Z = 49) isotopes as N approaches 50 from above using precision laser spectroscopy. Our results span almost the complete range between the two major closed neutron shells at N=50 and N=82, and reveal parabolic trends as a function of the neutron number, with a clear reduction towards these two closed neutron shells. A detailed comparison between our experimental results and numerical results from two complementary nuclear many-body frameworks (density functional theory and ab-initio methods) exposed deficiencies in nuclear models and established a benchmark for future theoretical developments.

doi : https://doi.org/10.1038/s41567-024-02612-y

This work was carried in collaboration with J. Karthein, C.M. Ricketts, R.F. Garcia Ruiz, J. Billowes, C.L. Binnersley, T.E. Cocolios, J. Dobaczewski, G.J. Farooq-Smith, K.T. Flanagan, G. Georgiev, W. Gins, R.P. de Groote, F.P. Gustafsson, J.D. Holt, A. Kanellakopoulos, A. Kos-´ zoru´s, D. Leimbach, K.M. Lynch, T. Miyagi, W. Nazarewicz, G. Neyens, P.-G. Reinhard, A.R. Vernon, S.G. Wilkins, X.F. Yang, and D.T. Yor- danov

**(B. K. Sahoo)**

**THz atomic clock using $\mathrm{N}b^{4+}$ ion**

By performing relativistic coupled-cluster calculations, scientists at PRL identified that the $4\mathrm{D}_{3/2}|3,\pm2>\rightarrow 4\mathrm{D}_{5/2}|3,\pm2>$transition in the $\mathrm{N}b^{4+}$ ion is a promising candidate for a terahertz (THz) atomic clock, with the transition frequency occurring at 56.0224 THz. This transition is primarily driven by the magnetic dipole decay channel, which can easily be accessed by a laser. We focused on the stable $^{93}\mathrm{N}b$ isotope, which has 100% natural abundance and a nuclear spin of $\mathrm{I} = 9/2$ for experimental advantage. Our data analysis allowed us to estimate potential systematic shifts in the proposed clock system, including those due to blackbody radiation, electric quadrupole, second-order Zeeman, and second-order Doppler shifts. The scheme presented in this study can help suppress the AC Stark and electric quadrupole shifts in the clock frequency measurement. All these analyses suggest that the proposed THz atomic clock using $\mathrm{N}b^{4+}$ could be valuable in both quantum thermometry and frequency metrology.

doi : https://doi.org/10.1103/PhysRevA.111.022813

This work was carried in collaboration with Jyoti, Zhiyang Wang, Jia Zhang, Jingbiao Chen and Bindiya Arora

**(A.Chakraborty and B. K. Sahoo)**

**General-order relativistic coupled-cluster theory to estimate electric-field response clock properties of $\mathrm{C}a^{+}$ and $\mathrm{Y}b^{+}$**

Accurate calculations of electric dipole polarizabilities, quadrupole moments, and quadrupole polarizabilities for the clock states of the singly charged calcium ($\mathrm{C}a^{+}$) and ytterbium ($\mathrm{Y}b^{+}$ ) ions were carried out using the general-order relativistic coupled-cluster (RCC) theory. Precise knowledge of these quantities is immensely useful for estimating uncertainties caused by major systematic effects such as the linear and quadratic Stark shifts and black-body radiation shifts in the optical $\mathrm{C}a^{+}$ and $\mathrm{Y}b^{+}$ clocks. A finite-field approach was adopted for estimating these quantities, in which the first-order and second-order energy level shifts were analysed by varying strengths of externally applied electric field and field gradient. To achieve high-accuracy results in the heavier $\mathrm{Y}b^{+}$ ion, we first calculated these properties in a relatively lighter clock candidate, $\mathrm{C}a^{+}$ , which involves similar clock states. From these analyses, we learned that electron correlation effects arising from triple excitations in the RCC theory contribute significantly to the above properties and are decisive factors in bringing the calculated values closer to the experimental results.

doi : https://doi.org/10.1103/PhysRevA.111.032801

This work was carried out in collaboration with Yan-mei Yu of Beijing National Laboratory for Condensed Matter Physics, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China.

**(B. K. Sahoo)**

**Beamsplitter-free, high bit-rate, quantum random number generator based on temporal and spatial correlations of heralded single photons**

Spontaneous parametric down-conversion (SPDC), an inherently random quantum process, produces pair photons with strong temporal and spatial correlations due to energy and momentum conservation, and acts as the key for quantum random number generation (QRNG). Standard QRNG methods primarily use temporal correlations with beam splitters, limiting bit rates. However, due to spatial correlation, the pair photons in a non-collinear phase-matched SPDC setup appear at diametrically opposite points on an annular spatial distribution. Therefore, exploring the temporal correlation between the spatially correlated photon-pairs from different sections of the annual ring can directly lead to device-independent, multi-bit QRNG at a high rate, eliminating the need for a physical object such as a beam splitter. As a proof-of-concept, we report on high-bit-rate QRNG by using spatial correlation of photon-pairs by sectioning the SPDC ring of a non-collinear, degenerate, high-brightness source and temporal correlation between the diametrically opposite sections. Dividing the annular ring of the high-brightness photon-pair source based on a 20-mm-long, type-0 phase-matched, periodically poled potassium titanyl phosphate (PPKTP) crystal into four sections, recording the timestamp of the coincidences (window of 1ns) between photons from diametrically opposite sections and assigning bits (0 and 1), we extracted 90 million raw bits over 27.7s at a pump power of 17mW. Using minimum entropy evaluation, we determined an extraction ratio of over 95% for raw bits. Further, using Toeplitz matrix-based post-processing, we developed QRNG with a bit rate of 3 Mbps, passing all NIST 800-22 and TestU01 test suites. The generic scheme shows the possibility of further enhancement of bit rate with more sectioning of the SPDC ring.

doi : https://doi.org/10.1116/5.0245672

This work was done in collaboration with Dr. C. M. Chandrashekar, IISc, Bangalore, India

**(Ayan Kumar Nai, Amritash Sharma, Vimlesh Kumar, Sandeep Singh, Shreya Mishra, and G. K. Samanta)**

**Dead-zone-free single-beam atomic magnetometer based on free-induction-decay of Rb atoms**

Free-induction-decay (FID) magnetometers have evolved as simple magnetic sensors for sensitive detection of unknown magnetic fields.

However, these magnetometers suffer from a fundamental problem known as "dead zone," making them insensitive to certain magnetic field directions. e demonstrate a simple experimental scheme for the dead-zone-free operation of a FID atomic magnetometer. Using a single laser beam containing equal strength of linear- and circular-polarisation components and amplitude modulation at a low-duty cycle, we have synchronously pumped the rubidium (($^{87}\mathrm{R}b$) atoms with both first- and second-order frequency harmonics. Such a pumping scheme has enabled us to observe the free Larmor precession of atomic spins at a frequency of $\Omega_{\mathrm{L}}$ (orientation) and/or $2\Omega_{\mathrm{L}}$ (alignment) in a single FID signal, depending on the direction of the external magnetic field. We observed that the amplitude of the FID signal does not go to zero for any magnetic field direction, proving the absence of dead zones in the magnetometer. The magnetometer has a sensitivity in the range of 3.2–8.4 $p\mathrm{T}/\sqrt{\mathrm{H}z}$ in all directions. Our experimental scheme can be crucial in developing miniaturised atomic magnetometers for various practical applications, including geomagnetic applications.

doi : `https://doi.org/10.1063/5.0248330`

This work was done in collaboration with Mr. Shrey Mehta and Dr. Raghwinder Singh Grewal, Ahmedabad University, Gujarat, India

**(G. K. Samanta)**

**Talbot effect-based sensor measuring grating period change in subwavelength range**

Talbot length, the distance between two consecutive self-image planes along the propagation axis for a periodic diffraction object (grating) illuminated by a plane wave, depends on the period of the object and the wavelength of illumination. This property makes the Talbot effect a straightforward technique for measuring the period of a periodic object (grating) by accurately determining the Talbot length for a given illumination wavelength. However, since the Talbot length scale is proportional to the square of the grating period, traditional Talbot techniques face challenges when dealing with smaller grating periods and minor changes in the grating period. Recently, we demonstrated a Fourier transform technique-based Talbot imaging method that allows for controlled Talbot lengths of a periodic object with a constant period and illumination wavelength. Using this method, we successfully measured periods as small as a few micrometres and detected sub-micrometre changes in the periodic object. Furthermore, by measuring the Talbot length of gratings with varying periods imaged through the combination of a thick lens of short focal length and a thin lens of long focal length and large aperture, we determined the effective focal length of the thick lens in close agreement with the theoretical effective focal length of a thick lens in the presence of spherical aberration. These findings establish the Talbot effect as an effective and simple technique for various sensing applications in optics and photonics by measuring any physical parameter influencing the Talbot length of a periodic object.

doi : `https://doi.org/10.1038/s41598-024-81722-2`

This work was done in collaboration with Prof. Majid Ebrahim-Zadeh, ICFO, Barcelona, Spain

**(Saumya J Sarkar, and G. K. Samanta)**

**Fast measurement of group index variation with optimum precision using Hong-Ou-Mandel interferometry**

Hong–Ou–Mandel (HOM) interferometry has emerged as a valuable means for quantum sensing applications, particularly in measuring physical parameters that influence the relative optical delay between photon pairs. Unlike classical techniques, HOM based quantum sensors offer higher resolution due to correlated photon pairs' intrinsic dispersion cancellation property. Due to the use of single photons, HOM-based quantum sensors typically involve a large integration time to acquire the signal and subsequent post-processing for high-resolution measurements, restricting their use for real-time operations. Based on our understanding of the relationship between measurement resolution and the gain medium length that produces photon pairs, we report on developingan HOM based quantum sensor for high-precision group index measurements. Using a 1mm long periodically poled KTP (PPKTP) crystal for photon-pair generation, we have measured the group index with a precision of $\sim 6.75 \times 10^{-6}$ per centimetre of sample length at an integration time of 100ms, surpassing the previous reports by 400%. Typically, the measurement range reduces with the increase in the resolution. However, using a novel scheme compensating photon delay due to stepwise group index changes with an optical delay stage; we have measured the group index variation of PPKTP crystal over a range of $3.5 \times 10^{-3}$ for a temperature change from 25 to 200°C, corresponding to an optical delay adjustment of $\sim 200\mu m$ while maintaining the same precision ($\sim 6.75 \times 10^{-6}$ per centimeter of sample length). The current results establish the usefulness of HOM-interferometer-based quantum sensors for fast, precise, and long-range measurements in various applications, including quantum optical coherence tomography.

doi : `https://doi.org/10.1063/5.0220993`

**(Sandeep Singh, Vimlesh Kumar, and G. K. Samanta)**

**Evolution of C-point singularities and polarisation coverage of Poincaré–Bessel beam in self-healing process**

As a vector version of scalar Bessel beams, Poincaré–Bessel beams (PBBs) have attracted a great deal of attention due to their non-diffracting and self-healing properties and the presence of polarisation singularities. Previous studies of PBBs have focused on cases that consist of a superposition of Bessel beams in orthogonal circular polarisation states. We present a theoretical and experimental study of PBBs for which the polarization states are taken to be linear, which we call a linear PBB. Using a mode transformation of a full Poincaré beam constructed from linear polarisation states, we observe the linear PBB as providing an in-principle infinite number of covers of the Poincaré sphere in the transverse plane and with an infinite number of C-points with positive and negative topological indices. We also study the dynamics of C-point singularities in a linear PBB in self-healing after being obstructed by an obstacle, providing insight into "Hilbert Hotel" style evolution of singularities in light beams. The present study can be useful for imaging in the presence of depolarising surroundings, studying turbulent atmospheric channels, and exploring the rich mathematical concepts of transfinite numbers.

doi : https://doi.org/10.1038/s41598-024-67582-w

This work was done in collaboration with Mr. Arash Shiri and Prof. Greg Gbur, University of North Carolina Charlotte, USA

**(Subith Kumar, Anupam Pal, and G. K. Samanta)**

### Harnessing nonlinear frequency upconversion of the Talbot effect with flexible Talbot lengths

PRL reports a simple experimental scheme demonstrating nonlinear frequency upconversion of the Talbot effect with controllable Talbot lengths at high conversion efficiency. Using a microlens array (MLA) as an array illuminator at 1064 nm onto a 1.2-mm-thick BiBO crystal, we have observed the second harmonic Talbot effect in green at 532 nm with a Talbot length twice that of the pump Talbot length. However, the Talbot length is constant for fixed parameters of the periodic object and the laser wavelength. With the formulation of a suitable theoretical framework, we have implemented a generic experimental scheme based on the Fourier transformation technique to independently control the Talbot lengths of the MLA in both the pump and the second harmonic, overcoming the stringent dependence of MLA parameters on the self-images. Deploying the current technique, the Talbot lengths are tuned from $z_T$=26cm to $z_T$=62.4cm in the pump and $z_T$=12.4 cm to $s_T$=30.8 cm in the second harmonic, respectively. The single-pass conversion efficiency of the Talbot images is $2.91\,\%\,W^{-1}$, an enhancement of a factor of $10^6$ as compared to the previous reports. This generic experimental scheme can be used to generate long-range self-images of periodic structures and program desired Talbot planes at required positions at both pump and upconverted frequency to avoid any mechanical constraints of experiments.

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**(Harshith Bachimanchi, Saumya J. Sarkar, M. Ebrahim-Zadeh, and G. K. Samanta)**

### Infrared spectroscopy reveals ethylene glycol is an anti-crystallizer in water-mixed astrochemical ices

Ethylene glycol (EG), $(CH_2OH)_2$, is among the numerous molecules identified in comets and the interstellar medium (ISM). In terrestrial conditions, EG is used as an antifreeze to prevent liquid $H_2O$ from turning into ice. However, in an environment where both of these molecules are frozen, the effect of EG on water is unknown. To investigate this, we simulated the low-temperature, low-pressure astrochemical conditions in the laboratory using the Simulator for Astromolecules at Low Temperature (SALT) experimental set-up in PRL. In our experiments, we prepared the ices of EG and $D_2O$ on top of ZnSe substrate, which acts as a dust analog. The ices were prepared as pure layers, layered combinations, or mixtures under ultra-high vacuum of $\sim 10^{-10}$ mbar at 10 K. The resultant ices were gradually heated to higher temperatures until their sublimation. The behaviour of the ices was studied in situ using mid-infrared (MIR) spectroscopy at various temperatures. The reason for using $D_2O$ instead of $H_2O$ was to avoid the spectral overlap arising due to the presence of the hydroxyl group (–OH) in both EG and $H_2O$. We observed significant interactions between EG and $D_2O$molecules even under our extreme experimental conditions. These interactions affected the typical phase transition of $D_2O$ ice (amorphous to crystalline), which usually occurs at 152 K. This shows that EG can act as an “anti-crystallizer” in icy environments of comets and ISM, much like its role as an antifreeze on Earth. Moreover, while pure $D_2O$ ice sublimation is known to occur at 182 K, it is increased to 240 K when it is present with EG in layered or mixed forms. Hence, based on these experiments, PRL scientists have compelling evidence that on comets containing EG, $H_2O$ can exist on the cometary nucleus at temperatures higher than previously known.

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This work is done in collaboration with V Venkataraman from Space Physics Laboratory (SPL), Vikram Sarabhai Space Center (VSSC), Thiruvananthapuram, Kerala, India, B N Rajasekhar from Institute of Astronomy Space and Earth Science, Kolkata, H Hill from International Space University, France and N J Mason from University of Kent, U.K

**(Wafikul Khan, R Ramachandran, S Gupta, J K Meka, P Janardhan, Anil Bhardwaj, B Sivaraman)**

### Experimental and Computational Study of Ethanolamine Ices under Astrochemical Conditions

Ethanolamine $(NH_2CH_2CH_2OH)$ has recently been identified in the molecular cloud G+0.693-0.027, situated in the SgrB2 complex in the Galactic centre. However, its presence in other regions, and in particular in star-forming sites, is still elusive. Given its likely role as a precursor to simple amino acids, understanding its presence in the star-forming region is required. Here, we present the experimentally obtained temperature-dependent spectral features and morphological behaviour of pure ethanolamine ices under astrochemical conditions in the 2-12 $\mu$m (MIR) and 120-230nm (VUV) regions for the first time. These features would help in understanding its photochemical behaviour. In addition, we present the first chemical models specifically dedicated to ethanolamine. These models include all the discussed chemical routes from the literature, along with the estimated binding energies and activation energies from quantum chemical calculations reported in this work. We have found that surface reactions $CH_2OH + NH_2CH_2 \rightarrow NH_2CH_2CH_2OH$ and $NH_2 + C_2H_4OH \rightarrow NH_2CH_2CH_2OH$ in warmer regions (60 - 90 K) could play a significant role in the formation of ethanolamine. Our modelled abundance of ethanolamine complements the upper limit of ethanolamine column density estimated in earlier observations in hot core/corino regions. Furthermore, we provide a theoretical estimation of the rotational and distortional constants for various species (such as HNCCO, $NH_2$CHCO, and $NH_2CH_2CO$ ) related to ethanolamine that have not been studied in existing literature. This study could be valuable for identifying these species in the future.

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Ramachandran, R., Sil, M., Gorai, P., Meka, J. K., Sundararajan, P., Lo, J.-I., Chou, S.-L., Wu, Y.-J., Janardhan, P., Cheng, B.-M., Bhardwaj, A., Rivilla, V. M., Mason, N. J., Sivaraman, B., Das, A

**(B. Sivaraman)**

### Study of thermoluminescence characteristics of quartz for

**high radiation doses (¿1 kGy): implications for extending the luminescence dating range**

This work characterises the luminescence response of quartz for HRDs (1-21 kGy) to improve existing understanding of the luminescence mechanism. Quartz is an omnipresent, abundant natural mineral, used for luminescence dating. Lately, quartz based optically stimulated luminescence (OSL) technique is widely used to estimate the equivalent doses (De) for dating geological events (up to 250 Gy, limited by saturation). Some works report thermoluminescence (TL) saturation around (10-40) kGy. Still, dose estimates for such a high radiation dose (HRD) range are not achieved. Significant research exists about luminescence response for low dose ranges (¡250 Gy), but limited studies have been done for HRDs (¿1 kGy). This work tries to understand the luminescence of quartz for such high doses. Results show that the characteristics of the trap (¡$200^{\circ}$C) differ significantly at HRDs compared to low doses. TL in multi-spectral detection (UV-Visible) band suggests an increase in 340-$380^{\circ}$C peak intensity up to 11 kGy dose. The measurements of saturation dose suggest that it depends on the trapping centres but is independent of recombination centres for the samples used for the study. The traps are found bleachable by sunlight, reducing TL signal to residual levels in 1 hour. Further, the bleachability is found to be anti-correlated with luminescence emission wavelength. At HRDs luminescence sensitivity is influenced by dose given in the previous cycle, which is difficult to correct by routine normalisation procedures.

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This work is done in collaboration with M. Panda and O. Annalakshmi from IGCAR, Kalpakkam and S. H. Shinde and S. Mondal from BARC, Mumbai

**(Singhal, M., and N. Chauhan)**

**Changes in thermoluminescence sensitivity of 110℃ glow peak of quartz grains from sediments of River Ganga: Observation and implications**

This study documents changes in TL (110℃) sensitivity (TLS) of quartz grains from active bar sediments from four transects totalling to $\sim$4000 km in the Ganga River system (the Ganga, Yamuna, Ramganga and Chambal rivers), and examines its possible use for sediment provenance and in the estimation of sediment fluxes at confluences. This study suggested that in a given reach between two major tributary confluences, TLS in UV and blue emissions for both bleached and unbleached samples showed similar behaviour. However, OSL sensitivity (OSLS) showed large variability, possibly due to changes caused by bleaching (Singhvi et al., 2011). This suggests that the often-used OSLS on bleached samples should be avoided for such provenance studies. No clear dependence of TLS on transport distance was seen, possibly due to the fact that these rivers transport sediments under turbid flow conditions and therefore, most grains do not receive the requisite daylight exposure. The TLS of quartz grains from rocks, regolith and fluvial sediments from the Chambal and Ramganga basins suggest that the duration of sediment generation processes is key to sensitisation of quartz TLS. This observation leads to a plausible suggestion that TLS can serve as a surrogate of denudation rates, currently being estimated using cosmogenic isotopes. Further, large variations in TLS in the areas of sand mining offer a potential to use it in estimating the volumes of sands extracted, a factor critical for the sustainability of river systems and economics.

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**(Parida, S., R. K. Kaushal, N. Chauhan and A. K. Singhvi)**

**Deep-rooted Indian Middle Palaeolithic: Terminal Middle Pleistocene lithic assemblage from Retlapalle, Andhra Pradesh, India**

The Indian Middle Palaeolithic has been recognised as crucial evidence for understanding the complex behavioural dynamics of hominins. It is seen as a behavioural marker of early Homo sapiens in the region. Recent research has pushed back the timeline of the Middle Palaeolithic to the Middle Pleistocene epoch, indicating a potential in-situ emergence from the earlier Late Acheulian culture. India's long-lasting Middle Palaeolithic culture evolved over multiple glacial-interglacial cycles, showing signs of behavioural resilience to bigger climatic upheavals like $\sim$74 ka Toba super-eruption. This has added to the complexity of our understanding of the Middle Palaeolithic in the region and emphasises the need for further research. This study focuses upon the investigation of Middle Palaeolithic artefacts found in the Retlapalle area within the upper Gundlakamma river basin, Andhra Pradesh. The dating of the artifact-bearing layer was carried out using the p-IR-IRSL (post infrared-infrared stimulated luminescence) method, which revealed a burial age of $139\pm17$ thousand years. The Retlapalle assemblage is characterised by a diverse range of Levallois core reductions, various retouched artefacts, with a dominance of pointed tools and a few blade components. The study provides a valuable addition to the existing body of data concerning Palaeolithic sites dating back to the Middle Pleistocene, a relatively underexplored period.

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This work is done in collaboration with Anil Devara, Prof. P. Ajithprasad and Vrushab Mahesh from MSU, Baroda; Gopesh Jha from the Department of Archaeology, Max Planck Institute of Geoanthropology, Jena, Germany and Zakir Khan from Pt. Ravishankar, Shukla University, Raipur

**(Monika Devi and Naveen Chauhan)**

**Luminescence and radiocarbon chronology of Bhagatrav: A Sorath Harappan camp site in South Gujarat**

Excavation at the site of Bhagatrav yielded four layers of cultural deposits: the lowermost being the Sorath Harappan, the upper two are medieval, and the remaining layer caps the Sorath Harappan layer. A horn-deity painted dish was found in a stratified context at the lowest level. The medieval deposit includes turquoise glazed and celadon wares, followed by an abundance of Monochrome Glazed Ware, which is otherwise known as the Khambhat ware. The date of the Sorath Harappan layer of the site, the time and space of the horn-deity motif in the Harappan world, and the date of Khambhat ware have long been subjects of discussion. With the help of a series of absolute dating (radiocarbon and luminescence), this paper attempts to place the site, the horn-deity motif, and the Khambhat ware in the cultural chronology of Gujarat

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This work is done in collaboration with A.K. Kanungo from IIT-GN, J.S. Kharakwal from JRN Rajasthan Vidyapeeth and S. Ansari from Deccan College, Maharashtra

**(R. K. Kaushal, R. Bhushan, N. Chauhan)**

### Luminescence and dosimetry investigations of Eu(III) doped $\mathrm{C}a_2\mathrm{C}e\mathrm{VO}_6$ novel double perovskite

A new novel phosphor having application to lighting devices and radiation dosimetry was synthesised. The composition of vanadate double perovskite $\mathrm{C}a_2\mathrm{C}e\mathrm{VO}_6$ doped with $\mathrm{E}u^{3+}$ was successfully achieved using combustion synthesis, wherein the doping levels of $\mathrm{E}u^{3+}$ ranged from 1 to 6 mol%. The Rietveld refinement of the powder X-ray diffraction (XRD) data confirmed the orthorhombic structure of the phosphors. Scanning electron microscopy (SEM) and energy-dispersive X-ray analysis (EDAX) were employed to investigate the surface morphology and elemental distribution in the phosphor, respectively. Under the excitation at 280 nm and 467 nm, the phosphor exhibited strong down-conversion red photoluminescence (PL) emission, attributed to $\mathrm{E}u^{3+}$ transitions (5D0-7FJ, where J = 0–3) originating from its 4f states. The intensity of PL emission shows an increasing trend with increasing doping concentration. However, exceeding the threshold doping concentrations led to a reduction in PL intensity due to multipolar interaction effects. Additionally, the $\mathrm{E}u^{3+}$ doped $\mathrm{C}a_2\mathrm{C}e\mathrm{VO}_6$ phosphors were subjected to irradiation with a radioactive $^{90}\mathrm{S}r/^{90}\mathrm{Y}$ beta source to explore their thermoluminescence (TL) properties. Post-irradiation, the phosphors displayed prominent TL glow curves, with the most intense peak at around 94 ℃, followed by peaks at 160 ℃ and 288 ℃. The TL intensity of these peaks exhibited a linear dose response within the dose range of 1 Gy–50 Gy. Besides, the TL fading and reproducibility tests showed satisfactory results. Furthermore, Tmax-Tstop experiments revealed the presence of three trap centres within the trap depth range of 0.7–2.1 eV in the $\mathrm{C}a_2\mathrm{CeVO}_6$:$\mathrm{Eu}^{3+}$ phosphor. Additionally, the glow curve deconvolution (GCD) was employed to determine trapping parameters, providing valuable insights into the TL behaviour of the phosphor. Overall, the results suggest that the novel phosphor under study holds promise for its applications in lighting devices and TL dosimetry (TLD)

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This work is done in collaboration with Naresh Degda, Nimesh Patel, Vishwnath Verma, Dr. M. Srinivas and Prof. K.V.R. Murthy from MSU Baroda

**(Malika Singhal and Naveen Chauhan)**

### Thermally stable luminescence and dosimetric features of Ho(III) activated tungstate double perovskite

Luminescent, efficient tungstate double perovskites $\mathrm{C}a_3\mathrm{WO}_6$ doped with $\mathrm{H}o^{3+}$ were synthesised via the solid-state reaction at 1200 ℃. The resulting phosphors were analysed using Rietveld refinement of X-ray diffraction (XRD) data, confirming a monoclinic crystal structure with crystallite sizes ranging between 50 and 55 nm. Optical band gap determination was facilitated by diffusion reflectance spectra (DRS). Fourier transform infrared (FTIR) studies were conducted to identify functional group vibrations. The optical excitation of the $\mathrm{C}a_3\mathrm{WO}_6$: $\mathrm{H}o^{3+}$ phosphors under different excitation conditions resulted in intense green photoluminescence (PL) emission at 545 nm, indicative of the 5F4–5I8 transition of $\mathrm{H}o^{3+}$ ions. Thermal stability assessment of $\mathrm{C}a_3\mathrm{WO}_6$:1 % $\mathrm{H}o^{3+}$ phosphor under blue excitation (454 nm) revealed good thermally stable luminescence of about 85.32 % at LED working temperature (150 $^\circ$C). PL decay studies were conducted to analyse fluorescent behaviour, wherein by means of PL decay lifetime, the PL quantum efficiency of $\mathrm{C}a_3\mathrm{WO}_6$ :1 % $\mathrm{H}o^{3+}$ phosphor is computed to be 91.1 %. The CIE (Commission Internationale de l'Eclairage) colour coordinates of the phosphors being investigated reside within the green spectral region, with a calculated colour purity of 93.25 % observed for $\mathrm{C}a_3\mathrm{WO}_6$ : 1%$\mathrm{H}o^{3+}$. Furthermore, the phosphors under study exhibited high-quality thermoluminescence (TL) after beta irradiation. The detailed TL characterisation conducted to assess dosimetric properties. The impact of $\mathrm{H}o^{3+}$ concentrations and beta dose on TL intensity is a major aspect that has been investigated in detail. TL fading experiments were performed to determine the dose storage capacity over a month after beta irradiation. Additionally, the various heating rates (VHR) experiments are conducted to determine the TL kinetic parameters. Besides, the glow curve deconvolution (GCD) for trap parameter determination is also applied, where the results obtained are comparable with the VHR results

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This work is done in collaboration with Naresh Degda, Nimesh Patel, Dr. M. Srinivas and Prof. K.V.R. Murthy from MSU Baroda

**(Malika Singhal and Naveen Chauhan)**

### Strong field-induced three-body fragmentation dynamics of $\mathrm{CH_3C}l^{2+}$

Fragmentation dynamics of doubly ionised polyatomic molecules is a complex process in which multiple bonds break simultaneously or sequentially. PRL scientists investigated the three-body fragmentation of $\mathrm{CH_3C}l$ dications induced by intense femtosecond laser pulses in a home-built COLd Target Recoil Ion Momentum Spectrometer (COLTRIMS) setup. To understand the complex excited-state dynamics of the dication and the momentum sharing between the fragments, Dalitz plots, Newton diagrams, and the native frame method were used, which helped distinguish between the concerted and sequential fragmentation mechanisms. The femtosecond pulse chirping and its effect on fragmentation are also studied. This study demonstrates that the pulse chirp influences the complex fragmentation dynamics of the $\mathrm{CH_3C}l$ dication.

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This work is under collaboration with Prof. Dheeraj K Singh, CUG, Gandhinagar

**(Rituparna Das, Amit K Bhojani, Madhusudhan P, Vinitha Nimma, Pranav Bhardwaj, Dheeraj K Singh and Rajesh Kumar Kushawaha)**

**Bimolecular photodissociation of interstellar 1-Cyanonaphthalene via Intermolecular Coulombic decay**

The Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous in space, and govern interstellar chemistry. The two isomers of cyanonaphthalene (1-CNN and 2-CNN) were the first PAHs to be recently identified in the Taurus Molecular Cloud (TMC-1). Their large abundance is attributed to high photostability with nearly no photofragmentation at photon energies above the ionisation potential. scientists at PRLshowed that at ambient light, and at densities akin to dense molecular clouds and the upper atmosphere of planets and moons, 1-CNN could undergo extensive fragmentation through a new mechanism leading to daughter cations. Intermolecular Coulombic decay between the two photoexcited units of the dimer leads to ionisation, and the subsequent molecular rearrangements form new daughter cations. These daughter cations could react further, contributing to rich bottom-up astrochemistry, and could play a pivotal role in developmental astrobiology

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This work is done in collaboration with Prof. Arvind G, IIT Madras, Chennai

**(Saurav Dutta, Nihar Ranjan Behera, Saroj Basik, Rajesh Kumar Kushwaha, Y. Sajeev, G. Aravind)**

**Investigation of signal enhancement in nanoparticle-enhanced molecular LIBS of graphite**

We have studied signal enhancement in molecular emission lines of C2 and CN formed after laser ablation of graphite samples in the presence of nano-particles. The observed enhancements have been explained by carrying out a systematic study of plasma evolution to estimate the lifetime of species in the plasma in the presence of silver nanoparticles. By calculating various plasma parameters, we have successfully demonstrated that these signal enhancements can be explained based on optimal changes in the electron number density, rotational and vibrational temperature of these species. This study has a direct impact on improving the detection limits of weak molecular bands using laser-induced breakdown spectroscopy.

doi : `https://doi.org/10.1039/D4JA00089G`

**(Swetapuspa Soumyashree and Prashant Kumar)**

**Quantitative analysis of trace elements in liquid samples using laser-induced breakdown spectroscopy**

We have demonstrated a technique utilising a drop-casting method for the determination of trace elements in liquids using Laser Induced Breakdown Spectroscopy (LIBS). The drop-casting method results in a homogeneous sample distribution over a laser-pre-treated target. This phase-conversion approach improves the repeatability, and, hence, reliability in analysing liquid samples directly using LIBS. The technique have been validated through a multi-element standard solution using in-house obtained calibration curves. This methodology was also used for some of the river water samples, and the results were compared with the ICP-OES technique, showing reasonable agreement.

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This work was done in collaboration with PDEU, Gandhinagar

**(Parmar, Darshitsinh & Mehta, Kavil & Soumyashree, Swetapuspa & Srivastava, Rohit & Sudheer, A. & Kumar, Prashant & Baruah, Prahlad)**

**Synergistic influence of external electric field on laser ablation in liquid: Correlating nanoparticle synthesis and cavitation bubble dynamics**

Experiments were carried out to investigate the influence of an external electric field on the cavitation bubble dynamics and silver (Ag) nanoparticles (NPs) during laser ablation in liquid (LAL). The width of size distribution for Ag NPs decreases significantly by 4 times in the presence of an electric field. The bubble size also decreases in the presence of an electric field. Due to the presence of electrons on the surface of NPs, Coulombic interactions between ablated matter inside the bubble will result in electrostatic pressure. If the charge distribution on the surface of NPs increases, the electrostatic repulsion between NPs will cause the size of NPs to decrease due to a decline in agglomeration of small NPs. Such repulsion inside the bubble will also lead to the synthesis of uniform NPs with a narrow size distribution.

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This work was done in collaboration with PDEU, Gandhinagar

**(Kavil Mehta, Manushi Ahuja, Prashant Kumar, Rajesh K Kushawaha and Prahlad K Baruah)**

**Enhancing Key Rates of QKD Protocol by Coincidence Detection**

Quantum key distribution provides unconditional security; however, its practical implementations are susceptible to vulnerabilities. Integrating coincidence detection (CD) protocol with the decoy pulses protocol enhances the security. Furthermore, monitoring the coincidences in the decoy state protocol leads to enhanced key rates under realistic experimental conditions, as carried out in the QST (Quantum science & technology) Lab

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This work is done in collaboration with Rutvij Bhavsar and Ayan Biswas from the University of York, UK

**(Tanya Sharma, Jayanth R, Pooja Chandravanshi, Shashi Prabhakar, and R. P. Singh)**

**Investigating device-independent quantum random number generation**

A random number generator is a resource necessary for cryptography and is a prerequisite for numerous applications. The quality of randomness in algorithmically generated random bit streams relies on their computational complexity and speed, and they do not provide the advantage of device independence. Quantum random number generators (QRNGs) offer an alternative approach based on their quantum unpredictability arising from the laws of quantum mechanics. There is no common consensus on using a single quantum certification for all quantum random number generators, and the certification process is also challenging.We proposed and experimentally implemented a technique for certification using quantum two-photon Hong-Ou-Mandel interference Our technique, being device-independent, assumes no constraints imposed by the devices. To test the generated random bits, we implemented the NIST statistical test suite and min-entropy, and found them to be statistically random

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This work is done in collaboration with Anindya Banerji Center for Quantum Technologies, National University of Singapore, 117543, Singapore

**(Vardaan Mongia, Abhishek Kumar, Shashi Prabhakar, and R. P. Singh)**

# Theoretical Physics

**Sensitivity to CP discovery in the presence of Lorentz invariance-violating potential at T2HK/T2HKK**

This work studied the possibility of testing violation of fundamental symmetries in neutrino oscillation experiments. The symmetry considered was the Lorentz Invariance symmetry which implies that the laws of physics are frame independent. The question explored was if the proposed neutrino oscillation experiment – T2HK in Japan can probe this. We investigated the sensitivity for the two proposed configurations of the T2HK experiment: (i) one detector each placed at 295 km and 1100 km, and (ii) two identical detectors at 295 km. One of the main aims for these experiments is to detect the violation of charge conjugation and parity symmetry in the lepton sector. We showed how the violation of Lorentz invariance symmetry can affect these measurements.

doi : `https://doi.org/10.1140/epjc/s10052-024-12541-y`

**(Supriya Pan, Kaustav Chakraborty, Srubabati Goswami)**

**Freeze-in production of sterile neutrino dark matter in a gauged U(1)$'$ model**

The evidence of tiny neutrino mass from the neutrino oscillation experiments has established that there is physics beyond the Standard Model (SM). Apart from the non-zero neutrino mass, the SM also cannot provide a candidate for the Dark Matter (DM). The non-observation of any signal in the direct detection of DM experiments puts stringent bounds on the DM-nucleon scattering cross section which severely restricts the models with Weakly Interacting Massive Particles whose masses are greater than 1 GeV. A general extension of the Standard Mode was studied to explain the observed light neutrino mass and the relic abundance of DM. In this scenario, the active light neutrinos are Majorana particles whereas the three pairs of heavy neutrinos are pseudo-Dirac in nature and one pair of them can be considered as the DM candidate whose relic abundance is generated through the freeze-in mechanism. The model also contains a Beyond Standard Model neutral gauge boson whose mass is generated once the additional symmetry is broken spontaneously. Considering different mass regimes of the DM, and reheating temperature, constraints on the parameters of the extended model that can give the correct relic abundance of DM was obtained. Constraints on mass and coupling of the new gauge boson were also derived from consideration of relic density as well as high energy collider experiments and/or intensity and lifetime frontier experiments. Additionally, in this model, the decay of pseudo-Dirac DM into active neutrinos can explain the 511 keV line observed by the INTEGRAL satellite.

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This work was done in collaboration with A. Das of Institute for the Advancement of Higher Education, Hokkaido University, K.N. Vishnudath of Universidad Técnica Federico Santa María, Chile and T.K. Poddar of Universidad Técnica Federico Santa María, Italy

**(Srubabati. Goswami)**

**Absolute neutrino mass observables and light sterile neutrinos**

Neutrinos are the second most abundant particles in the universe and three types of neutrinos have been detected experimentally so far. They exhibit a unique property of transforming among one another while traveling through large distances. This is the phenomenon of neutrino oscillation which established that at least two of the three neutrinos have small but non-zero mass. Some of the oscillation experiments hint towards the presence of another light neutrino which do not have the standard interactions. This is called a sterile neutrino. Neutrino oscillation experiments can only give an idea about the mass squared differences but not about the absolute mass of the neutrino states. This information can come from absolute neutrinos mass-observables, i.e., the sum of the neutrino masses, effective electron neutrino mass, and effective Majorana mass that are constrained from the observations of cosmology, nuclear beta decay, and neutrinoless double beta decay experiments, respectively. The impact of the presence of an additional light sterile neutrino was investigated for the different mass variables. In the presence of a sterile state, the ordering of the different neutrino mass states is unknown, with four possible mass spectra, where the sterile neutrino can be higher or lower than the one or more active neutrino states. Constraints were obtained on the various mass schemes. It was found that the mass spectra corresponding to the eV scale sterile neutrino are strongly constrained from all three observables. In contrast, the presence of an even lighter sterile neutrino is mildly constrained from current experimental sensitivities. Future experiments will be sensitive enough to probe these orderings.

doi : `https://link.aps.org/doi/10.1103/PhysRevD.110.015028`

**(Srubabati Goswami, Debashis Pachhar, Supriya Pan)**

**Neutrino mass, Neutrinoless double beta decay and flavour observables via scalar leptoquarks**

The process of double beta decay, in which no neutrinos are emitted accompanying a beta particle, can provide a smoking gun signal for violation of lepton number – a quantum number associated with the leptons, a class of fundamental particles. Such violations are often linked to generation of masses for neutrinos. A comprehensive analysis of neutrinoless double beta decay and its interplay with low-energy flavor observables in a radiative neutrino mass model with scalar leptoquarks were investigated. Leptoquarks are particles that can couple to both leptons and quarks and hence can contribute to the neutrino less double beta decay. The implications for these for the neutrino mass and neutrino less double beta decay were discussed for parameter values consistent with different experimental observations. It was found that in the presence of leptoquarks the lifetime of the neutrinoless double beta decay process can be different than the standard case. This can be probed in future neutrinoless double beta decay experiments.

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This work was done in collaboration with P.S.B. Bhupal Dev of Washington University St. Louis and C. Majumdar of University College of London.

**(Srubabati Goswami, Debashis Pachhar)**

**Soft gluon and charm loop effects in semi-leptonic B meson decays**

Non-factorizable charm loop effects are crucial in understanding the $B \to K\ell\ell$ and similar modes. Studies employing B-meson Distribution Amplitudes (DAs) have led to the conclusion that these effects are rather small. Employing light meson DAs and computing the effects is an independent check. It is found that charm loop effects vanish to the sub-sub-leading accuracy. A suggestive reason could be a more symmetric light meson light-cone DA structure, and thus, leads one to conclude that such charm loop effects can be safely neglected in such modes, thereby being important for new physics searches.

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This work was done in collaboration with Dayanand Mishra of Tata Institute of Fundamental Research, Mumbai, India

**(Namit Mahajan)**

**Radiative inclusive semi-leptonic decays of B-mesons and determination of nonperturbative parameters**

Semi-leptonic inclusive of B-mesons decays are theoretically clean and used routinely to extract the Cabibbo-Kobayashi-Maskawa (CKM) elements which are crucial parameters for the electroweak theory. These determinations are however marred with uncertainties stemming from inherent non-perturbative parameters that inevitably enter the theoretical description of these decays. A related set of decay modes could be where an additional hard (energetic) photon is present in the final state. Such a radiative inclusive decay is difficult to describe with the usual tools and therefore, approaching the problem in a more head-on way, i.e., directly calculating the dispersive parts, the decay rate of the modes with a heavier charm quark in the final state (where charm quark mass effects play an important role) as well as final states where the quark mass can be neglected are computed. The final states with charm quark appear more amenable to near future measurements. It is shown that making use of these processes with an additional hard photon in the final state can allow for a cleaner determination of the non-perturbative parameters, which for these two sets of modes turn out to be the same.

doi : `https://doi.org/10.1103/PhysRevD.110.053003`

**(Namit Mahajan, Dayanand Mishra)**

**Deep (machine) Learning for theoretical research**

Deep machine learning (DML) techniques have rapidly become indispensable tools in various branches of physics and the natural sciences. Their ability to extract meaningful information from complex, high-dimensional datasets has revolutionised data analysis and modelling. While DML's capabilities might suggest that human expertise is becoming obsolete, physics-inspired feature extractors offer significant advantages. These features provide a deeper understanding of the extracted information, leading to improved performance and interpretability of deep learning models. This work delves into the application of deep learning in particle physics, focusing on automatic feature extraction. By examining the benefits of physics-inspired architectures, we gain insights into how prior physics knowledge can enhance the naturalness of data representations, particularly in the context of point cloud analysis. Additionally, we explore the potential of graph-based methods for analysing LHC phenomenology. Through a systematic exploration of these topics, we aim to demonstrate the transformative power of deep learning in advancing our understanding of fundamental physics. By combining the strengths of human expertise and machine learning, one can unlock new frontiers of knowledge and discovery.

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This work was done in collaboration with Akanksha Bhardwaj, Oklahoma State University, United States and Vishal S. Ngairangbam, Institute for Particle Physics Phenomenology, Durham University, United Kingdom.

**(Partha Konar)**

**Precision Search for New Physics at the LHC**

Inert Higgs Doublet Model, augmented by Peccei-Quinn symmetry, presents a compelling framework for understanding dark matter. This model incorporates both Weakly Interacting Massive Particles (WIMPs) and axions as potential dark matter candidates. Interestingly, the PQ symmetry, originally proposed to address the strong CP problem, also ensures the stability of these WIMPs. This scenario offers a unique opportunity to explore dark matter at the Large Hadron Collider (LHC) through sophisticated machine-learning applications. By studying the interactions between visible particles, scientists can potentially infer the presence and properties of dark matter.

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**(Partha Konar, Anupam Ghosh)**

**Loop-induced masses for the first two generations with optimum flavour violation**

A mechanism for the masses of third, second, and first generation charged fermions at the tree, 1-loop, and 2-loop levels, respectively, is proposed. The fermionic self-energy corrections that lead to this arrangement are induced through heavy vector bosons of a new gauged flavour symmetry group, referred to as GF. It is shown that a single Abelian group suffices as GF. Moreover, the gauge charges are optimized to result in relatively smaller flavour violations in processes involving the first and second generation fermions. The scheme is explicitly implemented on the Standard Model fermions in an anomaly-free manner and is shown to be viable with observed charged fermion masses and quark mixings. Constraints from flavour violations dictate the lower limit on the new physics scale in these types of frameworks. Through optimal flavour violation, it is shown that nearly two orders of magnitude improvement can be achieved on the lower limit, leading to the new physics scale $\gtrsim$ 1000 TeV in this case. Further improvements are possible at the cost of the down quark mass deviating more than $3\sigma$ from its value extracted from lattice calculations. Options for inducing tiny masses for light neutrinos are also discussed.

doi : `https://doi.org/10.1007/JHEP12(2024)158`

**(Gurucharan Mohanta, Ketan M. Patel)**

**Residual flavor symmetries at the modular self-dual point and constraints on neutrino masses and mixing**

We explore the implications of symmetries that remain unbroken at the self-dual point $\tau = i$ in modular invariant theories. Assuming that (a) the three generations of lepton doublets transform as an irreducible representation of a finite modular group $\Gamma\mathrm{N}$, and (b) the light neutrino masses arise from the Weinberg operator and are in modular form, we demonstrate that this setup yields a unique residual flavor symmetry or antisymmetry for the neutrinos, depending on the modular weight. In the antisymmetric case, one neutrino is always massless, and the other two can be degenerate if the mass matrix is real. These findings are independent of the level N. If the charged leptons are arranged to exhibit an appropriate residual symmetry from the same $\Gamma\mathrm{N}$, they determine a column of the leptonic mixing matrix, leading to specific correlations between the mixing angles and the Dirac CP phase. The presence of residual (anti) symmetries enables the application of standard flavor symmetry techniques to derive these predictions, and we scan all possible $\Gamma\mathrm{N}$ satisfying condition (a). Most solutions yield $\mathrm{O}(1)$ entries in the fixed column, favouring relatively large lepton mixing.

doi : `https://doi.org/10.1103/PhysRevD.111.015010`

**(Monal Kashav, Ketan M. Patel)**

**Minimal type-I Dirac seesaw and leptogenesis under A4 modular invariance**

We present a Dirac mass model based on A4 modular symmetry within the Type-I seesaw framework. This extension of Standard Model requires three right-handed neutrinos and three heavy Dirac fermions superfields, all singlet under $\mathrm{SU}(2)_\mathrm{L}$ symmetry. The scalar sector is extended by the inclusion of a $\mathrm{SU}(2)_\mathrm{L}$ singlet superfield $\chi$. Here, the modular symmetry plays a crucial role as the Yukawa couplings acquire modular forms, which are expressed in terms of the Dedekind eta function $\eta(\tau)$. Therefore, the Yukawa couplings follow transformations akin to other matter fields, thereby obviating the necessity of additional flavon fields. The acquisition of vacuum expectation value by complex modulus $\tau$ leads to the breaking of A4 modular symmetry. We have obtained predictions on neutrino oscillation parameters, for example, the normal hierarchy for the neutrino mass spectrum. Furthermore, it is found that heavy Dirac fermions, in this model, can decay to produce the observed baryon asymmetry of the Universe through Dirac leptogenesis.

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This work was done in collaboration with L. Singh and S. Verma of Department of Physics and Astronomical Science, Central University of Himachal Pradesh, Dharamshala-176215, India

**(Monal Kashav)**

**Pseudogap in Strontium Iridate: Gorkov-Teitelbaum thermal activation model**

Recently, Hall effect measurements were done on Lanthanum doped Strontium Iridate which is the 5d analogue of cuprates. Hall effect measurements show that the effective carrier density exhibits a crossover near $x \simeq 0.16$. This is very similar to that found in cuprates around $p \simeq 0.19$. It is proposed that a pseudogap (PG) exists and ends at $x \simeq 0.16$. However, the PG boundary (in the doping-temperature phase diagram) remains unknown. In this work, a very successful Gorkov-Teitelbaum Thermal Activation (GTTA) model is applied to obtain its PG phase boundary and draw an updated phase diagram. Our results agree with previously known signatures of PG phase in this system. Using results from the GTTA model we also obtain the evolution of “Fermi arcs” in this system as a function of doping and temperature.

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This work was done in collaboration with Devarshi Dave of Chaitanya School, Gandhinagar, India.

**(Jalaja Pandya, Navinder Singh)**

**Drude’s lesser known error of a factor of two and Lorentz’s correction**

As is well known, Paul Drude put forward the very first quantitative theory of electrical conduction in metals in 1900. He could successfully account for the Wiedemann-Franz law which states that the ratio of thermal to electrical conductivity divided by temperature is a constant called the Lorenz number. As it turns out, in the Drude's derivation, there is a fortunate cancellation of two errors. Drude's under-estimate (by an order of 100) of the value of square of the average electron velocity compensated for his over-estimate of the electronic heat capacity (by the same order of 100). This compensation or cancellation of two errors lead to a value of the Lorenz number very close to its experimental value. This is well known. There is another error of a factor of two which Drude made when he calculated two different relaxation times for heat conductivity and electrical conductivity. In this article we highlight how and why this error occurred in Drude's derivation and how it was removed 5 years later (that is in 1905) by Hendrik Lorentz when he used the Boltzmann equation and a single relaxation time. This article is of pedagogical value and may be useful to undergraduate/graduate students learning solid state physics.

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**(Navinder Singh)**

**The Gorkov–Teitelbaum Thermal Activation Model for Cuprates: A Review**

While closing their famous paper entitled "Pseudogap: friend or foe of high-Tc?" Norman, Pines, and Kallin underlined that before we have a microscopic theory, we must have a consistent phenomenology. This was in 2005. As it turns out in 2006, a phenomenological theory of the pseudogap state was proposed by Gor'kov and Teitel'baum. This originated from their careful analysis of the Hall effect data, and it has been a very successful model as numerous investigations over the years have shown. In this mini-review the essence of the idea of Gor'kov and Teitel'baum is presented. The pseudogap obtained by them from the Hall effect data agrees very well with that obtained from the ARPES data. This famous Gor'kov-Teitel'baum Thermal Activation model (in short GTTA model) not only presents a consistent phenomenology of the pseudogap state but also it rationalizes the Hall angle data and it presents a strong case against the famous "two-relaxation times" idea of Anderson and collaborators.

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**(Navinder Singh)**

**Josephson diode effect in quantum dot junctions**

The diode effect in a semiconductor p-n junction is a well-established phenomenon in the literature. Recent breakthroughs showed the diode effect in superconductor junctions. PRL scientists have shown that combining a magnetic field and Rashba spin-orbit interaction induces a diode effect in quantum dot-based Josephson junctions. Interestingly, the sign and magnitude of the rectification coefficient of the Josephson diode are highly controllable by the magnetic field and Rashba strength. For realistic Rashba strength in the presence of a magnetic field and chirality, the rectification coefficient can be tuned to be as high as 70% by an external gate potential, indicating a giant Josephson diode effect in the junction. The proposed quantum dot-based Josephson diode has the potential for application in efficient superconductor-based quantum device components.

doi : `DOI:https://doi.org/10.1103/PhysRevB.109.174511`

**(Debika Debnath, Paramita Dutta)**

**Signatures of emergent Fermi surfaces in unconventional superconductor via transport**

The appearance of a gap in the Bogoliubov quasiparticle spectrum is a characteristic property of conventional ordinary Bardeen–Cooper–Schrieffer (BCS) superconductors. For many unconventional superconductors, this gap in the momentum space vanishes either at specific point nodes or along line nodes. Very recently, topologically protected inflated Fermi surfaces called Bogoliubov Fermi surfaces have been proposed to exist in some unconventional superconductors. PRL scientist found clear signatures of the Bogoliubov Fermi surface via transport phenomena through a hybrid junction that combines the unconventional superconductor and a normal metal, and also confirmed the role of the Bogoliubov quasiparticles present at the Fermi surface by checking the effective charge of the carriers.

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This work was done in collaboration with Amartya Pal and Arijit Saha of the Institute of Physics, Bhubaneswar, India

**(Paramita Dutta)**

**Thermal Diode effect in Weyl Josephson junctions**

Following the recent breakthroughs in the diode effect in superconductor junctions, PRL scientists proposed the thermal diode effect in the Josephson junction based on Weyl material. The application of an out-of-plane magnetic field to the middle region of the junction and a temperature gradient across the junction induces an asymmetry between the forward and reverse thermal currents, causing the thermal diode effect. Interestingly, it is shown that the sign and magnitude of the thermal diode rectification coefficient are highly tunable by the superconducting phase difference and the external magnetic field and also strongly depend on the junction length. The tunability of the rectification, particularly the sign-changing behavior associated with higher rectification, enhances the potential of this diode to be used as a functional switching component in thermal devices.

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This work was done in collaboration with Pritam Chatterjee of the Institute of Physics, Bhubaneswar, India.

**(Paramita Dutta)**

**Fermi arc mediated transport in Weyl semimetal nanowire**

Topological Fermi arcs are found in topological materials like Weyl semimetals. It is one of the unique properties of the novel topological Weyl semimetals. However, extracting the signatures of Fermi arcs from the bulk states has always been a challenge, as both of them are gapless in nature and connected to each other. PRL scientists captured the signatures of Fermi arcs via transport in an inversion symmetry broken Weyl semimetals, considering slab and nanowire geometry and found the Fermi arcs-mediated conductance to be quantized. The work is extended to include a Weyl semimetal/Weyl superconductor nanowire hybrid junction to find the signatures of the Fermi via the Andreev reflection process. The results are robust against delta-correlated quenched disorder and thus enhance the experimental feasibility.

doi : `https://doi.org/10.1103/PhysRevB.109.235419`

This work was done in collaboration with Amartya Pal and Arijit Saha of the Institute of Physics, Bhubaneswar, India

**(Paramita Dutta)**

**Signatures of emergent Fermi surfaces in unconventional superconductor via thermoelectricity**

Ordinary Bardeen–Cooper–Schrieffer (BCS) superconductors are characterized by a gapped density of states. This gap in the momentum space vanishes in some unconventional superconductors either at specific point nodes or along line nodes. Very recently, topologically protected inflated Fermi surfaces called Bogoliubov Fermi surfaces have been proposed to exist in some unconventional superconductors. PRL scientists found clear signatures of the Bogoliubov Fermi surface via thermoelectricity in a superconductor heterostructure and studied the role of the Bogoliubov quasiparticles present at the Fermi surface in the thermoelectric figure of merit. We observed a substantial enhancement in the Seebeck coefficient and thermoelectric figure of merit due to the generation of these Fermi surfaces and thus making such a setup a potential candidate for device applications.

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This work was done in collaboration with Amartya Pal and Arijit Saha of the Institute of Physics, Bhubaneswar, India

**(Paramita Dutta)**

**Field-free Josephson diode effect in chiral quantum dot junctions**

The diode effect in a semiconductor p-n junction is a well-established phenomenon in the literature. Recent breakthroughs showed the diode effect in superconductors, including Josephson junctions. PRL scientists have shown that the diode effect can appear in quantum dot Josephson junctions without any magnetic field in the presence of finite Coulomb repulsion and chirality. PRL scientists found a sign-changing behavior of the diode rectification coefficient with the Coulomb correlation and the lead-to-dot coupling strength, and found the maximum magnitude of the rectification to be 72% for moderate interaction strength. The proposed field-free Josephson diode based on interacting chiral quantum dots may be a potential switching component in superconductor-based devices.

doi : `https://iopscience.iop.org/article/10.1088/1361-648X/adbeaf`

**(Debika Debnath, Paramita Dutta)**

**On Higgs+jet production at next-to-leading power accuracy**

Computation of the next-to-leading power corrections is presented for Higgs plus one jet production in a hadron collider via gluon fusion channel. It is argued that shifting of spinors in the helicity amplitudes of non-radiative dipoles captures the leading next-to-soft radiative behaviour and makes the calculation tractable. The connection between the shifted dipole spinors and the colour ordered radiative amplitudes is established through this work. It is found that next-to-maximal helicity violating amplitudes do not play a role in this correction. Compact analytic expressions of next-to-leading power logarithms coming from different helicity configurations are shown for the first time in the literature.

doi : `https://doi.org/10.1103/PhysRevD.109.114018`

**(Sourav Pal, Satyajit Seth)**

**Soft quark effects on H+jet production at NLP accuracy**

Soft quark operators that enable construction of colour-ordered helicity amplitudes out of the non-radiative ones, are defined through this work. These operators are explored and applied for Higgs plus one jet production in a hadron collider and the next-to-leading power corrections on all partonic channels involving quark(s) and/or anti-quark(s) are studied. The effect of next-to-soft gluon radiation in these channels is also investigated employing the technique of shifting of dipole spinors, as illustrated in our previous work. Analytical expressions of next-to-leading power leading logarithms thus obtained are simple and compact in nature. Further, the connection of such logarithms with that of the pseudo-scalar Higgs plus one jet production is also studied in detail.

doi : `https://doi.org/10.1016/j.physletb.2024.139179`

**(Sourav Pal, Satyajit Seth)**

**Proxy-SU(4) symmetry in A=60-90 region of atomic nuclei**

Applications of the proxy-SU(3) model of Bonatsos and collaborators to nuclei in A=60-90 region introduces proxy-SU(4) symmetry. Shell model spaces with single particle orbits ${}^1p_{3/2}$, ${}^1p_{1/2}$, ${}^0f_{5/2}$ and ${}^0g_{9/2}$ are essential for these nuclei and also protons and neutrons in this region occupy the same single particle orbits. With this and applying the "proxy scheme", the ${}^0g_{9/2}$ changes to ${}^0f_{7/2}$ giving the spectrum generating algebra U(40) $\supset$ [U(10) $\supset$ G $\supset$ SO(3)] $\otimes$ [SUST(4) $\supset$ SUS(2) $\otimes$ SUT(2)]. With G=SU(3), we have the proxy-SU(3) model. It is easy to see that proxy-SU(3) symmetry implies goodness of the SU(4) symmetry appearing above, i.e. proxy-SU(4) symmetry. Shell model calculations pointing out the need for ${}^0g_{9/2}$ orbit, ground state masses, shape changes and shape co-existence in A=60-90 region and GT distributions clearly show the importance of proxy-SU(4) in this mass region. Besides showing this evidence, new proxy schemes with G=SU(5), SO(6) and SO(10) that are generated by good proxy-SU(4) symmetry are identified and developed in some detail. An important feature is that the four proxy symmetries SU(3), SO(6), SU(5) and SO(10) appear twice.

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This work was done in collaboration with R. Sahu of NIST, Berhampur.

**(V.K.B. Kota)**

### Cross sections of neutral-current neutrino scattering on ${}^{98,100}$Mo isotopes

Coherent elastic neutrino-nucleus scattering (CE$\nu$NS) is a neutral-current low-energy electro-weak reaction-channel detected recently by the COHERENT experiment at the ORNL, USA, in the Spallation Neutron Source facility. The extremely weak signal on the CsI detector of the first experiment and on the liquid Ar of the repeated COHERENT experiment is the energy-recoil due to the neutrino-nucleus interaction, where the nucleus is elastically scattered as a whole while simultaneously the neutrino goes out. Today, several promising nuclear detectors are on the way to be employed in designed and ongoing experiments. It is known that the Mo isotopes are prominent detection media. For our cross section calculations we utilize the Donnelly-Walecka multipole decomposition method in which the $\nu$-nucleus cross sections are given as a function of the excitation energy of the target nucleus. Also employed, in the calculations, for the initial and final nuclear states are the Deformed Shell Model (DSM) wavefunctions. The DSM was used previously by our group for similar predictions in other electroweak processes. We produced predictions for both coherent and incoherent scattering cross sections off neutrinos on ${}^{98,100}$Mo isotopes and found that the incoherent part is 10% of the total cross section.

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This work was done in collaboration with R. Sahu of NIST, Berhampur and T.S. Kosmas of University of Ioannina, Greece.

**(V.K.B. Kota)**

### Cross sections of neutral-current neutrino scattering on ${}^{94,96}$Mo isotopes

In our recent first work on neutral-current $\nu$-nucleus cross sections for the coherent and incoherent channels for ${}^{98,100}$Mo isotopes, assuming a Mo detector medium, we haven't included the contributions in the cross sections stemming from the stable ${}^{94,96}$Mo isotopes (abundance of ${}^{94}$Mo 9.12% and of ${}^{96}$Mo 16.50%). Following this, we have also performed detailed calculations of $\nu$-${}^{94,96}$Mo scattering cross sections, for a given energy $\mathrm{E}_\nu$ of the incoming neutrino, for coherent and incoherent processes. In many situations, the $\mathrm{E}_\nu$ ranges from 10-30 MeV and in the present work we used $\mathrm{E}_\nu = 15$ MeV. We have obtained cross sections as a function of the excitation energy (and J$^\pi$ values) of the target nucleus. Because only the coherent cross section is measured by current experiments, it is worth estimating what portion of the total cross section represents the measured coherent rate. This requires the knowledge of the incoherent cross section which is also calculated in the present work. Results for the four isotopes ${}^{94,96,98,100}$Mo show that most of the incoherent cross section ($\sim$ 10% of the total) comes from 2 or 3 Gamow-Teller-like 1+ states. In future, we plan to perform similar cross sections calculations for the rest of the stable Mo isotopes (i.e. for ${}^{92,95,97}$Mo). Given the CE$\nu$NS cross sections for all the seven stable isotopes, one may easily find the events predicted to be measured by, for example, a Mo detector of 100 kg mass.

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This work was done in collaboration with R. Sahu of NIST, Berhampur and T.S. Kosmas of the University of Ioannina, Greece.

**(V.K.B. Kota)**

### Anomalous tbW couplings and T-odd observables in single-top production

This study investigates whether an anomalous tbW coupling can be detected using T-odd observables, such as the transverse polarization of the anti-top quark and a momentum-based correlation in its leptonic decay. These observables are sensitive only to the imaginary part of one specific coupling, which could signal CP violation or quantum absorptive effects. The analysis estimates detection limits for a collider with 7 TeV protons and 60 GeV (or 150 GeV) electrons, showing that higher energy improves sensitivity to such new physics signals.

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**(S. D. Rindani)**

# Publications in Journals

**Astronomy and Astrophysics**


1. Algaba. J. C., M. Balokovic, S. Chandra, ..., W. Zhong, 2024, *"Broadband multi-wavelength properties of M87 during the 2018 EHT campaign including a very high energy flaring episode"*, Astronomy & Astrophysics, v. 692, p. 1-44, doi :`https://doi.org/10.1051/0004-6361/202450497`.

2. Banerjee. S., G. C. Dewangan, C. Knigge, M. Georganti, P. Gandhi, N. P. S. Mithun, P. Saikia, D. Bhattacharya, D. M. Russell, F. Lewis, and A. A. Zdziarski, 2024, *"A Multiwavelength Study of the Hard and Soft States of MAXI J1820+070 During Its 2018 Outburst"*, The Astrophysical Journal, v. 964, p. 189, doi :`https://doi.org/10.3847/1538-4357/ad24ef`.

3. Bhadari. N. K., L. K. Dewangan, O. R. Jadhav, A. Hoque, L. E. Pirogov, P. F. Goldsmith, A. K. Maity, Saurabh Sharma, A. Haj Ismail, T. Baug, 2025, *"JWST-ALMA study of a hub-filament system in the nascent phase"*, Astronomy & Astrophysics Letters, v. 694, p. 8, doi :`https://doi.org/10.1051/0004-6361/202452189`.

4. Bhalerao. V., D. Sawant, A. Pai, S. Tendulkar, S. Vadawale, D.Bhattacharya, V. Rana, H. K. L. Adalja, G. C. Anupama, S. Bala, S. Banerjee, J. Basu, H. Belatikar, P. Beniamini, M. Bhaganagare, A. Bhaskar, S. Bhattacharjee, S. Bose, B. Cenko, M. Vijay Chanda, G. Dewangan, V. Dixit, A. Dutta, P. Gawade, A. Ghodgaonkar, S. Kumar Goyal, S. Gunasekaran, M. Hemanth, K. Hotokezaka, S. Iyyani, P. J. Guruprasad, M. Kasliwal, J. G. Koyande, S. Kulkarni, A. Kutty, T. Ladiya, S. Mahapatra, D. Marla, S. Mate, A. Mehla, N. P. S. Mithun, S. More, R. Mote, D. Mukherjee, S. Narang, S. Narendranath, A. Nema, S. Nimbalkar, S. Nissanke, S. Palit, J. Patel, A. Patel, B. Paul, P. Pradeep, P. Ramachandran, K. Roy, B. S. B. Saiguhan, J. Saji, M. Saleem, D. Saraogi, P. Sastry, M. Shanmugam, P. Sharma, A. Shetye, N. Singh, S. Singh, A. Singhal, S. Sreekumar, S. Sridhar, R. Srinivasan, S. Tallur, N. K. Tiwari, A. Lakshmi Vadladi, C. S. Vaishnava, S. Vishwakarma, and G. Waratkar,, 2024, *"Science with the Daksha high energy transients mission"*, Experimental Astronomy, v. 57, p. 23, doi :`https://doi.org/10.1007/s10686-024-09923-1`.

5. Bhalerao. V., S. Vadawale, S. Tendulkar, D. Bhattacharya, V. Rana, H. K. L. Adalja, H. Belatikar, M. Bhaganagare, G. Dewangan, A. Ghodgaonkar, S. Kumar Goyal, S. Gunasekaran, G. P J, J. G. Koyande, S. Kulkarni, A. Kutty, T. Ladiya, S. Mahapatra, D. Marla, S. Mate, N. P. S. Mithun, R. Mote, S. Narang, A. Nema, S. Nimbalkar, A. Pai, S. Palit, A. Patel, J. Patel, P. Pradeep, P. Ramachandran, B. S. Bharath Saiguhan, D. Saraogi, D. Sawant, M. Shanmugam, P. Sharma, A. Shetye, N. Singh, S. Singh, A. Singhal, S. Sreekumar, S. Sridhar, R. Srinivasan, S. Tallur, N. K. Tiwari, A. Lakshmi Vadladi, C. S. Vaishnava, S. Vishwakarma, and G. Waratkar, 2024, *"Daksha: on alert for high energy transients"*, Experimental Astronomy, v. 57, p. 24, doi :`https://doi.org/10.1007/s10686-024-09926-y`.

6. Chakraborty. A., Kapil Kumar Bharadwaj, Neelam J.S.S.V. Prasad, Rishikesh Sharma, Kevikumar A. Lad, Ashirbad Nayak, Nikitha Jithendran, Vishal Joshi, Vivek Kumar Mishra, Nafees Ahmed, 2024, *"The PRL 2.5m Telescope and its First Light Instruments: FOC & PARAS-2"*, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, v. 93, p. 19, doi :`https://doi.org/10.25518/0037-9565.11602`.

7. Chand S., G. C. Dewangan, A. A. Zdziarski, D. Bhattacharya, N. P. S. Mithun, and S. V. Vadawale, 2024, *"Accretion Geometry of GX 339-4 in the Hard State: AstroSat View"*, The Astrophysical Journal, v. 93, p. 20, doi :`https://doi.org/10.3847/1538-4357/ad5a88`.

8. Chauhan Manish., M.R. Samal, 2024, *"Search for protostellar jets with UWISH2 in the molecular cloud complexes Vulpecula and IRDC G53.2"*, Monthly Notices of the Royal Astronomical Society, v. 530, p. 515, doi :`https://doi.org/10.1093/mnras/stae846`.

9. Chen. Li, Sheng-Li Qin, T. Liu, ...., L. K. Dewangan, ..., Y. Zhang, 2025, *"The ALMA-ATOMS survey: Vibrationally excited HC3N lines in hot cores"*, Astronomy & Astrophysics, v. 694, p. 14, doi :`https://doi.org/10.1051/0004-6361/202452598`.

10. Chhotaray. B., S. Naik, G. K. Jaisawal, G. Ahuja, 2024, *"Optical and X-ray studies of the Be/X-ray binary IGR J06074+2205'"*, Monthly Notices of the Royal Astronomical Society, v. 534, p. 2380-2847, doi :`https://doi.org/10.1093/mnras/stae2282`.

11. Cooper W. J., H. R. A, Jones, R. L. Smart, R. L., ...., A. S. Rajpurohit, ..., J. Shi, 2024, *"The Gaia ultracool dwarf sample-IV. GTC/OSIRIS optical spectra of Gaia late-M and L dwarfs"*, Monthly Notices of the Royal Astronomical Society, v. 534, p. 695-725, doi :`https://doi.org/10.1093/mnras/stae2102`.

12. Das S. R., M. Merello, L. Bronfman, ...., L. K. Dewangan, ..., L. V. Toth, 2024, *"ATOMS: ALMA three-millimetre observations of massive star-forming regions-XVII. High-mass star-formation through a large-scale collapse in IRAS 15394-5358"*, Monthly Notices of the Royal Astronomical Society, v. 534, p. 3832, doi :`https://doi.org/10.1093/mnras/stae2275`.

13. Dewangan L. K., N. K. Bhadari, A. K. Maity, O. R. Jadhav, Saurabh Sharma, A. Haj Ismail,, 2025, *"Mon R2: A Hub-Filament System with an Infrared Bubble at the Hub*

*Center"*, The Astronomical Journal, v. 169, p. 18, doi :https://doi.org/10.3847/1538-3881/ad9b22.

14. Evans. A., D. P. K. Banerjee, T. R. Geballe, A. Polin, E. Y. Hsiao, E. Y., K. L. Page, C. E. Woodward, S. Starrfield, 2025, *"Near-infrared spectroscopy of the LMC recurrent nova LMCN 1968-12a"*, Monthly Notices of the Royal Astronomical Society, v. 536, p. 1710-1717, doi :https://doi.org/10.1093/mnras/stae2711.
15. Evans. A., D. P. K. Banerjee, W. P. Varricatt, V. Joshi, 2024, *"A dusty rain falls on the nova V959 Monocerotis"*, Monthly Notices of the Royal Astronomical Society, v. 531, p. 728-738, doi :https://doi.org/10.1093/mnras/stae1240.
16. Gupta R., S. B. Pandey, S. Gupta, T. Chattopadhayay, D. Bhattacharya, V. Bhalerao, A. J. Castro-Tirado, A. Valeev, A. K. Ror, V. Sharma, J. Racusin, A. Aryan, S. Iyyani, and S. Vadawale, 2024, *"A Detailed Time-resolved and Energy-resolved Spectro-polarimetric Study of Bright Gamma-Ray Bursts Detected by AstroSat CZTI in Its First Year of Operation"*, The Astrophysical Journal, v. 972, p. 166, doi :https://doi.org/10.3847/1538-4357/ad5a92.
17. Jadhav O. R., L. K. Dewangan, A. Verma, N. K. Bhadari, A. K. Maity, Saurabh Sharma, Mamta, 2025, *"Uncovering the Hidden Physical Structures and Protostellar Activities in the Low-metallicity S284-RE Region: Results from ALMA and JWST"*, The Astrophysical Journal, v. 980, p. 14, doi :https://doi.org/10.3847/1538-4357/ada388.
18. Kayal Abhijit, V. Singh, 2024, *"X-ray spectral properties of dust-obscured galaxies in the XMM-SERVS coverage of the XMM-LSS field"*, Monthly Notices of the Royal Astronomical Society, v. 531, p. 830-850, doi :https://doi.org/10.1093/mnras/stae1191.
19. Kumar Ranjan., A. Moharana, S. Piridi, A. C. Pradhan, K. G. Helminiak, N. Ikonnikova, A. Dodin, R. Szczerba, M. Giersz, D. K. Ojha and M.R. Samal, 2024, *"Discovery of a hot post-AGB star in Galactic globular cluster E3"*, Astronomy and Astrophysics, v. 685, p. L6, doi :https://doi.org/10.1051/0004-6361/202449777.
20. Kumar. S., G. C. Dewangan, P. Gandhi, I. E. Papadakis, N. P. S. Mithun, K. P. Singh, D. Bhattacharya, A. A. Zdziarski, G. C. Stewart, S. Bhattacharyya, and S. Chandra, 2024, *"Multi-epoch UV-X-Ray Spectral Study of NGC 4151 with AstroSat"*, The Astrophysical Journal, v. 975, p. 73, doi :https://doi.org/10.3847/1538-4357/ad77ca.
21. Layek N., P. Nandi, S. Naik, A. Jana, 2025, *"A Long-term Study of Mrk 50: Appearance and Disappearance of Soft Excess"*, The Astrophysical Journal, v. 981, p. 21, doi :https://doi.org/10.3847/1538-4357/adabc0.
22. Maity A. K., L. K. Dewangan, N. K. Bhadari, Y. Fukui, A. Haj Ismail, O. R. Jadhav, Saurabh Sharma, H. Sano, 2025, *"G321.93-0.01: A Rare Site of Multiple Hub-filament Systems with Evidence of Collision and Merging of Filaments"*, The Astronomical Journal, v. 169, p. 20, doi :https://doi.org/10.3847/1538-3881/ad98ff.
23. Maity A. K., T. Inoue, Y. Fukui, L. K. Dewangan, H. Sano, R. I. Yamada, K. Tachihara, N. K. Bhadari, O. R. Jadhav, 2024, *"Cloud-Cloud Collision: Formation of Hub-filament Systems and Associated Gas Kinematics. Mass-collecting Cone-A New Signature of Cloud-Cloud Collision"*, The Astrophysical Journal, v. 974, p. 24, doi :https://doi.org/10.3847/1538-4357/ad7098.
24. Maurya Jayanand., M.R. Samal, L. Amard, Y. Zhang, H. Niu, S. C. Kim, Y. Joshi, B. Kumar, 2024, *"Origin of extended main-sequence turn-off in open cluster NGC 2355"*, Monthly Notices of the Royal Astronomical Society, v. 532, p. 1212, doi :https://doi.org/10.1093/mnras/stae1611.
25. Mishra A. K., D. R. Sarkar, P. Prajapati, A. Singh, P. K. Kasarla, S. Ganesh, 2024, *"A summary of instruments proposed for observing pulsating variables from the Mt. Abu Observatory"*, Journal of Astrophysics & Astronomy, v. 45, p. 1, doi :https://doi.org/10.1007/s12036-024-10019-7.
26. Mookerjea B., G. Maheswar, K. Acharyya, ...., L. K. Dewangan, ..., V. S. Veena, 2025, *"Research on the interstellar medium and star formation in the Galaxy : An Indian perspective"*, Journal of Astrophysics and Astronomy, v. 46, p. 1-26, doi :https://doi.org/10.1007/s12036-024-10022-y.
27. Naik S., B. Chhotaray, N. Kumari, 2024, *"Optical Spectroscopy of 1A 0535+262 Before, During, and After the 2020 Giant X-ray Outburst"*, Bulletin de la Société Royale des Sciences de Liège, v. 93, p. 657-669, doi :https://doi.org/10.25518/0037-9565.11829.
28. Nandi P., S. Naik, A. Chatterjee, S. K. Chakrabarti, S. Safi-Harb, N. Kumari, N. Layek, 2024, *"Accretion properties of a low-mass active galactic nucleus: UGC 6728"*, Monthly Notices of the Royal Astronomical Society, v. 532, p. 1185-1198, doi :https://doi.org/10.1093/mnras/stae1529.
29. Pandey Ruchi, M. K. Srivastava, G. Shaw, 2024, *"A phenomenological study of the evolution of shock-induced O I emission lines in the spectrum of nova V2891 Cygni"*, Monthly Notices of the Royal Astronomical Society, v. 532, p. 3985-4001, doi :https://doi.org/10.1093/mnras/stae1719.
30. Panwar Neelam., C. Rishi, S. Sharma, D. K. Ojha, M. R. Samal, H. P. Singh, and R. K. Yadav, 2024, *"Low-mass Stellar and Substellar Content of the Young Cluster Berkeley 59"*, Astronomical Journal, v. 168, p. 89, doi :https://doi.org/10.3847/1538-3881/ad5552.
31. Piridi S., R. Kumar., D. Pandey., A. Pradhan., 2024, *"A Comprehensive Catalog of UVIT Observations. I. Catalog Description and First Release of Source Catalog (UVIT DR1)"*, The Astrophysical Journal Supplement Series, v. 275, p. 34, doi :https://doi.org/10.3847/1538-4365/ad85de.
32. Raj A., M. S. Bisht, F.M. Walter, R. Pandey, C.E. Woodward, D.E. Harker, D. Bisht, H.P. Singh, A. Agarwal, J.Pandey, A.Joshi, K. Belwal and C. Buil, 2024, *"The dusty aftermath of a rapid nova: V5579 Sgr"*, Publications of the Astronomical Society of Australia, v. 41, p. e051, doi :https://doi.org/10.1017/pasa.2024.65.
33. Rawat Vineet., M. R. Samal, D. K. Ojha, B. Kumar, S, Sharma, J. Jose, R. Sagar, and R. K. Yadav, 2024, *"Peering into the Heart of the Giant Molecular Cloud G148.24+00.41: A Deep Near-infrared View of the Newly Hatched Cluster FSR 655"*, Astronomical Journal, v. 168, p. 136, doi :https://doi.org/10.3847/1538-3881/ad630d.
34. Saha A., A. Tej, H. Liu, ...., L. K. Dewangan, ..., L. V. Toth, 2024, *"Direct Observational Evidence of Multi-epoch Massive Star Formation in G24.47+0.49"*, The Astrophysical Journal, v. 970, p. 15, doi :https://doi.org/10.3847/2041-823/ad6144.

35. Sanjay Baliwal, Rishikesh Sharma, Abhijit Chakraborty, Akanksha Khandelwal, K.J. Nikitha, Boris S. Safonov, Ivan A. Strakhov, Marco Montalto, Jason D. Eastman, David W. Latham, Allyson Bieryla, Neelam J.S.S.V. Prasad, Kapil K. Bharadwaj, Kevikumar A. Lad, Shubhendra N. Das, Ashirbad Nayak, 2024, *"Discovery and characterization of a dense sub-Saturn TOI-6651b"*, Astron. & Astrophys., v. 931, p. 14, doi :https://doi.org/10.1051/0004-6361/202450934.

36. Sanjay Baliwal, Rishikesh Sharma, Abhijit Chakraborty, K. J. Nikitha, A. Castro-González, Hareesh G. Bhaskar, Akanksha Khandelwal, David W. Latham, Allyson Bieryla, Vincent Bourrier, Neelam J.S.S.V. Prasad, Kapil K. Bharadwaj, Kevikumar A. Lad, Ashirbad Nayak, Vishal Joshi and Jason D. Eastman, 2025, *"TOI-6038 A b: A dense sub-Saturn in the transition regime between the Neptunian ridge and savanna"*, The Astronomical Journal, v. 169:147, p. 15, doi :https://doi.org/10.3847/1538-3881/ada959.

37. Saraogi D., J. V. Aditya, V. Bhalerao, S. Bala, A. Balasubramanian, S. Mate, T. Chattopadhyay, S. Gupta, V. Prasad, G. Waratkar, P. K. Navaneeth, R. Gopalakrishnan, D. Bhattacharya, G. Dewangan, and S. Vadawale, 2024, *"Localization of gamma-ray bursts using AstroSat Mass Model"*, Monthly Notices of the Royal Astronomical Society, v. 530, p. 1386, doi :https://doi.org/10.1093/mnras/stae435.

38. Sil M., A. Das, R. Das, R. Pandey, A. Faure, H. Wiesemeyer, P. Hily-Blant, F. Lique, P. Caselli, 2024, *"Fate and detectability of rare gas hydride ions in nova ejecta: A case study with nova templates"*, Astronomy and Astrophysics, v. 692, p. 1-15, doi :https://doi.org/10.1051/0004-6361/202348445.

39. Singal A. K., 2024, *"Cosmic dipoles of active galactic nuclei at optical and radio wavelengths display much larger amplitudes than the cosmic microwave background dipole"*, Monthly Notices of the Royal Astronomical Society, v. 533, p. L1-L6, doi :https://doi.org/10.1093/mnrasl/slae039.

40. Singal A. K., 2024, *"Horizon, homogeneity and flatness problems: do their resolutions really depend upon inflation?"*, The European Physical Journal C, v. 84, p. 385, doi :https://doi.org/10.1140/epjc/s10052-024-12740-7.

41. Singal A. K., 2024, *"Enigmatic factor of 4/3 in electromagnetic momentum of a moving spherical capacitor"*, European Journal of Physics, v. 45, p. 52, doi :https://doi.org/10.1088/1361-6404/ad7ae4.

42. Singh Sadhana, J. C. Pandey, T. Hoang, N. Panwar, B. J. Medhi, V. Joshi, S. Ganesh, 2024, *"Foreground Dust Properties toward the Cluster NGC 7380"*, The Astronomical Journal, v. 167, p. 16, doi :https://doi.org/10.3847/1538-3881/ad36c3.

43. Soam A., C. Eswaraiah, A. Seta, L. K. Dewangan., G. Maheswar, 2024, *"Turbulence and magnetic fields in star formation"*, Journal of Astrophysics and Astronomy, v. 45, p. 1-12, doi :https://doi.org/10.1007/s12036-024-10005-z.

44. Tiwari N. K., S. V. Vadawale, N. P. S. Mithun, C. S. Vaishnava, and B. Saiguhan, 2024, *"DarsakX: A Python package for designing and analyzing imaging performance of X-ray telescopes"*, Astronomy and Computing, v. 47, p. 100829, doi :https://doi.org/10.1016/j.ascom.2024.100829.

45. Tiwari N. K., Vadawale S. V. and Mithun N. P. S., 2025, *"A novel optical design for wide-field imaging in X-ray astronomy"*, Experimental Astronomy, v. 59, p. 1-29, doi :https://doi.org/10.1007/s10686-025-09992-w.

46. Uppal N., S. Ganesh, V. Pelgrims, S. Joshi, M. Sarkar, 2024, *"Linear polarization study of open clusters in the anticenter direction: Signature of the spiral arms"*, Astronomy & Astrophysics, v. 690, p. 21, doi :https://doi.org/10.1051/0004-6361/202449537.

47. Vadawale S. V., N. P. S. Mithun, M. Shanmugam, Amit Basu Sarbadhikari, Rishitosh K. Sinha, Megha Bhatt, S. Vijayan, Neeraj Srivastava, Anil D. Shukla, S. V. S. Murty, Anil Bhardwaj, Y. B. Acharya, Arpit R. Patel, Hiteshkumar L. Adalaja, C. S. Vaishnava, B. S. Bharath Saiguhan, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, Yash Srivastava, Varsha M. Nair, Tinkal Ladiya, Shiv Kumar Goyal, Neeraj K. Tiwari, Shyama Narendranath, Netra S. Pillai, Arup Kumar Hait, Aaditya Patinge, Abhishek Kumar, Neeraj Satya, Vivek R. Subramanian, Sonal G. Navle, R. G. Venkatesh, Lalitha Abraham, K. Suresh, Amitabh, 2024, *"Chandrayaan-3 APXS elemental abundance measurements at lunar high latitude"*, Nature, v. 633, p. 327-331, doi :https://doi.org/10.1038/s41586-024-07870-7.

48. Verma A., Saurabh Sharma, L. K. Dewangan, D. K. Ojha, K. Mallick, R. K. Yadav, H. Kaur, T. Chand, Mamta, A. Gupta, 2024, *"Investigating the Star-forming Sites in the Outer Galactic Arm"*, The Astronomical Journal, v. 168, p. 15, doi :https://doi.org/10.3847/1538-3881/ad5a8b.

49. Von Fellenberg, S. D. and 26 colleagues including Chandra S., 2025, *"First Mid-infrared Detection and Modeling of a Flare from Sgr A*"*, The Astrophysical Journal Letters, v. 979, p. 1-15, doi :https://doi.org/10.3847/2041-8213/ada3d2.

50. Yang D., H. Liu, T. Liu, ...., L. K. Dewangan, ..., J. Xie, 2024, *"The ALMA-QUARKS Survey: Fibers' Role in Star Formation Unveiled in an Intermediate-mass Protocluster Region of the Vela D Cloud"*, The Astrophysical Journal, v. 976, p. 14, doi :https://doi.org/10.3847/1538-4357/ad8919.

51. Zhang S., T. Liu, K. Wang, ...., L. K. Dewangan, 2024, *"ATOMS: ALMA three-millimeter observations of massive star-forming regions - XVIII. On the origin and evolution of dense gas fragments in molecular shells of compact H II regions"*, Monthly Notices of the Royal Astronomical Society,, v. 535, p. 1364, doi :https://doi.org/10.1093/mnras/stae2415.

**Solar Physics**

52. Chaurasiya, R., Bayanna, A. R., 2025, *"Observational Study of the Atmospheric Gravity Waves in the Lower Solar Atmosphere"*, Monthly Notices of the Royal Astronomical Society, v. 537, p. 2243–2257, doi :https://doi.org/10.1093/mnras/staf045.

53. Chaurasiya, R., Bayanna, A. R., Louis, R. E., Pereira, T. M. D., Mathew, S. K., 2024, *"On the Response of the Transition Region and the Corona to Rapid Excursions in the Chromosphere"*, The Astrophysical Journal, v. 970, p. 179, doi :https://doi.org/10.3847/1538-4357/ad50d5.

54. Dalal, B., Chakrabarty, D., Srivastava, N., Sarkar, A., 2024, *"Suprathermal Population Associated with Stream*

*Interaction Regions Observed by STEREO-A: New Insights"*, The Astrophysical Journal, v. 960, p. 16, doi :https://doi.org/10.3847/1538-4357/ad08c6.

55. Dubey, S. K., Mathew, S. K., Bayanna, A. R., 2024, *"Umbral Flashes and Their Association with Running Penumbral Waves: A Study Using MAST Ca II 8542 ÅNarrow-band Observations"*, Monthly Notices of the Royal Astronomical Society, v. 535, p. 1228–1241, doi :https://doi.org/10.1093/mnras/stae2426.

56. Kumar, H., Kumar, B., Mathew, S. K., Bayanna, A. R., and Rajaguru, S. P., 2024, *"Investigation of Phase Shift and Travel Time of Acoustic Waves in the Lower Solar Atmosphere Using Multi-Height Velocities"*, The Astrophysical Journal, v. 972, p. 39–48, doi :https://doi.org/10.3847/1538-4357/ad5d60.

57. Kumar, S., Srivastava, N., Gopalswamy, N., Dash, A., 2024, *"On The Influence of the Solar Wind on the Propagation Of Earth-impacting Coronal Mass Ejections"*, The Astrophysical Journal, v. 977, p. 57, doi :https://doi.org/10.3847/1538-4357/ad8e63.

58. Maity, S.S., Sarkar, R., Chatterjee, P., Srivastava, N., 2024, *"Changes in Photospheric Lorentz Force in Eruptive and Confined Solar Flares"*, The Astrophysical Journal, v. 962, p. 86, doi :https://doi.org/10.3847/1538-4357/ad13f0.

59. Maurya, Y. K., Bhattacharyya, R., and Pontin, D., 2024, *"Generation and Annihilation of Three Dimensional Magnetic Nulls in Extrapolated Solar Coronal Magnetic Field: Data-Based Implicit Large Eddy Simulation"*, Physica Scripta, v. 99, p. 075017, doi :https://doi.org/10.1088/1402-4896/ad511e.

60. Maurya, Y. K., Bhattacharyya, R., Pontin, D., and Kumar, S., 2024, *"Exploring the Generation and Annihilation of Three-Dimensional Nulls Through MHD Simulations in Initially Chaotic Magnetic Field Devoid of Nulls"*, Physics of Plasmas, v. 31, p. 074502, doi :https://doi.org/10.1063/5.0217951.

61. Mohan, A., Gopalswamy, N., Kumari, A., Akiyama, S., Sindhuja, G., 2024, *"Interplanetary Type IV Solar Radio Bursts: A Comprehensive Catalog and Statistical Results"*, The Astrophysical Journal, v. 971, p. 86, doi :https://doi.org/10.3847/1538-4357/ad5315.

62. Nayak, S. S., Sen, S. S., Srivastava, S. K., Bhattacharyya, R., Athiray, P. S., 2024, *"Exploring the Magnetic and Thermal Evolution of a Coronal Jet"*, The Astrophysical Journal, v. 975, p. 143, doi :https://doi.org/10.3847/1538-4357/ad779c.

63. Oliveira, D.M., Allen, R.C., Srivastava, N., et al., 2024, *"Predicting Interplanetary Shock Occurrence for Solar Cycle 25: Opportunities and Challenges in Space Weather Research"*, Space Weather, v. 22, p. 8, doi :https://doi.org/10.1029/2024SW003964.

64. Patel, B. D., Joshi, B., Sterling, A. C., Moore, R. L., 2024, *"Source Region and Launch Characteristics of Magnetic-Arch-Blowout Solar Coronal Mass Ejections Driven by Homologous Compact-Flare Blowout Jets"*, The Astrophysical Journal, v. 969, p. 48, doi :https://doi.org/10.3847/1538-4357/ad4995.

65. Rao, S.S., Srivastava, N., Chakraborty, M., Kumar, S., Chakrabarty, D., 2024, *"Observations of Geomagnetic Crochet at High-latitudes Due to X1.5 Class Solar Flare on 3 July 2021"*, Space Weather, v. 22, p. 2, doi :https://doi.org/10.1029/2023SW003719.

66. Rawat, A., Gupta, G. R., 2024, *"Effect of Area Divergence and Frequency on Damping of Slow Magnetoacoustic Waves Propagating Along Umbral Fan Loops"*, Monthly Notices of the Royal Astronomical Society, v. 533, p. 1166, doi :https://doi.org/10.1093/mnras/stae1889.

67. Sarkar, J., Roy, S., Ramaprakash, A. N., Deogaonkar, R., Padinhatteeri, S., Tripathi, D., Ghosh, A., Bayanna, A. R., Ahmed, G. A., 2024, *"Photometric Calibration and Spectral Validation of the Solar Ultraviolet Imaging Telescope Onboard Aditya-L1"*, Journal of Astronomical Telescopes, Instruments, and Systems, v. 11, p. 014005, doi :https://doi.org/10.1117/1.JATIS.11.1.014005.

68. Sarkar, R., Srivastava, N., Gopalswamy, N., Kilpua, E, 2024, *"Modelling the Magnetic Vectors of ICMEs at Different Heliocentric Distances with INFROS"*, The Astrophysical Journal Supplement Series, v. 273, p. 36, doi :https://doi.org/10.3847/1538-4365/ad7dc0.

69. Sharma, K., Rajwanshi, A., Kumar, S., Das, R.M., Srivastava, N., 2024, *"Predicting Maximum Amplitude and Rise Time of Solar Cycle 25 Using Modified Geomagnetic Precursor Technique"*, Solar Physics, v. 299, p. 167, doi :https://doi.org/10.1007/s11207-024-02412-w.

70. Wagner, A., Price, D. J., Bourgeois, S., Daei, F., Pomoell, J., Poedts, S., Kumari, A., Barata, T., Erdélyi, R., Kilpua, E. K., 2024, *"The Effect of Data-Driving and Relaxation Models on Magnetic Flux Rope Evolution and Stability"*, Astronomy & Astrophysics, v. 692, p. A74, doi :https://doi.org/10.1051/0004-6361/202346951.

71. Yogesh, Gopalswamy, N., Chakrabarty, D., Laming, J.M., Mostafavi, P., Yashiro, S., Srivastava, N., Ofman, L., 2024, *"Origins of Very Low Helium Abundance in the Solar Wind"*, The Astrophysical Journal, v. 977, p. 89, doi :https://doi.org/10.3847/1538-4357/ad84d6.

**Planetary Sciences**

72. Ahmed, S., Acharyya, K., 2025, *"The extent of formation of organic molecules in the comae of comets showing relatively high activity"*, Icarus, 427, 116374, doi :https://doi.org/10.1016/j.icarus.2024.116374.

73. Ahmed, S., Soni, V., 2024, *"Modeling the plasma composition of 67P/C-G at different heliocentric distances"*, Icarus, 422, 116253, doi :https://doi.org/10.1016/j.icarus.2024.116253.

74. Almohammed, A., Bhui, U.K., Ray, D., Shukla, A.D., Madhavan, N., 2024, *"Spectroscopic characterization of fluorite of Amba Dongar, Gujarat, India: Linking chemical composition with color"*, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 318, 124464, doi :https://doi.org/10.1016/j.saa.2024.124464.

75. D. Banerjee, 2024, *"Theoretical modelling of alpha particle-induced X-ray signals from the lunar surface"*, Current Science, 126, 307-308, doi :https://www.currentscience.ac.in/Volumes/126/03/0307.pdf.

76. Diptiranjan Rout, S. V. Thampi, Y. Miyoshi, Tarun K. Pant and Anil Bhardwaj, 2024, *"The response of the Venusian upper atmosphere during the passage of interplanetary Coronal Mass Ejections"*, Journal of Geophysical Research: Space Physics, v. 129, p.1-15, doi :https://doi.org/10.1029/2024JA032553.

77. Durga Prasad, K., Ambily, G., 2024, *"Effect of COVID-19 global lockdown on our Moon"*, Monthly Notices of the Royal Astronomical Society, 535, L18-L25, doi :https://doi.org/10.1093/mnrasl/slae087.

78. Durga Prasad, K., Kumar, C., Ambily, G., Reddy, P.K., Mishra, S.K., Kumar, J. and Bhardwaj, A., 2025, *"Higher surface temperatures near south polar region of the Moon measured by ChaSTE experiment on-board Chandrayaan-3"*, Communications Earth and Environment, 6, 153, doi :https://doi.org/10.1038/s43247-025-02114-6.

79. Durga Prasad, K., Misra, D., Amitabh, Bhatt, M., Ambily, G., Sathyan, S., Srivastava, N. and Bhardwaj, A., 2024, *"Chandrayaan-3 alternate landing site: pre-landing characterization"*, Current Science, 126(7), 774-780, doi :https://doi.org/10.18520/cs/v126/i7/774-780.

80. Goyal, S. K., Tiwari, N. K., Patel, A. R., Shanmugam, M., Vadawale, S. V., Chakrabarty, D., Sebastian, J., Dalal, B., Sharma, P., Sarkar, A., Sarda, A., Ladiya, T., Verma, A. J., Singh, N., Kumar, S., Painkra, D. K., Kumar, P., Shah, M. S., Adhyaru, P. R., Adalja, H. L., Banerjee, S. B., Subramanian, K. P., Bapat, B., Dadhania, M. B., Kumar, A., Janardhan, P. and Bhardwaj, A., 2025, *"Aditya Solar Wind Particle Experiment on Board Aditya-L1: The Supra-Thermal and Energetic Particle Spectrometer"*, Solar Physics, 300, 35, doi :https://doi.org/10.1007/s11207-025-02441-z.

81. Indu, G. K., James, S., Sathyan, S., Aswathi, J., Rani, V.R., Nair, V.M., Varghese, L.M., Sajinkumar, K.S., Sharma, N., Dhali, M., Anand, A., Rajesh, V.J., Praveen, M.N., Chavan, A., Bhandari, S. and Malik, J.N., 2025, *"Revised chronology and expanded insights: Geologic perspective on the Luna Impact Event and its influence on the Harappan Civilization"*, Meteoritics and Planetary Science, 60, 422-441, doi :https://doi.org/10.1111/maps.14308.

82. Kimi, K. B., Harish, K. S., Sharini, K. S., Chavan, A. and Vijayan, S., 2024, *"Deformation of the Gruithuisen region lava tube under compressional stress on the Moon"*, Geology, 52(8), 625-630, doi :https://doi.org/10.1130/G52143.1.

83. Kimi, K. B., Vijayan, S., Sharini, K. S., Harish, S., Tuhi, S., Chavan, A. and Priya, R. K. S., 2025, *"Recent Tectonic Activity in and Around the Posidonius Crater, Moon"*, Journal of Geophysical Research, 130, e2024JE008446, doi :https://doi.org/10.1029/2024JE008446.

84. Majeed, T., Bougher, S. W., Withers, P., Haider, S. A. and Morschhauser, A., 2025, *"Magnetically controlled ionosphere of Mars: A model analysis with vertical plasma drift effects"*, Icarus, 429, 116467, doi :https://doi.org/10.1016/j.icarus.2024.116447.

85. Mathew, N., Durga Prasad, K., Mohammad, F., Aasik, V., Vajja, D.P., Chandran, M.S. and Bhardwaj, A., 2025, *"Thermal conductivity of high latitude lunar regolith measured by Chandra's Surface Thermophysical Experiment (ChaSTE) onboard Chandrayaan 3 lander"*, Scientific Reports, 15, 7535, doi :https://doi.org/10.1038/s41598-025-91866-4.

86. Mathew, N., Durga Prasad, K., Vajja, D.P., Aasik, V., Mohammad, F., Chandran, M.S. and Bhardwaj, A., 2025, *"Chandra's Surface Thermophysical Experiment (ChaSTE) onboard Chandrayaan 3 Lander"*, Advances in Space Research, 75(7), 5936-5945, doi :https://doi.org/10.1016/j.asr.2025.01.022.

87. Mookerjea, B., Maheswar, G. and Acharyya, K., 2025, *"Research on the interstellar medium and star formation in the Galaxy: An Indian perspective"*, Journal of Astrophysics and Astronomy, 46, 3, doi :https://doi.org/10.1007/s12036-024-10022-y.

88. Nath, R., Mali, S., Denesh, K., Verma, A. J., Kumar, A., Mahajan, R. R., Sarbadhikari, A. B., Varela, M. E., Ehgamberdiev, S. A., Kapadia, T. and Srivastava, N., 2025, *"Classifying meteorites with MetNet: A deep learning approach using reflectance spectroscopy"*, Meteoritics and Planetary Science, 2025, 14342, doi :https://doi.org/10.1111/maps.14342.

89. Patel, S., Harish, S., Vijayan, M.R. and El-Maarry, 2025, *"A case for young igneous volcanism in the Terra Sirenum region, Mars"*, Icarus, 432, 116512, doi :https://doi.org/10.1016/j.icarus.2025.116512.

90. Ray, D., Das, A., Sarkar, S., Bhattacharya, S. and Nayak, C., 2025, *"Natrojarosite formed in the Matanomadh Formation, Kutch, India; a Na analog of jarosite on Mars"*, American Mineralogist, 9360, 652365, doi :https://doi.org/10.2138/am-2024-9360.

91. Ray, D., Marhas, K. K., Sheel, V. and Bhardwaj, A., 2024, *"Report on the International Conference Meteoroid, Meteor and Meteorites: Messengers from Space - MetMESS-2024 held during 20-22 November 2024"*, Journal of Geological Society of India, 101(1), 136-137, doi :https://doi.org/10.17491/jgsi/2025/174073.

92. Ray, D., Misra, S., Park, C., Newsom, H.E. and Peterson, E.J., 2024, *"Maskelynite as seen in shocked Lonar target basalt, India, and martian and lunar meteorites"*, Geochemistry, 84, 126127, doi :https://doi.org/10.1016/j.chemer.2024.126127.

93. Ray, D., Sarkar, S., Das, A., Arora, G., Shukla, A.D. and Bhardwaj, A., 2025, *"The Kopargaon LL5 chondrite: A new fall of monomict breccia from India"*, Journal of Earth System Science, 134, 1-14, doi :https://doi.org/10.1007/s12040-024-02497-8.

94. Sana, T. and Mishra, S.K., 2024, *"Possibility of inverse sheath in the lunar nightside due to secondary electron emission"*, Fundamental Plasma Physics, 10, 100052, doi :https://doi.org/10.1016/j.fpp.2024.100052.

95. Sana, T. and Mishra, S.K., 2024, *"Revisiting lunar dust charging and dynamics", Physics of Plasmas"*, Physics of Plasmas, 31, 1-16, doi :https://doi.org/10.1063/5.0225693.

96. Shanmugam, M., Vadawale, S.V., Patel, A.R., Mithun, N.P.S., Kumar, H., Ladiya, T., Goyal, S.K., Tiwari, N.K., Singh, N., Kumar, S., Painkra, D.K., Hait, A.K., Patinge, A., Kumar, A., Basha, S. and Bhardwaj, A., 2024, *"Alpha Particle X-ray Spectrometer (APXS) on Chandrayaan-3 Pragyan Rover"*, Journal of Aerospace Sciences and Technologies, 76(2A), 336-341, doi :https://doi.org/10.61653/joast.v76i3a.2024.1007.

97. Sheel, V., Uttam, S. and Mishra, S.K., 2025, *"Electric fields due to charged dust within a vortex"*, Physics of Plasmas, 32, 033704, doi :https://doi.org/10.1063/5.0240977.

98. Singh, D., Sinha, R. K. and Acharyya, K., 2024, *"Comprehensive Analysis of a Chloride-Rich Topographic Depression in Terra Sirenum, Mars: A Possible Lost Basin with Astrobiological Significance"*, Journal of Geophysical Research, 129, e2024JE008311, doi :https://doi.org/10.1029/2024JE008311.

99. Singh, N., Shanmugam, M., Patel, A., Kumar, S., Painkra, D.K., Ladiya, T. and Vadawale, S., 2025, *"Characterisation of Multichannel SDD X-Ray Spectrometer with ASIC Readout"*, Advances in Space Research, 75, 5630-5639, doi :https://doi.org/10.1016/j.asr.2025.01.019.

100. Sinha, R.K., Gautam, A., Laha, J., Panwar, N., Vijayan, S., Srivastava, N. and Bhardwaj, A., 2025, *"Geological mapping of Chandrayaan-3 landing area: New insights into provenance of materials, crater chronology and origin of rocks"*, Advances in Space Research, 75(7),, 5911-5935, doi :https://doi.org/10.1016/j.asr.2025.01.020.

101. Soni, V. and Acharyya, K., 2024, *"Signature of Vertical Mixing in Hydrogen-dominated Exoplanet Atmospheres"*, The Astrophysical Journal, 977, 52, doi :https://doi.org/10.3847/1538-4357/ad891f.

102. Srivastava, Y., Basu Sarbadhikari, A., Yamaguchi, A., Takenouchi, A., Day, J. M. D. and Ubide, T., 2024, *"Magmatic evolution of KREEP-free lunar meteorite Asuka-881757 inferred from sector-zoned clinopyroxene, pyroxene symplectites, and thermodynamic modeling"*, Meteoritics and Planetary Science, 59, 14257, doi :https://doi.org/10.1111/maps.14257.

103. Verma, N., Bhatt, M., Dangi, M., Kumar, S., Bhardwaj, A., 2025, *"Exploring water-ice deposits in lunar polar craters with Chandrayaan-2 DFSAR data"*, Icarus, 432, 116492, doi :https://doi.org/10.1016/j.icarus.2025.116492.

104. Vijayan, S., Kimi, K. B., Chavan, A., Aditi, R., Thahira, U., Subramanian, V. R., Sinha, R. K., Vadawale, S., Shanmugam, M., Mithun, N. P. S., Patel, A. R., Basu, S. A., Iyer, K. V., Suresh, K., Prashar, A., Rima, G. and Bhardwaj, A., 2025, *"Chandrayaan-3 landing site evolution by South Pole-Aitken basin and other impact craters"*, Icarus, 425, 1-14, doi :https://doi.org/10.1016/j.icarus.2024.116329.

105. Vrinda Mukundan, Paul Withers, Smitha V. Thampi and Anil Bhardwaj, 2025, *"Decoupling the Influence of Solar Cycle and Seasons on Mars' Dayside Ionosphere: Insights from MAVEN Observations during the Declining Phase of Solar Cycle 24"*, Icarus, v. 431, p. 1-11, doi :https://doi.org/10.1016/j.icarus.2025.116470.

106. Wöhler, C., Arnaut, M. and Bhatt, M., 2024, *"Multiband Spectropolarimetry of Lunar Maria, Pyroclastics, Fresh Craters, and Swirl Materials"*, Astronomical Journal, 167, 1-12, doi :https://doi.org/10.3847/1538-3881/ad2f2f.

107. Yi, E.S., Kim, K., Wöhler, C., Berezhnoy, A.A., Hess and M., Bhatt, M., 2025, *"The origin of the high-$TiO_2$ region near the Manilius and Hyginus craters within Mare Vaporum on the Moon"*, Icarus, 433, 116495, doi :https://doi.org/10.1016/j.icarus.2025.116495.


**Space and Atmospheric Sciences**


108. Ankush Bhaskar, Jayadev Pradeep, Shyama Narendranath, Dibyendu Nandy, Bhargav Vaidya, Priyadarshan Hari, Smitha V. Thampi, Vipin K. Yadav, Geeta Vichare, Anil Raghav, Dibyendu Chakrabarty, R. Satheesh Thampi, Tarun Kumar Pant, 2024, *"AuroraMag: Twin Explorer of Asymmetry in Aurora and Solar Wind-Magnetosphere Coupling"*, Advances in Space Research, v. 75, p. 6687-6705, doi :https://doi.org/10.1029/2023GL106900.

109. Ansari, K., Panda, S.K., Venkatesh, K. and Jamjareegulgarn, P., 2024, *"Towards mitigating the effect of plasma bubbles on GPS positioning accuracy through wavelet transformation over Southeast Asian region"*, Advances in Space Research, v. 73, p. 3642-3657, doi :https://doi.org/10.1016/j.asr.2023.04.041.

110. B. G. Fejer, Luis A. Navarro and Dibyendu Chakrabarty, 2024, *"Recent results and outstanding questions on the response of the electrodynamics of the low latitude ionosphere to solar wind and magnetospheric disturbances"*, Front. Astron. Space Sci., v. 11, pp. 1-14, doi :https://doi.org/10.3389/fspas.2024.1471140.

111. Chandra, N., S. Lal, S. Venkataramani, P. K. Patra, A. Arora, H. Gadhavi, 2024, *"Recent decline in carbon monoxide levels observed at an urban site in Ahmedabad, India"*, Environmental Science and Pollution Research, v. 31, p. 39678–39689, doi :https://doi.org/10.1007/s11356-024-33813-w.

112. D. Patgiri, R. Rathi, V. Yadav, D. Chakrabarty, M. V. Sunil Krishna, S. Kannaujiya, P. Pavan Chaitanya, A. K. Patra, Jann-Yenq Liu, S. Sarkhel, 2024, *"A rare simultaneous detection of a mid-latitude plasma depleted structure in O(1D) 630.0 nm and O(1S) 557.7 nm all-sky airglow images on a geomagnetically quiet night"*, Geophysical Research Letters, v. 51, e2023GL106900, doi :https://doi.org/10.1029/2023GL106900.

113. Goel V., Tripathi, N., Gupta, M., Sahu, L. K., Singh, V., Kumar, M., 2024, *"Study of secondary organic aerosol formation and aging using ambient air in an oxidation flow reactor during high pollution events over Delhi"*, Environmental Research, v. 251, p. 118542, doi :https://doi.org/10.1016/j.envres.2024.118542.

114. Gogoi, M., Borgohain, A., Kundu, S. S., Sharma, S., Kundu, A., Bhuyan, P. K., ... & Aggarwal, S. P., 2024, *"Investigation of the atmospheric boundary layer characteristics over a high altitude station in North East India using measurements and reanalysis datasets"*, Theoretical and Applied Climatology, v. 155, p. 6265-6281, doi :https://doi.org/10.1007/s00704-024-04997-5.

115. Guharay, A., Sarkhel S., Paulino, I., 2024, *"Editorial: Advances in mesosphere and thermosphere dynamics"*, Frontiers in Astronomy and Space Sciences, v. 11, p. 1418420, doi :https://doi.org/10.3389/fspas.2024.1418420.

116. Gupta, M., Tripathi, N., Malik, T.G., Sahu, L. K., 2024, *"A review on air–sea exchange of reactive trace gases over the northern Indian Ocean"*, Journal of Earth System Science, v. 133, p. 02268-5, doi :https://doi.org/10.1007/s12040-024-02268-5.

117. K. Rajagopal, S. Ramachandran and R.K. Mishra, 2025, *"Influence of local meteorology and gaseous pollutant*

*emissions on atmospheric nanoparticle concentrations in a pedestrian way in urban region"*, Atmospheric Pollution Research, v. 16, 102358, doi :https://doi.org/10.1016/j.apr.2024.102358.

118. K. Rajagopal, S. Ramachandran and R.K. Mishra, 2024, *"Seasonal variation of particle number concentration in a busy urban street with exposure assessment and deposition in human respiratory tract"*, Chemosphere, v. 366, 143470, doi :https://doi.org/10.1016/j.chemosphere.2024.143470.

119. K. Rajagopal, S. Ramachandran and R.K. Mishra, 2024, *"Size resolved particle contribution to vehicle induced ultrafine particle number concentration in a metropolitan curbside region"*, Atmospheric Environment, v. 333, 120773, doi :https://doi.org/10.1016/j.atmosenv.2024.120773.

120. Kamat, D. K., Sharma, S. K., Kumar, K. N., Kumar, P., & Saha, S., 2024, *"Cloud characteristics in the Aravalli ranges of Western India: Insights from ground-based Lidar measurements"*, Bulletin of Atmospheric Science and Technology, v. 5, pp. 1-17, doi :https://doi.org/10.1007/s42865-024-00075-w.

121. Kamat, D. K., Sharma, S. K., Kumar, P., Kumar, K. N., Aniket, Saha, S., & Bencherif, H., 2025, *"Investigation of atmospheric clouds and boundary layer dynamics during a dust storm in the Western-Indian region"*, Remote Sensing Applications: Society and Environment, v. 37, p. 101442, doi :https://doi.org/10.1016/j.rsase.2024.101442.

122. Kamran Ansari and S. Ramachandran, 2025, *"Global insights on absorption characteristics of aerosols"*, Science of the Total Environment, v. 959, 178178, doi :https://doi.org/10.1016/j.scitotenv.2024.178178.

123. Kamran Ansari and S. Ramachandran, 2024, *"Global changes in aerosol single scattering albedo during COVID-19"*, Atmospheric Environment, v. 333, 120649, doi :https://doi.org/10.1016/j.atmosenv.2024.120649.

124. Kamran Ansari and S. Ramachandran, 2024, *"Optical and physical characteristics of aerosols over Asia: AERONET, MERRA-2 and CAMS"*, Atmospheric Environment, v. 326, 120470, doi :https://doi.org/10.1016/j.atmosenv.2024.120470.

125. Kiran and R. P. Singh, 2025, *"Vertical wave characteristics in the MLT region and its seasonal variations using OH(3-1) brightness and rotational temperature from Ahmedabad (23oN, 72.6oE)""*, Advances in Space Research, v. 75, p. 5484-5498, doi :https://doi.org/10.1016/j.asr.2025.01.017.

126. Larry Kepko, Rumi Nakamura, Yoshifumi Saito, Angelos Vourlidas, Matthew G.G.T. Taylor, Cristina H. Mandrini, Xóchitl Blanco-Cano, Dibyendu Chakrabarty, Ioannis A. Daglis, Clezio Marcos De Nardin, Anatoli Petrukovich, Minna Palmroth, George Ho, Louise Harra, Jonathan Rae, Mathew Owens, Eric Donovan, Benoit Lavraud, Geoff Reeves, Durgesh Tripathi, Nicole Vilmer, Junga Hwang, Spiro Antiochos, and Chi Wang, 2024, *"Heliophysics Great Observatories and international cooperation in Heliophysics: An orchestrated framework for scientific advancement and discovery"*, Advances in Space Research, v. 73, p. 5383–5405, doi :https://doi.org/10.1016/j.asr.2024.01.011.

127. Lissa, D., Gopi K, Seemala, Venkatesh, K, Prasad, D.S.V.V.D. and Niranjan, K., 2024, *"ROTI and scintillation index correlation under quiet and disturbed periods over an Indian low latitude station, Waltiar"*, Advances in Space Research, v. 73, p. 3494-3503, doi :https://doi.org/10.1016/j.asr.2023.09.060.

128. Malik, T.G., Gupta, M., Tripathi, N., and Sahu, L. K., 2025, *"Change in monoterpene concentrations during winter-to-summer transition period and impact of COVID-19 lockdown at an urban site in India"*, Atmospheric Environment, v. 350, p. 121141, doi :https://doi.org/10.1007/s12040-024-02268-5.

129. Mangaraj, P., Sahu, S. K., Beig, G., Mishra, A., & Sharma, S., 2024, *"What Makes the Indian Megacity Chennai's Air Unhealthy?-A Bottom-up Approach to Understand the Sources of Air Pollutants."*, Aerosol and Air Quality Research, v. 24, 240089, doi :https://doi.org/10.4209/aaqr.240089.

130. Mitra, G., Guharay, A., Paulino, I., 2024, *"Signature of a zonally symmetric semidiurnal tide during major sudden stratospheric warmings and plausible mechanisms: a case study"*, Scientific Reports, v. 14, p. 23806, doi :https://www.nature.com/articles/s41598-024-72594-7.

131. Prashant Kumar, Bhas Bapat, Manan S. Shah, Hiteshkumar L. Adalja, Arpit R. Patel, Pranav R. Adhyaru, M. Shanmugam, Dibyendu Chakrabarty, Swaroop B. Banerjee, K. P. Subramanian, Aveek Sarkar, Tinkal Ladiya, Jacob Sebastian, Abhishek Kumar, Sushil Kumar, Nishant Singh, M.B. Dadhania, Santosh V. Vadawale, Shiv Kumar Goyal, Neeraj Kumar Tiwari, Aaditya Sarda, Deepak Kumar Painkra, Piyush Sharma, Abhishek J. Verma, Yogesh, P. Janardhan, and Anil Bhardwaj, 2025, *"Aditya Solar Wind Particle Experiment (ASPEX) on Board Aditya–L1: The Solar Wind Ion Spectrometer (SWIS)"*, Solar Physics, v. 300, pp. 1-24, doi :https://doi.org/10.1007/s11207-025-02443-x.

132. Prateek Mayank, Stefan Lotz, Bhargav Vaidya, Wageesh Mishra, Dibyendu Chakrabarty, 2024, *"Study of Evolution and Geo-effectiveness of CME-CME Interactions using MHD Simulations with SWASTi framework"*, The Astrophysical Journal, v. 976, p. 126, doi :https://doi.org/10.3847/1538-4357/ad8084.

133. R. Rathi, M. Sivakandan, D. Chakrabarty, M. V. Sunil Krishna, A. K. Upadhayaya, S. Sarkhel, 2025, *"Evidence for the evolution and decay of an electrified Medium Scale Traveling Ionospheric Disturbances during two consecutive substorms: First results"*, Advances in Space Research (Adv. Space Res.), v. 75, p. 4896-4909, doi :https://doi.org/10.1016/j.asr.2025.01.007.

134. Ranjan, A., & D. Pallamraju, 2025, *"Latitudinal distribution of thermospheric NO infrared radiative cooling during May and October 2024 geomagnetic storms"*, Journal of Geophysical Research-Space Physics, v. 130, pp.1-15, doi :https://doi.org/10.1029/2024JA033559.

135. Rout, D., A. Kumar, R. Singh, R., S. Patra, D. K. Karan, S. Chakraborty, D. Scipion, D. Chakrabarty, and Juanita Riccobono, 2024, *"Evidence of unusually strong equatorial ionization anomaly at three local time sectors during the mother's day geomagnetic storm on 10–11 May 2024"*, Geophysical Research Letters, v. 52, e2024GL111269, doi :https://doi.org/10.1029/2024GL111269.

136. S. Ramachandran and Kamran Ansari, 2025, *"Influence of changes in anthropogenic and natural sources on global aerosol optical depth during COVID-19 lockdown: Ground-based observations, satellites, models"*, Atmospheric Environment, v. 343, 120948, doi :https://doi.org/10.1016/j.atmosenv.2024.120948.

137. Saha, S., D. Pallamraju, S. Kumar, F. I. Laskar, N. M. Pedatella, 2024, *"OI 630.0 nm Post-Sunset Emission Enhancement as an Effect of Tidal Activity over Low-Latitudes"*, Journal of Geophysical Research - Space Physics, v. 129, pp. 1-13, doi :https://doi.org/10.1029/2023JA031928.

138. Shah, R., Sharma, S., Kamat, D. K., Niranjan Kumar, K., Kumar, P., & Srivastava, R., 2024, *"Cloud characteristics and their role in the 2024 United Arab Emirates extreme rainfall events"*, Remote Sensing Letters, v. 15, p. 1153-1162, doi :https://doi.org/10.1080/2150704X.2024.2412800.

139. Shiokawa, K., D. Marsh, D. Pallamraju, S. Patsourakos, N. Pedatella, M. V. Ratnam, E. Rozanov, N. Srivastava, S. Tulasiram, 2024, *"Special Issue of SCOSTEP's 15th Quadrennial Solar-Terrestrial Physics Symposium (STP-15)"*, Journal of Atmospheric and Solar-Terrestrial Physics, v. 257, 106236, doi :https://doi.org/10.1016/j.jastp.2024.106236.

140. Shiv Kumar Goyal, Neeraj Kumar Tiwari, Arpit R. Patel, M. Shanmugam, Santosh V. Vadawale, Dibyendu Chakrabarty, Jacob Sebastian, Bijoy Dalal, Piyush Sharma, Aveek Sarkar, Aaditya Sarda, Tinkal LadiyaAbhishek J. Verma, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, Prashant Kumar, Manan S. Shah, Pranav R. Adhyaru, Hiteshkumar L. Adalja, Swaroop B. Banerjee, K.P. Subramanian, Bhas Bapat, M.B. Dadhania, Abhishek Kumar, P. Janardhan, and Anil Bhardwaj, 2025, *"Aditya Solar wind Particle Experiment (ASPEX) onboard Aditya–L1: The Supra-Thermal and Energetic Particle Spectrometer (STEPS)"*, Solar Physics, v. 300, pp. 1-30, doi :https://doi.org/10.1007/s11207-025-02441-z.

141. Shukla, G., Ojha, N., Kumar, A., Harithasree, S., Girach, I. and Sahu, L.K., 2025, *"Chemical composition of aerosols over the Arabian Sea based on global reanalyses data and on-board ship measurements"*, Atmospheric Environment, v. 347, p. 121085, doi :https://doi.org/10.1016/j.atmosenv.2025.121085.

142. Singh, D., G. Mitra, A. Guharay, D. Pallamraju, S. Gurubaran, 2024, *"Quasi-two-day wave amplification through interhemispheric coupling during the 2010 austral summer"*, Advances in Space Research, v. 73, p. 3452-3463, doi :https://doi.org/10.1016/j.asr.2023.06.044.

143. Sumanjit Chakraborty, Dibyendu Chakrabarty, Anil Yadav, Gopi Seemala, 2024, *"Influence of ICME-driven magnetic cloud-like and sheath region induced geomagnetic storms in causing anomalous responses of the low-latitude ionosphere: A case study"*, Advances in Space Research, v. 75, p. 4714-4730, doi :https://doi.org/10.1016/j.asr.2024.12.045.

144. T.A. Rajesh and S. Ramachandran, 2024, *"Atmospheric black carbon aerosol: Long-term characteristics"*, Science of the Total Environment, v. 934, 172928, doi :https://doi.org/10.1016/j.scitotenv.2024.172928.

145. Upadhyay, K., and D. Pallamraju, and S. Chakrabarti, 2024, *"Estimation of downward heat flux into the F region from the inner magnetosphere during Stable Auroral Red (SAR) arc events in the daytime obtained using OI 630.0 nm red line emissions"*, Journal of Geophysical Research - Space Physics, v. 129, e2024JA032694, doi :https://doi.org/10.1029/2024JA032694.

146. Upadhyay, K., K. Shiokawa, D. Palamraju, & A. Gololobov, 2024, *"Determination of electron heat flux in the topside of the ionosphere and its impact on the vertical profile of OI 630.0nm emission rate during nighttime SAR arcs for different solar activity conditions"*, Advances in Space Research, v. 75, p. 4731-4739, doi :https://doi.org/10.1016/j.asr.2024.12.046.

147. Venkatesh, K., D. Pallamraju, Dalsania P Kelvy, Chakrabarty, D. and Pant, T.K., 2024, *"Evaluation of the performance of F-layer peak height models used in IRI-2016 over the Indian equatorial and low latitudes"*, Advances in Space Research, v. 73, p. 3797-3807, doi :https://doi.org/10.1016/j.asr.2023.06.047.

148. Venkatesh, K., Pezzopane, M., 2024, *"Preface: Recent advances in equatorial, low- and mid-latitude mesosphere, thermosphere and ionosphere studies"*, Advances in Space Research, v. 73, p. 3365-3366, doi :https://doi.org/10.1016/j.asr.2024.01.047.

149. Wageesh Mishra, Preity Sukla Sahani, Soumyaranjan Khuntia, and Dibyendu Chakrabarty, 2024, *"Distribution and Recovery Phase of Geomagnetic Storms During Solar Cycles 23 and 24"*, MNRAS, v. 530, p. 3171 - 3182, doi :https://doi.org/10.1093/mnras/stae1045.

150. Yogesh, N. Gopalswamy, D. Chakrabarty, Parisa Mostafavi, Seiji Yashiro, Nandita Srivastava, Leon Ofman, 2024, *"Origins of Very Low Helium Abundance Streams Detected in the Solar Wind Plasma"*, The Astrophysical Journal, v. 977, p. 89 pp. 1-13, doi :https://doi.org/10.3847/1538-4357/ad84d6.

151. Yokoyama, T., Klenzing, J., Milla, M.A. Stolle, C. & Pallamraju, D., 2024, *"Special issue 16th International Symposium on Equatorial Aeronomy (ISEA-16) 2022"*, Earth Planets and Space, v. 76, p. 115, doi :https://doi.org/10.1186/s40623-024-02052-1.

152. Zubair I. Shaikh, Daniel Verscharen, Ivan Y. Vasko, Dibyendu Chakrabarty, Bennet Maruca, and Anil N. Raghav, 2024, *"Anisotropic heating and cooling within ICME sheath plasma"*, The Astrophysical Journal, v. 974, p. 249 pp. 1-8, doi :https://doi.org/10.3847/1538-4357/ad782b.

#### Geosciences

153. 4. Ansari M.A., Ansari A.H., Mishra R., Arif M., Jena P.S., Dabhi A., Bhushan R., Singh D.P., Maurya A.S., Das P.K., Rahi I.C., & Agrawal S., 2024, *"Centennial-millennial scale global climate-linked monsoonal and non-monsoonal changes in the eastern Arabian Sea during the last 42,800 years"*, Marine Geology, 472, 1-15, doi :https://doi.org/10.1016/j.margeo.2024.107307.

154. Agrawal R.K., Mohanty R.K., Rathi A., Mehta S., Yadava M.G., Kumar S. and Laskar A.H., 2024, *"Estimation of groundwater residence time using radiocarbon and stable carbon isotope ratio in dissolved inorganic carbon and soil $CO_2$"*, Radiocarbon, 66, 249-266, doi :https://doi.org/10.1017/RDC.2024.43.

155. Ambekar A.S., Sarkar A., & Bhushan R., 2024, *"Excavation at Vadnagar—Cultural chronology based on cultural materialism and radiocarbon dating by AMS"*, Heritage (Journal of Multidisciplinary Studies in Archaeology), 12, 1-26, doi :https://www.heritageuniversityofkerala.com/CurrentIssue.aspx?VID=12.

156. Arvind Singh, 2024, *"Challenges facing scientific publishing in Earth & Space Sciences"*, AGU Advances, 5, 1-7, doi :https://doi.org/10.1029/2024AV001334.

157. Banerji U., Bhushan R., Josh K.B., Dabhi A., Sudheer A.K., Dubey C.P., Panda R.K., Haridas N.V., & Mahesh G., 2024, *"Geochemical records of mudflat sediments from southern Saurashtra, Western India: Implication in Holocene climate and global teleconnection"*, The Holocene, 34, 1700-1720, doi :https://doi.org/10.1177/09596836241266398.

158. Bhatnagar A., Shukla A.D., Ngangom M., Thakkar M.G., Dubey,J., & Bhushan R., 2024, *"Analysis of sediment provenance using geochemical and isotopic data for a post-LGM sediment core from the western Great Rann of Kachchh, India"*, Palaeogeography, Palaeoclimatology, Palaeoecology, 644, 1-15, doi :https://doi.org/10.1016/j.palaeo.2024.112185.

159. Bhattu D., Tripathi S.N., Bhowmik H.S., Moschos V., Lee C.P., Rauber M., Salazar G., Abbaszade,G., Cui T., Slowik,J.G., Vats P., Mishra S., Lalchandani V., Satish R., Rai P., Casotto,R., Tobler A., Kumar V., Hao Y., Qi L., Khare P., Manousakas M.I., Wang,Q., Han Y., Tian J., Darfeuil S., Minguillon M.C., Hueglin C., Conil S., Rastogi N., Srivastava A.K., Ganguly D., Bjelic S., Canonaco F., Schnelle-Kreis J., Dominutti P.A., Jaffrezo J-L., Szidat S., Chen Y., Cao J., Baltensperger U., Uzu G., Daellenbach K.R., El Haddad I., & Prevot A.S.H, 2024, *"Local incomplete combustion emissions define the $PM_{2.5}$ oxidative potential in Northern India"*, Nature Communication, 15, 1-13, doi :https://doi.org/10.1038/s41467-024-47785-5.

160. Bhowmik H.S., Tripathi S.N., Puthussery J.V., Verma V., Dave J., & Rastogi N., 2024, *"Reactive Oxygen Species generation from winter water-soluble organic aerosols in Delhi's $PM_{2.5}$."*, Atmospheric Environment: X, 22, 1-10, doi :https://doi.org/10.1016/j.aeaoa.2024.100262.

161. Bhushan R., Gahlaut S.K.S., Kumar V., & Jain A.R, 2024, *"Carbon dates of copper hoard weapons found from Nigohi area, District Shahjahanpur, U.P., India. Indian Journal of Archaeology"*, Indian Journal of Archaeology, 7, 70-98, doi :https://www.ijarch.org/issue/ija-vol-7-no-4-october-2022-current.

162. Chakra S., Oza H., Ganguly A., Pandey A., Padhya V., & Deshpande R., 2024, *"Finer aspects of spatio-temporal variations in Indian summer monsoon rainfall trend reversals over the last 120 years"*, Climatic Change, 177, 1-22, doi :https://doi.org/10.1007/s10584-024-03780-9.

163. Chowdhury S., Berthelot H., Baudet C., González-Santana D., Reeder C., l'Helguen S., Maguer J., Löscher C., Singh A., Blain,S., Cassar N., Bonnet S. Planquette H., & Benavides M., 2024, *"Fronts divide diazotroph communities in the Southern Indian Ocean"*, FEMS Microbiology Ecology, 100, 95, doi :https://doi.org/10.1093/femsec/fiae095.

164. Das P., Padmalal D., Kumaran K.P.N., Limaye R.B., Mohan S.V., Banerji U.S., & Bhushan R., 2024, *"Tracing the late Quaternary coastal evolution of Central Kerala, India, around the lost ancient port Muziris using multi-proxy study of the sedimentary archives"*, Quaternary Science Advances, 14, 1-16, doi :https://doi.org/10.1016/j.qsa.2024.100197.

165. Dutt A., Shukla A.D., Singh A.K., & Narayanan A., 2024, *"A hydrous sub-arc mantle domain within the northeastern Neo-Tethyan ophiolites: Insights from cumulate hornblendites"*, Geochemistry, 84, 1-21, doi :https://doi.org/10.1016/j.chemer.2024.126122.

166. D'Souza N., Balakrishna K., Sudheer A.K., & Mahesh G., 2025, *"Paleoenvironmental reconstruction in Kali estuary, South-West Coast of India: A multi-proxy approach"*, Environmental Chemistry and Ecotoxicology, 7, 1-9, doi :https://doi.org/10.1016/j.enceco.2024.09.003.

167. Goswami V., Hannah J.L., Stein H.J., Ahlberg P., Maletz J., Lundberg F., & Ebbestad J.O., 2024, *"Re-Os geochronology and geochemical evolution of late Cambrian to Middle Ordovician Alum and Tøyen shales, Sweden"*, Global and Planetary Change, 142, 1-21, doi :https://doi.org/10.1016/j.gloplacha.2024.104580.

168. Haritha A., Kakkassery A.I., Rajesh V.J., Kumar S., & Khedr M.Z, 2024, *"Magnesite hosted by the Neoarchean ultramafic rocks in Attappadi, Southern India: A spectral and stable isotopic investigation"*, Geological Journal, 59, 3240-3257, doi :https://doi.org/10.1002/gj.5020.

169. Jena P.S., Bhushan R., Jena S.K., Ajay S., & Sudheer A.K., 2024, *"Spatial variability in residence time of Beryllium in the Indian Ocean"*, Journal of Environmental Radioactivity, 280, 1-5, doi :https://doi.org/10.1016/j.jenvrad.2024.107549.

170. Joshi S., Rastogi N., & Singh A., 2024, *"Insights into the formation of secondary organic aerosols from agricultural residue burning emissions: A review of chamber-based studies"*, Science of The Total Environment, 952, 1-14, doi :https://doi.org/10.1016/j.scitotenv.2024.175932.

171. Kadlag Y., Anand A., Fischer-Gödde M., Mezge, K., Szilas K., Goderis S., & Leya I., 2024, *"Identification of Earth's late accretion by large impactors through mass-independent Cr isotopes"*, Icarus, 418, 1-9, doi :https://doi.org/10.1016/j.icarus.2024.116143.

172. Kanungo A.K., Kaushal R.K., Bhushan R., Chauhan N., Kharakwal J.S., & Ansari S., 2024, *"Luminescence and radiocarbon chronology of Bhagatrav: A Sorath Harappan camp site in South Gujarat"*, Radiocarbon, 67, 53-73, doi :https://doi.org/10.1017/RDC.2024.119.

173. Khan M.A., Kumar S., Roy R., Prakash S., Lotliker A., & Baliarsingh S., 2024, *"Tidal scale dissolved inorganic and particulate carbon dynamics in a tropical estuary"*, Marine Chemistry, 267, 1-13, doi :https://doi.org/10.1016/j.marchem.2024.104451.

174. Khare S.K., Shukla A.D., & Venkatesh A.S, 2024, *"Vanadium-rich Fe-Ti oxide and Cu-sulfide mineralization in Paleoproterozoic Mangikhuta volcanics, Central Indian Craton: Metallogenic and petrogenetic implications"*, Ore and Energy Resource Geology, 16, 1-13, doi :https://doi.org/10.1016/j.oreoa.2024.100041.

175. Khurshid Z., Bhushan R., Sudheer A.K., Ganie S.A., & Gaddam M., 2024, *"Deciphering the chronological dynamics of*

*Azolla invasion in Dal Lake, Srinagar: Insights from sediment eDNA and 210Pb/137Cs dating techniques"*, Earth Systems and Environment, 9, 259-275, doi :https://doi.org/10.1007/s41748-024-00430-z.

176. Krishna A.V., Tirkey A., Raman M., Ali S.M., Sahay A., & Singh A., 2024, *"Unravelling pre-monsoon phytoplankton: pigment profiles and community structure in the western and central Bay of Bengal"*, Marine and Freshwater Research, 78, 24103, doi :https://doi.org/10.1071/MF24103.

177. Kumar N., Ganguly A., Biswal,K., Keesari T., Pandey A., & Deshpande R.D., 2024, *"Relative contribution from different water sources to supraglacial runoff in Western Himalaya"*, Journal of Hydrology, 635, 1-11, doi :https://doi.org/10.1016/j.jhydrol.2024.131137.

178. Laskar A.H., Sarkar A., Mohanty R.K., Agrawal R.K., Kumar S., & Shivam A., 2025, *"$CO_2$ flux and carbon dynamics in soil and respired $CO_2$ in a semi-arid region of western India"*, Soil Science Society of America Journal, 89, 1-15, doi :https://doi.org/10.1002/saj2.70026.

179. Mehta S., Kiko R., Hauss H., Ojha N., & Singh A., 2024, *"Phosphate influx and dust deposition create zonal and meridional biogeochemical gradients in Trichodesmium abundance"*, Global Biogeochemical Cycles, 38, 1-18, doi :https://doi.org/10.1029/2024GB008182.

180. Murali D., Reghunath R., Kannichankandy S., Bhushan R., & Krishnan K.A., 2024, *"Holocene coastal wetland evolution in a tropical ecosystem: Sedimentary archives from South Kerala, India"*, Journal of Geointerface, 3, 93-102, doi :https://doi.org/10.5281/zenodo.14264382.

181. Murali D., Reghunath R., Prakas, P., Bhushan R., Krishnan K.A., & Baby S.R., 2024, *"Paleoclimatic analysis of Quaternary sediments associated with the floodplain deposits of a tropical estuary along the southwestern coast of India"*, Studia Quaternaria, 41, 14-21, doi :https://doi.org/10.24425/sq.2023.148038.

182. Negi R., Rana N., Sati S.P., Shukla A., Juyal N., & Sharma S., 2024, *"Beas River Floods 2023: A watershed moment for paradigm shifts towards urbanization and development in Higher Himalayan valleys"*, Current Science, 127, 65-77, doi :https://doi.org/10.18520/cs/v127/i1/65-77.

183. Paul T., Sudheer A.K., Gaddam M., Pawar R., Maurya A.S., & Jyethi D.S., 2024, *"Carbonaceous aerosols in the Brahmaputra plains: Sources, and influence from the hotspot Indo-Gangetic plains, India"*, Journal of Atmospheric Chemistry, 81, 1-25, doi :https://doi.org/10.1007/s10874-024-09464-z.

184. Phartiyal B., Tiwari A., Kawsar M., Manoj M.C., Shekhar M., Ali S.N., Bhushan R., Pachchigar R.R., Kumar A., Prasanna K., & Sharma A., 2024, *"Millennial to centennial-scale climate oscillations since 15000 cal yrs BP from Kanwar wetland in the Central Ganga Plain, India"*, Quaternary Science Reviews, 335, 1-17, doi :https://doi.org/10.1016/j.quascirev.2024.108760.

185. Pradeep Attri, Devleena Mani, Siddhartha Sarkar, Sanjeev Kumar, Prashant Hegde, 2024, *"Stable isotope compositions, source apportionment and transformation processes of carbonaceous aerosols in PM10 in the urban city of Hyderabad, India"*, Urban Climate, 57, 1-18, doi :https://doi.org/10.1016/j.uclim.2024.102101.

186. Rahman A., Shah R.A., Yadava M.G., & Kumar S., 2024, *"Carbon and nitrogen biogeochemistry of a high-altitude Himalayan lake sediment: inferences for the late Holocene climate"*, Quaternary Science, 14, 1-10, doi :https://doi.org/10.1016/j.qsa.2024.100199.

187. Roy,P., Laskar A.H., Ghoshmaulik S., Bhattacharya,S.K., Rangarajan R., & Liang M.C., 2025, *"Triple oxygen isotopic fractionation in $CO_2$-$CaCO_3$-$H_2O$ system during $CO_2$-$H_2O$ exchange, carbonate precipitation, and acid digestion"*, Chemical Geology, 678, 1-13, doi :https://doi.org/10.1016/j.chemgeo.2025.122634.

188. Sahoo D., Saxena H., Nazirahmed S., Khan M.A., Rai D.K., Sharma N., John S., Kumar S., Sudheer A.K., Bhushan R., & Singh A., 2024, *"Winter convective mixing regulates oceanic C:N:P ratios"*, Limnology and Oceanography, 69, 1720-1733, doi :https://doi.org/10.1002/lno.12621.

189. Salana S., Yu H., Da, Z., Subramanian P.S.G., Puthussery J.V., Wang Y., Singh A., Pope F.D., Leiva G M.A., Rastogi N., Tripathi S.N., Weber R.J., & Verma V., 2024, *"Inter-continental variability in the relationship of oxidative potential and cytotoxicity with $PM_{2.5}$ mass"*, Nature Communication, 15, 1-13, doi :https://doi.org/10.1038/s41467-024-49649-4.

190. Sarkar S., & Kumar S., 2024, *"Water stagnancy and wastewater input enhance primary productivity in an engineered river system"*, River, 3, 191-198, doi :https://doi.org/10.1002/rvr2.88.

191. Sarkar S., Rahman A., Khan M.A., Rathi A., Ragavan P., Singh, A., & Kumar S., 2024, *"Isotopic evidence for degradation of particulate black carbon in the ocean"*, Geophysical Research Letters, 51, 1-9, doi :https://doi.org/10.1029/2023GL106050.

192. Sarkar S., Rathi A., Khan M.A., & Kumar S., 2024, *"Demystifying the particulate black carbon conundrum in aquatic systems"*, Environmental Research Communications, 6, 1-9, doi :https://doi.org/10.1088/2515-7620/ad4e0f.

193. Saxena H., Mehta S., Nazirahmed S., Kumar J., Kumar S., & Singh A., 2024, *"Diazotrophs: An overlooked sink of $N_2O$"*, Geophysical Research Letters, 52, 1-12, doi :https://doi.org/10.1029/2024GL114117.

194. Saxena H., Sahoo D., Nazirahmed S., Sharma N., Rai D.K., Kumar S., & Singh A., 2024, *"Winter convective mixing mediating coupling of N-gain and -loss in the Arabian Sea"*, Journal of Geophysical Research: Oceans, 129, 1-18, doi :https://doi.org/10.1029/2023JC020839.

195. Sharma S., & Shukla A.D., 2024, *"Mid-Holocene climate-glacier relationship inferred from landforms and relict lake sequences in the Southern Zanskar ranges"*, NW Himalaya. Geomorphology, 444, 1-21, doi :https://doi.org/10.1016/j.geomorph.2023.108953.

196. Shaw C., Rastogi N., Rathi A., Kumar S., & Meena R., 2024, *"Sources and processes affecting the abundances of atmospheric NHx using $\delta^{15}$N over northwestern Indo-Gangetic Plain"*, Chemosphere, 359, 1-10, doi :https://doi.org/10.1016/j.chemosphere.2024.142356.

197. Sheikh N.A., Dubey J., Arora P., Sharma S., Morthekai P., Sharma A., Kumar P., & Srivastava V., 2024, *"Glacier sensitivity to climate variability since MIS-2: Insights from*

*monsoon-dominated northeastern Himalaya"*, Geografia Fisica e Dinamica Quaternaria, 47, 160-173, doi :https://www.gfdq.glaciologia.it/index.php/GFDQ/issue/view/92.

198. Singh P., Sarangi V., Bhushan R., Ali S.N., Agrawal S., Tiwari P., Kawsar M., Agnihotri R., Sanyal P., Kumar K., & Morthekai P., 2024, *"Presence and implications of petrogenic organic carbon in High Himalayan Crystalline lake sediment"*, Radiocarbon, 66, 786-805, doi :https://doi.org/10.1017/RDC.2024.87.

199. Tiwari P., Thakur B., Srivastava P., Gahlaud S.K.S., & Bhushan R., 2025, *"Paleolimnology and natural versus anthropogenic influx during the late Holocene from Vembanad Wetland, Ramsar Site, Kerala, India"*, Quaternary, 8, 1-26, doi :https://doi.org/10.3390/quat8010003.

200. Tiwari P., Thakur B., Srivastava P., Gahlaud S.K.S., Bose T., Kumar A., Bhushan R., & Agnihotri R., 2024, *"Was the Little Ice Age synchronous with equatorial-tropical climate? A multiproxy study from the southwest coast of India"*, Quaternary International, 709, 66-81, doi :https://doi.org/10.1016/j.quaint.2024.09.004.

201. Xenopoulos M.A., Bond-Lamberty B., Desai A., Huntzinger D., Buchanan P., East A., Singh A., Wooden P., Jewett K., & Ricci M., 2024, *"AGU publications update authorship policy to foster greater equity and transparency in global research collaborations"*, AGU Advances, 5, 1-3, doi :https://doi.org/10.1029/2024AV001298.

202. Zitoun R., Marcinek S., Hatje V., Sander S.G., Völker C., Sarin M., & Omanović D., 2024, *"Climate change-driven effects on transport, fate, and biogeochemistry of trace element contaminants in coastal marine ecosystems"*, Communications Earth & Environment, 5, 1-17, doi :https://doi.org/10.1038/s43247-024-01679-y.

#### Theoretical Physics

203. Agarwal, N., Pal, S., Srivastav, A., Tripathi, A., 2024, *"Correlator webs of massive multiparton amplitudes at four loops: A study of boomerang webs"*, Physical Review D, v. 109, p. 36, doi :https://doi.org/10.1103/PhysRevD.109.094038.

204. Bhardwaj, A., Konar, P., Ngairangbam, V. S., 2024, *"Foundations of automatic feature extraction at LHC – point clouds and graphs"*, The European Physical Journal Special Topics (EPJ ST), v. 233, p. 2619–2640, doi :https://doi.org/10.1140/epjs/s11734-024-01306-z.

205. Bhupal Dev, P. S., Goswami, S., Majumdar, C., Pachhar, D., 2025, *"Neutrinoless double beta decay from scalar leptoquarks: interplay with neutrino mass and flavor physics"*, Journal of High Energy Physics, v. 01, p. 004, doi :https://doi.org/10.1007/JHEP01(2025)004.

206. Chatterjee, A., Garcia, J.H., Roeck, A.D., 2025, *"Heavy Neutral Lepton searches at an ICARUS-like detector using NuMI beam"*, The European Physical Journal C, v. 85, p. 195, doi :https://doi.org/10.1140/epjc/s10052-025-13846-2.

207. Chatterjee, A., Roeck, A.D., 2024, *"Neutrino oscillations with atmospheric neutrinos at large liquid argon TPCs"*, Physics Letters B, v. 855, p. 138838, doi :https://doi.org/10.1016/j.physletb.2024.138838.

208. Chatterjee, P., Dutta, P., 2024, *"Quasiparticles-mediated thermal diode effect in Weyl Josephson junctions"*, New Journal of Physics, v. 26, p. 073035, doi :https://doi.org/10.1088/1367-2630/ad617a.

209. Das, A., Goswami, S., K. N. Vishnudath, Poddar, K. T., 2024, *"Freeze-in production of sterile neutrino dark matter in a gauged U (1) model with inverse seesaw"*, Nuclear Physics B, v. 1004, p. 116568, doi :https://doi.org/10.1016/j.nuclphysb.2024.116568.

210. Debnath, D., Dutta, P., 2024, *"Gate-tunable Josephson diode effect in Rashba spin-orbit coupled quantum dot junctions"*, Physical Review B, v. 109, p. 174511, doi :https://doi.org/10.1103/PhysRevB.109.174511.

211. Debnath, D., Dutta, P., 2025, *"Field-free Josephson diode effect in interacting chiral quantum dot junctions"*, Journal of Physics: Condensed Matter, v. 37, p. 175301, doi :https://iopscience.iop.org/article/10.1088/1361-648X/adbeaf.

212. Ghosh, A., Konar, P., 2025, *"Precision prediction at the LHC of a democratic up-family philic KSVZ axion"*, Physics of the Dark Universe, v. 47, p. 101746, doi :https://doi.org/10.1016/j.dark.2024.101746.

213. Ghosh, A., Konar, P., 2024, *"Unveiling desert region in inert doublet model assisted by Peccei-Quinn symmetry"*, Journal of High Energy Physics, v. 09, p. 104, doi :https://doi.org/10.1007/JHEP09(2024)104.

214. Goswami, S., Pachhar, D., Pan, S., 2024, *"Constraining the mass-spectra in the presence of a light sterile neutrino from absolute mass-related observables"*, Physical Review D, v. 110, p. 015028, doi :https://doi.org/10.1103/PhysRevD.110.015028.

215. Kashav, M., & Patel, K. M., 2025, *"Residual flavor symmetries at the modular self-dual point and constraints on neutrino masses and mixing"*, Physical Review D, v. 111, p. 015010, doi :https://doi.org/10.1103/PhysRevD.111.015010.

216. Kosmas, T.S., Sahu, R., Kota, V.K.B., 2024, *"Cross-Sections of Neutral-Current Neutrino Scattering on 94,96Mo Isotopes"*, Particles 2024, v. 7, p. 887-898, doi :https://doi.org/10.3390/particles7040053.

217. Kota, V.K.B., Sahu, R., 2024, *"Proxy-SU(4) symmetry in A=60-90 region"*, Physica Scripta, v. 99, p. 065306/1-15, doi :https://doi.org/10.1088/1402-4896/ad46ca.

218. Kundu, S., Show, S., Konar, P., Das, P.K., 2024, *"Jet substructure probe to freeze-in DM in alternative cosmological background"*, European Physical Journal Special Topics (EPJ ST), v. 233, p. 2129–2134, doi :https://doi.org/10.1140/epjs/s11734-024-01233-z.

219. Mahajan, N., Mishra, D., 2025, *"Smallness of charm-loop effects in $\mathrm{B} \to \mathrm{K}^{(*)}\ell^+\ell^-$ at low q2: Light-meson distribution-amplitude analysis"*, Physical Review D, v. 111, p. 1-7, doi :https://doi.org/10.1103/PhysRevD.111.L031504.

220. Mahajan, N., Mishra, D., 2024, *"$\mathrm{B} \to \mathrm{X}_{c(u)}\ell\nu\gamma$ and determination of non-perturbative parameters"*, Physical Review D, v. 110, p. 053003/1-27, doi :https://doi.org/10.1103/PhysRevD.110.053003.

221. Mishra, S., Pal, S., Srivastav, A., Tripathi, A., 2024, *"Multiparton Cwebs at five loops"*, The Journal of High Energy Physics (JHEP), v. 07, p. 078, doi :https://doi.org/10.1007/JHEP07(2024)078.

222. Mohanta, G. & Patel, K. M., 2024, *"Loop-induced masses for the first two generations with optimum flavour violation"*, Journal of High Energy Physics, v. 2024, p. 158, doi :https://doi.org/10.1007/JHEP12(2024)158.
223. Pal, A, Saha, A., Dutta, P., 2024, *"Fermi arc mediated transport in an inversion symmetry broken Weyl semimetal nanowire and its hybrid junctions"*, Physical Review B, v. 109, p. 235419, doi :https://doi.org/10.1103/PhysRevB.109.235419.
224. Pal, A., Dutta, P., Saha, A., 2024, *"Transport signatures of Bogoliubov Fermi surfaces in normal metal/time-reversal symmetry-broken d-wave superconductor junctions"*, New Journal of Physics, v. 26, p. 053027, doi :https://doi.org/10.1088/1367-2630/ad481a.
225. Pal, A., Dutta, P., Saha, A., 2024, *"Identifying Bogoliubov Fermi surfaces via thermoelectric response in d-wave superconductor heterostructure"*, Physical Review B, v. 110, p. 245417, doi :https://doi.org/10.1103/PhysRevB.110.245417.
226. Pal, S., Seth, S., 2024, *"On Higgs+jet production at next-to-leading power accuracy"*, Physical Review D, v. 109, p. 114018, doi :https://doi.org/10.1103/PhysRevD.109.114018.
227. Pal, S., Seth, S., 2025, *"Soft quark effects on H+jet production at NLP accuracy"*, Physics Letters B, v. 860, p. 139179, doi :https://doi.org/10.1016/j.physletb.2024.139179.
228. Pan, S., Chakraborty, K., Goswami, S., 2024, *"Sensitivity to CP discovery in the presence of Lorentz invariance-violating potential at T2HK/T2HKK"*, European Physical Journal C, v. 84, p. 354, doi :https://doi.org/10.1140/epjc/s10052-024-12541-y.
229. Pandya, J., Dave, D., Singh, N., 2024, *"Pseudogap in doped strontium iridate: Gorkov-Teitelbaum thermal activation model"*, Physics Letter A, v. 507, p. 129469, doi :https://doi.org/10.1016/j.physleta.2024.129469.
230. Rindani, S.D., 2024, *"T-odd observables from anomalous tbW couplings in single-top production at an ep collider"*, Physics Letters B, v. 859, p. 1-5, doi :https://doi.org/10.1016/j.physletb.2024.139096.
231. Sahu R., Kota, V.K.B., Kosmas, T.S., 2024, *"Cross sections of neutral-current neutrino scattering on 98,100Mo isotopes"*, Journal of Phys. G: Nuclear and Particle Physics, v. 51, p. 065104/1-16, doi :https://doi.org/10.1088/1361-6471/ad3c5b.
232. Singh, L., Kashav, M. & Verma, S., 2024, *"Minimal type-I Dirac seesaw and leptogenesis under A4 modular invariance"*, Nuclear Physics B, v. 1007, p. 116666, doi :https://doi.org/10.1016/j.nuclphysb.2024.116666.
233. Singh, N., 2024, *"Drude's lesser known error of a factor of two and Lorentz's correction"*, European Journal of Physics, v. 45, p. 065501, doi :https://doi.org/10.1088/1361-6404/ad6e46.
234. Singh, N., 2024, *"The Gorkov–Teitelbaum Thermal Activation Model for Cuprates: A Review"*, J Low Temp Phys., v. 216, p. 789-799, doi :https://doi.org/10.1007/s10909-024-03188-w.
235. Van Beekveld, M., Danish, A., Laenen, E., Pal, S., Tripathi, A. and White, C.D., 2024, *"Next-to-soft radiation from a different angle"*, Physical Review D, v. 109, p. 16, doi :https://doi.org/10.1103/PhysRevD.109.074005.


**Atomic, Molecular and Optical Physics**


236. A. P. Singh, K. Sugisaki, V. S. Prasannaa, B. K. Sahoo, B. P. Dasand Y. Nakamura, 2024, *"Experimental computations of atomic properties on a superconducting quantum processor"*, Phys. Rev. A, v. 110, p. 062620, doi :https://doi.org/10.1103/PhysRevA.110.062620.
237. Arup Chakraborty and B. K. Sahoo, 2024, *"High-accuracy Nuclear Spin Dependent Parity Violating Amplitudes in $^{133}\mathrm{Cs}$"*, Phys. Rev. A, v. 110, p. 022812, doi :https://doi.org/10.1103/PhysRevA.110.022812.
238. Ayan Kumar Nai, Amritash Sharma, Vimlesh Kumar, Sandeep Singh, Shreya Mishra, C. M. Chandrashekar, and G. K. Samanta, 2025, *"Beamsplitter-free, high bit-rate, quantum random number generator based on temporal and spatial correlations of heralded single-photons"*, AVS Quantum Science, v. 7, p. 011401, doi :https://doi.org/10.1116/5.0245672.
239. B. K. Sahoo, S. Blundell, A. V. Oleynichenko, R. F. Garcia Ruiz, L.V. Skripnikov and B. Ohayon, 2025, *"Recent advancements in atomic manybody methods for high-precision studies of isotope shifts"*, Journal of Physics B (Topical review), v. 8, p. 042001, doi :https://doi.org/10.1088/1361-6455/adacc1.
240. B. Ohayon, J. Eduardo Padilla-Castillo, Sid C. Wright, Gerard Meijer and B.K. Sahoo, 2024, *"Reconciling differential radii in the silver chain through improved measurement and ab initio calculations"*, Phys. Rev. Research, v. 6, p. 033040, doi :https://doi.org/10.1103/PhysRevResearch.6.033040.
241. D Parmar, K Mehta, S Soumyashree, R Srivastava, AK Sudheer, P Kumar, PK Baruah, 2025, *"Quantitative analysis of trace elements in liquid samples using laser induced breakdown spectroscopy"*, Applied Physics B, v. 131, p. 31, doi :https://doi.org/10.1007/s00340-025-08396-0.
242. Degda, N., Patel, N., Singhal, M., Murthy, K.V.R., Chauhan, N., Srinivas, M., 2024, *"Thermally stable luminescence and dosimetric features of Ho(III) activated tungstate double perovskite"*, Journal of Luminescence, v. 275, p. 120775, doi :https://doi.org/10.1016/j.jlumin.2024.120775.
243. Degda, N., Patel, N., Singhal, M., Murthy, K.V.R., Chauhan, N., Verma, V., Srinivas, M., 2024, *"Luminescence and dosimetry investigations of Eu(III) doped Ca2CeVO6 novel double perovskite"*, Optical Materials, v. 155, p. 115861, doi :https://doi.org/10.1016/j.optmat.2024.115861.
244. Devara Anil , M.D., Gopesh Jha ,Zakir Khan,Vrushab Mahesh,P. Ajithprasad,Naveen Chauhan, 2024, *"Deep-rooted Indian Middle Palaeolithic: Terminal Middle Pleistocene lithic assemblage from Retlapalle, Andhra Pradesh, India"*, PLoS ONE, v. 19, NA, doi :https://doi.org/10.1371/journal.pone.0302580.
245. Dutta, S., Lee, C.-F., John-stone, D., Lee, J.-E., Hirano, N., Di Francesco, J., Moraghan, A., Liu, T., Sahu, D., Liu, S.-Y., Tatematsu, K., Goldsmith, P. F., Lee, C. W., Li, S., Eden, D., Juvela, M., Bronfman, L., Hsu, S.-Y., Kim, K.-T., Kwon, W., Sanhueza, P., Liu, X., L´opez-V´azquez, J. A., Luo, Q., & Yi, H.-W., 2024, *"ALMA Survey of Orion Planck Galactic Cold Clumps (ALMASOP): Molecular Jets and Episodic Accretion in Protostars"*, The Astronomical Journal, v. 162, p. 72, doi :https://doi.org/10.3847/1538-3881/ad152b.

246. Harshith Bachimanchi, Saumya J. Sarkar, M. Ebrahim-Zadeh, and G. K. Samanta, 2024, *“Harnessing nonlinear frequency upconversion of Talbot effect with flexible Talbot lengths”*, Optics Express, v.32, p. 15967-15977, doi :`https://doi.org/10.1364/OE.518005`.

247. Hsu, S.-Y., Lee, C.-F., Liu, S.-Y., Johnstone, D., Liu, T., Takahashi, S., Bronfman, L., Chen, H.-R. V., Dutta, S., Eden, D. J., Evans, N. J., Hirano, N., Juvela, M., Kuan, Y.-J., Kwon, W., Lee, C. W., Lee, J.-E., Li, S., Liu, C.-F., Liu, X., Luo, Q., Qin, S.-L., Sahu, D., Sanhueza, P., Shang, H., Tatematsu, K., & Yang, Y.-L, 2024, *“ALMASOP. The Localized and Chemically Rich Features near the Bases of the Protostellar Jet in HOPS 87”*, The Astrophysical Journal, v. 976, p. 29, doi :`https://doi.org/10.3847/1538-4357/ad7e25`.

248. J. Karthein, C.M. Ricketts, R.F. Garcia Ruiz, J. Billowes, C.L. Binnersley, T.E. Cocolios, J. Dobaczewski, G.J. Farooq-Smith, K.T. Flanagan, G. Georgiev, W. Gins, R.P. de Groote, F.P. Gustafsson, J.D. Holt, A. Kanellakopoulos, A. Koszoru´s, D. Leimbach, K.M. Lynch,´ T. Miyagi, W. Nazarewicz, G. Neyens, P.-G. Reinhard, B. K. Sahoo, A.R. Vernon, S.G. Wilkins, X.F. Yang, and D.T. Yordanov, 2024, *“Electromagnetic Properties of Indium Isotopes Elucidate the Doubly Magic Character of* $^{100}Sn$*”*, Nature Physics, v. 20, p. 1719–1725, doi :`https://doi.org/10.1038/s41567-024-02612-y`.

249. Jyoti, A. Chakraborty, Z. Wang, J. Zhang, J. Chen, B. Arora, and B. K. Sahoo, 2025, *“Investigating the* $4\mathrm{D}_{\frac{3}{2}}|3,\pm2>-4\mathrm{D}_{\frac{5}{2}}|3,\pm2>$ *transition in* $\mathrm{N}b^{4+}$ *for a THz atomic clock”*, Phys. Rev. A, v. 111, p. 022813, doi :`https://doi.org/10.1103/PhysRevA.111.022813`.

250. K Mehta, M Ahuja, P Kumar, RK Kushawaha, PK Baruah, 2024, *“Synergistic influence of external electric field on laser ablation in liquid: Correlating nanoparticle synthesis and cavitation bubble dynamics”*, Physica Scripta, v. 100, p. 065948, doi :`https://doi.org/10.1088/1402-4896/ad4698`.

251. K Mehta, P Kumar, RK Kushawaha, PK Baruah, 2024, *“Optimizing laser ablation in liquid: The role of ablation region confinement”*, Journal of Laser Applications, v. 37, p. 042005, doi :`https://doi.org/10.2351/7.0001613`.

252. K Mehta, P Kumar, RK Kushawaha, PK Baruah,, 2025, *“Silver nanoparticles doped* $\mathrm{M}o\mathrm{S}_2$ *flakes as highly efficient electrocatalyst for hydrogen evolution reaction”*, Journal of Laser Applications, v. 37, p. 012011, doi :`https://doi.org/10.2351/7.0001685`.

253. Khan, W., Ramachandran, R., Gupta, S., Meka, J.K., Venkataraman, V., Hill, H., Rajasekhar B.N., Janardhan, P., Bhardwaj, A., Mason, N. J., Sivaraman, B.,, 2025, *“Infrared spectroscopy 1 reveals ethylene glycol is an anti crystallizer in water-mixed astrochemical ices”*, Life Sciences in Space Research, NA, NA, doi :`https://doi.org/10.1016/j.lssr.2025.01.006`.

254. Lo, J-L., Lu, H-C., Hu, W-H., Sivaraman, B., Mason, N. J., Cheng, B-M., 2024, *“Photoabsorption spectra of solid* $\mathrm{O}_2$ *in ultraviolet and far-vacuum ultraviolet region at 9-30 K”*, Monthly Notices of the Royal Astronomical Society, v. 529, p. 4818-4823, doi :`https://doi.org/10.1093/mnras/stae779`.

255. Mifsud, D. V., Herczku, P., Ramachandran, R., Sundararajan, P., Rahul, K. K., Kovács, S. T. S., Sulik, B., Juhász, Z., Rácz, R., Biri, S., Kaňuchová, Z., Ioppolo, S., Sivaraman, B., McCullough, R. W., Mason, N. J., 2024, *“A systematic mid-infrared spectroscopic study of thermally processed* $\mathrm{H}_2\mathrm{S}$ *ices”*, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, v. 319, p. 124567, doi :`https://doi.org/10.1016/j.saa.2024.124567`.

256. Nihar Ranjan Behera, Saroj Barik, Saurav Dutta, Rajesh Kumar Kushawaha, Sajeev Y and Aravind G, 2024, *“Multiphoton Dissociative Ionization of Gas-Phase Styrene”*, The Journal of Physical Chemistry A, v. 128, p. 9235-9239, doi :`https://doi.org/10.1021/acs.jpca.4c05621`.

257. P Kumar, B Bapat, MS Shah, et al., 2024, *“Aditya Solar Wind Particle Experiment (ASPEX) on Board Aditya—L1: The Solar Wind Ion Spectrometer (SWIS)”*, Solar Physics, v. 300, p. 37, doi :`https://doi.org/10.1007/s11207-025-02443-x`.

258. Parida, S., Kaushal, R.K., Chauhan, N., Singhvi, A.K., 2025, *“Changes in thermoluminescence sensitivity of 110℃ glow peak of quartz grains from sediments of River Ganga: Observation and implications”*, Earth and Planetary Science Letters, v. 656, p. 119267, doi :`https://doi.org/10.1016/j.epsl.2025.119267`.

259. Ramachandran, R., Sil, M., Gorai, P., Meka, J. K., Sundararajan, P., Lo, J.-I., Chou, S.-L., Wu, Y.-J., Janardhan, P., Cheng, B.-M., Bhardwaj, A., Rivilla, V. M., Mason, N. J., Sivaraman, B., Das, A., 2024, *“Experimental and Computational Study of Ethanolamine Ices under Astrochemical Conditions”*, The Astrophysical Journal, v. 975, p. 181, doi :`https://doi.org/10.3847/1538-4357/ad77c5`.

260. Rituparna Das, Amit Bhojani, Madhusudhan P, Vinitha Nimma, Pranav Bhardwaj, Dheeraj K Singh, Rajesh Kumar Kushawaha, 2025, *“Strong field-induced three-body fragmentation dynamics of* $\mathrm{CH_3C}l^{2+}$*”*, Journal of Physics B: Atomic, Molecular and Optical Physics, v. 58, p. 045603, doi :`https://doi.org/10.1088/1361-6455/adac93`.

261. S Soumyashree, P Kumar, 2024, *“Investigation of signal enhancement in nanoparticle enhanced molecular LIBS of graphite”*, Journal of Analytical Atomic Spectrometry, v. 39, p. 2270-2277, doi :`https://doi.org/10.1039/D4JA00089G`.

262. Sandeep Singh, Vimlesh Kumar, and G. K. Samanta, 2024, *“Fast measurement of group index variation with optimum precision using Hong-Ou-Mandel interferometry”*, APL Quantum 1, v. 1, p. 046117, doi :`https://doi.org/10.1063/5.0220993`.

263. Saumya J Sarkar, M Ebrahim-Zadeh, and G. K. Samanta, 2024, *“Talbot effect-based sensor measuring grating period change in subwavelength range”*, Scientific Reports, v. 14, p. 30872, doi :`https://doi.org/10.1038/s41598-024-81722-2`.

264. Saurav Dutta, Nihar Ranjan Behera, Saroj Barik, Rajesh Kumar Kushawaha, Y. Sajeev, G. Aravind, 2024, *“Bimolecular photodissociation of interstellar 1-Cyanonaphthalene via Intermolecular Coulombic decay”*, The Journal of Chemical Physics, v. 161, p. 124302, doi :`https://doi.org/10.1063/5.0226386`.

265. Shrey Mehta, G. K. Samanta, and Raghwinder Singh Grewal, 2025, *“Dead-zone-free single-beam atomic magnetometer based on free-induction-decay of Rb atoms”*, Applied Physics

Letters, v. 126, p. 044002, doi :https://doi.org/10.1063/5.0248330.

266. Singhal, M., Panda, M., Shinde, S.H., Mondal, S., Annalakshmi, O., Chauhan, N., 2024, *"Study of thermoluminescence characteristics of quartz for high radiation doses (¿1kGy): implications for extending the luminescence dating range"*, Radiation Measurements, v. 178, p. 107300, doi :https://doi.org/10.1016/j.radmeas.2024.107300.

267. SK Goyal, NK Tiwari, AR Patel, M Shanmugam, SV Vadawale, et al., 2024, *"Aditya Solar wind Particle Experiment (ASPEX) onboard Aditya–L1: The Supra-Thermal and Energetic Particle Spectrometer (STEPS)"*, Solar Physics, v. 300, p. 35, doi :https://doi.org/10.1007/s11207-025-02441-z.

268. Somesh Chamoli, Anmol Mishra, Achintya Kumar Dutta, Richa SharmaKesarkar, and B.K. Sahoo, 2024, *"Relativistic equation-of-motion coupledcluster theory analysis of black-body radiation shift in the clock transition of Zn I"*, Phys. Rev. A, v. 109, p. 063111, doi :https://doi.org/10.1103/PhysRevA.109.063111.

269. Subith Kumar, Anupam Pal, Arash Shiri, G. K. Samanta, 2024, *"Evolution of C-point singularities and polarization coverage of Poincare-Bessel beam in self-healing process"*, Scientific Reports, v.14, p. 16647, doi :https://doi.org/10.1038/s41598-024-67582-w.

270. Tanya Sharma, Rutvij Bhavsar, Jayanth Ramakrishnan, Pooja Chandravanshi, Shashi Prabhakar, Ayan Biswas, and R. P. Singh, 2025, *"Enhancing key rates of QKD protocol by Coincidence Detection"*, Advanced Quantum Technologies, NA, p. 2400685, doi :https://doi.org/10.1002/qute.202400685.

271. Vanitha Patnala, Gangi Reddy Salla, Shashi Prabhakar, R. P. Singh, Venkateswarlu Annapureddy, 2024, *"Analysing the Grain size and asymmetry of the particle distribution using auto-correlation technique"*, Applied Physics A, v. 130, p. 191, doi :https://doi.org/10.1007/s00339-024-07332-x.

272. Vardaan Mongia, Abhishek Kumar, Shashi Prabhakar, Anindya Banerji, and R. P. Singh, 2024, *"Investigating Device Independent Quantum Random Number Generation"*, Physics Letters A, v. 526, p. 129954, doi :https://doi.org/10.1016/j.physleta.2024.129954.

273. Wasson, R.J., Amaral, A.L., Rouwenhorst, J., Fifield, K., Chauhan, N., Pietsch, T., Alongi, D.M., Tirendi, F., Singhvi, A.K., 2024, *"Timor-Leste: preliminary assessment of a rapidly eroding landscape in the Coral Triangle"*, Marine and Freshwater Research, v. 75, NA, doi :https://doi.org/10.1071/MF24156.

274. Y.-M. Yu and B. K. Sahoo, 2025, *"Application of general-order relativistic coupled-cluster theory to estimate electric-field response clock properties of $\mathrm{C}a^+$ and $\mathrm{Y}b^+$"*, Phys. Rev. A, v. 111, p. 032801, doi :https://doi.org/10.1103/PhysRevA.111.032801.

275. Zhang, J., Muiña, A. T., Mifsud, D. V., Kaňuchová, Z., Cielinska, K., Herczku, P., Rahul, K. K., Kovács, S. T. S., Rácz, R., Santos, J. C., Hopkinson, A. T., Craciunescu, L., Jones, N. C., Hoffmann, S. V., Biri, S., Vajda, I., Rajta, I., Dawes, A., Sivaraman, B., Juhász, Z., Sulik, B., Linnartz, H., Hornekær, L., Fantuzzi, F., Mason, N. J., Ioppolo, S., 2024, *"A systematic IR and VUV spectroscopic investigation of ion, electron, and thermally processed ethanolamine ice"*, Monthly Notices of the Royal Astronomical Society, v. 533, p. 826-840, doi :https://doi.org/10.1093/mnras/stae1860.

276. Zhi-Ming Tang, Yuan-Fei Wei, B. K. Sahoo, Cheng-Bin Li, Yang Yang,Yaming Zou, and Xue-Ren Huang, 2024, *"Blackbody-radiation Zeeman shifts in optical clocks: the role of fine-structure intramanifold resonances"*, Phys. Rev. A, v. 110, p. 043108, doi :https://doi.org/10.1103/PhysRevA.110.043108.

# Publications in Proceedings of Conference/ Symposia/ Workshops

**Astronomy and Astrophysics**

1. Adassuriya, J., S. Ganesh, P. De Cat, S. Joshi, C. Jayaratne, 2024, *"Curve of Growth Analysis of SZ Lyn"*, Bulletin de la Société Royale des Sciences de Liège, 2024, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, v. 93, p. 470-47.
2. Aravind, K., S. Ganesh, 2024, *"Optical Spectroscopy of Comets"*, Bulletin de la Société Royale des Sciences de Liège, 2024, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, v. 93, p. 102-111.
3. Joshi, S., P. De Cat, M. De Becker, K. Kolenberg, S. Mondal, S. Ganesh, L. Mahy, D. Karinkuzhi, A. P. Yadav, T. Baug, J. C. Pandey, K. Misra, C. S. Stalin, N. Veerabathina, B. Joshi, D. Berghmans, T. Van Doorsselaer, 2024, *"Bulletin de la Société Royale des Sciences de Liège"*, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, v. 93, p. 1-31.
4. Singh, S., J. C. Pandey, V. Joshi, 2024, *"Polarimetric Approach Towards Membership Probability of Open Star Cluster NGC 2345"*, Bulletin de la Société Royale des Sciences de Liège, 2024, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, v. 93, p. 308-314.
5. Srivastava, M. K., A. Maiti, V. Kumar, B. Mistry, A. Patel, V. Dixit, K. Lad, 2024, *"Development of ProtoPol: a medium resolution echelle spectro-polarimeter for PRL 1.2m and 2.5m telescopes, Mt Abu, India"*, Proceedings Volume 13096, Ground-based and Airborne Instrumentation for Astronomy X ; 130961V, Event: SPIE Astronomical Telescopes + Instrumentation, Yokohama, Japan, v. 13096.
6. Uppal, N., S. Ganesh, S. Joshi, M. Sarkar, P. Prajapati, A. Dileep,, 2024, *"Optical Polarisation Study of Galactic Open Clusters"*, Proceedings of the 3rd BINA Workshop on the Scientific Potential of the Indo-Belgian Cooperation, Bulletin de la Société Royale des Sciences de Liège, v. 93, p. 155-169.

**Solar Physics**

7. Rawat, A., Gupta, G. R., 2024, *"Exploring magnetic coupling of solar atmosphere through frequency modulations of 3-min slow magnetoacoustic waves"*, Bulletin de la Société Royale des Sciences de Liège (BSRSL), Proceedings of the Third BINA Workshop., v. 93, p. 948–961.

**Planetary Sciences**

8. Ambily, G., Durga Prasad, K., and Bhardwaj, A., 2025, *"Distinct Local Scale Thermophysics of the Moon through Improved 3D Modelling: Insights for Future Exploration"*, 56$^{th}$ Lunar and Planetary Science Conference (LPSC 2025), Abstract 1941.
9. Chandan Kumar , Mishra, S. K., Durga Prasad, K., and Bhardwaj, A., 2024, *"Novel Design of Heat Flow Probe Electronics: Design, Development, Testing and Performance"*, 21$^{st}$ Annual Meeting of Asia Oceania Geosciences Society (AOGS-2024), Pyeongchang, South Korea, v. 20.
10. Durga Prasad, K., Ambily, G., Kumar, C., Kalyana Reddy, P., Mishra, S. K., Kumar, J., Ladiya, T., Patel, A., and Bhardwaj, A., 2025, *"ChaSTE Onboard Chandrayaan-3 Provides First Thermal Measurements of Southern Polar Region of the Moon"*, 56$^{th}$ Lunar and Planetary Science Conference (LPSC 2025) (Virtual Participation),, Abstract no.1951.
11. Jitarwal, S., Sheel, V., and Pabari, J., 2024, *"Radio Occultation Experiment for Deriving Planetary Atmospheric Profiles"*, 6$^{th}$ URSI RCRS, Bhimtal,, 0733.
12. Kimi, K. B., Sahoo, R., Chavan, A., and Vijayan, S., 2025, *"Investigating Subsurface Faults through Fault-Crater Interactions"*, 56$^{th}$ Lunar and Planetary Science Conference, Abstract No.2125.
13. Kondhiya, T., and Pabari, J., 2024, *"Understanding the Venusian and Terrestrial Lightning Due to Streamer Propagation"*, 6$^{th}$ URSI RCRS, Bhimtal, 6399.
14. Nair, V. M., Basu Sarbadhikari, A., Vijaya Kumar, T., Sorcar, N., Mukherjee, S., and Babu, E. V. S. S. K., 2025, *"Unveiling Magma Evolution: Insights from Melt Inclusions in Enriched and Intermediate Shergottites"*, 6$^{th}$ Indian Planetary Science Conference (IPSC-2025), Centre for Space Science and Technology, Indian Institute of Technology (IIT) Roorkee, NA.
15. Pabari, J., Roshni, M., and Sahu, A., 2024, *"Extreme Conditions for Electrification during Dust Devils on Mars"*, 6$^{th}$ URSI RCRS, 4491.
16. R. Kraft, Á Bogdán, J. ZuHone, J. S. Adams, J. D. Alvarado-Gómez, C. Argiroffi, M. Ayromlou, M. Azadi, S. R. Bandler, M. Barbera, A. Bhardwaj, V. Biffi, D. Bodewits, E. Boettcher, et al., 2024, *"The Line Emission Mapper (LEM) probe mission concept"*, Space Telescopes and Instrumentation 2024: Ultraviolet to Gamma Ray, v. 13093, pp. 1309327.
17. Rani, A., Haviland, H. F., Bremner, P. M., Woo, A., Roy, A., Mallik, A., Basu Sarbadhikari, A., and Karunatillake, S., 2025, *"Constraining the Magmatic Evolution of the Elysium Volcanic Province, Mars"*, 56$^{th}$ Lunar and Planetary Science Conference, Abstract no.2187.
18. Sahoo, R., Kimi, K. B., Chavan, A., and Vijayan, S., 2025, *"Evidence for Recent Tectonic Activity in an Ice-Filled Impact Crater on Mars"*, 56$^{th}$ Lunar and Planetary Science Conference, Abstract no.2108.

19. Sahu, A., and Pabari, J., 2024, *“Influence of Gravitational and Non-Gravitational Forces on Interplanetary Dust”*, $6^{th}$ URSI RCRS, Bhimtal, 7419.
20. Shrivastava, K., and Pabari, J., 2024, *“Investigation of Whistler Waves in the Venusian Atmosphere”*, $6^{th}$ URSI RCRS, Bhimtal, 4825.
21. Tuhi, S., Wray, J. J., Harish, S., Vijayan, S., and Ganesh, I., 2025, *“Bernard Crater, Mars: Insights into Diverse Volcanic and Tectonic Processes”*, $56^{th}$ Lunar and Planetary Science Conference, Abstract no. 1460.

**Space and Atmospheric Sciences**

22. Jacob Sebastian, Abhishek Kumar, Dibyendu Chakrabarty, Prashant Kumar, Shiv Kumar Goyal, Santosh Vadawale, M. Shanmugam, M. Hasan, Aveek Sarkar, Bijoy Dalal, Aakash Gupta, Shivam Parashar, Bhas Bapat, Manan S. Shah, Pranav R. Adhyaru, Arpit R. Patel, Hitesh Kumar Adalja, Neeraj Kumar Tiwari, Aaditya, 2025, *“GSICS Quarterly Newsletter Winter 2025 Issue”*, Comparison of Solar Wind flux and bulk parameters obtained from Aditya L1-ASPEX with Wind-3DPPESA-L and ACE-EPAM-LEMS120, Vol. 18 No 4.

**Geosciences**

23. Devaprasad M., Rastogi N., Das S. K., Jena P. S., Dhab, A., and Bhushan R., 2024, *“Inter-annual variability in sources and characteristics of carbonaceous aerosols using dual carbon isotopes over a mega city in eastern India”*, Published in Indian Aerosol Science and Technology Association (IASTA) 2024 conference held at Doon University, Dehradun during December 17-20, 2024., NA.
24. Joshi S., Shaw C., Rastogi N., and Singh A., 2024, *“Role of aerosol pH and liquid water content on gas-particle partitioning and deposition of total nitrate and ammonia”*, Indian Aerosol Science and Technology Association (IASTA) 2024 conference held at Doon University, Dehradun during December 17-20, 2024, NA.
25. Shaw C., Mandal R., Singh A., Sanyal P., and Rastogi N., 2024, *“Insights into the major sources of NOx and formation pathways of particulate NO3- using dual isotope proxy”*, In Indian Aerosol Science and Technology Association (IASTA) 2024 conference held at Doon University, Dehradun during December 17-20, 2024., NA.

**Theoretical Physics**

26. Agarwal, N., Pal, S., Srivastav, A., Tripathi, A., 2024, *“Cwebs in multiparton scattering amplitude: Structures at four loops”*, Proceedings of the QCD@Work 2024, International Workshop on Quantum Chromodynamics, EPJ Web Conf., v. 314, p. 00024.
27. Agarwal, N., Danish, A., Mishra, S., Pal, S., Srivastav, A., Tripathi, A., 2024, *“Soft Anomalous Dimension Structure at Five Loops”*, Proceedings of the XXV DAE-BRNS High Energy Physics (HEP) Symposium 2022, Springer Proceedings in Physics, v. 304, p. 1117–1119.
28. Bansal, A., Mahajan, N., Mishra, D., 2024, *“Quest for New Physics with Ratio of CKM Elements”*, 25th DAE-BRNS High Energy Physics Symposium, Springer Proc.Phys., v. 304, p. 1270-1272.
29. Danish, A., Mishra, S., Pal, S., Srivastav, A., Tripathi, A., 2024, *“Next-to-eikonal Webs in Multiparton Amplitude”*, Proceedings of the XXV DAE-BRNS High Energy Physics (HEP) Symposium 2022, Springer Proceedings in Physics, v. 304, p. 1114-1116.
30. Ghosh, A., Konar, P., Seth, S., 2024, *“Precise Probing of the Inert Higgs-Doublet Model at the LHC”*, Springer Proc. Phys., v. 304 (2024), p. 128-132.
31. Kundu, S., Show, S., Konar, P., Das, P. K., 2024, *“Freeze-In Dark Matter Search at Colliders with Jet Substructure Analysis”*, Springer Proc. Phys., v. 304 (2024), p. 393-396.
32. Mohanta, G., 2024, *“Radiatively Generated Quarks and Lepton Masses in Extended Gauge Theories”*, Proceedings of the 25th DAE-BRNS High Energy Physics Symposium, Springer Proc.Phys., v. 304, p. 282-285.
33. Pal, S., Agarwal, N., Mukhopadhyay, A., Tripathi, A., 2024, *“EDGE: A Simple Way to Obtain Power Corrections for Event Shape Variables”*, Proceedings of the XXV DAE-BRNS High Energy Physics (HEP) Symposium 2022, Springer Proceedings in Physics, v. 304, p. 789-791.
34. Pal, S., Seth, S., 2024, *“NLP corrections for H+jet production”*, Proceedings of the 42nd International Conference on High Energy Physics (ICHEP2024), Proceedings of Science, v. 476, p. 044.
35. Rao, K., Rindani, S.D., Sarmah, P., Singh, B., 2024, *“Z polarization at an e+e- collider and properties of decay-lepton angular asymmetries”*, Proceedings of the Indian National Science Academy, v. 90, issue 3, p. 1-14.
36. Sahu, R., Kota, V.K.B. Kota, Kosmas, T.S., 2024, *“Deformed Shell Model Applications to Weak Interaction Processes”*, International Workshop on ”Physics Beyond the Standard Model in Leptonic and Hadronic Processes and Relevant Computing Tools”, Particles, v. 7, p. 595–602.
37. Show, S., Ghosh, P., Konar, P., Saha, A. K., 2024, *“Realization of self-interacting freeze-in via dark matter”*, Springer Proc. Phys., v. 304 (2024), p. 1186-1188.
38. Shukla, S. K., 2024, *“Analysis of Scalar Mediated Proton Decays in Non-SUSY SO(10) GUTs”*, Proceedings of the 25th DAE-BRNS High Energy Physics Symposium, Springer Proc.Phys., v. 304, p. 863-865.

# Books Edited / Review Articles / Other Publications

**Books Edited**

1. Bhuwan Joshi, 2024, *"Onset and evolution of solar flares: Application of 2D and 3D models of magnetic reconnection"*, Bulletin de la Société Royale des Sciences de Liège (BSRSL)v. 93(2), p. 983–1003

**Review Articles**

1. Trushit Upadhyaya, Jayesh Pabari, Upesh Patel, Killol Pandya, Ramakant Mahajan and Anil Bhardwaj, 2025, *"A system and method for performing lightning characterization and detection for realization of a planetary lightning"*, Official Journal of the Patent Office, v.No.202421071579 A, https://ipindia.gov.in/journal.htm
2. Chahat Kaushik, Anirban Ghosh, Chaitanya Kumar, Kavita Devi, Ritwick Das, GK Samanta, 2025, *"Non-interferometric measurement of Pancharatnam-Berry phase using stimulated second-harmonic-generation"*, SPIE : Nonlinear Frequency Generation and Conversion: Materials and Devices XXIV, v.v. 13347, p. 1334707
3. Shashi Prabhakar, 2024, *"Roadmap on computational methods in optical imaging and holography"*, Applied Physics B: Lasers and Optics, v.v. 130, p. 166
4. Dipen Sahu, Sheng-Yuan, Naomi Hirano and ALMASOP team, 2024, *"Multiscale Observations of Starless Cores: Visualizing Core Evolution from Collapse to Centrally Dense (Sub)structures and First Core-like Nucleus"*, URSI-RCRS, v.NA, NA
5. Joshi S., Rastogi N., and Singh A., 2024, *"Insights into the formation of secondary organic aerosols from agricultural residue burning emissions: A review of chamber-based studies"*, Science of The Total Environment, v.952(175932), 1-14
6. B. G. Fejer, Luis A. Navarro and Dibyendu Chakrabarty, 2024, *"Recent results and outstanding questions on the response of the electrodynamics of the low latitude ionosphere to solar wind and magnetospheric disturbances"*, Frontiers in Astronomy and Space Sciences, v.v. 11, pp. 1-14

# Papers Presented in National/ International Conferences

**International**

1. Dutta, P., Cayao, J., Black-Schaffer, A. M. , Burset, P., "Signatures of Majorana bound states in Andreev interferometer", Conference on Advances in Topological Condensed Matter, International Center for Theoretical Physics, Trieste, Italy, 11/11/2024 to 15/11/2024, Presented By: Paramita Dutta.
2. Debnath D., Dutta, P, "Josephson diode effect in quantum dot junction", International Conference on Bose-Einstein Condensation, Superconductivity, Superfluidity and Quantum magnetism, S. N. Bose Centre for Basic Sciences, Kolkata, 12/11/2024 to 16/11/2024, Presented By: Debika Debnath.
3. Pal, S., Seth, S., "On Higgs+jet production at next-to-leading power accuracy", 42nd International Conference on High Energy Physics (ICHEP2024), Prague, Czech Republic, 18 July- 24 July, 2024, Presented By: Sourav Pal.
4. Chaurasiya, R., and Bayanna, A. R., "Propagation of Shock Waves in the Solar Atmosphere", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: R. Chaurasiya.
5. Bayanna, A. R., Louis, R. E., Beck, C., Mathew, S. K., and Chaurasiya, R., "Temperature and Velocity Stratifications in an Active Region in MAST Observations", International Conference on Sun, Space Weather and Solar-Stellar Connections, Indian Institute of Astrophysics (IIA), 20–24 January 2025, Presented By: Raja Bayanna.
6. Kumar, H., Kumar, B., and Rajaguru, S. P., "Gravity Waves in the Lower Solar Atmosphere", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Brajesh Kumar.
7. Dubey, S. K., Mathew, S. K., Beck, C., and Choudhary, D. P, "Multi-Height Study of the Chromospheric Inverse Evershed Flow and Its Association with Photospheric Flows", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Sandeep K. Dubey.
8. Patel, B. D., Joshi, B., Sterling, A. C., and Moore, R. L., "Coronal Mass Ejections Driven by Homologous Compact-Flare Blowout Jets", 10th Plasma Science Society of India Plasma Scholars Colloquium, 4–6 July 2024, Presented By: Binal D. Patel.
9. Patel, B. D., Joshi, B., and Upadhyay, K., "Source Region of Intense Solar Radio Burst During an Eruptive Flare: Correlating Flare-CME Signatures from Udaipur-CALLISTO Dynamic Spectrum and AIA/SDO Observations", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Binal D. Patel.
10. Rawat, A., and Gupta, G. R., "Propagation and damping of 3-min slow waves from photosphere to corona along the umbral fan loops", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Ananya Rawat.
11. Gupta, G. R., Rawat, A., Mason, H., and Erdélyi, R., "Exploring propagation of small-scale flare heat flux in the lower and upper atmosphere of solar active region", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Girjesh R. Gupta.
12. Kumari A., Gopalswamy N., Jensen L., Fung S. F., Li L., Deshpande M. D., "Space-Based Radio Instrumentation for Faraday Rotation Measurements: SNR Requirements", AGU Fall Meeting 2024, 9–13 December 2024, Presented By: Anshu Kumari.
13. Kumari, A., Mohan, A., Monstein, C., Hemapriya, R., Gopalswamy, N., "Observing the Annular and Total Solar Eclipse Using a Low-Cost GHz Radio Instrument", AGU Fall Meeting 2024, 9–13 December 2024, Presented By: Anshu Kumari.
14. Kumari, A. and Gopalswamy, N., "Type II Burst without a Coronal Mass Ejection", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Anshu Kumari.
15. Kumari, A., Mohan, A., Makela, P., Morosan, D., Gopalswamy, N., "Radio Observations and Their Role in Understanding Solar Energetic Particle Events", International Conference on Sun, Space Weather and Solar-Stellar Connections, 20–24 January 2025, Presented By: Anshu Kumari.
16. Srivastava, N., "Influence of Solar Wind Medium on the Propagation of Earth-Impacting CMEs", IAUS 340, Krakow, Poland, 5–9 May 2024, Presented By: Nandita Srivastava.
17. Bhatt, M., Wöhler, C., Hess, M., Arnaut, M., Aravind, K., Ganesh, S., and Bhardwaj, A., "Lunar Swirls: Outcomes from Systematic Spectral and Physical Characterisation", $45^{th}$ Scientific Assembly, 13 July-21 July, 2024, Presented By: Megha Bhatt.
18. Denesh, K., Srivastava, N., Verma, A., Anbazhagan, S., Bose, S., Panwar, N., Kapadia, T., Durga Prasad, K., Bhatt, M. and Bhardwaj, A., "Reflectance Spectroscopy of Lunar Soil Simulants: A Comparative Study of LSS-ISAC-1 and JSC 1A Basalt", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: Denesh, K.
19. Harshita and Pabari, J., "Image analysis of dust ring in the orbit of Venus", Venus Science Conference (Venus-SC 2024), 23 September-24 September, 2024, Presented By: Harshita.
20. Jaiswal, S., Mahajan, R. R., and Ngangom, M., "Cosmic Ray Exposure Ages of HED Meteorites: Unveiling the Neon Isotope

Record", $56^{th}$ Lunar and Planetary Science Conference (LPSC), 10 March –14 March, 2025, Presented By: S. Jaiswal.

21. Jitarwal, S., Pabari, J. P., Nambiar, S., Prasad, N. J. S. S. V., Rashmi, Acharyya, K., Upadhyaya, T. and Team, "Venusian Lightning and possibility of ground-based observation", Venus Science Conference (Venus-SC 2024), 23 September-24 September, 2024, Presented By: Sonam Jitarwal.
22. Misra, D., Bhatt, M., Wöhler, C., Arnaut, M., Rai, N., Srivastava, N., and Bhardwaj, A., "Towards Understanding Spectral and Physical Characteristics of Lunar Pyroclastics", Europlanet Science Congress 2024, Freie Universität Berlin, 8 September -13 September, 2024, Presented By: Dibyendu Misra.
23. Misra, D., Suvagiya, K. C., and Bhatt, M., "Lunar Pyroclastics: A Novel Way of Detection, Characterization and Validation", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: Dibyendu Misra.
24. Nambiar, S., Pabari, J. P., Jitarwal, S. and Rashmi, "Sporadic nature of meteor layer in planetary atmosphere", Venus Science Conference (Venus-SC 2024), 23 September-24 September, 2024, Presented By: Srirag Nambiar.
25. Nath, R., Mali, S. D., Denesh, K., Panwar, N., Verma, A., Mahajan, R. R. and Srivastava, N., "Decoding meteorites using Reflectance Spectroscopy and Deep Learning", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: Nath, R.
26. Panda, D. K., Mahajan, R., and Kumar, A., "Mineralogy and Noble Gas Study in Chondrule", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: D. K. Panda.
27. Panwar, N., Srivastava, N., Yadav, A., Bhatt, M., Wöhler, C. and Bhardwaj, A., "Volcanism along the rings of the Crisium Basin on the Moon: New Insights", AGU Fall Meeting,( Online), 9 December-13 December 2024, Presented By: Neha Panwar.
28. Sahu A. and Pabari, J. P., "Evolution of interplanetary dust from the asteroid belt under the influence of different forces", $56^{th}$ Lunar and Planetary Science Conference (LPSC), 10 March-14 March 2025, Presented By: Aanchal Sahu.
29. Sathyan, S., Bhatt, M., Kumar, S., Srivastava, N., and Bhardwaj, A., "Depth to Diameter Ratio of Lunar Craters and Its Possible Correlation to the Water Ice Deposits", Europlanet Science Congress 2024, Freie Universität Berlin, 8 September -13 September, 2024, Presented By: Sachana Sathyan.
30. Sathyan, S., Sajinkumar, K. S., and Bhatt, M., "Luna Impact Crater: Cosmic Fingerprint on Harappan Civilization", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: Sachana Sathyan.
31. Shanmugam, M., Vadawale, S. V., Patel, A. R., Mithun, N. P. S., Kumar, H., Ladiya, T., Goyal, S. K., Singh, N., Kumar, S., Painkra, D. and Bhardwaj, A., "Alpha Particle X-Ray Spectrometer on Chandrayaan-3 Pragyan Rover: Performance and Initial Results", $45^{th}$ COSPAR Scientific Assembly, 13 July-21 July, 2024, Presented By: Shanmugam, M.
32. Sheel, V., Sharma, S. M. and Paetzold, M., "Space Weather Effects on Venusian Ionosphere", $45^{th}$ COSPAR Scientific Assembly, 13 July-21 July, 2024, Presented By: Varun Sheel.
33. Shrivastava, K. and Pabari, J. P., "Correlation between whistler wave occurrences in the Venusian ionosphere and the number of sunspots", $22^{nd}$ Meeting of the Venus Exploration Analysis Group (VEXAG), Louisville, Kentucky (USA), 17 November-19 November 2024, Presented By: Kriti Shrivastavaa.
34. Sinha, R. K., "Meteorite Impacts of Shallow Moonquakes: What Triggered the Biggest Boulder-Fall on the Moon", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: R. K. Sinha.
35. Srivastava, N., Verma, A. J., Denesh, K., Anbazhagan, S., Bose, S., Panwar, N., Kapadia, T., Bhatt, M., Durga Prasad, K. and Bhardwaj, A., "Retrieval of abundance in a particulate mixture using spectro-goniometer at Planetary Remote Sensing Laboratory", $4^{th}$ International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS), 20 November-22 November, 2024, Presented By: Neeraj Srivastava.
36. Wöhler, C., Bhatt, M., and Arnaut, M., "Multi-Band UV-VIS-NIR Imaging Spectropolarimetry of Lunar Terrains", $45^{th}$ COSPAR Scientific Assembly, 13 July-21 July, 2024, Presented By: C. Wöhler.
37. Wöhler, C., Bhatt, M., Arnaut, M., Misra, D., Ganesh, S., and Bhardwaj, A., "Terrain-Dependent Spectral Properties of Lunar Polarisation at Small Phase Angles", Europlanet Science Congress 2024, Freie Universität Berlin, 8 September -13 September, 2024, Presented By: C. Wöhler.
38. Yadav A. and Pabari, J. P., "Identification of flux rope in the nightside induced magnetosphere of Venus", $56^{th}$ Lunar and Planetary Science Conference (LPSC), 10 March-14 March 2025, Presented By: Aarti Yadav.
39. Yadav, A. and Pabari, J., "Flux rope observations near Venus", Venus Science Conference (Venus-SC 2024), 23 September-24 September, 2024, Presented By: Aarti Yadav.
40. Sheel, V., Spiga, A. and Kalita, T., "Characterisation of Turbulence and Dust Devils at different locations on Mars", $45^{th}$ COSPAR Scientific Assembly, Busan, South Korea, 13 July-21 July, 2024, Presented By: Varun Sheel.
41. Manash Samal, Vineet Rawat et al, "Formation and Early Evolution of Massive Star Clusters: An Observational Prospective", The 1st Indo-Thai Symposium on Astrophysics and Technology Development (ITSAT 2024), 26-28 August 2024, Presented By: Manash Samal.
42. Mudit K. Srivastava, Arijit Maiti, Vipin Kumar, Bhaveshkumar Mistry, Ankita Patel, Vaibhav Dixit, Kevikumar Lad, "Development of ProtoPol: a medium resolution echelle spectro-polarimeter for PRL 1.2m and 2.5m telescopes, Mt. Abu, India", Ground-based and Airborne Instrumentation for Astronomy X, SPIE Astronomical Telescopes + Instrumentation, 16-21 Jun 2024, Presented By: Mudit K. Srivastava.
43. Mudit K. Srivastava, "Design and Development of Spectro-polarimeters for PRL Telescopes", 1st Indo-Thai Symposium on Astrophysics and Technology Development (ITSAT 2024), 26-28 August 2024, Presented By: Mudit K. Srivastava.

44. B Sivaraman, Arijit Roy, Ragav Ramachandran, J K Meka, W Khan, S Gupta, D Sahu, Y – J Wu, A Das, B N Rajasekar, P Janardhan, Anil Bhardwaj, N J Mason, “Interstellar Quantum dots – Analogues Synthesized in the Laboratory”, QuantumGrain Workshop, 09 Jun-12 June, 2024, Presented By: Bhalamurugan Sivaraman.

45. R. Ramachandran, Surendra V Singh, W Khan, A Corrigen, Zoltán Juhász, V Thiruvenkatam, Péter Herczku, Sándor TS Kovács, Anil Bhardwaj, Bela Sulik, N J Mason, B Sivaraman, “Sulphur implantation under astrochemical conditions: Implications to the Jovian system”, Collisions Physics and Chemistry and their Applications (COPCA) conference - 2024, 15 Oct-18 October, 2024, Presented By: Ragav Ramachandran.

46. R. Ramachandran, Surendra V Singh, W Khan, A Corrigen, Zoltán Juhász, V Thiruvenkatam, Péter Herczku, Sándor TS Kovács, Anil Bhardwaj, Bela Sulik, N J Mason, B Sivaraman, “Converting One Amino Acid to the Other Containing Sulfur Via Ion Irradiation: Implication to Chemical Evolution on Europa Surface Ices”, DIG Astrochemistry - 2: Icy Dust - Astrochemistry Workshop, 25 June, 2024, Presented By: Ragav Ramachandran.

47. Tanya Sharma, Rutvij Bhavsar, Jayanth Ramakrishnan, Pooja Chandravanshi, Shashi Prabhakar, “Enhancing key rates of QKD protocol by Coincidence Detection”, $14^{th}$ International Conference on Quantum Cryptography (QCrypt- 2024), 02 Sept-06 Sept, 2024, Presented By: Tanya Sharma.

48. Venugopal, G.R. Tripathy, V. Goswami, T. Khan, “Tracking the Mesoproterozoic Ocean anoxia: Inferences from Mo isotopic study of black shales from Cuddapah Basin, India”, EGU General Assembly, Vienna, Austria, 14 Apr-19 Apr, 2024, Presented By: A. Venugopal.

49. Kadlag, Y., Leya, I., Villeneuve, J., Bouvier, A. S., & Mezger, K, “26Al-26Mg Ages of Chondrules from Unequilibrated Chondrites”, LPI Contributions Series, 11 Mar-15 Mar, 2024, Presented By: Yogita Kadlag.

50. D. Asokan, Y. Kadlag, K. Das, R. Hazarika, A. Chavan, “Mineralogical and Geochemical Characterization of Suspected Impactites from the Luna Structure, Western India”, MetMESS-2024, 20 Nov-22 Nov, 2024, Presented By: Ajay Dev Asokan.

51. Arijit roy, “Bottom-up formation pathways of ISM minerals in a flash - an experimental study”, $76^{th}$ International Symposium of Molecular Spectroscopy (ISMS), 17 June - 21 June, 2024, Presented By: Arijit Roy.

52. M. Singhal, M. Panda, S. H. Shinde, S. Mondal, O. Annalakshmi, Naveen Chauhan, “Thermoluminescence characteristics of quartz at high radiation doses (¿1kGy)”, UK Luminescence and ESR meeting (UKLUM2024), 11 Sep - 13 Sep, 2024, Presented By: Malika Singhal.

53. Malika Singhal, Madhusmita Panda, O. Annalakshmi, Parth Chauhan, Naveen Chauhan, “Do Sensitivity Normalization Methods Limit the Upper Range of Luminescence Dating Using BSL Quartz”, American Geophysical Union (AGU 2024), (online), 09 Dec - 13 Dec,2024, Presented By: Malika Singhal.

54. Mansi Gupta, Nidhi Tripathi, L.K. Sahu, Arvind Singh, “Role of air-sea exchange exchange and atmospheric atmospheric processes influencing the distributions of isoprene and dimethyl sulfide over the Bay of Bengal and Andaman Sea during post-monsoon season”, 9th Surface Ocean–Lower Atmosphere Study (SOLAS) Open Science Conference (OSC), 10-14 November 2024, Presented By: Mansi Gupta.

55. L.K. Sahu, Mansi Gupta, Nidhi Tripathi, “Distributions of volatile organic compounds over the northern Indian Ocean: Role of continental transport and air-sea exchange”, 9th Surface Ocean–Lower Atmosphere Study (SOLAS) Open Science Conference (OSC), 10-14 November 2024, Presented By: L.K. Sahu.

56. L.K. Sahu, Tanzil Malik, Mansi Gupta, Nidhi Tripathi, “Changes in ambient concentrations of monoterpenes during the winter-summer transition period in an urban site of India”, European Geosciences Union (EGU) General Assembly 2024, 14–19 April 2024, Presented By: L.K. Sahu.

57. D. Kamat, Som Sharma, P. Kumar, S. Saha, K. N. Kumar, “Investigation of the Characteristics and Formation Mechanism of Convective Clouds Below and Near the Lifting Condensation Level”, 9th International Training School on Convective and Volcanic Clouds– CVC– detection, monitoring and modeling, 5-13 October 2024, Presented By: D. Kamat.

58. D. Kamat, Som Sharma, S. Saha, P. Kumar, K. N. Kumar, “Exploring the dynamics of the Atmospheric Boundary Layer over the Western-Indian region: Insights and Implications”, European Geosciences Union (EGU) 2024 General Assembly, 14–19 April 2024, Presented By: D. Kamat.

59. Harithasree, S., Sharma, K., Girach, I. A., Sahu, L. K., Singh, N., Flemming, J., Babu, S. S., Ojha, N., “Variability in surface ozone & related chemical species over the Himalayan region: Exploiting reanalyses and machine learning”, 6th WCRP International Conference on Reanalysis (ICR6), 28 Oct – 01 Nov 2024, Presented By: S. Harithasree.

60. Kamran Ansari and S. Ramachandran, “Aerosol optical and radiative properties over Asia: Ground-based AERONET observations”, European Geosciences Union (EGU) General Assembly 2024, 14–19 April 2024, Presented By: Kamran Ansari.

61. Guharay, A., Batista, P. P., and Buriti, R. A., “Characteristics of intraseasonal oscillations in middle atmosphere”, 16th International Workshop on Technical and Scientific Aspects of iMST Radar and Lidar (MST16/iMST3), 09-13 September 2024, Presented By: Amitava Guharay.

62. Mitra, G., Guharay, A., Batista, P. P., & Buriti, R. A., “Low-Latitude Planetary Waves Dynamics during an Unusual Antarctic Sudden Stratospheric Warming”, 16th International Workshop on Technical and Scientific Aspects of iMST Radar and Lidar (MST16/iMST3), 09-13 September 2024, Presented By: Gourav Mitra.

63. Mitra, G., Guharay, A., Batista, P. P., & Buriti, R. A., “Study of Low-Latitude Planetary Wave Dynamics during 2019 Minor Sudden Stratospheric Warming”, International Symposium on the 40th Anniversary of the MU Radar, 18-21 November 2024, Presented By: Gourav Mitra.

64. K. Venkatesh and D. Pallarmaju, D. Lissa and Gopi K. Seemala, “On the association of loss of locks in GNSS signals with electron density depletions over the equatorial and low latitudes”, 45th COSPAR Scientific Assembly (COSPAR-2024), 13-21 July 2024, Presented By: K. Venkatesh.

65. Pallamraju, D, “Space Weather Effects on Equatorial Regions: Complexities and Implications”, 45th COSPAR General Assembly, 14 - 20 July, 2024, Presented By: D. Pallamraju.

66. Pallamraju, D., and K.Upadhyay, “First ground-based daytime red line observations of stable auroral red arcs and storm enhanced densities — signatures of plasmasphere-ionosphere interactions in the daytime”, 45th COSPAR General Assembly, 14 -20 July, 2024, Presented By: D. Pallamraju.
67. Kumar, S., D. Pallamraju, & S. Saha, “Response of ICON/MIGHTI OI 630.0 nm dayglow emission to the geomagnetic activities”, American Geophysical Union Annual Meeting – 2024, 9 - 13 December 2024, Presented By: S. Kumar.
68. Pallamraju, D. D. Chakrabarty, R. P. Singh, T. K. Pant, S. Thampi, C. Vineeth, S. Sarkhel, S. Narendranath and DISHA team, “Investigations of Space Weather effects on Earth’s Ionosphere -thermosphere through Space-based measurements”, International Conference on Space for Sustainability: Science, Technology, 04 – 07 March 2025, Presented By: D. Pallamraju.

**National**

69. Debnath D., P. Dutta, “Field-free Josephson diode effect in interacting chiral quantum dot junction”, Young Investigators Meet on Quantum Condensed Matter Theory, Indian Institute of Science Education and Research, Pune, 20 Dec- 24 Dec, 2024, Presented By: Debika Debnath.
70. Debnath D., Dutta, P, “Diode effect in quantum dot-based Josephson junction”, 7th Annual Conference on Quantum Condensed Matter (QMAT2024), Indian Institute of Technology, Guwahati, 20 Dec- 24 Dec, 2024, Presented By: Debika Debnath.
71. Shukla, S K, “Threshold Corrections and an Optimal SU(5)”, XXVI DAE BRNS HEP Symposium 2024, IIT BHU-Varanasi, 19 Dec- 23 Dec, 2024, Presented By: Saurabh K Shukla.
72. Kashav, M., “Implication on Neutrino Masses and Mixing at Fixed Point $\tau = i$ in Modular Symmetries”, XXVI DAE BRNS HEP Symposium 2024, IIT BHU-Varanasi, 19 Dec- 23 Dec, 2024, Presented By: Monal Kashav.
73. Patel, B. D., Joshi, B., and Upadhyay, K., “Identifying the Source Region of Intense Radio Burst During X4.0 Solar Eruptive Flare: Exploring Udaipur-CALLISTO Observation”, 6th URSI Regional Conference on Radio Science, 22–25 October 2024, Presented By: Binal D. Patel.
74. Kumari, A and Gopalswamy, N., “Can a Type II Burst Occur Without a Coronal Mass Ejection?”, 6th URSI Regional Conference on Radio Science, 22–25 October 2024, Presented By: Anshu Kumari.
75. Anshu Kumari, Nat Gopalswamy, Liz Jensen, Shing F. Fung, Lihua Li, Manohar D. Deshpande, “Design Requirements of Space-Based Radio Instruments at L4–L5 for FR Measurements”, 6th URSI Regional Conference on Radio Science, 22–25 October 2024, Presented By: Anshu Kumari.
76. Bhatt, M., Narendranath, S., Wöhler, C., and Srivastava, N., “Remote Sensing Techniques for Analysing Lunar Surface Composition: Method and Comparison”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Megha Bhatt.
77. Bose, S., Kumari, A., Denesh, K., Kapadia, T., Panwar, N. and Srivastava, N., “Surface temperatures of the Moon derived from high-resolution IIRS on-board Chandrayaan-2: A case study on the Schrödinger Basin”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Bose S..
78. Kondhiya, T. and Pabari, J., “Electrostatic Discharges and Upward Lightning on Venusian Atmosphere”, Space for Sustainability: Science, Technology, Education and Policy (S2:STEP2025) and 6$^{th}$ Indian Planetary Science Conference (IPSC), 4 March-7 March, 2025, Presented By: Tejaswi Kondhiya.
79. Kumar, A., and Mahajan, R. R., “Cosmic Ray Exposure Ages and Noble Gas Study in Different Aliquots of Rantila Meteorites”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Avadh Kumar..
80. Kumar, S., Kumar, C., Mishra, S. K., Ladiya, T., Durga Prasad, K. and Shanmugam, M., “Design and Development of a Low-frequency Sweep Generator for Lunar Water-ice Detection by Measuring the Dielectric Permittivity of the Medium”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Sushil Kumar.
81. Mali, S. D., Nath, R., Denesh, K., Bose, S., Kapadia, T., Panwar, N., Verma, A. J., Mahajan, R. R. and Srivastava, N., “Estimation of olivine-pyroxene mineral abundance using reflectance spectroscopy”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Mali, S. D..
82. Misra, D., Hess, M., Wohlfarth, K., Arnaut, M., Wöhler, C., and Bhatt, M., “Characterization of Lunar Pyroclastic Deposits”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Dibyendu Misra.
83. Panda, D. K., Mahajan, R., and Kumar, A., “Mineralogy and Isotopic Study of Ordinary Chondrite”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: D. K. Panda.
84. Rashmi, Pabari, J., Jitarwal, S. and Nambiar, S., “Acquisition and analysis of signals captured by Lightning Instrument for VEnus (LIVE)”, Venus Science Conference (Venus-SC 2024), 23 September-24 September, 2024, Presented By: Rashmi.
85. Sahu, A. and Pabari, J., “Dust Trapping Around Planets Induced by Mean Motion Resonances”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Aanchal Sahu.
86. Sathyan, S., Bhatt, M., Basilevsky, A. T., and Sajinkumar, K. S., “Assessing Lunar Polar Craters for Water Ice Retention through Morphology”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Sachana Sathyan.
87. Shrivastava, K. and Pabari, J., “Whistler Wave Diagnostics of the Nightside Ionosphere of Mars and Venus: Insights from Electric and Magnetic Field Variability”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Shrivastava, K.
88. Vijayan, S., “Apollinaris Mons region, Mars: A possible northern ocean or impact of ice melt”, 6$^{th}$ Indian Planetary Science Conference, Indian Institute of Technology Roorkee, 4 March-7 March, 2025, Presented By: Vijayan, S.

89. Arijit Maiti, “On-sky Characterization of ProtoPol: a medium resolution echelle spectro-polarimeter for PRL telescopes”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Arijit Maiti.
90. Arijit Maiti, “Development and On-sky Characterization of ProtoPol: a medium resolution echelle spectro-polarimeter for PRL Telescopes”, The Young Astronomers’ Meet 2025, 18 - 21 Mar, 2025, Presented By: Arijit Maiti.
91. Ashish Kumar Mandal, “Enhancing GRB Localisation Accuracy of Proposed Daksha Mission”, the Young Astronomers Meet 2025, 18 - 21 Mar, 2025, Presented By: Ashish Kumar Mandal.
92. Kevikumar A. Lad, Kapil Kumar Bharadwaj, Vivek Kumar Mishra, JSSV, Prasad Neelam, Ashirbad Nayak, Abhijit Chakraborty,, “Mirror Coating Plant for PRL 2.5m Telescope”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Kevikumar A. Lad.
93. Kapil Kumar Bharadwaj; Kevi Kumar Lad; Prasad Neelam; Rishikesh Sharma; Prof. Abhijit Chakraborty, “Indigenous Innovations for Achieving Sub m/s Precision in High-Resolution Spectroscopy with PARAS-2”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Kapil Kumar Bharadwaj.
94. K.J.Nikitha, Kevikumar Lad, Neelam JSSV Prasad, Rishikesh Sharma, Nafees Ahmed, Akanksha Khandelwal, Kapil Bharadwaj, Vivek Mishra, Ashirbad Nayak, Abhijit Chakraborty, “Indigenous Innovations for Achieving Sub m/s Precision in High-Resolution Spectroscopy with PARAS-2”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Nikitha Jithendran.
95. Manash Samal and Ranjan Kumar, “Exploring star clusters using the 2.5m Mt. Abu telescope: the case of NGC 5053”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Manash Samal.
96. Mudit K. Srivastava, “Polarization in Astronomy: Science, Instrumentation and Measurements”, The Student Conference on Optics and Photonics 2024 (SCOP-24),, 25 - 27 Sep 2024, Presented By: Polarization in Astronomy: Science, Instrumentation and Measurements.
97. N. P. S. Mithun, “High-energy Transient Missions – On-board vs On-ground Processing: Where to draw the line?”, Transients 2024, 01-02 Apr 2024, Presented By: N. P. S. Mithun.
98. Neelam J S S V Prasad, Kapil Bharadwaj, Kevikumar, Nikitha Jithendran, Rishikesh Sharma, Vishal Joshi, Mudit Srivastava, Abhijit Chakraborty, “2.5M Telescope and backend instruments”, 43rd Astronomical Society of India (ASI) meeting, 15-19 February 2025, Presented By: Neelam J S S V Prasad.
99. Vaibhav Katyal, Arup Chakraborty, B.K. Sahoo, “Accurate Estimation of Differential Radius between (38m,39)K from Isotope Shift Study”, National Conference on ECR and Acceleraor-based Atomic and Molecular Physics (ECAAMP 2025), 07 Mar-09 Mar, 2025, Presented By: Vaibhav Katyal.
100. A. Chakraborty and B. K. Sahoo, “Study of Nuclear Anapole Moment in 133Cs”, $24^{th}$ National Conference on Atomic and Molecular Physics (NCAMP2025), 08 Jan–11 Jan, 2025, Presented By: Arup Chakraborty.
101. A. Chakraborty and B. K. Sahoo, “Relativistic Coupled-Cluster Theory Analysis of Nuclear Spin-Dependent Parity-Violating Amplitude in $^{133}\mathrm{C}s$”, National Conference on ECR and Acceleraor-based Atomic and Molecular Physics (ECAAMP 2025), 06 Mar-07 Mar, 2025, Presented By: A. Chakraborty.
102. Wafikul Khan, R. Ramachandran, S Gupta, J K Meka, A Roy, B N Rajasekhar, P Janardhan, Anil Bhardwaj, N J Mason, B Sivaraman, “Formation of water ice at 200 K as a result of hydrogen bonding between diols and water”, International Conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS-2024), 20 Nov-22 Nov, 2024, Presented By: Wafikul Khan.
103. Wafikul Khan, R Ramachandran, S Gupta, J K Meka , A Roy, B N Rajasekhar, P Janardhan, Anil Bhardwaj, N J Mason, B Sivaraman, “Formation of water ice at 200 K- a result of hydrogen bonding between diols and water”, National Conference on Atomic and Molecular Physics (NCAMP-2025), 08 Jan-11Jan, 2025, Presented By: Wafikul Khan.
104. Wafikul Khan, R Ramachandran, S Gupta, J K Meka, A Roy, Anil Bhardwaj, N J Mason, B Sivaraman, “Energetic processing of CO reveals new pathway for the formation of aromatic molecules at low temperature”, International conference on sustainability: Science, Technology, Education and Policy ($S^2$: STEP 2025) and 6th Indian Planetary Science Conference (IPSC 2025), 04 Mar-07 Mar, 2025, Presented By: Wafikul Khan.
105. S. Gupta, W Khan, R Ramachandran, J K Meka, B N Rajasekhar, P Janardhan, Anil Bhardwaj, N J Mason, B Sivaraman, “Investigating Astrochemical Ices Containing Intramolecular Hydrogen Bond - 1,4 Butanediol Ice”, International conference on Meteoroids, Meteors and Meteorites: Messengers from Space (MetMeSS-2024), 20 Nov-22 Nov, 2024, Presented By: Shivanshi Gupta.
106. Ganapathy Srinivasan, R Ramachandran, J K Meka, S Gupta, W Khan, P Janardhan, B N Rajasekhar, Anil Bhardwaj, N J Mason, and B Sivaraman, “Ammonia - water interaction under astrochemical conditions”, 24th National Conference on Atomic and Molecular Physics (NCAMP-2025), 08 Jan-11 Jan, 2025, Presented By: Ganapathy Srinivasan.
107. Ganapathy Srinivasan, R Ramachandran, A Roy, Y-J Wu, S-L Chou, P Janardhan, Anil Bhardwaj, N J Mason, B Sivaraman, “Tentative detection of Amines on Jupiter’s moon Callisto”, International conference on Meteoroid, Meteor, Meteorites: Messenger from Space (Metmess-2024), 20 Nov-22 Nov, 2024, Presented By: Ganapathy Srinivasan.
108. Ganapathy Srinivasan, R Ramachandran, J K Meka, S Gupta, W Khan, P Janardhan, B N Rajasekhar, Anil Bhardwaj, N J Mason, and B Sivaraman, “Ammonia - water interaction under astrochemical conditions”, Spectroscopy and Dynamics of molecules and clusters (SDMC-2025), 20 Feb-23 Feb, 2025, Presented By: Shivanshi Gupta.
109. J K Meka, R Ramachandran, S Gupta, S Vijayan, D Sahu, V Thirukumaran, A Bhardwaj, and B Sivaraman, “Chemical enrichment of asteroids - Low velocity impacts in microgravity using PRL’s short range drop facility”, $14^{th}$ Asian Microgravity Symposium (AMS 2024), 01 Dec-06 Dec, 2024, Presented By: Jaya Krishna Meka.
110. J K Meka, R Ramachandran, S Gupta, A Bhardwaj, K P J Reddy, S Vijayan, B Sivaraman, “Converting the Gifford Shaft in KGF into a Microgravity Drop Tube”, $14^{th}$ Asian Microgravity Symposium (AMS 2024), 01 Dec-06 Dec, 2024, Presented By: Jaya Krishna Meka.

111. Arijit Roy, S.V. Singh, J. K Meka, R. Ramachandran, D. Sahu, S. Gupta, V Venkataraman, V. Jayaram, J. Cami, B.N. Rajasekhar, Anil. Bhardwaj, H. Hill, N.J. Mason, B. Sivaraman, “Shock Processing of smaller PAHs and its consequences on interstellar chemistry”, $8^{th}$ National Symposium on Shock Waves (NSSW 2024), 12 Nov-15 Nov, 2024, Presented By: Arijit Roy.

112. B Sivaraman, R Sanil, S Vijayan, V Thirukumaran, Anil Bhardwaj, “Tardigrades On Icy Moons – Investigating Their Survivability Using Salt”, International conference on Meteoroid, Meteor, Meteorites: Messenger from Space (Metmess-2024), 20 Nov-22 Nov, 2024, Presented By: Bhalamurugan Sivaraman.

113. Mr. Jayanth R, Pooja Chandravanshi, Tanya Sharma, Shashi Prabhakar, R P Singh, “Integrating Multiple QKD Links: Road to country wide QKD Network”, International Conference on Emerging Trends in Optical Technologies (ETOT-1), 02 Jan-05 Jan, 2025, Presented By: Jayanth R.

114. Rachita Nandan & Shashi Prabhakar, “Atmospheric turbulence effect onOAM beams for QKD application”, International Conference on Emerging Trends in Optical Technologies (ETOT-1), 02 Jan-05 Jan, 2025, Presented By: Rachita Nandan.

115. D. Singh, R.K. Panda, A. Singh, A.T. Behera, V. Goswami, A. D. Singh, “Reconstructing the ocean oxygenation through the Neoproterozoic: Insights from geochemical and stable Molybdenum isotopes in Upper Vindhyan shales”, Conference on Integrated Earth (CITE)-2024, 01 Sept-02 Sept, 2024, Presented By: D. Singh.

116. V. Goswami, T. Malviya, A. Kumar, D. Singh, “Bottom water circulation in the eastern Indian Ocean over the last glacial cycle: connections to the climate and hydrography”, Conference on Integrated Earth (CITE)-2024, 01 Sept-02 Sept, 2024, Presented By: Vineet Goswami.

117. A. Venugopal, G.R. Tripathy, V. Goswami, T. Khan, “Evidence for late Paleoproterozoic oceanic euxinia from Mo isotopic study of black shales from the Cuddapah basin”, Conference on Integrated Earth (CITE)-2024, 01 Sept-02 Sept, 2024, Presented By: A. Venugopal.

118. A. H. Laskar, R. K. Agrawal, R. K. Mohanty, “Identification of carbon loss pathways from soils of the Himalayan permafrost region”, Conference on Integrated Earth (CITE)-2024, 01 Sept-02 Sept, 2024, Presented By: Amzad H. Laskar.

119. Anagha S M, Ajay Dev Asokan, Yogita Kadlag, and, Shivansh Verma, “Measurement of Sr and Nd Isotopes using MC-ICP-MS for Geological Applications”, Frontiers in Geosciences Research Conference-2025, 05 Feb-07 Feb, 2025, Presented By: Anagha S M.

120. D. Asokan, Y. Kadlag, “Anoxic Ocean conditions recorded by the Banded iron formations from the Neoarchean Sandur Greenstone Belt, Eastern Dharwar Craton”, Frontiers in Geosciences Research Conference-2025, 05 Feb-07 Feb, 2025, Presented By: Ajay Dev Asokan.

121. Janaarthanan P. A., Sanjeev Kumar, A. D. Shukla, Ritesh Purohit, K. K. Sharma, and, Yogita Kadlag, “Did oceanic nitrate decline from Paleoproterozoic to mid-Proterozoic?”, Frontiers in Geosciences Research Conference-2025, 05 Feb-07 Feb, 2025, Presented By: Janaarthanan P. A..

122. Vinayak Kumar, “Estimation of cosmic radiation flux received by meteorites from their thermoluminescence study”, MetMess-2024, 20 Nov - 22 Nov, 2024, Presented By: Vinayak Kumar.

123. Pooja Chandravanshi, “LFSR based RNG on FPGA for cryptographic application”, International Topical meeting on Classical and Quantum Optics (INTOCQ-24), 16 Dec – 18 Dec, 2024, Presented By: Pooja Chandravanshi, Jayakrishna Meka, Vardaan Mongia, Shashi Prabhakar, R P Singh.

124. M. Singhal, S. Mitra, H. Moitra, S. Gupta, N. Chauhan and A.K. Singhvi, “Dosimetric Investigation of Jarosite: A Martian Analogue”, Meteoroids, Meteors and Meteorites: Messengers from Space” (MetMeSS-2024), 20 Nov - 22 Nov, 2024, Presented By: Malika Singhal.

125. Mansi Gupta, L.K. Sahu, Nidhi Tripathi and Arvind Singh, “Impact of source trade-off on the distribution of DMS and Isoprene in the southern coastal regions of the northern Indian Ocean”, Frontiers in Geosciences Research Conference (FGRC), 5-7 February 2025, Presented By: Mansi Gupta.

126. R. Shah, Som Sharma, H. Gadhavi, D. Kamat, and R. Srivastava, “Insights on cirrus clouds over the Arabian Sea during southwest monsoon”, FGRC 2025, 5-7 February 2025, Presented By: R. Shah.

127. D. Kamat, Som Sharma, A. Patel, R. Shah, “Investigation of atmospheric clouds and the boundary layer characteristics over a semi-arid region in the Aravalli Range of Western India”, FGRC 2025, 5-7 February 2025, Presented By: D. Kamat.

128. P. J. Sahu, B. Pathak, B. Dutta, Som Sharma, A. Patel, D. Kamat, K. J. Baishya, Kalyan Bhuyan, Pradip Kumar Bhuyan, “Investigation of Atmospheric Boundary Layer characteristics using Ceilometer Lidar over Dibrugarh: a semi urban location in North East India”, FGRC 2025, 5-7 February 2025, Presented By: P. J. Sahu.

129. M. Singh, P. Singh, P. Prasad, A. Tripathi, Som Sharma, S. Rastogi, “Study of Cloud base height over Gorakhpur in the Indo-Gangetic Plain”, FGRC 2025, 5-7 February 2025, Presented By: M. Singh.

130. K. J. Baishya, B. Pathak, B. Dutta, Som Sharma, P. J. Sahu, K. Bhuyan, A. Patel, P. K. Bhuyan, “Vertical distribution of Clouds over Dibrugarh in Eastern Himalayan Foothills”, FGRC 2025, 5-7 February 2025, Presented By: K. J. Baishya.

131. S. Kalita , A. Patel , Som Sharma, D. Kamat, “Estimation of Atmospheric Boundary Layer Height using Ceilometer Backscatter profile: a new approach based on Machine Learning technique and Image Processing”, CITE 2024, 1-2 September 2024, Presented By: S. Kalita.

132. Ojha, N., Girach, I. A., Harithasree, S., Soni, M., Vaishya, A., Sarangi, T., Singh, N., Sahu, L. K., “Chemistry and Transport of Atmospheric Trace Constituents over the Indian Subcontinent”, URSI Regional Conference on Radio Science (URSI-RCRS), 22 – 25 October 2024, Presented By: N. Ojha.

133. Harithasree, S., Shukla, G., Girach, I. A., Sahu, L. K., Kumar, A., Ojha, N., “Variability in aerosols and related chemical species over the Indian Ocean”, SOLAS Open Science Conference 2024, National Institute of Oceanography (NIO), 10 – 14 November 2024, Presented By: S. Harithasree.

134. Harithasree, S., Girach, I., Chakraborti, A., Tiwari, R., Sahu, L. K., Ojha, N., “Spatial heterogeneity of ozone and

fine particulate matter over India simulated through machine learning", Frontiers in Geosciences Research Conference, 5 – 7 February 2025, Presented By: S. Harithasree.

135. Vishnu Kumar Dhaker and T. A. Rajesh, "Characteristics and trends in aerosol properties over a tourist city in Western India", Indian Aerosol Science and Technology Association (IASTA) National Conference 2024, 17–20 December 2024, Presented By: Vishnu Kumar Dhaker.
136. Nitinkumar Ladhva, T. A. Rajesh, S. Ramachandran and Vishnu K. Dhaker, "Vertical distribution of aerosols: layer wise quantification to total extinction over an urban environment", Indian Aerosol Science and Technology Association (IASTA) National Conference 2024, 17–20 December 2024, Presented By: Nitinkumar Ladhva.
137. Kamran Ansari and S. Ramachandran, "Global insights on optical and radiative characteristics of aerosols", Indian Aerosol Science and Technology Association (IASTA) National Conference 2024, 17–20 December 2024, Presented By: Kamran Ansari.
138. Kamran Ansari and S. Ramachandran, "Global insights on aerosol absorption characteristics: Ground-based observations and model simulation", Frontiers in Geosciences Research Conference (FGRC) – 2025, 5-7 February 2025, Presented By: Kamran Ansari.
139. Mitra, G., Guharay, A., Conte, J. F., Chau, J. L., "Observational Evidence of Two-Step Nonlinear Interactions Involving Zonally Symmetric Waves During Major Sudden Stratospheric Warmings", International Conference on Meteoroid, Meteor, Meteorites: Messenger from Space (MetMeSS) 2024, 20-22 November 2024, Presented By: Gourav Mitra.
140. Mitra, G., Guharay, A., Paulino, I., "Characteristics and Generation Mechanisms of the Zonally Symmetric Atmospheric Tide during Sudden Stratospheric Warnings", Frontiers in Geosciences Research Conference (FGRC-2025), 05-07 February 2025, Presented By: Gourav Mitra.
141. Kiran and R. P. Singh, "Influence of upward propagating waves in the MLT region using PAIRS Observations", Frontiers in Geosciences Research Conference (FGRC-2025), 5 - 7 February 2025, Presented By: Kiran.
142. Kiran and R. P. Singh, "Long time scale oscillations in OH(3-1) intensities and its temperatures using ground and satellite based measurements", 6th URSI Regional Conference on Radio Science (URSI-RCRS 2024), 22 - 25 October, Presented By: Kiran.
143. Kiran and R. P. Singh, "Vertical Wave characteristics using OH(3-1) brightness and rotational temperature in the MLT region using Krassovsky's ratio method", 6th URSI Regional Conference on Radio Science (URSI-RCRS 2024), 22 - 25 October, 2024, Presented By: Kiran.
144. Kiran and R. P. Singh, "Long time scale oscillations in OH(3-1) intensities and its temperatures using ground and satellite based measurements", 3rd Indian Space Weather Conference (ISWC-2024), 05-09 October, 2024, Presented By: Kiran.
145. K. Venkatesh and D. Pallamraju, "The role of F-layer peak parameters on the uncertainties in estimating ionospheric electron density profiles and Total Electron Content (TEC) over the low latitudes", 6th URSI Regional Conference on Radio Science (URSI-RCRS 2024), 23-25 October 2024, Presented By: K. Venkatesh.
146. K. Venkatesh and D. Pallamraju, "On the uncertainties in estimating the vertical electron density profiles through empirical formulations over the low latitudes", 3rd Indian Space Weather Conference (ISWC-3), 7-9 October 2024, Presented By: K. Venkatesh.
147. K. Venkatesh, D. Pallamraju, T.K. Pant and P. Suryawanshi, "Parametric dependence of topside ionospheric scale height in NeQuick2 model and its consequences on the estimation of TEC over the equatorial and low latitudes", 22nd National Space Science Symposium (NSSS-2024), 26 Feb - 1 March 2024, Presented By: K. Venkatesh.
148. Komal, D. Pallamraju, and P. Suryawanshi, "Unveiling Altitude-Specific Dynamics and Seasonal Trends in Green Line Dayglow Emissions", 3rd Indian Space Weather Conference (ISWC-2024), 07-09 October, 2024, Presented By: Komal.
149. Upadhyay, K., and Duggirala Pallamraju, "Quantification of sub-auroral electron temperature enhancements affecting the brightness of O(1D) emissions under the influence of plasmasphere - ionosphere coupling in the dayside of the Earth", 3rd Indian Space Weather Conference (ISWC2024), 07-09 October 2024, Presented By: K. Upadhyay.
150. Ranjan, A.K., M. V. Sunil Krishna, A. Kumar, D. Nailwal, S. Sarkhel, "Evidence of potential thermospheric overcooling during the May 2024 geomagnetic superstorm", 3rd Indian Space Weather Conference 2024 (ISWC 2024), 07 - 09 October 2024, Presented By: A. K. Ranjan.
151. Dalal, B., Chakrabarty, D., Vadawale, S. V. et al, "Investigations on suprathermal ions observed by ASPEX/STEPS on board Aditya-L1 during its earth-bound orbits", Sun, Space Weather, and Solar-Stellar Connection (SSWSSC-2025), 20-24 January 2025, Presented By: Bijoy Dalal.
152. Dalal, B., Chakrabarty, D., Cohen, C. M. S., Srivastava, N., "Investigations on the properties of energetic ions upstream of the Earth's bow shock from L1 point measurement", 3rd Indian Space Weather Conference (ISWC-2024), 7-9 October 2024, Presented By: Bijoy Dalal.
153. Aakash Gupta, Dibyendu Chakrabarty, Bijoy Dalal, Nandita Srivastava, "Investigations on Energetic Particles in Solar Wind using Multiple Spacecraft", 3rd Indian Space Weather Conference (ISWC-3), 5 - 9 October 2024, Presented By: Aakash Gupta.
154. Aakash Gupta, Dibyendu Chakrabarty, S. Vadawale, B. Dalal, S. K. Goyal, Jacob Sebastian, Neeraj K. Tiwari, A. R. Patel, M. Shanmugam, PiyushSharma, A. Sarkar, A. Sarda, T. Ladiya, Abhishek J. Verm, "Investigations on suprathermal ions in the interplanetary medium using STEPS/ASPEX measurements from Aditya L1", Sun, Space Weather and Solar Stellar Connection (SSWSSC-2025), 20-24 January 2025, Presented By: Aakash Gupta.
155. R. Pathak, D. Chakrabarty, "Detector Selection and Prototype Development for ISRO's Airglow Photometer Experiment", Venus Science Conference, 23-24 September 2024, Presented By: Rahul Pathak.
156. Deekshya Roy Sarkar, Goldy Ahuja, Anwesh Kumar Mishra, Shashikiran Ganesh, Ranjan Kumar, "Development of a Wide-Field Imager for telescopes at PRL Mt Abu Observatory", 43rd meeting of the Astronomical Society of India (ASI), 15 - 19 Feb, 2025, Presented By: Deekshya Roy Sarkar.
157. Chandan Kumar, K. Durga Prasad, S. Mishra, Sushil Kumar, T. Ladiya and M. Shanmugam, "Design and development of PRATHIMA electronics for LUPEX/Chandrayaan-5 Rover", $6^{th}$ Indian Planetary Science Conference (IPSC)-2025, IIT Roorkee, 4-7 March 2025, Presented By: Chandan Kumar.

# Various Events, and Outreach Activities at PRL

### A Light Dialogue: On Carving a Niche and Life in Science

A public discussion hosted by PRL in collaboration with a Science Podcast – Zeroing In on 23 July 2024. Zeroing In is a non-profit science communication venture that curates conversations with eminent Indian Scientists from across the globe, spanning varied areas of science and research. The guest of honour for the public discussion was Prof. Ravindra Pratap Singh, who is working as Senior Professor at PRL. The audience for the event included PRL members and over 150 students and faculty from schools, and those pursuing Bachelors and Masters degree from five different institutes across Ahmedabad.

### Meet and Greet program for the New (2024) batch of JRFs

Physical Research Laboratory has recruited 26 Junior Research Fellows (JRFs) in July 2024. To give an orientation about PRL to these newly recruited JRFs, a "Meet and Greet program" was arranged on 26 July 2024, and the Director, PRL, led the programme. In this programme, new JRFs introduced themselves in detail, including their educational information, hobbies, etc. Subsequently, rules concerning the academic administration and academic course work, responsibilities of research fellows, Dos & Don'ts, and code of conduct were communicated to the new Junior Research Fellows. The intent of this event was to provide orientation to new JRFs and introduce them to PRL's scientific research, facilities, and administrative requirements. JRFs were also informed to carry out lab visits during their first semester through coordination by the Academic Committee. This was a unique programme to welcome new JRFs in the last several years, and JRFs were happy and felt welcomed with this initiative.

### National Space Day (NSPD) and 105th Vikram Jayanti Celebration

The Physical Research Laboratory (PRL) celebrated the National Space Day (NSpD) and 105th Vikram Jayanti across its four campuses on 12 August 2024. To commemorate the successful soft landing of the Vikram Lander of the Chandrayaan-3 Mission and the deployment of the Pragyaan Rover on the Moon on 23 August 2023, the Government of India has declared the 23rd day of August as the National Space Day (NSpD) to be celebrated every year. With this achievement, India joined the elite group of space-faring nations, becoming only the fourth to land on the surface of the Moon and the first Nation to land near the south pole of the Moon. To mark this special day in the history of the Indian space programme, the Department of Space announced nationwide celebrations during August to engage and inspire the Nation's youth towards space science and space applications. This special day was celebrated in all four campuses of PRL on the 12th August 2024, coinciding with the celebration of the 105th Vikram Jayanti – the birth anniversary of Dr. Vikram Sarabhai who is the Founder of PRL and considered as the father of the Indian Space Program. The celebration started with the garlanding of the statue of Dr. Vikram Sarabhai at the PRL main campus, which was followed by tree plantation, and the inauguration of the Open House Exhibition through a Rainwater Harvesting plant in PRL. The Open House was OPEN on all the four campuses of PRL, namely at Navrangpura and Thaltej campuses in Ahmedabad, Udaipur Solar Observatory in Udaipur, and PRL's Mt. Abu Observatory at Mt. Abu. The Open House exhibition provided a rare opportunity for curious minds to interact, in person, with renowned scientists of PRL, visit scientific exhibits displayed in the Open House, and participate in other exciting events at PRL campuses. PRL received an overwhelming response with more than 3000 students and the general public visiting the PRL's two campuses in Ahmedabad, and more than 340 students visited the Udaipur Solar Observatory in Udaipur. The visitors comprised of school students from classes 8 to 12, UG and PG students across all disciplines, colleges, universities, school teachers, science communicators, and parents. The visitors visited several state of the art laboratories, science exhibits and infographics on the campuses. In addition, there were live quizzes and lectures on common scientific interests. This event was a humble effort by PRL to ignite young minds to take up challenging career options and contribute their talent towards nation-building in the future. At Mt. Abu Observatory of PRL, the 2-day NSpD-2024 event was organised from 30-31 July, where more than 350 students and teachers participated.

### Celebration of the First National Space Day at Bharat Mandapam

To commemorate the historic landing of the Chandrayaan-3 mission on the Moon last year, the Government of India declared 23 August as National Space Day (NSpD). Several outreach activities were being organised by ISRO, PRL, and other institutes across the country, leading up to the maiden Space Day celebration on 23 August 2024. The celebration was organised in Bharat Mandapam, where delegates from various ISRO/DOS centres, space industries, and academia participated in person, and the event was telecast live on YouTube. School students were also invited to the inaugural session and exhibition of the NSpD event. A team of 12 members from PRL also participated in the celebration held at the Bharat Mandapam in Delhi. The Hon'ble President of India Draupadi Murmu graced the occasion and inaugurated the program. It was a moment of pride that the Hon'ble President mentioned the recently published results from the PRL-led APXS experiment on the Chandrayaan-3 Pragyan rover in the inaugural address. The Hon'ble President awarded prizes to the winners of the Robotics Challenge and Bharatiya Antariksh Hackathon (BAH), which ISRO organised as part of NSpD celebrations. PRL colleagues mentored two teams that received the BAH awards. In the subsequent session of the NSpD event, the peer-reviewed data sets from all the payloads of the Chandrayaan-3 mission were released to the public by the Hon'ble Minister of State (Space) in the presence of Chairman ISRO, Director PRL, and other dignitaries. There were also exhibitions by various ministries and institutes focusing on effectively using space infrastructure for varied applications and emerging space industries showcasing their capabilities. There were also exhibits from ISRO showing the prototypes for major future projects such as Chandrayaan-4, Surya: the Next Generation Launch Vehicle (NGLV), and the Bharatiya Antariksh Station (BAS). Winners of the robotic challenge and BAH were also given the opportunity to showcase their work. Panel discussions on varied topics related to the Space sector were also arranged as part of the program, which concluded with a movie screening on Chandrayaan-3 and a Mohiniyattam rendering of the story of the quest to reach the Moon.

**Visit by research students from MNIT, Jaipur**

Research students (M.Tech and Ph.D) and a faculty member from the Department of Electronics and Communication Engineering, Malviya National Institute of Technology, Jaipur (MNIT) visited Udaipur Solar Observatory on 25.10.2024. A talk on the "Enigmatic Sun" was delivered by a PRL researcher to introduce the visitors to the Sun, Solar observations, and observational facilities at the USO. They have visited different observational facilities at the observatory and interacted with scientists at the USO. Visitors were also briefed about the RESPOND program of ISRO and how they can participate in this program for carrying out collaborative research.

**Visit of students from Gurunanak Girl's P.G. College, Udaipur**

Faculty members along with 35 Students (B. Sc.) from the Department of Physics, Gurunanak Girl's P.G. College, Udaipur, visited the Udaipur Solar Observatory on 22.11.2024. A talk on "The Sun – Daytime Star" was delivered by a PRL researcher to introduce the visitors to the Sun, Solar activity, and observational facilities at USO. A visit to different observational facilities at the observatory was arranged along with interactions with scientists and the engineers at the USO.

**One-day Lab visit of students from GUJCOST under the GujSAC BHAVIKA program**

The Gujarat Council on Science and Technology (GUJCOST), Department of Science & Technology, Government of Gujarat, conducted GujSAC BHAVIKA (Gujarat SAC BHAvi VaIgnanik KAryakram) in collaboration with the Space Applications Centre (SAC), Ahmedabad. This program was organised from 16 to 23 November 2024, for the students of the 9th to 12th standard of Gujarat, with an aim to inspire the next generation of the state to take up science and engineering as their carrer. In this program, 90 students (30 girls and 60 boys) and 10 teachers from 33 districts across Gujarat participated. A one-day Lab visit of these students and teachers was arranged at PRL Thaltej campus on 22 November, 2024. In this visit, students and teachers interacted with the PRL scientists. All the students under the GujSAC BHAVIKA program were excited after seeing the laboratories and the work being carried out at PRL.

**2nd Winter School in Solar Physics at USO-PRL**

The 2nd Winter School in Solar Physics was held at the Udaipur Solar Observatory, PRL, from 9 to 13 December 2024. A total of 30 students representing 12 Universities and Colleges across India attended the School. The list of Institutions included Andhra University (Visakhapatnam Andhra Pradesh), University of Hyderabad (Hyderabad Telengana), Fergusson College (Pune Maharashtra), St. Teresa's College (Cochin Kerala), Maharaja Sayajirao University (Baroda Gujarat), St. Joseph"s College (Trichy Tamil Nadu), Calicut University (Kozhikode Kerala), St. Xavier's College (Mumbai Maharashtra), St. Xavier's College (Ahmedabad Gujarat), Madras Christian College (Chennai Tamil Nadu), Jai Narayan Vyas University (Jodhpur Rajasthan), and Mohanlal Sukhadia University (Udaipur Rajasthan).

**Lab Visit of CSSTEAP Students**

Under the aegis of the UN-affiliated Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), the 5th Post Graduate Course on Global Navigation Satellite System (GNSS05) was conducted by SAC, Ahmedabad. As part of the said programme, the students of this course visited the Digisonde facility at PRL on 24 February 2025. The CSSTEAP students were curious to know about the radio probing technique of the digisonde. Propagation characteristics of radio waves in the upper atmosphere, including their refraction, reflection conditions, and their dependence on plasma frequency and radio signal frequency, were explained to them. Students were very enthusiastic to know about the ionospheric effects on radio wave propagation and the applications of digisonde to identify the maximum usable frequency for long-distance communication.

**Celebration of the Success of Chandrayaan-3 APXS**

While the entire Nation was gearing up to celebrate the first National Space Day on 23 August 2024 to commemorate the historic landing of the Chandrayaan-3 mission on the Moon, the first scientific results from the mission using observations with PRL-built Alpha Particle X-ray Spectrometer (APXS) were published in the prestigious journal 'Nature'. To celebrate the highly successful operations of the APXS instrument on the Pragyan rover for ten days on the Moon and the impactful scientific results from APXS observations, an event was organised in PRL on 6 September 2024. In this event all those who contributed to the APXS experiment, which included not only PRL members but also those colleagues who superannuated from PRL and SAC, Ahmedabad, were invited to partake in this event and to provide their reminisces about the journey from the experiment's inception to scientific outcomes.

**Swachhta Hi Seva Campaign 2024**

PRL has celebrated the Swachhta hi Seva Campaign. To kick start the campaign on 27 September 2024, a mass Swachhta Pledge has been undertaken by all PRL members. Further, PRL staff members were sensitised to keep their workplace and area neat and clean. The following activities were carried out during the campaign: 1. Swachhta Jagrukta Samvad at Kendriya Vidyalaya School: PRL Swachhta Pakhwada Committee organised a Jagrukta Samvad by expert Dr. R D Deshpande, Retired Sr. Professor & former Registrar, PRL on the topic "Cleanliness, Sanitation and Hygiene – essential for health, wealth and prosperity" in Kendriya Vidhyalaya (SAC), Vastrapur, Ahmedabad. He interactively conveyed to the students that keeping ourselves clean, sanitised and adopting hygiene are essential for one's health and gaining knowledge of wealth and prosperity in our surroundings. The principal, students, and teachers appreciated the PRL team's efforts. The Swachhta Committee also organised a quiz for students after the Jagrukta Samvad. The session was followed by tree Plantation in the premises of the school. 2.

Interactive session on holistic health and well-being of PRL Employees and Contractual Staff was conducted in PRL on 17.10.2024 by Dr. Punit Chaturvedi, Assistant Professor, National Institute of Ayurveda, AYUSH Ministry. 3. Safaimitra Suraksha Shivir – A Preventive Health Checkup Camps/Shivirs were organised in various campuses of PRL under the Swachhta Hi Seva Campaign for contractual employees, horticulture and housekeeping workers. Based on the examination & pathological reports, the contractual employees were advised on the future course of action as per their respective diagnoses. 4. Cleanliness Drive – PRL Mt. Abu Campus: A cleanliness drive was carried out in and around the PRL's Mt. Abu Campus by its employess on 16.10.2024. 5. School Visit for Swachhta Jagrukta Samvad – PRL Mt. Abu: PRL's Mt. Abu employees visited the Govt. Upper Primary School, Salgoan, and conducted an awareness session for the school children, and distributed hygiene kits and plant saplings

### Grammarly for Education Session: Enhancing Writing and Research at Physical Research Laboratory

On December 18, 2024, PRL Library hosted an informative session on "Grammarly for Education," a tool aimed at helping students and faculty improve their writing skills to communicate their research better. The session focused on maximising Grammarly's powerful features to enhance writing quality, making it more effective, polished, and academically sound. Overall, the session demonstrated that Grammarly for Education is an invaluable resource for enhancing writing quality and academic performance, benefiting both students and faculty at PRL.

### PRL's Exemplary Participation at the 25th Rashtra Katha Shibir

Physical Research Laboratory (PRL) participated in the 25th Rashtra Katha Shivir held at Pransala village, located 140 km from Rajkot, Gujarat. The event commenced on December 28, 2024, and concluded on January 05, 2025. Organised by the Shri Vedic Mission Trust under the visionary leadership of Swami Dharmabandhu, this annual national youth camp has been fostering the vision of a strong and vibrant India for the past 24 years. It aims to promote national integration, respect for diversity, social harmony, and the intellectual development of participants. This year, the Shivir witnessed an overwhelming response, attracting around 16,000 enthusiastic students from elementary level to college and approximately 1,500 teachers from 23 states and union territories across the country. The event featured exhibitions and demonstrations by esteemed organisations such as the Indian Air Force, Indian Army, Indian Navy, Indian Coast Guard, BSF, CISF, CRPF, ITBP, SSB, RAF, NDRF, ISRO, Homi Bhabha Science and Education Centre, Mumbai, and the Meteorology Department. PRL actively engaged in the event during the initial three days, from December 28 to 30, 2024, under the unified banner of ISRO. The participation from PRL was marked by the exhibition of engineering models of the Solar Wind Ion Spectrometer (SWIS) and the Superthermal and Energetic Particle Spectrometer (STEPS), both integral subunits of the ASPEX payload on the Aditya L1 mission. In addition to the ASPEX/Aditya-L1 mission, the PRL team showcased informative standees and posters on Chandrayaan-2's Solar X-ray Monitor (XSM) and Chandrayaan-3's Chandra's Surface Thermophysical Experiment (ChaSTE) and Alpha Particle X-ray Spectrometer (APXS). These exhibits captivated the visiting students, providing insightful explanations about the instruments' workings and inspiring young minds to explore the wonders of space science. The team further engaged students by distributing informative stickers, leaving a lasting impression on their curious minds. PRL's participation in the 25th Rashtra Katha Shivir exemplifies its commitment to inspiring the next generation of scientists and contributing to the vision of a scientifically empowered and united India.

### Special lecture on VAST (SAFE and VISWAS)

A special lecture on VAST (SAFE and VISWAS) was organized at the Physical Research Laboratory (PRL) on February 11, 2025, to enhance awareness among staff members about this exclusive scheme for ISRO/ DOS employees. The session was conducted in a hybrid mode, and enthusiastic participation was witnessed with around 150 attendees from all four PRL campuses. The lecture was delivered by Shri Piyush J. Bhanani, Trustee, VAST, from Space Applications Centre (SAC), Ahmedabad. He provided valuable insights into the unique benefits of the scheme, explaining its provisions in detail and addressing queries from the participants. The session served as an excellent platform for employees to gain a deeper understanding of SAFE and VISWAS, ensuring they could make the most of the opportunities offered by VAST.

### The 1st Professor Ravipati Raghavarao Memorial Lecture

The Professor Ravipati Raghavarao Memorial Lecture has been instituted by the family of Prof. Raghavarao and is administered by PRL as an annual event. Professor R. Raghavarao was an illustrious faculty member of PRL who served from 1966 to 1989 and had significantly contributed to upper atmospheric investigations. He was a pioneer in aeronomy and worked on both theoretical and experimental aspects, and is credited with several firsts and discoveries, including the topside ionospheric ledges, role of winds in the Equatorial Electroject, role of vertical winds in the generation of equatorial plasma irregularities and the equatorial temperature and wind anomaly (ETWA). As he was a true PRLite in his heart and was genuinely interested in all the fields of science being pursued in PRL, his family desired the speaker to be any scientist working in India in any fields being pursued in PRL. The selection will alternate between a young and a senior scientist every year. The speaker for the first Professor Ravipati Raghavarao Memorial Lecture was selected through an expert committee with a three-layer scrutiny process. The speaker, Dr. Sanjib Kumar Agarwala from the Institute of Physics, Bhubhaneswar, was chosen as the first recipient of this honour in recognition of his significant contributions to neutrino physics. The event was held on 21 Februaruy 2025, wherein Dr. Sanjib Kumar Agarwala delivered his lecture entitled "Imaging the Deep Earth with Neutrinos".

His lecture focused on the emerging interdisciplinary field of neutrino tomography, which uses neutrinos to study the internal structure and composition of the deep Earth, complementing traditional seismic and gravitational measurements. Dr. Agarwala discussed various ways to study Earth's interior, including gravitational measurements (information about mass, moment of inertia, and average density), seismic waves (revealing internal structures and density variations), and neutrinos as a new candidate probe. Dr. Agarwala explained two main ways neutrinos can be used for tomography: o Neutrino absorption tomography: At very high energies (TeV-PeV), neutrinos can be absorbed by the Earth, and the amount of absorption can reveal information about matter distribution. Ice Cube experiment data is being analysed to see a five-layer structure of the Earth using this method. A 2019 study using Ice Cube data showed the potential to reveal five layers with associated uncertainties in density. Neutrino oscillation tomography: At lower energies, neutrinos oscillate between different flavours. Their oscillation pattern can be modified when they pass through matter due to coherent forward scattering with ambient electrons (MSW effect). Core-passing neutrinos can experience amplified oscillations due to parametric resonance, providing information about the Earth's core. Dr. Agarwala was presented with a plaque and a citation. The vote of thanks acknowledged the family of Professor Raghavarao for instituting the lecture, PRL management for their support, Professor Sridharan for sharing his memories about Prof. Raghavarao, the nominators and selection committee, and Dr. Sanjib Kumar Agarwala for delivering an insightful lecture.

#### National Science Day celebration at PRL

PRL celebrated National Science Day (NSD) 2025 with great zeal and enthusiasm on 1st March, 2025, bringing together a lively community of students, educators, and science enthusiasts. National Science Day commemorates the discovery of the Raman Effect by Nobel Laureate Sir C.V. Raman. PRL has always been at the forefront of honouring this day with educational and inspiring events. The objective is to celebrate science's spirit and instil a passion for scientific inquiry among young minds. This year, the event welcomed an impressive participation of 168 students, 79 teachers, and numerous accompanying parents from across Gujarat. NSD 2025 was especially memorable due to the introduction of several new and creative activities, making it a refreshing and enriching experience for everyone involved. The carefully curated program aimed to balance competition, collaboration, creativity, and communication. Each students had the opportunity to participate in two diverse activities, one from Group A and one from Group B, allowing them to explore different dimensions of science in an enjoyable and engaging way.

Group A Activities: Quiz Competition – A lively test of knowledge and teamwork that attracted 118 participants, and Science Model Competition – A showcase of innovation and design, with 35 students presenting original working and conceptual models.

Group B Activities: Science Rangoli Competition – A unique fusion of art and science, featuring 10 beautiful entries, Science Cartoon (SciToon) Competition – A platform for creative scientific expression through illustrations, with participation from 102 students, Impromptu Speech Competition – A spontaneous and thought-provoking challenge taken up by 71 students, reflecting their understanding and communication skills in science.

To encourage and inspire educators, an exclusive "Innovations in Teaching" session was arranged for accompanying teachers. One teacher presented a creative and engaging approach to teaching Pascal's Triangle, offering insights into innovative pedagogy that fosters better student understanding. Adding further excitement to the celebration, PRL staff and research fellows presented a live science skit titled "Mission Grah Pravesh". The performance, blending theatrical storytelling with scientific themes, captivated the audience and highlighted the importance of science communication in an entertaining format.

Another highlight of the day was an interactive hands-on STEM session, conducted by Mr. Jay Thakkar and Ms. Jasmine Amandine from the Centre for Creative Learning (CCL), IIT Gandhinagar. Their engaging talk and activities received overwhelming appreciation from both students and faculty. 62 prizes were distributed across the various competitions, recognizing and encouraging excellence, creativity, and participation. Among these were the prestigious Aruna Lal Scholarships—five scholarships awarded to outstanding science students of 11th standard. An entrance test for these scholarships was conducted on 19th January 2025, and it saw enthusiastic participation from science students across the state of Gujarat. The tremendous success of NSD 2025 is a testament to the dedicated efforts, meticulous planning, and teamwork of the PRL organizing committee and volunteers. The joy, curiosity, and engagement seen on the faces of students, teachers, and parents alike reaffirms PRL's commitment to nurturing scientific temperament in the society, at large.

#### International Women's Day 2025 Celebration at PRL

PRL celebrated International Women's Day 2025 with a series of events focused on awareness, empowerment, and recognition. The celebrations began with an interactive Health & Hygiene session on 7th March, attended by women staff across all PRL campuses. A notable feature of this session was the open discussion with cleaning staff, where they shared challenges related to washroom upkeep and explored practical solutions. A Poster Making Competition on the theme "Role of Women in the Economy", in line with the UN's IWD theme, received enthusiastic participation. The posters were displayed at the KRR foyer on the main celebration day, 18th March. On 18th March, women staff members received a complimentary lunch and tokens of appreciation. The event featured a video tribute to Women at PRL, followed by a thought-provoking montage act, "Perspectives", performed by PRL staff, exploring various viewpoints related to women around us. A special cultural performance by artists from Raah Foundation—a non-profit supporting specially-abled individuals, especially visually impaired girls in performing arts—was a highlight of the day. The event concluded with a prize distribution ceremony for the poster competition, a vote of thanks, and high tea. The celebration was streamed live to PRL's Udaipur and Mount Abu campuses for the colleagues working there.

#### Internal Complaints Committee (ICC) Activities

An Orientation Programme for newly joined JRFs was held on July 26 2024. Also, a separate session with only female entrants was held on the same day. In this program, members and the Chair of ICC-PRL addressed the new JRFs, and awareness was created regarding ICC-PRL and PRL's ZERO TOLERANCE POLICY regarding sexual harassment of women inProgram, members and the Chair of ICC-PRL addressed the new JRFs and an awareness was created regarding ICC-PRL and PRL's ZERO TOLERANCE POLICY towards sexual harassment of women at the workplace. They were also briefed about the Rules and regulations about Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) PoSH Act, 2013, followed by a note on addressing sexual harassment complaints.

ICC meetings were held on all PRL campuses during the reporting year of this Annual Report.

Following the guidelines of the honourable Supreme Court, a SHe box portal of PRL has been created.

An e-poster about ICC-PRL has been prepared and displayed on all campuses.

As per the mandate of the ICC, an Orientation Program was conducted at the Udaipur Solar Observatory (USO), Udaipur, during November 2024 for all the employees, followed by a separate session for female employees. The lengthy discussion on various topics resulted in an enriching interaction.

A poster competition was held on zero tolerance towards sexual harassment in the workplace during November 2024. All competition winners were awarded on the Republic Day 2025 by the Director, PRL.

**Dance and Scientific Interfaces: Exploring Cosmic Enigmas Through Performance Special Lecture by Prof. Sharada Srinivasan**

Prof. Sharda Srinivasan delivered an engaging talk with illustrations titled, "Dance and Scientific Interfaces: Exploring Cosmic Enigmas Through Performance", on 26 March 2025. This talk explored how the medium of dance has been used—both in antiquity and in contemporary contexts—to interpret and express the mysteries of the cosmos. The session began with a focus on the symbolic richness of the Chola-period Nataraja bronze, illustrating how this iconic form, paired with traditional Bharatanatyam repertoire, has long conveyed metaphors of cosmic creation, destruction, and the cyclical nature of existence. Through insightful commentary and video inserts, Padma Shri Prof. Srinivasan demonstrated how dance served as a philosophical medium to embody the enigma of the universe in ancient times. The talk then transitioned to a modern reinterpretation of these ideas through Danse e-Toile, an interactive, internet-streamed performance in which Prof. Srinivasan herself was a performer. This contemporary work incorporated adaptations of the traditional Bharatanatyam repertoire and delved into themes of quantum duality and the convergence of classical and quantum realities. It offered a compelling example of how ancient forms can evolve to engage with present-day scientific metaphors and digital media. Prof. Srinivasan, a seasoned Bharatanatyam exponent, has previously presented her work at esteemed venues including the Royal Academy of Arts, London (2007) and Space City, Toulouse (2009), among others across India and abroad. Her unique approach—bridging art and science—left the audience with much to reflect upon regarding the timeless relevance of classical art forms.

**Celebration of International Day of Yoga-2024**

The 10th International Day of Yoga (IDY-2024) was celebrated on Friday, 21 June 2024. The theme for IDY-2024 was "Yoga for Self and Society." All participants actively engaged in practicing Yoga by sitting, standing, and lying postures, with explanations of their significance provided throughout the session.

**Independence Day celebration**

The 78th Independence Day was celebrated with great enthusiasm at PRL Main campus, Library lawn on Thursday, 15 August 2024. Prof. Anil Bhardwaj, Director, PRL hoisted the National flag, which was followed by the National Anthem. As per protocol, the CISF held a parade on this occasion. Merit and service awards were given to CISF cadets thereafter. The prize distribution was carried out for various events, namely, Annual Badminton, Annual Table Tennis competition and SOLIS competition. A token of appreciation was also given to the winners of Inter-Centre Sports Meet (ICSM)-2023.

**National Unity Day**

As per the directives received from the Government of India, Department of Space , 31 October was observed as the National Unity Day, to commemorate the Sardar Vallabhbhai Patel's birth anniversary. The National Unity Day Pledge was taken by PRL members at respective work place on this occassion

**The Constitution Day**

The Constitution Day was celebrated in PRL on Tuesday, 26 November 2024. On this occasion, the "PREAMBLE OF THE CONSTITUTION "was read by all the PRL members at their respective division/section.

**Republic Day Celebration at PRL**

Republic Day marks the adoption of the Constitution of India. It is a day of National pride. The 76th Republic Day was celebrated on Sunday, 26 January 2025, at the PRL Thaltej campus. Prof. Anil Bhardwaj, Director, PRL, hoisted the National Flag, followed by the National Anthem. Three Merit awards were given to the CISF, as per the practice in vogue. Following this, the children of PRL staff members who had secured the highest marks in Hindi subject in 10th and 12th Standard in the year 2024 were felicitated. The prize distribution for various events was carried out, such as the Essay Writing competition held during Vigilance Awareness Week 2024, the Ashulekhan Competition held on World Hindi Diwas, SOLIS-Hindi Incentive Scheme, and the Poster Competition organized by the Internal Complaint Committee-PRL. To mark the occasion, kids and PRL family members released tri-colour balloons. Tree plantation was done by the newly joined PRL staff and other PRL members. Thereafter, the Director PRL formally inaugurated the PRL Football tournament.

**Martyr's Day**

In accordance with the directives from the Ministry of Home Affairs, Government of India, and the Department of Space, 30 January is observed annually as Martyrs' Day. This day commemorates the death anniversary of Mahatma Gandhi. It serves as a solemn moment to pay tribute to all individuals who fought and died for India's independence. On this occasion, a two-minute silence was observed by the PRL staff members in memory of those who sacrificed their lives in the struggle for India's freedom.,

# Capacity Building Programmes

#### Report on ISRO-RESPOND Programme for Space Sciences at PRL

Physical Research Laboratory (PRL) administers the Indian Space Research Organization (ISRO) RESPOND programme to provide funding to academia in India for conducting research and development activities in the areas of Space Sciences, i.e. Astronomy and Astrophysics, Planetary Physics, Solar Physics, Astrochemistry, the Physics of Earth's atmosphere/ionosphere, Solar Physics, Space Weather, Space Plasma Physics. The main aim of the RESPOND programme is to invite research proposals from qualified academic institutions for joint research in areas of relevance to the Indian space programme.

Under the RESPOND programme, PRL offers RESPOND Basket proposals which include timely and relevant research topics aligned with PRL's research areas with specific objectives & brief summary of each research topic outlining anticipated deliverables with its potential linkages to Indian Space Programme. Under the RESPOND Basket- 2023, PRL offered 13 proposals as listed in `https://www.isro.gov.in/media$_$isro/pdf/programme/respond$_$basket$_$2023.pdf`, out of which 9 were selected for funding in 2024.

Proposals are also invited through Space Technology Cells (STC) established at various premier engineering institutions including several IITs, and IISc, for carrying out joint research. Further, Space Technology Innovation Centre (STIC) at NITs in various regions to focus on entrepreneurial oriented projects and Regional Academia Centres for Space (RAC-S) are instituted in different regions of the country to encourage the collaborative projects in space in that region. A comprehensive document "Research Areas in Space-2023" (`https://www.isro.gov.in/media$_$isro/pdf/programme/Research$_$Areas$_$in$_$Space$_$for$_$web2023.pdf`) was released on ISRO-Academia day, in May 2023, with a list of research topics for soliciting proposals from STCs, STIC & RAC-S ISRO. This document also included PRL's thrust areas, current and upcoming R&D requirements, Based on this 5 new projects of IIT Madras, IIT Kanpur, IIT Kharagpur, IIT Bombay and IISc, Bangalore were selected in 2024 for funding. In November 2024, the RESPOND Basket-2024 of ISRO was released which included 9 proposals offered by PRL The number of currently ongoing RESPOND basket proposals is 19, in STC is 12, STIC is 1 and RAC-S is 2 . These include proposals from different universities and national institutes both.

The RESPOND programme at PRL mainly supports space sciences research in universities, colleges and national institutes for projects of 2-3 years duration. The main deliverables of the RESPOND programme at PRL are PhD theses, research publications in international and national refereed journals and training of manpower. Occasionally the funding through RESPOND is utilised to set up an experimental facility for research at the university or the host institute. Few projects pursued under RESPOND programme at PRL aim at providing theoretical modeling support to various scientific problems in Space physics, Astrophysics and Earth Sciences.

#### Three Days HPC Workshop "Parallel Programming and Concepts of AI

Computer Networking and Information Technology (CNIT) Division of PRL organised a three-day High Performance Computing (HPC) workshop on "Parallel Programming and Concepts of AI" during July 01-03, 2024. It was organised to celebrate the 1st anniversary of the 1Petaflop (PF) Param Vikram-1000 High Performance Computing (HPC) facility installed and available for scientific use since June 2023. The workshop's main objective was to: 1. Foster a community of scientists, researchers, and academicians in Parallel Computing and Artificial Intelligence (AI), 2. Provide a platform for knowledge sharing and collaboration, and 3. Address challenges and opportunities in various research areas using HPC and AI.

#### Workshop on ArcGIS Pro and ENVI from ESRI Professionals

An ArcGIS Pro and ENVI workshop was conducted at the PRL Thaltej campus on 24 July 2024. The workshop was attended by nearly 40 participants from the S&T members from the Planetary Sciences, Geosciences, and Atomic Molecular Physics divisions of PRL. It was highly interactive and beneficial, with participants engaging in valuable discussions regarding implementing ArcGIS and ENVI software in their research. The ESRI professionals have presented various aspects of data handling, management, representation, processing, and integration using ENVI and ArcGIS Pro. They demonstrated specific tasks such as boulder identification and mapping, crater detection, image segmentation, SAR interferogram generation, and spectral analysis using Chandrayaan-1 M3 and Mars Reconnaissance Orbiter (MRO) CRISM datasets through live demonstrations and discussions. New tools and techniques added to ENVI and ArcGIS Pro were also discussed, highlighting their applications in planetary and terrestrial data analysis. The workshop participants gained significant new insights into the potential of ENVI, ArcMap, and ArcGIS Pro for geospatial data analysis.

#### Symposium on "Emerging Trends in Hydrology Research: An Indian Perspective

The growth of a research institution is often measured by its work's national and global impact. Over the past four decades, PRL has been a leader in isotope hydrology research. To celebrate the achievements of PRL's hydrology team and provide a platform for future directions, a one-day symposium titled "Emerging Trends in Hydrology Research: An Indian Perspective" was organised on 20 September 2024. The symposium featured sessions on key topics such as Water Management, Rivers and Climate, and Stable Isotopes in Hydrology, covering India's latest research trends and practical solutions for water-related issues. The symposium attracted over 100 participants from prestigious institutions across India, including BHU, Kashmir University, IITM Pune, IISER Pune, and IIT Roorkee, fostering a vibrant exchange of ideas and collaborative discussions.

### Venus Science Conference 2024

Physical Research Laboratory (PRL) organised the 4th conference on Venus Science, Venus-SC 2024 (online) during 23-24 September 2024. It focused on modelling, observations, data analysis, conceptual instrument design and scientific experiments for Venus exploration. The primary research areas covered in the conference were surface, atmosphere, lightning, habitability, ionosphere, interplanetary dust, and solar wind interaction with the planets. Such a gathering provided an opportunity to interact with the global community and collaborate with people working in similar fields over a time. Around 180 delegates had registered for the conference, including speakers for oral and short oral presentations. The oral presentations had 28 talks from universities/institutes within and outside India. The short oral presentations included 26 talks from India and other institutions. A few examples of the topics of the talks are geological history of Venus, sedimentary process, mafic dyke, Akatsuki radio science results, effect of magnetic fields, microorganisms, general circulation, Lightning and its impact on chemistry, heterogeneous aerosols, observations of Venus' O2 airglow and interplanetary dust in the inner Solar system. Those praticipants from outside India included those from the US, UK, Japan, Sweden, Taiwan, Russia, and Canada. The centres/institutes from within India were SAC, SPL, PRL, CHARUSAT, Amity Univeristy, NARL, PSG College, IIT, Mahatma Gandhi College, and University of Delhi. The Venus Science Conference included speakers spanning 4 time zones.

### Student Conference on Optics and Photonics (SCOP) -2024

In a spectacular convergence of knowledge and inspiration, the Physical Research Laboratory Student chapter hosted the 9th edition of Student Conference on Optics and Photonics (SCOP) 2024, which left an indelible mark on attendees. The "SCOP-2024" held during 25-27 September 2024, welcomed an array of leading experts, researchers, and students in the fields of optics and photonics, creating an electrifying atmosphere of knowledge and innovation. The conference provided an excellent academic exchange and platform for collaboration, with sessions focusing on emerging research and practical applications. The highlight of the conference was a series of invited talks by prominent speakers, covering a wide range of topics, including quantum optics, photonic crystals, ultrafast spectroscopy, nanophotonics, biophotonics, optical materials, and optical communication. Each speaker provided insights into the cutting-edge research, with lively discussions. The presentations ignited interest in future collaborations, particularly among young researchers. A key highlight was the diversity of topics, seamlessly blending fundamental theories with real-world applications. A significant highlight of SCOP 2024 was the 96th PRL Ka Amrut Vyakhyan, entitled, Structured light for materials science delivered by Prof. Takashige Omatsu, Director, Molecular Chirality Research Centre, Chiba University, Japan. The lecture not only celebrated PRL's rich legacy in research but also inspired participants to explore the frontiers of optical science. An interactive poster session was held to allow participants, especially students, with the opportunity to present their research. Overall, SCOP 2024 was a resounding success, fostering meaningful discussions and collaborations in the optics and photonics community. Participants left the event energised to pursue new ideas and strengthen the research ecosystem in optics and photonics.

### International Conference on "Meteoroid, Meteor and Meteorites: Messengers from Space: (MetMESS) 2024

The Physical Research Laboratory (PRL), Ahmedabad, hosted the International Conference on "Meteoroids, Meteorites, and Messengers from Space" (MetMeSS-2024) during 20-22 November 2024. In this in-person gathering international experts presented and discussed recent advancements in meteoritic and planetary sciences. The conference encompassed a broad spectrum of research areas, including meteor phenomena and space weathering, extra-terrestrial organic molecules in the interstellar medium and meteorites, surface and subsurface processes on terrestrial planets and small bodies, astrochemistry, astrobiology, and terrestrial analogues. MetMeSS-2024 served as a vital platform for fostering interest and creating opportunities for emerging researchers in meteoritics. The conference facilitated interaction between the PhD candidates, postdoctoral fellows, early-career scientists, and graduate students with established planetary scientists from India and abroad over its seven sessions. Approximately 90 scientific papers were presented at the conference, which was attended by 140 participants from diverse fields within planetary science. Keynote presentations included a plenary talk by Prof. Hisayoshi Yurimoto on asteroid sample return missions (Hayabusa 1 & 2), and the sessions were dedicated to diverse topics, such as, stardust, astrochemistry and astrobiology, differentiated planetary bodies, meteor and space weathering, impact processes, planetary surface and subsurface characteristics, and analogue studies. These sessions, featuring invited talks and contributed presentations, stimulated extensive scientific discourse and promoted collaboration within the field. The conference provided a crucial forum for disseminating cutting-edge research and fostering the next generation of planetary scientists. Several students were felicitated with young researcher awards in recognition of their scientific research presented as an oral talk or poster presentation. A two-day (19–20 November) pre-conference workshop (Karyashala) was conducted as an outreach activity to introduce postgraduate and PhD students to laboratory analytical methods and instrumentation. The conference concluded with a post-conference field trip to the Kutch region of Gujarat, a terrestrial Martian analogue site, led by renowned scientists. This immersive experience gave young researchers valuable insights into field research methodologies and the practical application of planetary science concepts.

### ISRO Structured Training Program 2024

The ISRO Structured Training Program (ISRO-STP) 2024, held from 25.11.2024 to 29.11.2024, at the Physical Research Laboratory (PRL) in Ahmedabad, focused on the theme "Multi-Wavelength Astronomy with Ground- and Space-based Facilities." The training programme was attended by 38 participants from 15 different DOS/ISRO centres, all nominated by their respective centres. The program was designed to provide participants with a comprehensive understanding of multi-wavelength astronomy regardless of their specific work areas. The training featured a series of lectures covering a broad spectrum of ground- and space-based astronomy, including optical, infrared, submillimetre, meter, ultraviolet, and X-ray wavelengths. PRL experts from various domains also provided insights into solar eruptive phenomena, space weather, planetary exploration, and sample return missions. Hands-on experience was facilitated through eight different group studies, which gave the smaller groups a deeper understanding of a few selected topics to the smaller groups. As part of the ISRO Structured Training Program (ISRO-STP) 2024, participants could engage in both educational and cultural activities that complemented their training. The program concluded on 29.11.2024 with a visit to PRL's Infrared Observatory at Mount Abu, Rajasthan, wherein the participants explored the operation of the 1.2m and 2.5m telescopes and also visited the Dilwara Temple, making the educational experience even more memorable.

#### Industry Meet-2024

Physical Research Laboratory, Ahmedabad, organised an industry meet on 28 November 2024, in which 35 companies and their 60 delegates participated from various places in the country. The event brought together PRL scientists, industry professionals, and innovators to explore the latest trends, challenges, and opportunities within the fundamental scientific research and its industrial applications. The event featured keynote talks, group discussions, and networking opportunities, offering attendees valuable insights into specific topics, like, analytical techniques, space technology, and electronics, optics, LASER, and computation analytics. Various group discussions conducted by PRL scientists offered diverse perspectives on various topics. The exhibits showcased cutting-edge products, services, and solutions from leading companies in the industry, with live demonstrations and products. The industry meet was a successful event that provided invaluable learning experiences and networking opportunities. Attendees left with a deeper understanding of research trends and actionable insights that will shape their strategies moving forward. The event underscored the importance of innovation and collaboration in driving the future of research industry collaborations.

#### Vikram Discussions – II

As a part of the national science network building initiation of the Physical Research Laboratory, the institute has started "Vikram Discussions," an annual discussion series to bring together scientists of a particular science fields to discuss, debate and design the future course of the community in focused and niche areas of science. This discussion series is named after the visionary Dr. Vikram Sarabhai, the founder of PRL and the Indian Space program. As a suitable tribute to the ideals of Dr. Vikram Sarabhai, the newly formed Interdisciplinary Program for Astrobiology and Astrochemistry (IPAA), PRL, organized the second Vikram Discussion (VD-II) on Astrobiology and Astrochemistry at PRL on 02 January 2025. Based on Vikram Discussions-II, the following focused points were arrived at: 1. Tardigrade map of India - to identify the species that best survives extreme conditions. First mapping of tardigrades in the known Indian craters, Ladakh, Kutch, Dunes, Deccan traps, and caves. 2. Samples from Barren Island and ISRO's clean rooms to study the microbial diversity. 3. Microgravity payload for astrobiology - Need, design, and development. 4. Space bricks or Space binders - 3D printing or binding of lunar and martian analogues. 5. Building a new experimental system for gas-grain interaction in an astrochemical environment. The discussions were intense, and the participants (24 experts) agreed that the above five points should be prioritised. A set of action items was agreed to be taken up over the next few months, especially the exploration of Barren Island for astrobiology and analogue studies. Several new collaborations were fostered.

#### Frontiers in Geosciences Research Conference (FGRC) 2025 at PRL

Physical Research Laboratory (PRL), Ahmedabad, successfully hosted the Frontiers in Geosciences Research Conference (FGRC) 2025 during February 5-7, 2025, bringing together leading scientists, early-career researchers, and students to discuss cutting-edge advancements and future directions in geosciences research in India. The conference served as a vibrant platform for knowledge exchange, fostering collaborations and pushing the frontiers of scientific inquiry. FGRC 2025 witnessed the participation of approximately 250 researchers from 76 institutes and universities across India, ranging from young master's and Ph.D. students to distinguished senior scientists. The conference featured engaging keynote lectures, invited talks, and contributed presentations, covering a broad spectrum of geoscience disciplines, including solid earth studies, climate change, marine and terrestrial biogeochemistry, aerosol chemistry, hydrological sciences, oceanography, earth surface processes, and modern modeling and analytical techniques. The technical sessions covered emerging research themes, with presentations from both senior and early-career researchers. The event also provided a valuable platform for young researchers to showcase their work, with the best papers receiving awards. FGRC 2025 at PRL was a resounding success, reaffirming the institute's commitment to scientific excellence and interdisciplinary geoscience research. Future FGRC events will continue to expand the horizons of geoscientific exploration and innovation to strengthen India's position in global geoscience research.

#### Astrophysical Dust and Ices Workshop 2025

The one-day Workshop on "Astrophysical Dust and Ices: Insights from Recent Telescopes" was organised by PRL, Ahmedabad, on 10 March 2025. Conducted online, this event aimed to bridge the gap between astrophysics, astronomy, and astrochemistry communities. The workshop witnessed an overwhelming interest with 842 registrations representing 451 institutes, exceeding the projected attendee limit of 500 participants. Ultimately, 351 participants, including researchers, academics, and students, attended the workshop from across 20 countries spanning five continents. Certificates were distributed to about 160 attendees who met the criterion of attending at least three hours of the sessions. There were about 20 -30 panellists from various institutions across the globe, including faculties from PRL, who participated in the webinar. The workshop discussed topics ranging from observations of molecular cores, protostars, protoplanetary disks, dust in M-Dwarf stars, and exoplanetary atmospheres, to the capabilities of instruments such as JWST, ALMA, and PRL's Mount Abu Observatory facilities, alongside findings from the PRL Astrochemistry Laboratory. This workshop marked a significant first step in encouraging knowledge-sharing and promoting impactful scientific results by utilising the existing facilities and expertise within PRL. Looking ahead, the workshop also discussed continuing to strengthen interdisciplinary collaborations through similar workshops, enhanced interactions, and impactful deliverables.

#### Indo-German Solar Physics Workshop: "Two Eyes on the Sun – Aditya-L1 and Solar Orbiter

The Indo-German Solar Physics Workshop, "Two Eyes on the Sun – Aditya-L1 and Solar Orbiter", was held online on March 19, 2025. The Udaipur Solar Observatory (USO), PRL, and the

Solar Physics Group, Leibniz Institute for Astrophysics Potsdam (AIP), Germany, jointly organised this one-day event. The Principal Investigators (PIs) of the Indo-German DST–DAAD collaborative project coordinated the workshop. The scientific program featured eight invited talks, showcasing ongoing research and prospects using data from Aditya-L1, Solar Orbiter, XSM/Chandrayaan-2, and other contemporary solar observatories. The sessions highlighted the synergistic potential of these missions in advancing our understanding of the Sun, with a particular emphasis on coordinated observations and multi-wavelength diagnostics. With 118 participants, the workshop fostered vibrant discussions and facilitated valuable exchanges of ideas, further strengthening Indo-German collaboration in solar physics.

#### Vikram Discussion on Neutrino Astrophysics

The Vikram Discussions on Neutrino Astrophysics (VDNA), organised by the theoretical physics division of PRL during 19-21 March 2025, was aimed at focused discussions within the expansive field of neutrino astrophysics. Neutrinos interact solely via the weak force. This unique property allows them to travel vast galactic and intergalactic distances, carrying crucial information about astrophysical events. Over the past fifty years, neurtino's theoretical and experimental studies have significantly advanced, with immense progress in understanding their properties via observing the phenomenon of neutrino oscillations. In particular, the field of neutrino astrophysics and cosmology has seen rapid growth over the last two decades, driven by advancements in theory and experiment alike. The VDNA's core goal was to evaluate the current neutrino astrophysics critically. The discussions sought to highlight areas where further progress could be made and to identify strategies for reinforcing ongoing efforts. Additionally, VDNA aimed to open new investigative pathways, offering fresh opportunities to create synergies between theoretical and experimental work. The scientific program encompassed extensive discussions in 10 sessions, averaging 1.5 hours each. Approximately 50

#### One-Day Hindi Workshop Organised by PRL's Udaipur Solar Observatory for TOLIC Member Offices

On 20 March 2025, the PRL's Udaipur Solar Observatory (USO), Udaipur, successfully organised a One-Day Hindi Workshop for the member offices of the Town Official Language Implementation Committee (TOLIC), Udaipur. The workshop saw participation from 33 attendees representing 19 TOLIC member offices. The inaugural, official language, and scientific sessions were broadcast live for PRL members based in Ahmedabad and at the Mount Abu Observatory Campus. The workshop participants embarked on a guided tour of the Island Observatory. Attendees observed live solar phenomena.

As a part of capacity building efforts PRL.

#### Administrative Staff courses

1. Smt. Nandini Ravi Rao, 05-day Refresher Training Programme for Purchase & Stores Officer working in DOS/ISRO, URSC, Bengaluru, 01.04.2024 to 05.04.2024.
2. Shri Sandeep PS, 05-day Refresher Training Programme for Purchase & Stores Officer working in DOS/ISRO, URSC, Bengaluru, 01.04.2024 to 05.04.2024.
3. Shri Solanki Steven Alois, 05-day Refresher Training Programme for Purchase & Stores Officer working in DOS/ISRO, URSC, Bengaluru, 01.04.2024 to 05.04.2024.
4. Smt. Smita Binoy Pillai, 05-day Refresher Training Programme for Purchase & Stores Officer working in DOS/ISRO, URSC, Bengaluru, 01.04.2024 to 05.04.2024.
5. Smt. Rumkee Dutta, Special Technical Translation Training Programme, Branch Secretariat, New Delhi, 10.06.2024 to 14.06.2024.
6. Shri Pradeep Singh Chauhan, Seminar on "Public Procurement- A Paradigm Shift Policy Initiatives, GeM, Govt. and PSU Procurement", Organized by Indian Institute of Materials Management (IIMM) at Le-Meridian, New Delhi, 29.06.2024.
7. Dr. Md. Nurul Alam, Five-day National Workshop on "Data Carpentry and AI/ML Tools for libraries", B.C. Roy Memorial Library, IIM Calcutta, 01.07.2024 to 05.07.2024.
8. Shri Modi Bhavikkumar Lalitkumar, Driver's Training Programme (DTP), Institute of Driving Training & Research (IDTR), Pune, 22.07.2024 to 24.07.2024.
9. Shri Pradeep Kumar Sharma, Hindi Diwas and Fourth All India Official Language Conference, Bharat Mandapam, New Delhi, 14.09.2024 to 15.09.2024.
10. Smt. Rumkee Dutta, Hindi Diwas and Fourth All India Official Language Conference, Bharat Mandapam, New Delhi, 14.09.2024 to 15.09.2024.
11. Shri Anand D. Mehta, Training Programme on "Right to Information Act 2005 for CPIO and Appellate Authorities", Lemon Tree Hotel, Port Blair, 23.09.2024 to 25.09.2024.
12. Dr. Shital Hitesh Patel, 52nd Annual Conference of "Research Society for The Study of Diabetes in India", Yashobhoomi, Dwarka, New Delhi, 14.11.2024 to 17.11.2024.
13. Shri Kartik Patel, Workshop on RTI ACT, NRSC Outreach Facility, Jeedimetla Campus, 05.12.2024 to 06.12.2024.
14. Shri Kartik Patel, Administrative Vigilance-Role of IO/PO, ISTM, New Delhi, 30.12.2024 to 02.01.2025.
15. Shri Pradeep Kumar Sharma, Training Programme on Legal Information Management & Briefing System (LIMBS), VSSC, Thiruvananthapuram, 08.01.2025 to 09.01.2025.
16. Dr. Shital Hitesh Patel, Association of the Physicians of INDIA (APICON 2025) Conference, Kolkata, 23.01.2025 to 26.01.2025.
17. Dr. Shital Hitesh Patel, Joint International Conference-2025, Ahmedabad, 10.01.2025 to 12.01.2025.
18. Shri Yugal Surendra Kumar Jain, Management Development Programme (MDP) on "Accounts of Autonomous Bodies", AJNIFM, Faridabad, 20.01.2025 to 22.01.2025.
19. Shri Abhishek Upadhyay, Joint Regional Official Language Conference, Deepsmriti Auditorium, Mansarovar, Jaipur, 17.02.2025.

#### Scientific and Technical Staff courses

20. Dr. Shanmugam M., Online Orientation Training programme on "Preventive Vigilance", ISTM (Online), 03.06.2024 to 04.06.2024.

21. Dr. S. Vijayan, The 9th National Conference on Computer Vision, Pattern Recognition, Image Processing, and Graphics (NCVPRIPG), IIST, Thiruvananthapuram, 18.07.2024 to 20.07.2024.
22. Dr. Rishitosh Kumar Sinha, The 9th National Conference on Computer Vision, Pattern Recognition, Image Processing, and Graphics (NCVPRIPG), IIST, Thiruvananthapuram, 18.07.2024 to 20.07.2024.
23. Shri Rajiv Ranjan Bharti, The 9th National Conference on Computer Vision, Pattern Recognition, Image Processing, and Graphics (NCVPRIPG), IIST, Thiruvananthapuram, 18.07.2024 to 20.07.2024.
24. Shri Akash Ganguly, The 9th National Conference on Computer Vision, Pattern Recognition, Image Processing, and Graphics (NCVPRIPG), IIST, Thiruvananthapuram, 18.07.2024 to 20.07.2024.
25. Shri Sanjay S. Wairagade, Capacity Building Programme on Labour Codes in India, V.V. Giri National Institute (VVGNLI), Noida, 22.07.2024 to 26.07.2024.
26. Dr. Shashi Prabhakar, Structured Training Programme on ”Projects Management”, SDSC SHAR, Sriharikota, 26.08.2024 to 30.08.2024.
27. Dr. Girjesh R. Gupta, Hindi Diwas and Fourth All India Official Language Conference, Bharat Mandapam, New Delhi, 14.09.2024 to 15.09.2024.
28. Dr. Sunil Chandra, Hindi Diwas and Fourth All India Official Language Conference, Bharat Mandapam, New Delhi, 14.09.2024 to 15.09.2024.
29. Ms. Sonam Jitarwal, Hindi Diwas and Fourth All India Official Language Conference, Bharat Mandapam, New Delhi, 14.09.2024 to 15.09.2024.
30. Shri Rajiv Ranjan Bharti, Structured Training Programme on ”Advances in Satellite Radar Imaging”, IIRS Dehradun, 23.09.2024 to 27.09.2024.
31. Dr. Megha Upendra Bhatt, Structured Training Programme on ”Advances in Satellite Radar Imaging”, IIRS Dehradun, 23.09.2024 to 27.09.2024.
32. Shri Lovjeet Meena, ISRO Technical Training Programme (ITTP) on ”Supervisory Development”, NSTI, Bengaluru, 14.10.2024 to 18.10.2024.
33. Shri Shiv Kumar Goyal, Structured Training Programme on ”AI/ML for Space Systems”, SAC, Ahmedabad, 21.10.2024 to 25.10.2024.
34. Dr. Arpit Patel, Structured Training Programme on ”AI/ML for Space Systems”, SAC, Ahmedabad, 21.10.2024 to 25.10.2024.
35. Shri Maanyash Jain, ISRO Induction Training Programme (IITP-35), SAC, Ahmedabad and visit to SDSC, SHAR, SAC-SHAR: 04.11.24 to 05.12.24.
36. Shri Vibhor Agrawal, ISRO Induction Training Programme (IITP-35), SAC, Ahmedabad and visit to SDSC, SHAR, SAC-SHAR: 04.11.24 to 05.12.24.
37. Shri Churchil Dwivedi, ISRO Induction Training Programme (IITP-35), SAC, Ahmedabad and visit to SDSC, SHAR, SAC-SHAR: 04.11.24 to 05.12.24.
38. Shri Dheerajkumar Khonde, ISRO Induction Training Programme (IITP-35), SAC, Ahmedabad and visit to SDSC, SHAR, SAC-SHAR: 04.11.24 to 05.12.24.
39. Shri Rakeshkumar G. Mahar, ISRO Technical Training Programme (ITTP) on ”Industrial Air Conditioning, Chiller Plant, BMS”, National Skill Training Institute, Calicut, 18.11.2024 to 22.11.2024.
40. Shri Sachin Gavhare, ISRO Technical Training Programme (ITTP) on ”Industrial Air Conditioning, Chiller Plant, BMS”, National Skill Training Institute, Calicut, 18.11.2024 to 22.11.2024.
41. Shri Lakhansinh G. Chavda, ISRO Technical Training Programme (ITTP) on ”Power Electronics & Its Applications”, National Skill Training Institute, Dehradun, 18.11.2024 to 22.11.2024.
42. Shri Aaditya Sarda, Structured Training Programme, Master Control Facility, Hassan, 06.01.2025 to 10.01.2025.
43. Shri Mitesh B. Bhavsar, ISRO Technical Training Programme (ITTP) on ”Industrial Robotics Training”, National Skill Training Institute, Bengaluru, 27.01.2025 to 31.01.2025.
44. Dr. Mudit Kumar Srivastava, Training Programme on ”Socio-Economic Impact Assessment of S&T Outcomes”, CSIR-Human Resource Development Centre (HRDC), Ghaziabad, 10.02.2025 to 14.02.2025.
45. Shri Ashirbad Nayak, Training Programme on ”Technology Risk Management”, Engineering Staff College of India, Hyderabad, 03.02.2025 to 14.02.2025.
46. Shri Lakum Yagnikkumar Bhimjibhai, ISRO Technical Training Programme (ITTP) on ”Network and Cyber Security, CCTV Security Devices”, National Skill Training Institute, Ramanthapur, Hyderabad, 10.02.2025 to 14.02.2025.
47. Shri Neeraj Kumar Tiwari, Structured Training Programme on ”Satellite Mission Architecture”, ISRO Guest House, Devanahalli, Bengaluru, 16.02.2025 to 21.02.2025.
48. Shri Anilkumar Lakshmishankar Yadav, AutoCAD-3D Modelling Advanced Training, National Skill Training Institute (NSTI), Chennai, 24.02.2025 to 28.02.2025.

# Official Language promotion at PRL

**Rajbhasha Activities held during April 2024-March 2025**

The Physical Research Laboratory (PRL), being one of the premier Research Institute, is maintaining the outreach to different strata of work force and common people. This breeze of enthusiasm is maintained in the innovative ways of promotion Official Language activities too. Some of the noteworth acitivites held throughout the year are as follows:

1. Physical Research Laboratory, Ahmedabad was awarded prize for the best implementation of Official Language Policy of Government of India during the year 2023-24 at the Town Official Language Implementation level on 26.06.2024.
2. The Official Language Implementation Committee (OLIC) is in place at PRL to review the implementation of the Official Language Policy, compliance, and to achieve the targets set by the Official Language Department to promote the progressive use of Hindi in daily office work and to remove the difficulties coming in its way. Meetings of the committee are held every quarter under the chairmanship of the Head of the Department.
3. As per Official Language Department Rules, Hindi Workshops are organized every quarter with the aim of providing various types of training in the official language, assistance for working in Hindi on computers, to provide information about incentive schemes related to Hindi work, to ensure strict compliance of the Official Language Rules. A total of 04 workshops were organized in the financial year April 2024 to March 2025.
4. Departmental Annual Official Language Inspection of PRL Main Campus was conducted on 24 September 2024 by the Controller, URSC, Benguluru.
5. Departmental Annual Hindi Inspection of PRL USO, Udaipur was conducted on 03 January 2025 by the Deputy Secretary, Department of Space, Benguluru.
6. Departmental Annual Hindi Inspection of PRL, Mount Abu was conducted online on 25 March 2025 by the Joint Director (O.L.), Department of Space, Benguluru.
7. This year Hindi Month celebration started on 14 September 2024 with participation in Hindi Diwas Celebration and Fourth All India Official Language Conference 2024 at Bharat Mandapam, New Delhi, and this conference was chaired by the Hon'ble Home and Cooperation Minister, Shri Amit Shah. The following nominated members of PRL participated in this All India Official Language Conference.
   1. Dr. Girjesh R. Gupta, Associate Professor
   2. Dr. Sunil Chandra, Assistant Professor
   3. Shri Pradeep Kumar Sharma, Senior Administrative Officer
   4. Ms. Sonam Jitarwal, Scientist/Engineer-SD
   5. Smt. Rumkee Dutta, Assistant Director (OL)
8. PRL, Ahmedabad celebrated Hindi Month 2024 from 17 September to 15 October 2024, which was formally inagurated on 17 September 2024.

**Following activities were organized during the Hindi Month 2024 celebrations:**

- Kavita Path competition and Matribhasha se Rajbhasha Tak competition
- Online Hindi Typing, Hindi Sulekh and Anekta Mein Ekta Competition
- Hindi Kahani Lekhan Competition (for class 7-10 students)
- Hindi Gaayan programme
- Hamara Kaarya (Our Work) Competition
- Shabd Prashnottari (Word Quiz) Competition
- Laghunatika (Skit) Competition
- On-stage Hindi drama performance

**Gujarat State Level Hindi Competition "Shabd Manthan-Prashna Manjari-2024" organized on 18 October 2024**

Physical Research Laboratory, Ahmedabad organized Gujarat State Level Hindi Competition "Shabd Manthan-Prashna Manjari-2024", wherein participants from various Central Government offices/banks across the state of Gujarat participated in this competition. 59 members from 21 organizations from all over the state of Gujarat participated in it. Five different offices won prizes.

**Presentation of Paper/Poster by three members in Inter-Centre Hindi Technical Seminar at SAC, Ahmedabad on 07-08 November 2024.**

1. Prof. Som Kumar Sharma SPASC, PRL "Analysis of atmospheric clouds and boundary layers from Indian LIDAR Network Programme of PRL"
2. Smt. Sangeeta Verma GSDN, PRL "Use of stable isotopes to study critical regions"

3. Shri Kapil Kumar A & A, PRL “Atmospheric Dispersion Corrector: Indigenously Design and Development”

**Paper presented in Hindi Technical Seminar-2024 organized at IIT Jodhpur on 02 December 2024**

1. Smt. Garima Arora PSDN, PRL “Chemical dating for understanding the timing of asteroid impact: a future planetary exploration tool”
2. Shri Prashant Jangid CNIT, PRL “Cyber Security and Individuals”

As per the instructions issued by the Department of Space, children of PRL staff members were rewarded for securing highest marks in Hindi subject in class 10th and 12th in the 2024 examinations conducted by CBSE, ICSE and State Boards.

Ashulekhan competition was organized on World Hindi Day 2025 on 10 January 2025.

Participation of Assistant Director (OL) in Special Technical Translation Training organised by Department of Space during 10-14 June 2024.

Special vyakhyaan by Prof. Anil Bhardwaj, Director, Physical Research Laboratory on “Indian Solar System Exploration Programme” in Hindi at the seminar on “Developed India 2047- Contribution of your Institute/Organization” organized by Institute for Plasma Research on 08 August 2024.

Participation of Assistant Director (OL) in the Hindi seminar on ”Developed India 2047- Contribution of your Institute/Organization” by Institute for Plasma Research on 08th August 2024.

Invited talk by Assistant Director (O.L.) at Airport Authority of India, Ahmedabad for Workshop on 23 August 2024.

Sr. Administrative Officer, Main Campus, Sr. Administrative Officer (USO), In-charge, (O.L.) Mount Abu and Assistant Director (O.L.), attended the 164th meeting of the Departmental Official Language Implementation Committee (DOLIC) on 27.03.2025.

**PRL Amrut Rajbhasha Vyakhyan (PARV)**

The monthly Hindi Vyakhyaan Series is named ‘PRL Amrut Rajbhasha Vyakhyaan (PARV)’. PARV Vyakhyaans are delivered by eminent personalities covering a wide range of subjects like Science and Arts, Engineering and Technology, Literature and Rajbhasha, Corporate Business and Entrepreneurship, Management, Industry and Marketing, Finance and Human Resources, Law and Social Sciences, Sports and Travelogue, Adventure Missions, Spiritual Philosophy and Traditional Knowledge. During April 2024 to March 2025, 12 vyakhyaans of PARV were organized.

# Facilities and Services

**Computer Networking and Information Technology (CNIT) Division**

The Computer Networking & Information Technology Division (CNIT) is responsible for providing services/facilities like Secure Networking (Internet, Local Area Network, Wifi, SPACENET), High performance Computing, E-mail, Web, DNS, Proxy, VPN, Centralized Printing, DHCP, Video Conference, EGPS, COWAA/COINS, software development, and maintenance. Apart from this, CNIT members have actively participated in ISRO/DOS level various Cyber Security Vulnerability Assessment & Penetration Testing (VAPT) and internal Cyber security Audit activities.

The following services/facilities are provided by the CNIT division during the year 2024-2025.

**A. Three Days HPC Training Workshop - "Parallel Programming and Concepts of AI"**

The HPC Committee and CNIT Division of PRL organized a three-day High Performance Computing (HPC) training workshop on "Parallel Programming and Concepts of AI" during July 01-03, 2024. It was organized to celebrate the 1st anniversary of 1 PetaFLOPS (PF) Param Vikram-1000 HPC facility which was installed in June 2023. The main objective of the training workshop was to:

(i) Foster a community of scientists, researchers, and academician in Parallel Computing and Artificial Intelligence (AI),

(ii) Provide a platform for knowledge sharing and collaboration and

(iii) Address challenges and opportunities in various research using HPC and AI.

Around 45 Scientific/Technical faculties and research scholars of PRL and Universities/Colleges participated in the workshop on an invitation basis. The participants gained valuable insights into parallel programming and concepts of AI along with hands-on lab sessions. They also performed hands-on lab exercises on Param Vikram-1000 HPC to understand the nitty-gritty of parallel programming.

Figure No. 1: Three Days HPC Training Workshop-"Parallel Programming and Concepts of AI"

It has been observed that the workshop fulfilled its objective by providing a platform for networking and collaboration among the HPC experts, researchers, academia, and students. The workshop was very well appreciated by all the participants.

### B. 1 PetaFLOPS High Performance Computing Cluster (HPC) HPC cluster at PRL

Work Details: To cater the high-end computing requirement of PRL's scientific & technical fraternity, PRL has PARAM VIKRAM -1000 1 Peta Flops HPC facility, consists of 108 computing nodes dispenses 7296 CPU cores, 2,76,480 GPU Cores, 74 TB of RAM and 1 PB of high-performance parallel Lustre file system. The new HPC compute nodes are Make in India, and the majority of the software used is open source. To cater the need of the Scientific and Technical Fraternity, open source as well commercial software like COMSOL, CST Studio, Geant4, Intel oneAPI HPC toolkit, Gnu Library, Conda, and Python have been installed on HPC.

At present, it is extensively utilized for various scientific and research activities by the PRL Scientific & Technical Fraternity. During April, 2024 to March, 2025 period, 24 Scientific Papers have been published in reputed Scientific Journals where Param Vikram-1000 facility has been acknowledged.

Figure No. 2: 1 PetaFLOPS High Performance Computing Cluster (HPC) HPC cluster at PRL

**C. Addition of New Services**

(1) **Network Link Establishment** In coordination with Delhi Earth Stations (DES), Delhi, a VSAT network link has been established at Main Campus and Infrared Observatory (IRO), Mount Abu. In case of unavailability of existing Point-to-Point (P2P) OFC link of BSNL, this link provides seamless communication from IRO to within PRL as well as to the external collaborators over Internet through VSAT. The link has been managed by Delhi Earth Station (DES), ISRO.

(2) **Remote Desktop Application - Rustdesk**
PRL campuses, situated in Ahmedabad and Rajasthan,

house various scientific instruments that are either directly connected or connected through computer and accessible within PRL LAN. PRL fraternity frequently need to access these Instruments, PCs remotely to monitor and verify the status of the instruments. To streamline the remote desktop experience, the CNIT division has deployed RustDesk, a self-hosted, open-source solution within PRL LAN.

RustDesk provides a secure, dependable, and efficient platform for remote desktop access. Its implementation has significantly simplified the process for users, ensuring they can effortlessly and securely check the status of scientific instruments. This solution has been widely adopted across PRL, reflecting its reliability and effectiveness.

(3) **File Sharing Service: Tempshare**

Efficient file sharing is an indispensable need within any organization, including PRL, where seamless collaboration across various divisions is essential. Users often exchange a wide range of files such as documents, spreadsheets, presentations, applications, zip archives, and entire folders. However, file sharing within PRL LAN using USB or through shared network folder is not safe & secure method. Also, due to security reasons, usage of USB is not permitted in PRL LAN.

To address this critical challenge and to balance both security and convenience, CNIT has setup a robust and innovative solution called “TempShare” using open source tools. This web-based platform revolutionizes file sharing by enabling users to effortlessly transfer files and folders between computers in PRL LAN without relying on USB devices or requiring the installation of any additional software or through shared network folders. Moreover, by offering a user-friendly, software-free experience, it eliminates the technical barriers that could hinder smooth file sharing, ensuring an efficient and secure work environment.

This solution not only simplifies the file-sharing process but also aligns with PRL’s commitment to maintaining a high standard of cybersecurity while fostering collaboration and productivity.

**D. Cyber Security Activities** Information Security is a continuous process. CNIT division sincerely puts all its efforts into securing our IT services, Network, and data across all the campuses from emerging threats. Cyber Security Awareness is an important pillar of an Information Security domain. CNIT regularly spreads cyber security awareness through lectures/talks, all users emails, and posters.

The Cyber and Information Security (CIS) Section has developed an Information Security website featuring cyber security related information. Professor Anil Bhardwaj, Director, PRL, inaugurated the newly developed Information Security website on January 09, 2025.

At DOS/ISRO Level, the CNIT team members have actively contributed in the following committees/teams:

(1) Cyber Security Mock Drill (CSMD)

(2) Vulnerability Assessment & Penetration Testing (VAPT)

(3) Root Cause Analysis (RCA)

(4) Cyber Security Audit of IT Infrastructure

Figure No. 3 : Information Security Website

**E. Software Development and Management:**

(1) **Comprehensive Human Image Visualization Interface (CHHAVI)**

PRL has made approximately 37,000 event images available online, with each event featuring over 300 photos. Navigating through this vast collection to find specific personal images can be a challenge. To simplify the process, the CNIT division has developed CHHAVI - Comprehensive Human Image Visualization Interface. CHHAVI streamlines person-wise event image search and categorization. Leveraging an open-source, deep learning-based application, it accurately identifies tagged individuals across multiple images, even in cases of varied facial orientation, lighting conditions, and shadows.

(2) **Automation through Web Applications for Web Content Management**

CNIT team members have recently developed as well as further improved the various web application to automate the information updation workflow of PRL website content like “What’s New”, “Recent Publications”, “PRL In News”, “RTI”, “Tenders”, “Recruitment”, “PARV”, “PKAV”, “Scientific Divisions’ Web Pages”, “Colloquiums/Seminars”, “*Hindi Vichar* “*Aaj ka Hindi Shabd*”, ‘*Hindi Anubhag*”, “Dispensary”, “Construction & Maintenance Group” and many more. The application automatically sends an email to Hindi Section to update modified English content in Hindi.

(3) **Budget Monitoring Web Application**

The CNIT team, in collaboration with PPEG, Purchase, and Accounts, has developed a highly effective customize PRL specific application that provides a comprehensive overview of PRL’s budget utilization. This tool enables stockholders to access budget status in multiple formats - whether consolidated, division-wise, or line-item-wise - offering clarity and precision in financial planning.

One of the key advantages of this application is its ability to empower PPEG in projecting and predicting PRL’s budget trends, allowing for strategic financial forecasting and decision-making. Furthermore, this innovative solution has significantly enhanced operational efficiency across PPEG, Purchase, Accounts, and various divisions/sections of PRL. By offering real-time visibility into budget utilization, it enables divisions and sections to actively monitor their expenditures and plan procurement activities with greater accuracy and confidence.

This application has not only improved budget tracking but also facilitated informed decision-making, ultimately contributing to the overall efficiency and financial health of PRL.

(4) **Junior Research Fellow (JRF) Induction Application**

Each year, PRL inducts Junior Research Fellows (JRFs) to embark on research across various scientific domains. To facilitate a seamless and efficient induction process, in coordination with stockholder, a dedicated web application has been developed, significantly enhancing the overall management of the JRF induction program. This application streamlines numerous aspects of the induction process, ensuring smooth coordination and effective execution. Beyond its core functionalities, an additional application plays a vital role in generating essential reports required for both pre-processing and post-processing stages of induction. These reports provide comprehensive data and insights, allowing the committee to assess various parameters, track application progress, and make well-informed decisions.

By leveraging the capabilities of this web application, the committee gains a structured and data-driven approach to planning and executing the induction process. It enables them to evaluate applications systematically, identify trends, and optimize resources accordingly. Moreover, it ensures transparency, improves efficiency, and facilitates strategic decision-making, ultimately contributing to a more organized and effective JRF induction program at PRL.

(5) **NSD and VIKAS Web and OMR Applications**

CNIT team members have developed an application for registration and evaluating OMR sheets of students for NSD and VIKSA scholarship outreach activities. More than 5000 students registered for NSD 2025 & VIKAS 2025, for which CNIT provided technical support for student registration and OMR evaluation. A total of 5226 students from 1811 schools had registered in the OMR-based examination of NSD & VIKAS scholarship of PRL. The examination went very well.

In addition to the mentioned web applications, several other software solutions have been developed, including the Online CHSS Annual Declaration Form for Permanent Employees of PRL, the Budget Monitoring Application, and an Automated Email Notification system for payment processing against purchase orders, MIRV, and gate pass approvals. These applications have significantly enhanced the operational efficiency of various sections such as PPEG, Administration, Accounts, the Dean's Office, and Stores & Purchase.

**F. CNIT Nukkad - Chai Pe Byte:** To share experiences & knowledge in the different IT verticals like Web, Email, HPC, Cyber Security, and Cloud Technology and to strengthen the overall bonding between CNIT Division and PRL colleagues, the CNIT division has started a new initiative, "CNIT Nukkad - Chai Pe Byte". As a part of this initiative, CNIT has organized the following sessions on different IT verticals:

(1) Automation: Transforming Web Content Management (February 12, 2025)

(2) Synergy for Effective Technology Utilization (SETU) - 2025 (January 09, 2025)

(3) Know ISRO/DOS SPACENET Services (06/December/2024)

(4) Know Your Computer (KYC) -1 (October 23, 2024)

(5) Identify Phishing Email (July 30 2024)

(6) MIS Report Generation Online Portal (June 06, 2024)

**G. Hindi Language Promotion Activities:**

Mr. Prashant Jangid presented a paper titled "Cyber security and individual and the future" at the 'Hindi Technical Seminar 2024' held at IIT Jodhpur on December 2, 2024, aimed at popularizing technology and promoting cyber awareness among a wider section of society through Hindi.

**Library & Information Services**

Library and Information Services are important in catering to the information needs of the PRL researchers and staff members. These information services are provided on all the PRL campuses. A few important ones are - documents (books, journals, CDs), lending services, Online access (internet and through remote access) to the Institutional repository, E-journals, Theses, E-books, Archives, Technical Reports, etc. The library also provides the Inter Library Loan facility, Research Support Services like Similarity Checks, Grammar Check, Research Impact Measurement Services, Reprography, Information display through the Digital Notice Boards, and Book procurement for project grants. Important Statistics:

| | |
|---|---|
| Books Added | 319 |
| E- books access added | 2071 |
| Journals accessible through PRL, AG & ONOS | 13029 |
| Circulation Service | 3242 |
| Inter Library Loan Service | 91 |
| Similarity Checks | 74 |
| Reprographic Services | 58213 |
| Items added to Dspace Repository | 1255 |

Figure no. 1 :Annual Statistics

**Library Online Resources** In 2024, the PRL Library provided access to a wide range of full-text databases including the GSA Archive, PROLA, Science Archive, ProQuest Dissertations and Theses (PQDT), Nature.com, Springer Journals, Elsevier Journals, Wiley Journals, as well as the SPIE and IEEE Digital Libraries. Additionally, databases such as SCOPUS, INSPEC, and COMPENDEX were available through the Antariksh Gyaan consortium. With the implementation of the One Nation One Subscription (ONOS) initiative in January 2025, the PRL Library now has access to the journals covered under ONOS from 30 publishers. The library continues to offer seamless access to online resources and information services through its in-house developed and managed website: https://www.prl.res.in/ library/resource.html. New Initiatives:

1. **PRIME (PRL Research Information and Metrics Engine)** It is

a cutting-edge Research Information Management System (RIMS) designed to streamline research data management at Physical Research Laboratory (PRL). It has centralized research publication data, offering secure aggregation, seamless analysis, and enhanced collaboration. PRIME provides actionable insights through robust reporting, analysis, and benchmarking, helping decision-makers optimize resources and assess research impact. compliant with global standards, it ensures interoperability and scalability. The platform aims to boost institutional visibility by showcasing research achievements, and attracting collaborators and funding agencies.


Figure no. 2 : Snapshot of PRIME

**2. Annif: AI/ML-Powered Subject Indexing at PRL Library** The PRL Library is leveraging Annif, an AI/ML-powered system, to enhance subject heading and improve cataloguing efficiency. Installed in a Python virtual environment, Annif is trained on the Library of Congress Subject Headings (LCSH) in Turtle format. It utilizes TF-IDF as the backend algorithm and Snowball as the text analyser to ensure accurate classification. Running on Ubuntu, the system streamlines metadata tagging, reducing manual effort while maintaining precision. Currently, Annif is operational and accessible for PRL Library staff, supporting seamless subject classification for research materials.

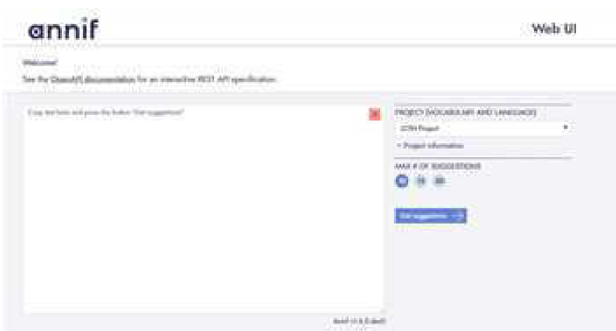


Figure no. 3: Snapshot of Annif

**3. QueryQuest: An AI-Powered Library Chatbot** QueryQuest, developed at the PRL Library, is an AI-powered chatbot designed to improve information services by offering precise and timely access to library resources. It aims to help users locate books, and retrieve research materials efficiently. Leveraging Retrieval-Augmented Generation (RAG) and Large Language Models (LLM), QueryQuest aims to enhance search accuracy by providing context-aware responses. Currently, it is accessible within the local network (LAN), ensuring secure and efficient information retrieval for researchers and library users.


Figure no. 4 : Snapshot of QueryQuest

**4. Digitization and Archival Facility at PRL** The Digitization and Archival Facility at PRL is dedicated to preserving and enhancing access to historically significant and rare materials from the institute's inception. This initiative employs advanced digitization techniques to create high-quality digital surrogates of manuscripts, photographs, and archival documents, ensuring their accuracy and longevity. A Digital Book Scanner (CopiBook), installed at the Thaltej Campus Library as shown in the figure, plays a crucial role in this process. CopiBook is powered by LIMB Capture software, which efficiently manages the entire digitization workflow. Additionally, LIMB Processing enriches images by optimizing their quality and metadata, ensuring enhanced accessibility and searchability. This system safeguards delicate materials while making them more widely available for research and scholarship. By preserving these invaluable historical records in a digital format, the initiative not only prevents deterioration but also facilitates knowledge dissemination, supporting academic and institutional research for future generations. Total digitised documents uploaded includes 567 Journal articles, 503 Electronic theses and dissertations, 68 Rare photographs and 117 Technical Notes.


Figure no. 5 : A Glimpse of Digitization Facility

**Renovation of Thaltej Library** The renovation of the Thaltej Library (figure 6) (2nd floor, Old Building) commenced on March 23, 2024, necessitating the temporary relocation of library materials and furniture to the Ground Floor of the New Building at the Thaltej Campus.

Figure no. 6 : Old Thaltej Library

A systematic transfer of essential resources, including books, journals, and furniture, was executed to maintain uninterrupted library services. During this transition, provisions for change of flooring, air conditioning, internet connectivity, and electrical and LAN infrastructure were implemented alongside installing a modern library counter and shelving systems to sustain an optimal study and research environment for students, researchers, and faculty members. The renovation was completed on March 28, 2025, following which the Thaltej Library (figure 7) started relocating back to its original space on the 2nd floor of the Old Building. The facility is getting refurbished and will feature enhanced infrastructure, improving accessibility and user experience. Additionally, as part of the restructuring process, all bound volume journals from the Thaltej Campus Library were transferred to the Navrangpura Campus Library, which will be stored on the second floor alongside other bound volumes. This strategic relocation aims to optimize space utilization while ensuring continued accessibility of academic resources for users. The renovation of the Thaltej Library underscores a significant initiative to modernize library infrastructure and services.

Figure no. 7 : A Glimpse of Ongoing Renovation and refurbishing of Thaltej Library

**Library Outreach** Library Poster for NSPD - Library outreach poster was prepared showcasing the services and collection of the Library.

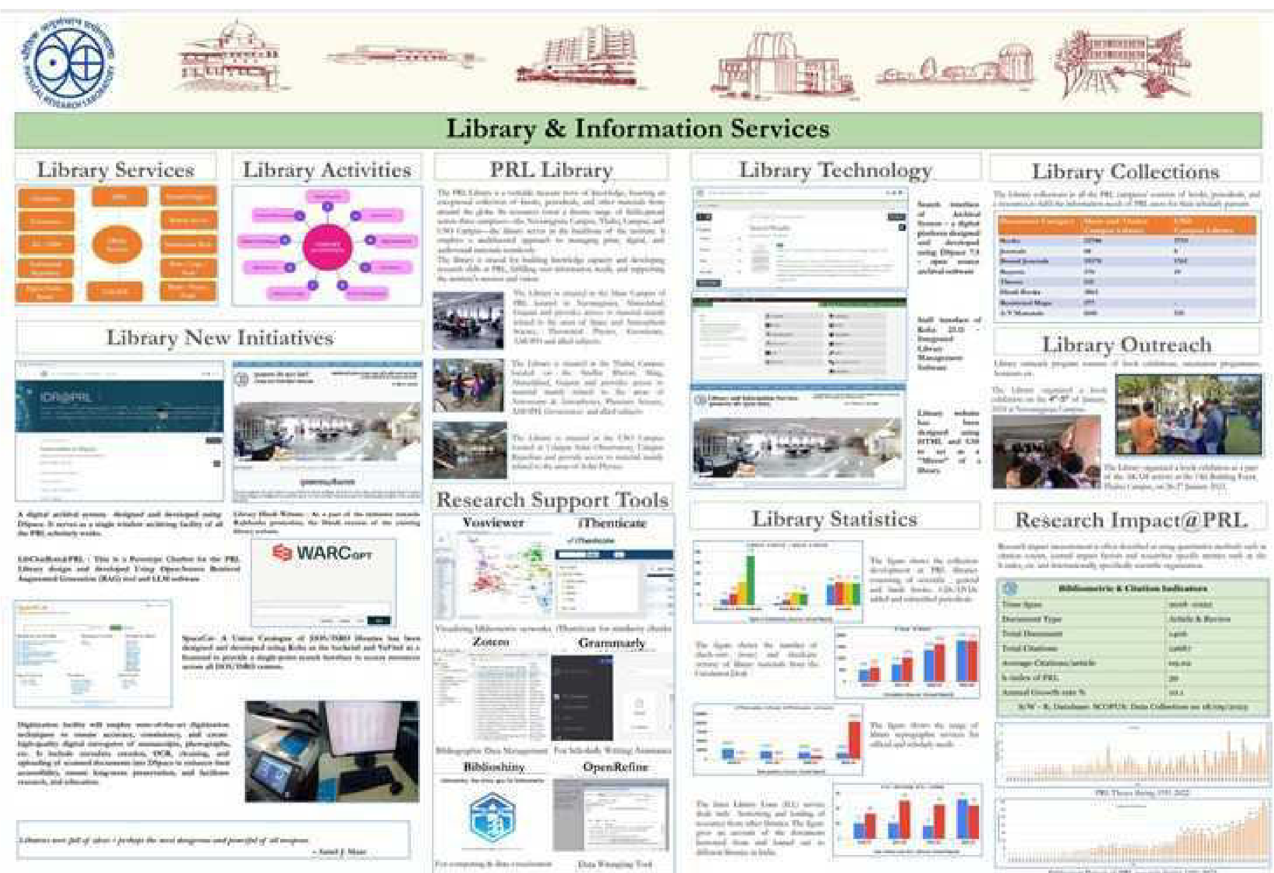


Figure no. 8 : Library Poster

**Book exhibition:** The PRL Library hosted a book exhibition for the PRL students and staff on December 19–20, 2024. Over two days, attendees had the opportunity to peruse a vast array of around 600 books that included both scientific and popular topics. The exhibition showcased cutting-edge scientific literature and general books on history, philosophy, literature (Hindi and English), and art. Four renowned booksellers—Kushal Books, Bombay Books, Himanshu Books, and Aanjaneya Books—each with their assortment of books were a part of this program.

Figure no. 9 : Book Exhibition

**Grammarly for Education Session** On December 18, 2024, PRL Library hosted an informative session on "Grammarly for Education," a tool aimed at helping students and faculty improve their writing and research. Led by Ms. Mansi Saini, the session focused on maximizing Grammarly's powerful features to enhance writing quality, making it more effective, polished, and academically sound.

Figure no. 10 : Grammarly for education session

**PRL-Workshop**

The PRL mechanical workshops (main campus and thaltej campuses) serve as vital support centres for the institute's scientific and academic divisions by providing end-to-end solutions in design optimisation, fabrication, and precision machining of mechanical systems and subsystems. Staffed with two engineers, one Thaltej in-charge, four senior technicians, and several skilled trainees across various trades such as machining, turning, welding, and fitting, the workshops are well-equipped to meet diverse technical demands. Both facilities house state-of-the-art equipment, including Vertical Machining Centres (VMC-850 & VMC-640), Turn Mill Centre (TMC NVU-200), CNC Turning Centre (DX-200), and Electric Discharge Machines (EDM & Wirecut). To support high-precision, complex manufacturing, the workshops utilise advanced CAD/CAM software such as SolidWorks, Inventor, MasterCam, and Autodesk's Product Design & Manufacturing Collection (PDMC), enabling accurate and automated CNC programming directly from 3D models. From April to December 2024, both workshops made significant contributions to the fabrication and testing of scientific instruments, mechanical subsystems, space-borne components, back-end instruments, and experimental setups for ongoing development projects and upcoming scientific missions. Their continuous engagement with PRL's scientific & engineering fraternities across PRL ensures seamless operational support and effective implementation of research and engineering solutions, making them indispensable to PRL's R&D activities.

**Graphite-Hot Plate for Metal Isotope Analysis**

The digestion and processing of rock samples for isotope analysis involve strong acids like Hf, HNO3, and HCl, where the hot plate plays a crucial role. To prevent contamination and corrosion from acids, a chemical-resistant, metal-free hot plate with an exposed surface is essential. The GENESIS lab at the Geoscience division uses stable isotopes of metals such as Cr, Fe, W, and Ni to study core formation, igneous crystallisation, and metamorphic processes, which contribute to understanding the evolution of Earth and other planets.

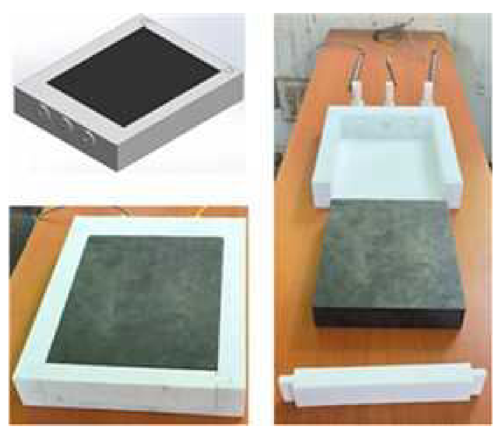

Figure no. 1: Graphite-Hot Plate for Metal Isotope Analysis

For this work, a Graphite Block (257 mm x 207 mm x 44 mm) and a Teflon Block (332 mm x 270 mm x 60 mm) were machined using a VMC-60 machine. The Teflon Block was designed with an internal cavity to perfectly fit the Graphite Block, ensuring the top surfaces of both blocks align precisely. Provisions were made to house 2 heaters (for heating the graphite block) and 1 thermocouple (for temperature measurement), which are inserted through the Teflon block and fully embedded in the Graphite block, with exposed wires for connection at the Teflon block end. The complete Hot Plate Assembly was taken to the laboratory for testing, where it was successfully used for the digestion and processing of rock samples and meteorites in a clean environment.

### Optical Turbulence Assembly for Laser Beam Analysis

An Optical Turbulence Assembly was developed to replicate atmospheric turbulence within a controlled environment, using a fabricated box 369×174×195mm equipped with two or four air blowers featuring built-in temperature control. Scientifically, the setup enables the study of laser beam behaviour, such as position shifts, wavefront distortion, polarisation changes, and quantum effects like entanglement, under varying thermal gradients, simulating real atmospheric turbulence. Fabrication-wise, the base, top cover, and blower side walls were machined at the PRL-Workshop, Main Campus, while components like sensor mounts, exhaust covers, heat gun mounts, and optical window side walls were produced at the PRL-Workshop, Thaltej Campus. Air blowers mounted on the side walls generate controlled thermal gradients, with exhaust covers guiding airflow to shape temperature patterns confirmed through simulations. The laser enters via a sealed optical window in an orange plate, ensuring an airtight environment for precise turbulence simulation and optical experimentation.

Figure no. 2: Optical Turbulence Assembly for Laser Beam Analysis

### Robotic Photometer Assembly (2-Axis Sky Imager)

The airglow photometer detects faint night-time airglow emissions from the Earth's upper atmosphere using interference filters to capture specific wavelengths.

Figure no. 3: Robotic Photometer Assembly (2-Axis Sky Imager)

This provides insights into atmospheric composition and dynamics. The photometer is designed for efficient data acquisition in low-light conditions, offering a complete spatial view of airglow emissions across the sky. The photometer is mounted on a robotic arm for azimuth motion, enabling sky-wide observations. It uses two motors and bearings for rotary motion. The compact design (268 mm x 300 mm x 581 mm) ensures portability and adaptability in challenging environments. A total of 15 parts were fabricated on a VMC-850 machine to assemble the robotic photometer.

### UHV-Compatible SS-304 Angular and Mounting Clamps for Femtosecond Lab

SS-304 clamps have been fabricated for securely mounting optical posts in the Femtosecond Lab, with the chosen SS-304 material ensuring ultra-high vacuum (UHV) compatibility.

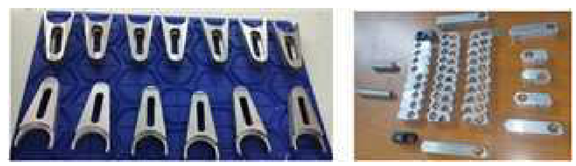

Figure no. 4: UHV-Compatible SS-304 Angular and Mounting Clamps for Femtosecond Lab

A total of 10 standard clamps were manufactured for use with optical post holders, along with three types of precision angular clamps—135○, 90○, and 45○ metric post clamps (10 nos. each)—designed and machined on the VMC-850 machine. These clamps are essential for stable and accurate alignment of optical components in high-precision laser experiments, contributing to the robustness and modularity of the lab's optical setup.

### Shielded Al. Sample Holders for uDOSE Calibration Standards

Two aluminium alloy (Al-6061) holders, each sized 225.4×225.4×16 mm, have been fabricated to securely store high-radioactivity calibration standard samples for the alpha-beta counting machine, uDOSE. Fabrication-wise, the precision-machined holders ensure structural strength and corrosion resistance, while custom square O-rings (3 mm section) from an external vendor provide effective sealing. From a scientific perspective, the design ensures shielding from environmental contaminants like dust and moisture, preserving sample integrity and ensuring safe handling.

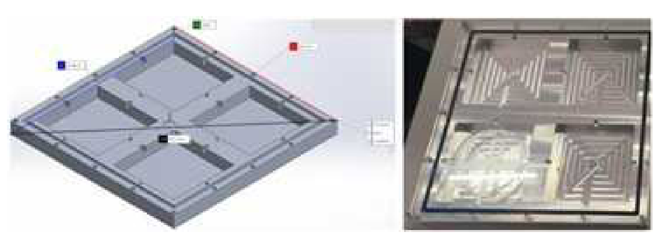

Figure no. 5: Shielded Al. Sample Holders for uDOSE Calibration Standards

### Sample Crushing Sets for High-Frequency (vibration) Sample Crusher

For the User's sample crushing setup, two sets (4 pieces each) were initially fabricated from WPS material to replace the cracked original bowl of a 20-year-old high-frequency vibration crusher. Fabrication-wise, the parts were precision-machined to match the original design, but due to iron content, rusting occurred. To resolve this, an additional set was made from corrosion-resistant SS-304, and an anti-rust coating plan was implemented for the WPS components. Scientifically, this ensures consistent sample pulverization and long-term material stability without contamination.

Figure no. 6: Sample Crushing Sets for High-Frequency (vibration) Sample Crusher

### In-line Sequential Filtration Unit for Phytoplankton Isolation

An in-line sequential filtration unit was fabricated in May 2024 during the Sagar Sampada cruise expedition to isolate phytoplankton from natural seawater. The system consists of two 2.5-foot aluminium pipes, five special aluminium clamps, a 250 mm diameter base, and brass M8 knobs, all assembled to a height of 5 feet for easy transportation. The filtration system employs vacuum filtration through sequential filters, with a specific pore size to capture phytoplankton ranging from $\geq 200\mu\text{m}$ to $\leq 2\mu\text{m}$. Scientifically, the unit enables analysis of phytoplankton's elemental and isotopic compositions, contributing to the study of primary production, carbon export flux, and marine food web dynamics.

Figure no. 7: In-line Sequential Filtration Unit for Phytoplankton Isolation

### Acrylic Base and Cover for Sample Mounting

The fabrication of acrylic sample holders and covers was carried out on the VMC-850 machine using a vacuum plate. The Acrylic Base Holder (Dia. 305 mm $\times$ 13 mm) is designed to hold SS-304 disks on the rotating wheel of the RISO machine, allowing easy removal after operations. The Acrylic Cover (Dia. 312 mm $\times$ 6 mm) is designed to enclose the base holder, securely positioning the disks for the process. A total of 10 components were successfully fabricated, ensuring precise alignment and functionality for the RISO machine's sample mounting process.

Figure no. 8: Acrylic Base and Cover for Sample Mounting

**Machining of Knife Edges and PCD Tapping on SS-304 CF Flanges - Femtosecond Lab** The SS-304 flange blanks provided by the Femtosecond Lab underwent precise machining for knife edges and PCD tapping. The PCD holes, taps, and through-holes were machined using the TMC-200 machine, ensuring accurate dimensions and thread integrity. For the knife edges, conventional lathe machines were used to achieve the required sharpness and precision. This machining process ensured high-quality finishes and tight tolerances, meeting the specifications for the CF flanges.

Figure no. 9: Machining of Knife Edges and PCD Tapping on SS-304 CF Flanges - Femtosecond Lab

**Fabrication of PVC Platters with Hinged Covers** A total of 30 assemblies of PVC platters were fabricated on the VMC-850 machine. Each assembly consists of two parts: A Sample Storage Plate (25 units) and a Top Cover Plate (25 units), joined using small SS-304 hinges. The grooves for placing the hinges were machined on the VMC-850 machine.The plates, featuring blind circular pockets with dimensions of 104 mm $\times$ 221 mm $\times$ 3 mm, have a total of 50 blind circular pockets, each numbered individually. Special small SS-304 hinges were used to join the plates. Also, another 25 covers, each measuring 104 mm $\times$ 221 mm $\times$ 3 mm, were fabricated on the same machine. Special grooves were machined to fit the small SS-304 hinges, allowing easy opening and closing of both plates.

Figure no. 10: Fabrication of PVC Platters with Hinged Covers

#### SS-304 Sample Holders Base and SS-304 Covers for Samples

A total of 10 SS-304 Sample Holder Bases (Dia. 31.25mm × 30mm) were fabricated, each featuring a step on the top side and a circular blind pocket of Dia. 9.7mm × 0.5mm depth—designed to hold SS-304 disks of Dia. 9.65mm × 0.5 mm thickness—have been fabricated on the TMC-200 NVU machine. Also, 10 SS-304 covers of Dia. 31.25mm × 5.20mm have been fabricated on the same machine. The top covers are designed with tapered opening holes of Dia. 2 mm, Dia. 3 mm, Dia. 4 mm, Dia. 5 mm, and Dia. 8 mm, which were machined using a conventional lathe machine.

Figure no. 11: SS-304 Sample Holders Base and SS-304 Covers for Samples.

#### Sliding Cover for “Multiwavelength Imaging Spectrometer Using E-Schell Grating MISE”

A single sliding hood has been fabricated for the MISE (Multi-wavelength Imaging Spectrograph using Echelle grating) instrument using an aluminium extrusion frame and a 2mm thick aluminium sheet, with overall dimensions of 4ft.× 4ft.× 2.5ft.

Figure no. 12: Sliding Cover for “Multiwavelength Imaging Spectrometer Using E-Schell Grating MISE”

Designed for dual-directional observations, the hood features two fixed 4-inch slits aligned in North-South and East-West directions, eliminating the need for rotational movement. Structurally, it includes three 3-inch mid-support legs with mounting holes and three 1-inch corner legs for added stability. Four 1-inch handles are integrated for convenient handling. Scientifically, the interior is finished with a matt dull black coating to suppress internal reflections and enhance data quality, while the white exterior aids in thermal management, offering a practical and efficient solution for stable, direction-selective observations.

#### Back-End Instruments’ Fabrication Activities for the 1.2 m and 2.5 m Telescope: PARAS-2 (Scrambler- FP Interlink Assembly)

Figure no. 13: PARAS-2 (Scrambler - FP Interlink Assembly)

The Scrambler–FP interlink assembly for the 2.5m telescope, a key component of the PARAS-2 project aimed at improving radial velocity (RV) precision, was reviewed and finalised with a focus on Design for Manufacturing (DfM) principles. The complete fabrication was carried out at the PRL Thaltej workshop using precision machining tools, including the CNC Turning Centre (DX-200), VMC-640, and EDM Wire Cut. All components were manufactured with stringent control over tolerances and surface finishes to meet the high-precision opto-mechanical requirements. The final assembly achieved the required positioning accuracy as per the engineering drawing specifications, ensuring reliable integration into the overall instrument integrity.

**Fabry-Perot Interferometer for Wavelength Calibration-PARAS-2**

The Fabry-Perot interferometer, designed for precise wavelength calibration, uses multiple-beam interference with a 5 mm gap between plates to selectively allow wavelengths with constructive interference based on the refractive index of air.

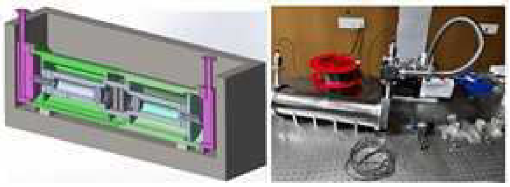

Figure no. 14: Fabry-Perot Interferometer for Wavelength Calibration-PARAS-2

Fabrication-wise, the system consists of a collimator, FP etalon, and a focuser, housed in a vacuum chamber with a 600×200×200 mm temperature control system. The vacuum chamber was split into two argon-welded parts, sealed with Viton O-rings to maintain a low vacuum of 1 mbar. Precision machining was employed for optical alignment and system assembly, ensuring a seamless fit of 13 components, including lens holders, retaining rings, and fibre collars. Scientifically, this setup allows for accurate wavelength calibration in a stable temperature and pressure environment, using a Xenon arc lamp as the white light source and an achromatic triplet lens to reduce chromatic aberrations.

**Xenon Arc Lamp Assembly for Faint Object Camera (FOC) in PARAS-2 Instrument**

The Xenon Arc lamp assembly for the Faint Object Camera (FOC) in the PARAS-2 instrument was fabricated at the PRL-Workshops (both), ensuring precise fibre tip alignment and stable light entry into the detector. Fabrication-wise, the assembly includes five aluminium housing walls, an optics table, Teflon bases for the xenon lamp stand, and various precision machined components such as optics slider bases, stands, lens holders, and filter holders, totalling 39 parts.

Figure no. 15: Xenon Arc Lamp Assembly for Faint Object Camera (FOC) in PARAS-2 Instrument

Fabrication was carried out using CNC turning (DX-200), VMC-640, and EDM wire-cut machines, maintaining tight tolerances and surface finishes. The setup includes a xenon arc lamp, mirror, collimator, band-pass filter, and an achromatic triplet lens to focus light onto the output fibre. The system replaces the uranium argon lamp, providing stable and accurate wavelength calibration by filtering wavelengths between 400-700nm, with the water bath dimensions being 660mm×250mm×250mm and the Fabry-Perot instrument measuring 586mm×259mm×160.5mm. Scientifically, this setup ensures precise and stable calibration for accurate spectral measurements.

**NISP: Filter Wheel Assembly for Vacuum Testing**

Design of NISP: Filter wheel assembly for vacuum testing was reviewed as per the ‘Design for Manufacturing (DFM)’ aspect, and the complete assembly was fabricated at the Thaltej workshop.

Figure no. 16: NISP: Filter Wheel Assembly for Vacuum Testing

This is part of the NISP project and is aimed at testing the filter with rotary movement under vacuum conditions. The machine tools used were a CNC turning centre DX-200, a VMC-640 and an EDM wire cut. The gear-cutting operation was outsourced. Bearings were fitted with tolerances accounted as per thermal soaking requirements. Components were made with controlled tolerances and surface finishes to end up at the required fitting level from a kinematics point of view. The geometrical & positioning accuracy of the assembly was maintained as per drawing specifications.

**Proto-Pol Instrument Parts for Fibre Arrangement in Calibration Unit and Slit Viewer**

Figure no. 17: Proto-Pol Instrument Parts for Fibre Arrangement in Calibration Unit and Slit Viewer

The components design of components fibre arrangement in the calibration unit and slit viewer (Proto-Pol Instrument) was reviewed as per the 'Design for Manufacturing (DFM)' aspect, and the complete assembly was fabricated at the Thaltej workshop. The machine tools used were a CNC turning centre DX-200, VMC-640, and EDM wire cut. The gear-cutting operation was outsourced. Components were made with controlled tolerances and surface finishes to end up at the required fitting level from a kinematics point of view. The geometrical & positioning accuracy of the assembly was maintained as per drawing specifications.

### Payload Instrumentation Fabrication Activities: PRATHIMA Payload (for Chandrayaan-5/LuPEX mission): Probe Lab Model

The PRATHIMA payload works on the principle of permittivity measurement for water ice detection in the lunar subsurface. Before the realisation of EM hardware and evaluation of the current version of probe design, including optimum sizing and shape of transmitting electrodes, a series of characterization tests needed to be performed in the laboratory environment. This necessitated the fabrication of a size equivalent probe with similar material with optimum realization time. Therefore, from a realisation point of view, a segmented probe was designed by the project team with active consultation from the workshop engineers, with the incorporation of 'DfM' aspects. The construction of the probe core material is of Teflon material with threaded interfaces between the segments. These segments were fabricated using the CNC lathe machine. The copper electrodes were machined using CNC turning, CNC milling, and EDM wire cut machining to achieve the required fit with the Teflon core structure. Finally, the entire set of components was assembled by the Thaltej workshop team and handed over to the user group. As per feedback from the user group, the probe is being used successfully for various probe and electronics characterization tests at the SIMPEX lab.

Figure no. 18: PRATHIMA Payload (for Chandrayaan-5/LuPEX mission): Probe Lab Model

**Upper Bracket Support for PRATHIMA Mechanism** The fabrication of the upper bracket support for the PRATHIMA mechanism has been successfully completed using the VMC-850 machine. The machining process was complex, requiring a total of four different setups. After completing the machining on one side, the job had to be reoriented and re-fixed for machining on the other faces, ensuring precision and alignment to house the bearings. The overall dimensions of the upper bracket are 77.5mm×92mm×63mm. Tolerances were maintained while machining a circular pocket to accommodate two bearings.

Figure no. 19: Upper Bracket Support for PRATHIMA Mechanism

### PRATHIMA Payload Transmitter & Receiver Electronics Enclosures

PRATHIMA Payload is a selected payload for the LuPEX/ Chandrayaan-5 mission of ISRO. This payload works on the principle of permittivity measurement for water ice detection in the lunar South Pole. For testing the performance of electronics of transmitter and receiver electronics (in an EMI shielding environment), enclosure assemblies were fabricated at the Thaltej workshop. The fabrication utilized the VMC-640, wire-cut EDM and drilling machine tools. These enclosures are successfully utilized in testing PCBs of PRATIMA electronics by the payload development team.

Figure no. 20: PRATHIMA Payload Transmitter & Receiver Electronics Enclosures

### DISHA mission- Drift Meter Payload: Power and Processing Electronics Enclosures

The Drift Meter (DM) payload, part of the upcoming twin Aeronomy satellite mission DISHA, is currently under Engineering Model (EM) development. The DM assembly includes power electronics, processing units, front-end electronics, and sensors. To ensure structural integrity in space, dedicated enclosures with integrated ribs were designed to house the power and processing assemblies, providing mechanical strength against launch vibrations and dynamic loads. Fasteners ensure secure connections while allowing ease of integration and maintenance. Provisions for mounting DC-DC converters were included to enable direct heat dissipation to the satellite deck for effective thermal management.

In line with the finalized mechanical design, the power and processing enclosures were fabricated at the workshop facility. These will support the mounting of electronic cards and integrate with the sensor assembly to complete the EM assembly. Fabrication involved extensive use of VMC-640, EDM wire-cut, and drilling/tapping machines. The power and processing enclosures measure 248 mm ×

248 mm × 15 mm$^3$ and 248 mm × 248 mm × 55 mm$^3$, respectively, comprising two power enclosures, one processing enclosure, and four connector plates. Ribbed components required custom fixtures and multiple setups, with each job involving 47 holes tapped to 3 mm. The final ribbed part weighs 600 grams, machined from a 15 kg raw block.

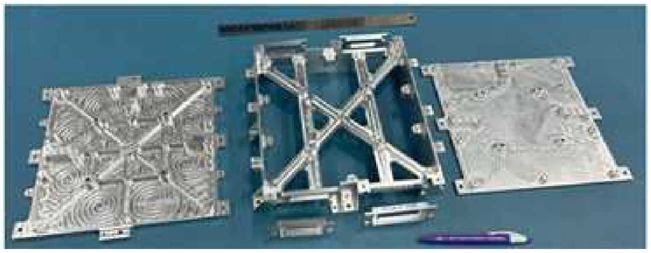

Figure no. 21: DISHA mission- Drift Meter Payload: Power and Processing Electronics Enclosures

### DISHA Mission- Langmuir Probe Payload: Electronics Enclosures

Langmuir Probe Payload is a selected payload for the upcoming DISHA mission of ISRO. This payload uses two Langmuir probes mounted on top of the electronics enclosure itself, so as to make it into a single package. For characterising the FE and PE electronics, the required electronics enclosure assemblies with a provision to integrate the PCBs were fabricated at the Thaltej workshop. The fabrication of these subassemblies utilised the VMC-640, Wire-cut EDM and drilling machine tools. These enclosures are successfully realised as per the design requirements by the payload development team.

Figure no. 22: DISHA Mission- Langmuir Probe Payload: Electronics Enclosures

### DISHA mission- Airglow Photometer Payload: GLUX PCB Electronics Box & Lens Barrels

Airglow Photometer Payload is a selected payload for the upcoming DISHA mission of ISRO. This payload uses a single lens optics with filter arrangement and correspondingly uses the detectors. For characterising the GLUX detector, the required electronics enclosure assembly with a provision to integrate the optical barrel was fabricated at the Thaltej workshop. Also the sets of optical lens barrels were fabricated at Thaltej workshop for testing the opt mechanical assembly with the detector as a single functioning unit. The fabrication of theses subassemblies utilized the VMC-640, CNC Turning, wire-cut EDM and drilling machine tools. These enclosures and barrels are successfully realised as per the design requirements by the payload development team.

Figure no. 23: DISHA mission- Airglow Photometer Payload: GLUX PCB Electronics Box & Lens Barrels

### IDM Copper Quadrants for In-Drift Meter (IDM) Payload

Eight copper quadrants, each with a sector radius of 36mm and a thickness of 5.5mm, were fabricated for the IDM sensor of the DM payload. The quadrants are designed to form a four-piece detector, mounted on a stepped PCB, creating a lightweight, compact assembly. The design ensures a 0.5 mm effective detector thickness, with fastening done via threaded rods on the backside, ideal for space applications. After electronic testing and validation, the detectors will be integrated into the ion chamber for measurement and calibration, supporting the Drift Meter (DM) payload in the DISHA mission.

Figure no. 24: IDM Copper Quadrants for In-Drift Meter (IDM) Payload

### Lens System for RPA Sensor Calibration

| ITEM NO. | PART NUMBER | QTY. |
|---|---|---|
| 1 | Front nozzle | 1 |
| 2 | Plate 1 | 5 |
| 3 | Teflon stand off front one | 3 |
| 4 | Teflon stand off front remaining | 12 |
| 5 | 8mm rod | 3 |

Figure no. 25: Lens System for RPA Sensor Calibration

A precision lens system was fabricated to calibrate the RPA sensor by simulating ionospheric conditions using an ion gun. Fabrication-wise, the system includes a 300×200×5 mm aluminium mounting plate and six circular planar plates (110 mm dia., 300 mm length), assembled with 18 Teflon insulator studs and a central threaded rod to ensure structural integrity and alignment. Scientifically, the lens system reduces ion energy below 25 eV and is rigidly mounted within a vacuum chamber, enabling accurate, space-like calibration of the RPA sensor.

#### DM Payload Testing – Fabrication of Lens System and Copper Detectors

For DM payload testing, a precision lens system was fabricated using a mounting plate, six planar plates, 18 Teflon studs, and a threaded rod to reduce ion gun energy to below 25eV within a vacuum chamber, simulating ionospheric conditions.

Figure no. 26: DM Payload Testing – Fabrication of Lens System and Copper Detectors

Fabrication-wise, all components were carefully machined for proper alignment and vacuum compatibility. Additionally, 14 copper quadrant detectors (70mm dia., 4mm thick) were machined using high-precision turning and milling in the PRL Workshop. Scientifically, these detectors, integrated into the IDM and RPA systems via PCB mounting, ensure accurate measurement of ion arrival angles and velocities, enabling high-performance payload calibration.

#### Shield Tube for NIMS Instrument for Future Space Science Missions

The Neutral and Ion Mass Spectrometer (NIMS) is being developed at PRL under the Technology Development Program (TDP) for future planetary missions to perform in-situ measurements of neutral and ion species. Its performance will be demonstrated through Balloon and POEM-PS4 platforms. NIMS is a quadrupole mass spectrometer designed with the required stiffness and strength to withstand the harsh space environment. A critical and mass-intensive component is the shield tube, which protects the quadrupole section during mission phases and ensures vacuum sealing during ground tests. Both ends of the tube are fitted with Conflat flanges to interface with vacuum systems. Designed as a single component with a two-legged configuration, it offers structural integrity and precision for mounting.

To optimise mass, the wall thickness was reduced to 0.5 mm, posing significant fabrication challenges. Additionally, the inner surfaces required stringent surface finish and dimensional accuracy to meet vacuum and assembly needs. This complex component was successfully fabricated in a single piece without any welding or joining, using VMC, CNC lathe, tapping, and other precision machines. The internal honing operation was outsourced due to its specialised nature.

Figure no. 27: Shield Tube for NIMS Instrument for Future Space Science Missions.

# Honorary Fellow & Faculties

**Honorary Fellows**

K. Kasturirangan [Deceased 25 April 2025]

S. A. Haider
FNA, FASc, FNASc
J.C. Bose Fellow

**Honorary Faculty**

A. K. Singhvi
FNA, FASc, FNASc, FTWAS
DST-SERB-Year of Science Chair Professor

A. S. Joshipura
FNA, FASc, FNASc
J.C. Bose & Raja Rammanna Fellow

J. N. Goswami
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Shyam Lal
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J.C. Bose Fellow & INSA Sr. Scientist

S.D. Rindani
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| 2 | A K Sudheer | Sci./Eng.-SF | Chemistry Of Atmospheric Aerosol & Biogeochemistry | GSDN | PhD (2018) |
| 3 | A. Shivam | Sci./Eng.-SD | Electronics Development and Accelerator Mass Spectrometry | GSDN | M.Tech. (2018) |
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| 6 | Abhishek | Sr. Admin. Officer | General Administration | USO | PGDip. (2009) |
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| 23 | Anilkumar Lakshmishankar Yadav | Sr. Sci. Assistant-A | Optical Instrumentation For Airglow And GPS/GNSS/IRNSS For TEC Measurments | SPASC | M.Sc. (2014) |
| 24 | Anirban Ghosh | Sr. Sci. Assistant-A | Semiconductor Device, Photonics, Nonlinear Optics, Quantum Optics, Structured Optical Beams | AMOPH | M.Sc. (2016) |
| 25 | Anisha Kulhari | Sr. Sci. Assistant-A | Scientific Observations | USO | M.Sc. (2016) |
| 26 | Ankala Raja Bayanna | Sci./Eng.-SF | Optical Instrumentation, Adaptive Optics, Solar Physics | USO | PhD (2015) |
| 27 | Ankita Patel | Sci./Eng.-SD | Electronic Instrument Control System, GUI, PCB Designing and Firmware Development, PC Based Real Time Control System For AO, Mechanical 3D CAD Modelling | A&A | B.E. (2015) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
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| 32 | Arvind Singh | Asso. Professor | Ocean Biogeochemistry And Climate Change | GSDN | PhD (2011) |
| 33 | Arvind Singh Rajpurohit | Asst. Professor | Atmosphere Of Very Low Mass Stars And Brown Dwarfs | A&A | PhD (2013) |
| 34 | Aseem Jaini | Sci./Eng.-SD | Civil Engineering | CMDV | B.Tech. (2016) |
| 35 | Ashirbad Nayak | Sci./Eng.-SD | Electronics | A&A | B.E. (2017) |
| 36 | Ashish Govindrao Sawadkar | Senior Assistant | Hindi section and administration related work | ADMGN | CC (2006) |
| 37 | Ashish Kumar | Sci./Eng.-SD | Civil Engineering | USO | B.Tech. (2016) |
| 38 | Atul Ashok Manke | Sci./Eng.-SE | Software development and scientific data analysis | SPASC | M.Tech. (2013) |
| 39 | Avadh Kumar | Sr. Sci. Assistant | Noble Gase Mass spectrometery and Vacuum Setups | PSDN | M.Sc. (2018) |
| 40 | Aveek Sarkar | Asso. Professor | Magnetohydrodynamic Simulation | A&A | PhD (2005) |
| 41 | Ayush Kumar Patel | Library Assistant-A | Library and Information Services, Scientometric, Bibliometric | LIBSR | (M.Lib.I.Sc) (2020) |
| 42 | B G Thakor | Sr. Proj. Attendant | Purchase attendent | ADMPR | Ninth (1991) |
| 43 | B. S. Bharath Saiguhan | Sci./Eng.-SC | Astronomy & Astrophysics | A&A | MS (Integrated) (2021) |
| 44 | B. Anne Matilda | Admin. Officer | General Administration and Accounts | ADMGN | M.Com (1997) |
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| 46 | Bhalamurugan Sivaraman | Professor | Astrochemistry - Astrobiology | AMOPH | PhD (2009) |
| 47 | Bhavesh Raj Singh Nehra | Sci./Eng.-SC | Electronics and Communication Engineering | PSDN | B.Tech (2024) |
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| 49 | Bhushit G. Vaishnav | Sci./Eng.-SF | Theoretical Atomic And Molecular Physics, Academic Administration, Scientific Editing And Reports Preparation | ADMDN | PhD (2008) |
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| 51 | Bijaya Kumar Sahoo<br>Dy. Head-II, AMOPH | Sr. Professor | Probing Sub-Atomic Physics, Relativistic Atomic And Molecular Many-Body Methods, Computational Physics | AMOPH | PhD (2006) |
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| 62 | Debabrata Banerjee<br>Dy. Head-II, PSDN | Professor | Planetary Science, Gamma Ray Spectroscopy And Luminescence Physics | PSDN | PhD (1997) |
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| 96 | Jayashree Balan Iyer | Sr. Proj. Assistant | CHSS, BACS, Visitor Mgmnt System, Despatch, Pension Cards, Liasoning Work | ADMGN | B.HSc. (1993) |
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| 103 | K.K. Sasikumar | Head P & G A | Transport, Estate And Right To Information | ADMGN | M.B.A. (2014) |
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| 129 | Mahesh Kumar A Raval | Senior Lv Driver-B | Driver | ADMGN | Ninth (1989) |
| 130 | Malaidevan P | Sci./Eng.-SD | Electronics (Avionics), Solidwork Software | SPASC | B.Tech. (2015) |
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| 136 | Mantu Meher | Sr. Assistant | Procurement (GeM, Coins, Cash Purchase) | ADMPR | B.Sc. (2015) |
| 137 | Md. Nurul Alam | Library Officer -C | Library Automation, Digital Library, Scientometrics, Digitization, Serials Control | LIBSR | PhD (2017) |
| 138 | Megha U Bhatt | Assistant Professor | Planetary Remote Sensing, Visible - Infrared Spectroscopy | PSDN | PhD (2012) |
| 139 | Mistry Bhaveshkumar V | Technical Assistant | Astronomy & Astrophysics | AST-AS | B.E. (2021) |
| 140 | Mitesh B Bhavsar | Sr.Technician-A | Circuit Fabrication And Testing, Soldering/Desoldering Work, Supporting Space Science Instrumentation | SPASC | I.T.I (1998) |
| 141 | Mithun Neelakandan Ps | Sci./Eng.-SE | High Energy Astrophysics And Instrumentation | A&A | PhD (2024) |
| 142 | Modi Bhavikkumar L | L V Driver-A | Driver | ADMGN | Bachelor of Rural Studies (2008) |
| 143 | Mohit Kumar Soni | Sci./Eng.-SD | Avionics Instrumentation (Hardware And Software), Ground Based Insturmentation, Image Processing And Deep Learning | SPASC | B.Tech. (2019) |
| 144 | Mudit Kumar Srivastava | Asso. Professor | Observational Astronomy, Studies Of Novae, Symbiotic Stars And Transients, Optical Astronomical Instrumentation, Design And Development Of Optical Imaging And Spectroscopy Instruments | A&A | PhD (2012) |
| 145 | N Jain | Sci./Eng.-SE | Design, Development And Coordinate Maintenance Of Electrical Systems at USO | USO | AMIE (2002) |
| 146 | N S Rajput | Sr.Tech.-A | Assitance with Telescope operations | A&A | Eight (1985) |
| 147 | Nafees Ahmad | Sci./Eng.-SD | Upgradation of 1.2M Infrared Telescope Upgradation, Operations And Maintenance. | A&A | AMIE (2015) |
| 148 | Namit Mahajan Dy. Head-I, THEPH | Professor | Theoretical High Energy Physics | THEPH | PhD (2004) |
| 149 | Nandini Ravi Rao | Pur. & Stores Officer | Purchase administration | ADMPR | B.Sc. (1991) |
| 150 | Nandita Srivastava | Sr. Professor | Solar Physics, Space Weather | USO | PhD (1994) |
| 151 | Narendra Ojha | Assistant Professor | Atmospheric Chemistry, Earth System Modeling | SPASC | PhD (2014) |
| 152 | Naveen Chauhan | Asso. Professor | Luminescence Dating, Luminescence Physics, Dosimetry | AMOPH | PhD (2013) |
| 153 | Navinder Singh | Professor | Theoretical Condensed Matter Physics | THEPH | PhD (2006) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
|---|---|---|---|---|---|
| 154 | Neelam J S S V Prasad | Sci./Eng.-SE | Ground Based Instrumentation, Design And Development Of Hardware And Software For Telescope Back-end Instruments And Control System For Scientific Detectors, Antenna Design And Basic Astronomical Telescope Technology | A&A | B.Tech. (2015) |
| 155 | Neeraj Kumar Tiwari | Sci./Eng.-SE | Mechanical And Thermal Design Of Space Instruments And X-Ray Optics Development | A&A | B.Tech. (2015) |
| 156 | Neeraj Rastogi<br>Dy. Head-II, GSDN | Asso. Professor | Atmospheric Science: Aerosol Chemistry, Composition, And Characteristics | GSDN | PhD (2005) |
| 157 | Neeraj Srivastava | Asso. Professor | Planetary Remote Sensing: Mission Data Analysis For Geology & Laboratory Reflectance Spectroscopy Under Smulated Conditions | PSDN | PhD (2015) |
| 158 | Nileshkumar N Dodiya | Sr.Tech.-A | Carpentary Work | CMDV | CC (2000) |
| 159 | Nimma Vinitha | Sci./Eng.-SD | Ultrafast Spectroscopy, Laser Physics, Optical Instrumentation | AMOPH | M.Tech. (2019) |
| 160 | Nirbhay Kumar Upadhyay | Sci./Eng.-SF | System Engineering Of Space Instrumentation, Aerospace Systems' Mechanical Design, Mechanical Engineering (Spl. In Machine Design) | PSDN | M.Tech. (2008) |
| 161 | Nishant Singh | Sci./Eng.-SD | Electronics Engineer, Design And Development Of Space Based Instruments | PSDN | B.E. (2017) |
| 162 | P Narendra Babu | Sci./Eng.-SD | Electrical works | CMDV | B.Tech. (2013) |
| 163 | P S Patwal | Tech. Officer-D | Electrical Engineering | A&A | D.EL.E (1993) |
| 164 | Padia Girishkumar D | Sci./Eng.-SD | Database Administration, Web Application Security Auditing, Applicationvirtualization, Linux Server Administration, Shell Scripting | CNIT | M.Tech. (2013) |
| 165 | Pankaj Kumar Kushwaha | Sci./Eng.-SD | Electronics, Development Of low current Electronics Circuit For Space-Borne And Ground Based Scientific Instruments, PCB Designing, Checkout And Automation Of Instruments. | SPASC | B.Tech. (2016) |
| 166 | Paramita Dutta | Asst. Professor | Theoretical Physics | THEPH | PhD (2015) |
| 167 | Parmar Viral M | Sci./Eng.-SF | Electrical Engineering - Capital, Minor And Maintenance Electrical Works | CMDV | B.E. (2002) |
| 168 | Partha Konar<br>Dy. Head-II, THEPH | Professor | Theoretical Particle Physics, High Energy Collider, Dark Matter, Neutrino, Supersymmetry, Deep Machine Learning | THEPH | PhD (2005) |
| 169 | Patel Anil Shivpujan | Sr. Technical Assistant. | Maintenance (Electrical) | CMDV | B.E. (2015) |
| 170 | Peddireddy Kalyana Srinivasa R | Sci./Eng.-SD | Mechanical Engineer, Payload Design, Structural And Thermal Analysis Of Payload Structures, Computer Based Numerical Simulations, Experimental Simulations Involving High Vacuum Assemblies | PSDN | B.Tech. (2016) |
| 171 | Piyush Sharma | Sci./Eng.-SD | Design Electronics For Space Based Instruments | PSDN | M.Tech. (2017) |
| 172 | Pooja Chandravanshi | Sci./Eng.-SD | Electronics And Communication Engineer, Free Space Quantum Communication, Post Processing Of Quantum Key Distribution (QKD) Protocols, Labview Based Data Acquisition And Automation | AMOPH | B.E. (2016) |
| 173 | Prachi Vinod Prajapati | Sci./Eng.-SD | Massive Stars-Nonthermal Emission-Particle Acceleration In Astrophysics, Radio Astronomy, NIR-Optical Instrumentation And Observations, Solar System Science | A&A | M.S. (2019) |
| 174 | Pradeep Kumar Sharma | Sr. Admn. Officer | General Administration, CISF Matters, Safety and Security, Rajbhasha, Canteen and Catering, Welfare | ADMGN | M.A. (2012) |
| 175 | Pradeep Singh Chauhan | Senior Pur. & Stores Officer | International Trade, Contract Law & Management, Government Emarketplace, Service Contracts, Public Procurement | ADMPR | M.Com (2021) |
| 176 | Pradip Shivaji Suryawanshi | Sr. Sci. Assistant-A | Ground And Space Based Optical Instrumentation For Ionospheric Studies, Digisonde Data Analysis | SPASC | M.Sc. (2016) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
|---|---|---|---|---|---|
| 177 | Pragya Pandey | Library Officer-C | Information Services & Documentation, Acquisition & Technical Processing, Scientometric Analysis, Library Automation | LIBSR | PhD (2019) |
| 178 | Pranav R Adhyaru | Sci./Eng.-SG | Design & Development Of Electronics Hardware And Software For Scientific Applications. | GSDN | B.E. (1991) |
| 179 | Prashant Jangid | Sci./Eng.-SD | Web Application Development, Website Development, Web Application Security Auditing, Mathematics, Algorithm, Operating System | CNIT | B.Tech. (2015) |
| 180 | Prashant Kumar | Sci./Eng.-SF | Experimental Atomic And Molecular Physics, Laser Plasma Physics, Optical Emission And Mass Spectroscopy, Payload Development | AMOPH | PhD (2020) |
| 181 | Priti K Poddar | Sr. Proj. Assistant | Accounts & Purchase | ADMGN | PGDCA (1993) |
| 182 | R A Parmar | Sr. Proj. Attendant | Office attendant | ADMGN | Ninth (1988) |
| 183 | R D Deshpande | Registrar & Senior Professor GSDN | Isotope Hydrology, Hydrogeology | GSDN | PhD (2007) |
| 184 | R H Kalal | Canteen Boy-C | Canteen Boy -C | ADMGN | Eight (1987) |
| 185 | R K Jaroli | Sr. Proj. Assistant | Assistance with office work at USO | USO | B.Com (1987) |
| 186 | R P Singh Head, AMOPH | Sr. Professor | Laser Physics, Light Scattering, Singular Optics, Quantum Optics And Quantum Information | AMOPH | PhD (1994) |
| 187 | R R Mahajan | Sci./Eng.-SF | Meteorites, Mass Spectrometer, Noble Gas, Nitrogen, Vacuum, Laser, Mars | PSDN | M.Tech. (1997) |
| 188 | R R Shah | Sci./Eng.- SG | Instrumentation & Control, Astronomy & Space Appl. Telescope, Satelite Tracking, Pointing, Imaging Space Servilance Simulation And System Development | A&A | M.B.A. (1997) |
| 189 | Rahul Pathak | Sci./Eng.-SD | Design And Development Of Electronics For Ground-Based And Space-Borne Instruments. Front-End Processing, Checkout System Design For SCMOS and CMOS, Data Acquisition And Automation | SPASC | B.Tech. (2013) |
| 190 | Rahul Sharma | Sci./Eng.-SD | Database Administration (EGPS, COWAA), Networking | CNIT | M.Sc. (2013) |
| 191 | Rajan Sharma | Library Asst-A | Library and Information Services | LIBSR | MLIS (2022) |
| 192 | Rajesh A Patel | Technician-G | Refridgeration And Air Conditioning Maintenance | CMDV | I.T.I (2014) |
| 193 | Rajesh Kumar Kushawaha | Asso Professor | Atomic, Molecular And Optical Physics: Ultrafast Spectroscopy, Collision Physics, Extreme Photonics & Femtosecond/Attosecond Spectroscopy | AMOPH | PhD (2010) |
| 194 | Rajeshkumar G Kaila | Sr.Tech.-A | Operating & Programing VMC/ TMC Machine Using Mastercam Software, Design And Fabrication Of User Specific Scientific Jobs, And Working On Conventional Lathe/ Milling Machines | WORSH | CC (2000) |
| 195 | Rajiv Ranjan Bharti | Sci./Eng.-SE | Planetary Remote Sensing | PSDN | PhD (2025) |
| 196 | Rakeshkumar G Mahar | Sr.Tech.-A | Design And Fabrication Of User Specific Scientific Jobs | CMDV | I.T.I (1998) |
| 197 | Ram Lakhan Agrawal | Sci./Eng.-SE | Conventional Lathe And Milling Machines | CMDV | B.Tech. (2013) |
| 198 | Ramitendranath Bhattacharyya Dy. Head-II, USO | Professor | Solar Physics, Dynamics Of The Solar Corona, Magnetic Reconnection, Numerical Simulation. | USO | PhD (2006) |
| 199 | Rashmi | Sci./Eng.-SD | Design And Development Of Space Based Instruments. | PSDN | B.Tech. (2019) |
| 200 | Rashmi Ranjan | Head Purchase & Stores Officer | Stores, Purchase, Sale, Administration, Account, Computer Applications, Dgs&D Contract | ADMST | M.A. (2011) |
| 201 | Ravi Bhushan | Sr. Professor | Oceanography, Paleoclimate, Ocean Biogeochemistry, AMS Radiocarbon Dating, Cosmogenic Radionuclide Application | GSDN | PhD (2009) |
| 202 | Ravindra Pratap Singh | Sci./Eng.-SF | MLT Dynamics, Coupling of Atmospheres, Airglow, Atmospheric Waves, Optical/IR Instrumentation | SPASC | PhD (2018) |
| 203 | Richa Prashant Kumar | Senior Catering Manager | Catering, Hospitality And Estate Management | ADMGN | B.Sc. (2009) |
| 204 | Rishikesh Sharma | Sr. Sci./Eng.-SC | High-Resolution Spectroscopy And Photometric Data Reduction And Analysis, Characterization Of Exoplanets, Astronomical Instrumentation | A&A | M.Sc. (2017) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
|---|---|---|---|---|---|
| 205 | Rishitosh Kumar Sinha | Sci./Eng.-SE | Planetary Remote Sensing Data Analysis Of Mars And Moon | PSDN | PhD (2023) |
| 206 | Rohan Eugene Louis | Asso. Professor | Solar Physics | USO | PhD (2011) |
| 207 | Rohit Meena | Sci. Assistant | Atmospheric Science: Aerosol Chemistry, Composition, And Characteristics | GSDN | M.Sc. (2018) |
| 208 | Rumkee Dutta | Asst. Director [OL] | Hindi Cell Administration | ADMGN | M.A. (2004) |
| 209 | Rutuj Gharate | Sci./Eng.-SC | Electronics And Communication | AMOPH | B.Tech. (2022) |
| 210 | S Ramachandran | Sr. Professor | Aerosols, Radiation, and Chemistry-Climate Interactions | SPASC | PhD (1996) |
| 211 | S Venkataramani | Sci./Eng.- SG | Atmospheric Science - Trace Gases Related To Ozone In Troposphere | SPASC | M.Sc. (1986) |
| 212 | S Vijayan | Assto. Professor | Planetary Remote Sensing | PSDN | PhD (2013) |
| 213 | Saba Abbasi | Sr. Assistant (ADHOC) | Purchase services | ADMST | M.B.A. (2015) |
| 214 | Sachindranatha Naik<br>Dy. Head-II, A&A | Professor | High Energy Astronomy And Astrophysics | A&A | PhD (2003) |
| 215 | Sachin Gavhare | Technical Assistant | Mechanical Engineering(AC) | CMDV | B.E (2014) |
| 216 | Sameer Patidar | Sci./Eng.-Sc | Astronomy & Astrophysics | A&A | M.Sc (2024) |
| 217 | Samir V Dani<br>Head, Dispensary | Med. Officer-SG | Medical Management Of Communicable And Non-Communicable Diseases, Specialization In Diabetes Management. Chss Management At Dispensary Level. | DISSR | CC (2018) |
| 218 | Sandeep B Manglani | Jr. Pers. Assistant | Stenography & Secretarial Work. | ADMDIR | SHAND (2017) |
| 219 | Sandeep PS | Purchase & Stores Officer | PURCHASE & STORES | ADMPR | M.B.A.(2006) |
| 220 | Sandip Hasmukh Doshi | Tech. Officer-D | Technical Work, Maintanace, Installations And Upgradation Of Hardware And Software. Computer Hardware, Lan Based Networking And Set Up. | A&A | Dip. (1982) |
| 221 | Sandipkumar S Galthara | Sr.Tech.-A | Electrical Maintenance Work | CMDV | D.EL.E (2002) |
| 222 | Sangeeta Verma | Sr. Sci. Assistant-A | Geosciences, Stable Isotopes | GSDN | M.Phil. (2008) |
| 223 | Sanjay Kumar Mishra | Associate Professor | Plasma Physics, Complex (Dusty) Plasmas, Planetary Plasma Atmosphere: Airless Bodies (Like Moon), Theory, Modeling & Implications. | PSDN | PhD (2009) |
| 224 | Sanjay S Wairagade<br>Head, CMG | Sci./Eng.-SF | Construction And Maintenance | CMDV | B.E. (1993) |
| 225 | Sanjeev Kumar<br>Head, GSDN | Professor | Biogeochemistry, Stable Isotopes, Climate And Environmental Change | GSDN | PhD (2006) |
| 226 | Sanjeev Kumar Mishra | Sci./Eng.-SD | Electronics Design, Development And Testing For Space-Based Applications, Numerical Calculation/Simulation, Data Analysis Using Numerical Methods. | PSDN | B.Tech. (2016) |
| 227 | Santosh V Vadawale<br>Dy. Head-I, A&A | Sr.Professor | X-Ray Astronomy, Black Hole Binaries, Solar X-Ray Astronomy, Instrumentation Related To X-Ray Astronomy And Solar / Planetary X-Rays, X-Ray Polarimetry, X-Ray Optics | A&A | PhD (2003) |
| 228 | Satyajit Seth | Asso. Professor | Theoretical High Energy Physics | THEPH | PhD (2014) |
| 229 | Satyendra Nath Gupta | Asst. Professor | Atomic Molecular and Optical Physics | AMOPH | PhD (2018) |
| 230 | Saurabh Suman | Jr. Pers. Assistant | Secretarial And Administrative Work | ADMDN | M.A Geography (2022) |
| 231 | Senthil Babu T.J. | Sr. Admn. Officer | All Establishment & Service Matters, General Administration | ADMGN | B.Sc. (1995) |
| 232 | Shaileshgiri I Goswami | Technician-G | Electrical Maintenance | CMDV | I.T.I (2013) |
| 233 | Shanmugam M<br>Dy. Head-I, PSDN | Sci./Eng.-SG | Electronics Engineer, Design And Development of Space Instruments | PSDN | PhD (2017) |
| 234 | Shashank Urmalia | Sci./Eng.-SD | Mechanical Design For Ground Based And Space Instruments. | SPASC | B.E. (2014) |
| 235 | Shashi Kant | Sr. Assistant | CMG Office Assistantance | CMDV | B.Sc. (2016) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
|---|---|---|---|---|---|
| 236 | Shashikiran Ganesh | Professor | Milky Way Galaxy, Comets, Astronomical Instrumentation, Polarimetry | A&A | PhD (2010) |
| 237 | Shashi Prabhakar | Asst. Professor | Atomic Molecular and Optical Physics | AMOPH | PhD (2015) |
| 238 | Shibu K Mathew<br>Head, USO | Sr. Professor | Solar Physics Solar Instrumentation | USO | PhD (1999) |
| 239 | Shital Hitesh Patel | Med. Officer-SF | Medical Management of Communicable And Non-Communicable Diseases | DISSR | M.D (1999) |
| 240 | Shivansh Verma | Sci./Eng.-SC | Geosciences | GSDN | MS (Integrated) (2021) |
| 241 | Shivanshi Gupta | Sci./Eng.-SC | Atomic, Molecular and Optical Physics | AMOPH | MS (Integrated) (2021) |
| 242 | Shiv Kumar Goyal | Sci./Eng.-SF | Planetary And Space Instrumentation For Radiation Measurements (Charged Particles, X-Rays, Gamma-Rays) And Mass Spectrometer | PSDN | M.Tech. (2019) |
| 243 | Shreeya Natrajan | Sci./Eng.-SD | Organic Studies In Meteorites, Isotope Cosmochemistry, Spectroscopic Studies | PSDN | M.Tech. (2019) |
| 244 | Shreya Mishra | Sci./Eng.-SC | Atomic Molecular and Optical Physics | AMOPH | B.Tech. (2021) |
| 245 | Shreya Pandey | Sr. Assistant | Specialisation In PRL External Project Accounting, Preparation Of Fucs & Monthly Coins Compilation | ADMAC | M.Com. (2019) |
| 246 | Shubhra Sharma | Asst. Professor | Quaternary Geology, Geomorphology | GSDN | PhD (2017) |
| 247 | Smita Binoy Pillai | Purchase & Store Officer | Purchase & Stores | ADMPR | M.Sc. (2003) |
| 248 | Sneha Nair | Sr. Assistant | Purchase & Stores | ADMPR | M.SC. (2003) |
| 249 | Solanki Steven Alois | Purchase & Stores Officer | Purchase & Stores | ADMPR | B.C.A. (2011) |
| 250 | Som Kumar Sharma<br>Dy. Head-II, SPASC | Professor | Atmospheric Dynamics, Weather And Climate, Long Term Changes, Lidar Probing Of Atmosphere | SPASC | PhD (2010) |
| 251 | Somabhai N Koted | Sr. Proj. Attendant | Cleaner and assistance in Director's office | ADMDIR | Fifth (1990) |
| 252 | Sonam Jitarwal | Sci./Eng.-SD | Electronics Engineer, Design And Development Of Space Based Instruments | PSDN | M.Tech. (2019) |
| 253 | Soumya Kohli | Sci./Eng.-SC | Astronomy & Astrophysics | A&A | M.S.(Integrated) (2022) |
| 254 | Sourabh Goyal | Asst. Rajbhasha | Hindi Cell Administration | ADMGN | M.A. (2020) |
| 255 | Srirag Narayanan Nambiar | Sci./Eng.-SD | Planetary Science, Ablation Physics, Numerical Modelling, Space Instrumentation | PSDN | B.E. (2017) |
| 256 | Srishti Sharma | Sci./Eng.-SD | Web Application Development, Database Management | CNIT | B.Tech. (2012) |
| 257 | Srubabati Goswami<br>FNA, FASc,<br>FNASc,FTWAS<br>Head, THEPH | Sr. Professor | High Energy Physics | THEPH | PhD (1998) |
| 258 | Sunil Chandra | Asst. Professor | Extragalactic Astronomy | A&A | PhD (2013) |
| 259 | Sunil D Hansrajani | Sr. Proj. Assistant | Stores / Purchase; Administration / Accounts | ADMST | B.Com (1991) |
| 260 | Sunil Kumar Singh<br>FNA, FNASc | Professor | Isotope And Elemental Geochemistry | GSDN | PhD (1999) |
| 261 | Suraj Kumar | Sr. Assistant (ADHOC) | General Administration | ADMGN | B.Com (2015) |
| 262 | Sureshkumar K Patel | Senior Accounts Officer | Accounts services | ADMAC | M.Com (2014) |
| 263 | Sushil Kumar | Sci./Eng.-SD | Electronics Engineer: Design And Development Of Space Related Instruments | PSDN | B.Tech. (2014) |
| 264 | Suthar Pramodkumar | Technician-G | Workshop services | WORSH | D.M.E. (2016) |
| 265 | Swetapuspa Soumyashree | Sci./Eng.-SD | Laser Induced Breakdown Spectroscopy, Plasma Imaging, Femtosecond Physics,Payload Related Simulation In Simion And Comsol, Matlab Coding | AMOPH | B.E. (2017) |
| 266 | Tanmoy Chakraborty | Asst. Professor | Quantum Optics, Quantum Network | AMOPH | PhD (2015) |
| 267 | T A Rajesh | Sci./Eng.-SF | Atmospheric Aerosols, Black Carbon Aerosol Source Apportionment, Aerosol Radiative Forcing, Aerosol Chamber Experiment, Aerosol Instrumentation | SPASC | PhD (2019) |

| Sr. No. | Name | Designation | Specialization | Division | Highest Degree Obtained |
|---|---|---|---|---|---|
| 268 | T K Sunilkumar | Sr. Tech. Assistant-D | Maintenance of trace gas analyzers | SPASC | B.Pharm (1991) |
| 269 | T. S. Neethu | Sr. Proj. Assistant | Administration And Stores | ADMST | M.Com (2007) |
| 270 | Tejas Narendra Sarvaiya<br>Dy. Head, CNIT | Sci./Eng.-SF | Cyber Security, Server Virtualization, Linux/Unix Sysadmin, Network Administration, Shell Scripting, Website/Server Auditing. | CNIT | M.E. (2014) |
| 271 | Tinkal Ladiya | Sci./Eng.-SC | Electronics Design And Development For Space And Ground Application Instruments | PSDN | AMIE (2020) |
| 272 | Udit Khanna | Asst. Professor | Theoretical Condensed Matter Physics | THEPH | PhD (2018) |
| 273 | V H Chavda | Technician-G | Masonary | CMDV | Ninth (1980) |
| 274 | V R Patel | Sr.Tech.-A | Workshop services | WORSH | Twelve (1985) |
| 275 | Vaibhav Dixit | Sci./Eng.-SE | Optical Designing, Astronomical Instrumentation, Adaptive Optics, H/W-S/W Interface, Data Analysis Pipeline, Simulation Software Development, Parallel Programing, Ai, Deep Learning, Linux Real-Time Scheduling | A&A | M.Tech. (2017) |
| 276 | Vaibhav Varish Singh Rathore | Sci./Eng.-SD | Cyber Security, Linux And Unix System Admin, Network Management, Virtulization, Sever/Website Audit | CNIT | B.Tech. (2017) |
| 277 | Varun Sheel<br>Head, PSDN | Senior Professor | Modeling Planetary Atmospheres | PSDN | PhD (1996) |
| 278 | Veeresh Singh | Asso. Professor | Active Galactic Nuclei (Agn) And Their Evolution, Radio Astronomy | A&A | PhD (2012) |
| 279 | Vibhor Agrawal | Scientist/ Engineer-SC | Planetary Sciences | PSDN | B.Tech (2023) |
| 280 | Vijaysinh Mansinh Rathod | Sr.Tech.-A | Electrical Repair and Maintance Works | CMDV | H.Sc. (1996) |
| 281 | Vikram Goyal | Sr. Sci. Assistant-A | Planetary Sciences, Isotope Cosmochemistry | PSDN | M.Sc. (2016) |
| 282 | Vimlesh Kumar | Sci./Eng.-SD | Mechanical, Photonics, Nonlinear Optics, Single Photons, Quantum Optics, Structured Optical Beams | AMOPH | B.Tech. (2016) |
| 283 | Vinayak Kumar | Sci./Eng.-SD | Astrophysics, Programming | AMOPH | B.Tech. (2013) |
| 284 | Vineet Goswami | Asso. Professor | Isotope Geochemistry, Geochronology, Chemical Oceanography, Non-Traditional Metal Stable Isotope Geochemistry, Inverse Modelling, Mass Spectrometry | GSDN | PhD (2012) |
| 285 | Virendra Kumar Padhya | Sci./Eng.-SE | Hydrology and IWIN Mass Spectrometery | GSDN | M.Tech. (2013) |
| 286 | Vishal Joshi | Asst. Professor | Astronomy & Astrophysics | A&A | PhD (2014) |
| 287 | Vishnu Kumar Dhaker | Sr. Sci. Assistant-A | Atmospheric Aerosols | SPASC | M.Sc. (2016) |
| 288 | Vishnubhai R Patel | Sci./Eng.-SD | In CAD Disign,CAM Programming, workshop services | WORSH | B.E. (2018) |
| 289 | Vivek Kumar Mishra | Sci./Eng.-SD | Mechanical Design,Telescope Mirror Coating & Cleaning,Mechanical Maintainance Of Eqipments | A&A | B.E. (2015) |
| 290 | Yogita Kadlag | Asst. Professor | Isotope Geology, Cosmochemistry and Mass Spectrometry | GSDN | PhD (2015) |
| 291 | Yugal Surendra Kumar Jain | Head Accounts | IFA | ADMAC | MBA(2009), CA (2013) |


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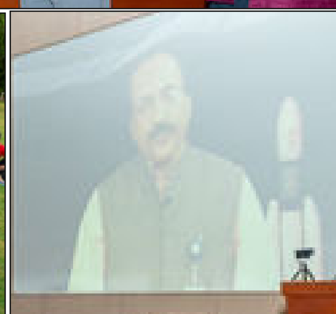







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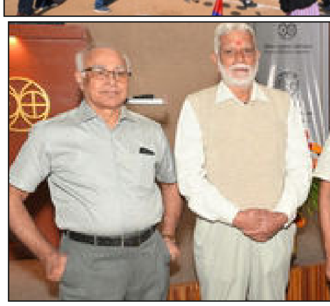



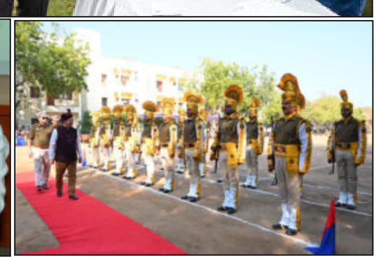


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