

Issue 26 - March 2021

# PRL NEWS – The Spectrum

Monthly Newsletter of the Physical Research Laboratory



## EDITORIAL - NEWSLETTER TEAM AND WOMEN CELL @ PRL

The Newsletter Team and the Women Cell at PRL are pleased to present this Special issue of “PRL-Newsletter- the Spectrum” on the occasion of International Women's Day - 2021. We take this opportunity to wish you a very happy and fulfilling International Women's Day. This year's International Day for Women and Girls in Science (11th February) and the International Women's Day (8th March) are both extraordinary as they fall amidst the times when the whole human race is striving hard to steer through one of the worst human crises i.e. the COVID-19 pandemic. The resilience and optimism with which each of us is facing the crisis shows that despite all, the basic human instinct to overcome the obstacles remains intact. PRL has a legacy of renowned women scientists working in diverse research fields. We are one of the few Institutes with researchers in a multitude of areas in Physical sciences like Astronomy, Astrophysics, Earth Sciences, Space & Atmospheric Science, Theoretical Physics, Solar Physics and Optical Physics. In Engineering, PRL has a wide spectrum of expertise in the fields of Electronics, Avionics, Aerospace to Communications and IT. In addition, PRL has an amazing amalgamation of qualified women professionals in the Medical, Technical and Administrative areas. We are proud of the incredible legacy that the likes of Prof. Bibha Chowdhuri, the first female particle physicist of India, and Prof. Bimla Buti, the first Indian woman Physicist to become a Fellow of Indian National Science Academy (INSA) and The World Academy of Sciences (TWAS) have offered us to take forward and it is a matter of immense happiness that even during the pandemic, our women researchers have shone brilliantly in their own respective fields and have brought many laurels to the Institute.

Prof. Bimla Buti, Senior Professor (Retd.) of PRL was awarded the R. D. Birla Memorial Award in Physics by the Indian Physics Association for the year 2020. Prof. Srubabati Goswami, Senior Professor, Theoretical Physics division was awarded the prestigious JC Bose fellowship and got elected as the Fellow of The World Academy of Sciences (TWAS), Prof. Nandita Srivatsava, Senior Professor and Deputy Head, Udaipur Solar Observatory, PRL has been selected as a Science Discipline Representative (SDR) to the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP). Prof. Kuljeet K Marhas, Professor, PSDN, has been nominated as a Member of the Scientific Program Committee of Geochronology Facility at Inter-University Accelerator Centre (IUAC), New Delhi and Dr. Megha Bhatt, Reader, Planetary Sciences Division, PRL has been elected as a Vice-Chair of "Sub-commission B3: The Moon" for the duration 2021-2024 of COSPAR. In addition, we have seen submission of Seven PhD theses during the year by our young women researchers. The accolades each of our women staff members has brought will be cherished forever by us. With this, special issue, we acknowledge the contribution of the Women staff at PRL and put forth before you a pool of articles contributed by them from diverse scientific fields. We believe that you would be enthralled by the amazing intellectual output they offer to the world of Science.

Happy Reading !

## Latest science

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## The curious case of the sterile neutrino

(*Srubabati Goswami and Ananya Mukherjee*)

**“One’s ideas must be as broad as Nature if they are to interpret Nature.”**

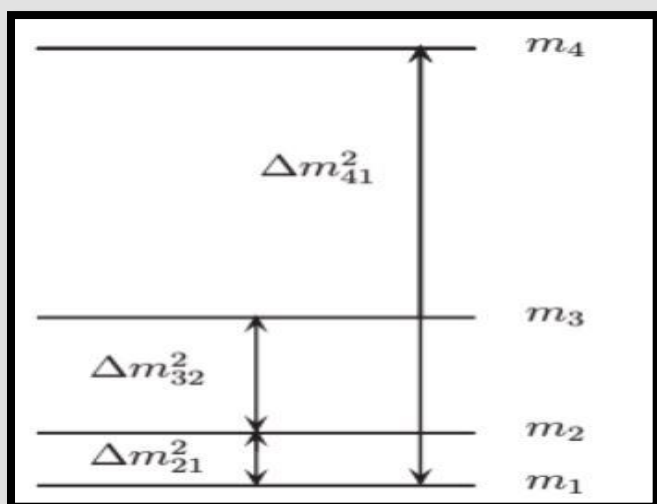
--- Arthur Conan Doyle in “A study in scarlet”

Neutrinos are one of the most abundant particles in the Universe, but being weakly interacting it is difficult to detect them. Three types of neutrinos have been identified — electron, muon and tau neutrinos produced in association with the three charged leptons. These are called the active neutrinos. Interestingly, these neutrinos can transform amongst each other enroute the source to the detector through the quantum mechanical interference phenomena of neutrino oscillation. This depends on the mass squared differences between propagating neutrino states and the mixing parameters.

A sterile neutrino has no charged lepton counterpart and hence no standard interactions. How can they make their presence felt then? This happens through their mixing with active neutrinos giving rise to oscillations. The results reported by the LSND and MiniBOONE experiments in which muon neutrinos are seen to be converted to electron neutrinos can be explained by oscillation with mass difference  $eV^2$  between an extra sterile neutrino and the three active neutrinos. But some other experiments did not confirm this. Many future experiments are planned to resolve this issue.

The addition of a sterile neutrino leads to a mass spectrum with three independent mass squared differences (figure 1). The mixing is parametrized by a 4 X4 unitary matrix with six angles and three phases. How can one theoretically accommodate such a scenario? We studied this within the context of the seesaw mechanism which is the most elegant way to generate small neutrino masses. Our model has three active light neutrinos, one eV scale sterile neutrino and three heavier sterile states which help in generating the mass spectrum shown in the figure. We use the symmetry group  $A_4$  which is the symmetry group of the tetrahedron to explain the observed mixing pattern. Our model contains only four free parameters which can be constrained by experimental data and give interesting correlations between different parameters and new predictions which can be tested in future experiments.

[doi.org/10.1007/JHEP09\(2020\)050](https://doi.org/10.1007/JHEP09(2020)050)



**Figure:** The mass spectrum in presence of one sterile and three active neutrinos.

$$\Delta m^2_{ij} \equiv m^2_i - m^2_j$$

with  $i, j = 1, 2, 3, 4$ ;  $m_i$  denote the mass of the  $i^{\text{th}}$  state.

## The Authors:



Dr. Srubabati Goswami

### About her:

Dr. Srubabati Goswami is a senior Professor in Theoretical Physics Division. Her research interests include neutrino oscillation physics, probing physics beyond the Standard Model, etc. She is a member of the India-based Neutrino Observatory Collaboration



Dr. Ananya Mukherjee

### About her:

Dr. Mukherjee completed her Ph.D. thesis work from University of Tezpur, Assam and joined PRL as a postdoctoral fellow in Theoretical Physics Division in 2019. Her research interests include neutrino mass models, beyond Standard Model physics etc





## The Author:



Dr. Megha Bhatt

### About her:

Dr. Megha Bhatt received her Ph.D. from the Max Planck Institute for Solar System Research, Germany. Her research field is planetary sciences and research focus is on understanding the evolution of our solar system by studying the surface composition of airless bodies and spectrometric observations in the Visible-Near infrared wavelength

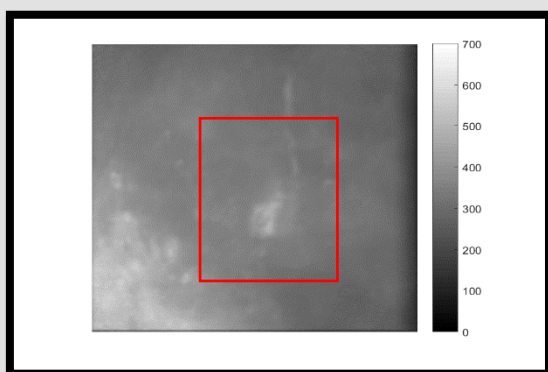
## Telescopic polarisation imaging of the Reiner Gamma swirl

(M. Bhatt, C. Wöhler, K. Aravind, S. Ganesh, A. Bhardwaj)

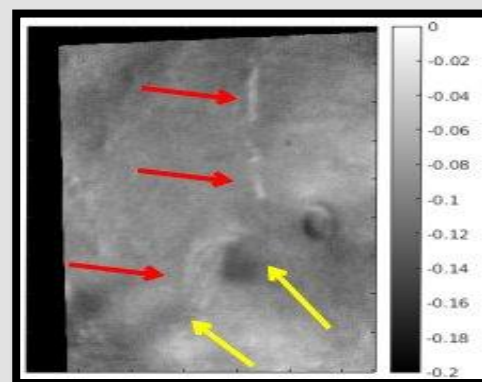
Lunar swirls may correspond to single bright structures but also to associations of numerous curved lines covering tens to hundreds of kilometers. These features are of specific interest because their origin is still unknown. Swirls are commonly assumed to have formed due to magnetic shielding of the surface from the solar wind [e.g., 1]. Another plausible mechanism proposed is resurfacing due to one or multiple cometary impacts [e.g., 2]. The Reiner Gamma structure of high-albedo curved lines extending across an area of about 200 km<sup>2</sup> is a unique swirl that can be observed using ground based telescopic facilities. The imaging polarimetric observations of Reiner Gamma can be used to derive physical regolith properties; grain size and roughness. Since the polarization degree is dependent on phase angle, we carried out systematic polarimetric observations of Reiner Gamma from Mount Abu IR Observatory using the electron multiplying CCD based optical imaging polarimeter (EMPOL) developed in-house [3]. We derived total flux, amplitude, the linear polarization fraction and the angle of the orientation from a set of 48 images. Based on observations obtained at different phase angles; we derived the phase ratio maps. We found anomalies on and around the Reiner Gamma swirl indicating that some specific areas of the swirl are smoother than surrounding mare regions (red arrows) and other areas are rougher than surroundings (yellow arrows) as shown in figure.

We derived roughness and median grain size maps using an approach explained in [4,5]. We found significant differences in median grain sizes and roughness within the Reiner Gamma swirl (Fig. 1). These results suggest that multiple surface alteration might have disrupted the regolith microstructure on the swirl. These findings are consistent with an external mechanism of swirl formation by interaction between the regolith and cometary gas [2, 6].

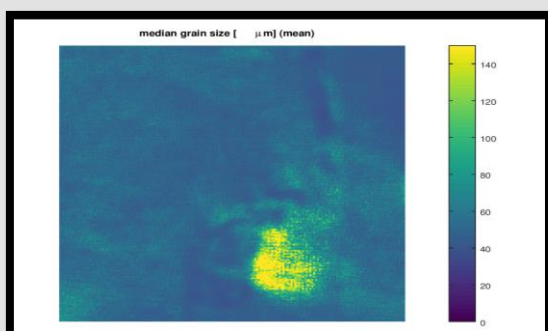
References: [1] Bamford, R. A. et al., (2016) *Astrophys. J.* 830(2). [2] Shevchenko, V. V. (1993) *Astron. Rep.* 37(3), 314-319. [3] Ganesh S. et al. (2020) *Proc. SPIE* 11447, 114479E. [4] Dollfus A. (1999), *Icarus* 140, 313-327. [5] Dollfus, A. (1998), *Icarus*, 136, 69. [6] Hess, M. et al. (2020) *A&A* 639, A12.



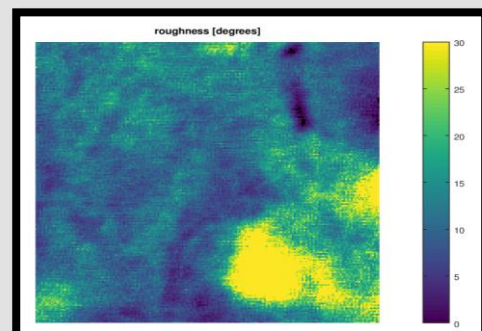
**Figure (a):** Total Flux. Red square is the area considered for deriving maps shown in (c) and (d).



**Figure (b):** Logarithmic phase ratio (980/840). Red arrow show smoother and yellow arrow show rougher surface than surroundings.



**Figure (c):** Roughness map in degrees derived using equations from [4].



**Figure (d):** Median grain size in  $\mu\text{m}$  derived using equations from [5].



## The Author:



Dr. Kuljeet K. Marhas

### About her:

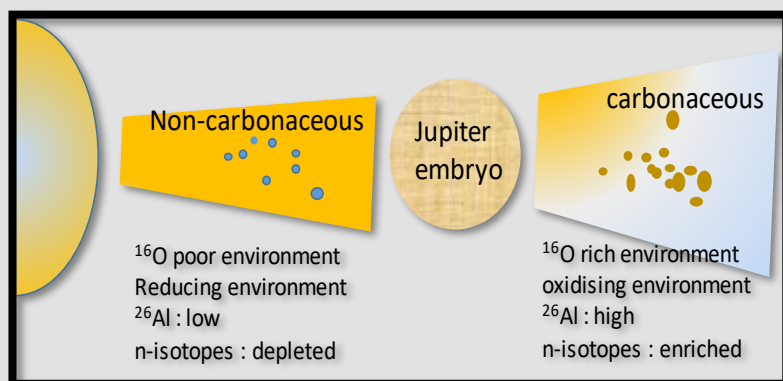
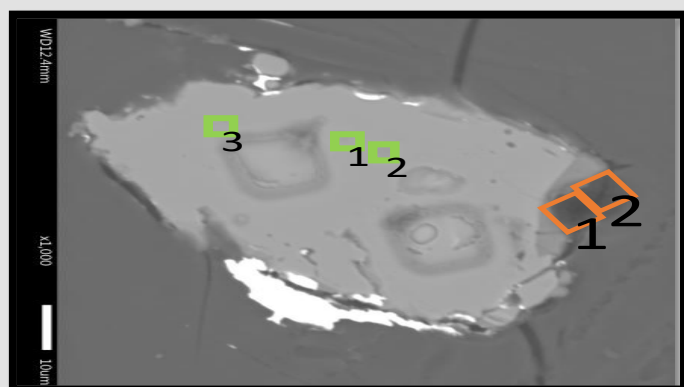
*Dr. Kuljeet Kaur Marhas is a Professor, working in the field of planetary science with expertise in nano-scale, in situ isotopic, and elemental studies of meteorites, extra-terrestrial materials, and terrestrial sample that advance our understanding of the origin and evolution of the Solar system. Her significant accomplishments include domains of theoretical and experimental studies of stellar nucleosynthesis, evolution via laboratory studies of presolar/circumstellar grains. She is a recipient of various awards, the latest being, American Geophysical Union D. Lal memorial award, and Eminent Mass spectrometerist.*

## Chronology, and formation of Itokawa near-Earth Asteroid: Perspective(s) from analyses of grains returned by HAYABUSA-1

(Kuljeet Kaur Marhas, Ritesh Kumar Mishra & Vikram Goyal)

Chondrules are mm- cm sized igneous silicate spherules that are the most abundant component (~80 vol. %) of chondrites. Chondrules formed over an extended duration of ~5-10 Ma under diverse petrogenetic conditions after the fiducial origin of the Solar system (~4.568 Ga ago) anchored to the formation of Calcium-aluminium-rich inclusions. Recent high-precision isotopic analyses have revealed a distinct dichotomy in the isotopic composition (e.g., Cr, Ti, O, Mo, etc.) of chondrules from non-carbonaceous and carbonaceous meteorites. This distinctive diversity/ dichotomy is attributed to the stopping of proto-planetary disk scale wide mixing due to the creation of a relative massive proto-Jupiter. PRL, nanoSIMS laboratory analyzed few grains from the sample returned mission Hayabusa-I mission (JAXA) from asteroid Itokawa. Asteroids are the remnants of the planetesimal building process that escaped aggregation to larger bodies or impacts collisional remnants of larger planetesimals. Asteroid Itokawa is a near-Earth, non-carbonaceous, (ordinary chondrite type) asteroid. The objective of the project was to check the formation timescale and formation scenario of the Itokawa asteroid.  $^{26}\text{Al}$ - $^{26}\text{Mg}$  systematic is a relative chronometer used for obtaining high-resolution temporal records of the early Solar system events and processes.  $^{26}\text{Al}$ - $^{26}\text{Mg}$  analyses of mm-sized particles of the Itokawa asteroid indicate disturbed  $^{26}\text{Al}$ - $^{26}\text{Mg}$  isotopic data that give an upper limit time of formation of 2.4 Ma.

A thorough investigation and comparison with various isotopic anomalies and mineralogical data, we conclude that the formation region of the Itokawa asteroid should have been ~2 A.U, after ~2 Ma of SS formation during the initiation of the outward migration of Jupiter's embryo.



**Figure:** (a) Itokawa asteroid grain (Hayabusa-1) analysed with PRL nanoSIMS. Green spots on olivine are 2x 2 microns, orange spots on plagioclase are 8x 8-micron raster. (b) a cartoon indicating the formation of Itokawa asteroid in non-carbonaceous region



## The Author:



Kamlesh Bora

### About her:

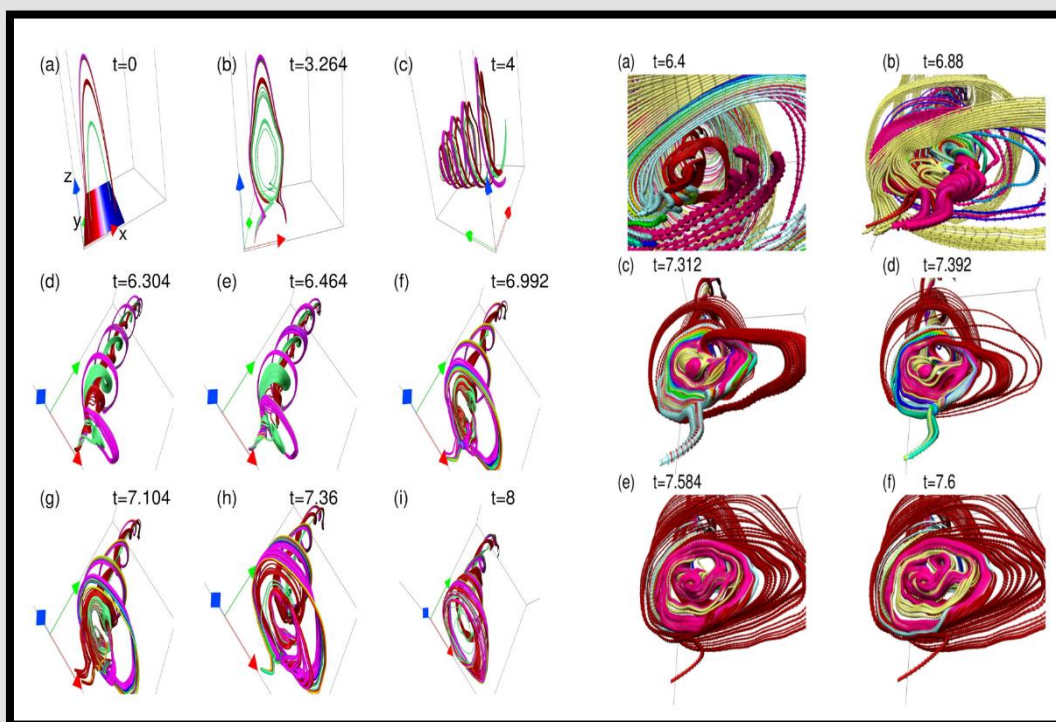
Kamlesh is a Senior Research Fellow at Udaipur Solar Observatory. Her current research interests include magnetic reconnection in astrophysical plasmas and coronal heating problem in solar physics.

## Evolution of Three-Dimensional Coherent Structures in Hall Magnetohydrodynamics

(K. Bora, R. Bhattacharyya, P.K. Smolarkiewicz)

Hall Magnetohydrodynamics (HMHD) is important to explore physical systems undergoing fast magnetic reconnection at the order of the ion inertial length scale. Examples include solar transients along with reconnections in magnetosphere, magnetotail, and laboratory plasmas. We have extended the computational model EULAG-MHD to include Hall forcing. In addition to successful benchmarking of the numerical Hall MHD model initiated with unidirectional sinusoidal magnetic field, the HMHD simulations emphasize the complexity of three-dimensional (3D) evolution over its two-dimensional counterpart. The magnetic reconnections onset significantly earlier in HMHD. Importantly, the magnetic field generated by the Hall term breaks any inherent symmetry, ultimately making the evolution 3D. The resulting 3D reconnections develop magnetic flux ropes (MFRs) and magnetic flux tubes. Projected on the reconnection plane, the ropes and tubes appear as magnetic islands, which later break into secondary islands, and finally coalesce to generate an X-type neutral point. These findings are in agreement with the theory and contemporary simulations of HMHD. We have executed the simulations to understand the influence of the Hall forcing on generation and ascend of an MFR from sheared magnetic arcades—a novel scenario instructive in understanding the coronal transients. The rope evolves through intermediate complex structures, ultimately breaking locally because of reconnections. Interestingly, the breakage occurs earlier in the presence of the Hall term, signifying faster dynamics leading to magnetic topology favourable for reconnections.

<https://iopscience.iop.org/article/10.3847/1538-4357/abc8f7/>



**Figure:** The formation and local breakage of the solar-like magnetic flux rope initiated with the bipolar sheared arcades (panels (a)-(i) left) and instances of zoomed internal reconnection within the flux rope (panels (a)-(f) right).



## Impact of COVID-19 lockdown on ozone build up over Ahmedabad: A modelling perspective

(Meghna Soni, Narendra Ojha, Imran Girach)

Air composition is a manifestation of complex interplay between diverse natural and man-made influences. An unprecedented lockdown to contain the spread of COVID-19 created a rare opportunity to decouple the impacts of man-made emissions versus atmospheric variability on the ozone build up over Ahmedabad. Interestingly, in contrast with the precursors, ozone build up over Ahmedabad showed enhancement by 39% during the lockdown.

To explain this observation, we incorporated measurements of chemical species and prescribed environmental conditions of this region into a photochemical box model (NCAR Master Mechanism). Model, in a good agreement with measurements (Figure 1), shows enhancement in ozone levels by 41% during the lockdown condition. Sensitivity simulations unravelled that ozone enhancements were contributed by both the non-linear chemistry (by ~25%) as well as change in meteorological conditions (by ~16%). We estimated that the net  $O_3$  production rate was higher by up to  $1.2 \text{ ppbv h}^{-1}$  during the lockdown as compared to the pre-lockdown (Figure 2).

Our analyses highlights that the effects of large reduction in anthropogenic emissions could get modulated by complex air chemistry and meteorological variations. Therefore, stringent lockdown could not yield anticipated reductions in secondary pollutant ozone over this region. The findings of this rare lockdown would be very valuable in developing future policies to curb  $O_3$  pollution over this region.

<https://www.currentscience.ac.in/cs/Volumes/120/02/0376.pdf>

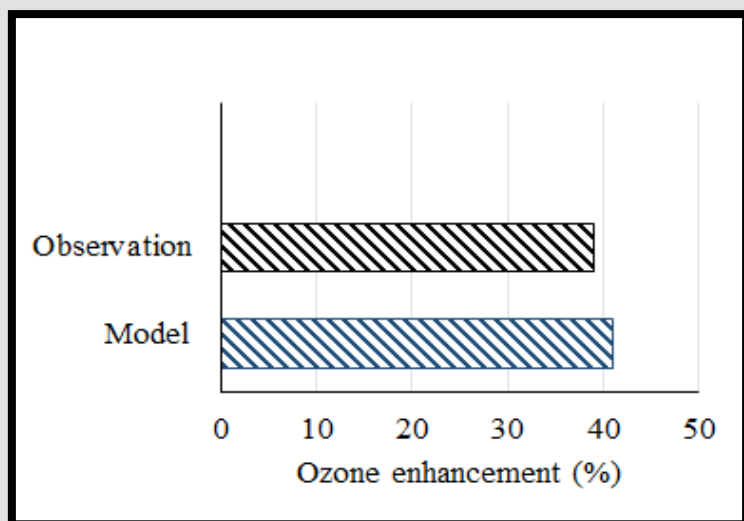
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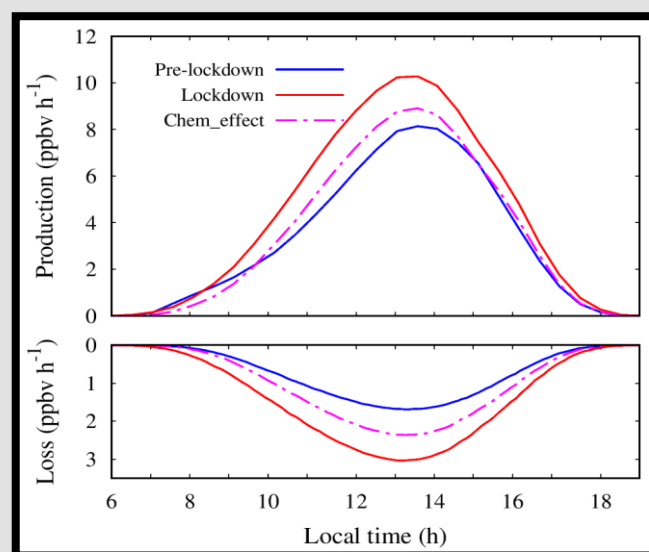
Meghna Soni

### About her:

Meghna Soni is a Senior Research Fellow at PRL, Ahmedabad. She performs model simulations to investigate the links between atmospheric chemistry and meteorological variability over the Indian region.



**Figure 1:** Comparison of model simulated and observed enhancements in ozone during lockdown as compared to pre-lockdown over Ahmedabad.



**Figure 2:** Model derived ozone production and loss rates for simulations: pre-lockdown, lockdown and chem\_effect (influence of chemistry).



## The Author:



Pratheeksha Nayak

### About her:

Pratheeksha is working as an engineer in radiocarbon dating laboratory. She works on understanding paleoclimate using archives such as speleothems. Her interests include open source software development, machine learning, gardening and reading.

## SPADE : Software for PRL AURiS Data Exploration

(Pratheeksha Nayak and M.G. Yadava)

SPADE is a web application developed in-house to process the raw data obtained from Accelerator Mass Spectrometry (PRL-AURiS) and obtain radiocarbon age estimates for samples. It has an interactive interface that facilitates user experience and can be deployed anywhere and used without any prerequisites. SPADE estimates isotopic ratios of  $^{14}\text{C}/^{13}\text{C}$ ,  $^{14}\text{C}/^{12}\text{C}$  and  $^{13}\text{C}/^{12}\text{C}$  using mean or weighted mean and the error associated with these as standard deviation, standard error of mean or error associated with weighted mean, based on the users' discretion. Undesired batches of any sample(s) can be dynamically deselected using the interactive plots and omitted from further analysis. Multiple standards or backgrounds can be selected for estimation of radiocarbon ages. The results displayed at each stage are compiled and a table constituting of isotopic ratios, radiocarbon age estimates using both  $^{14}\text{C}/^{13}\text{C}$  and  $^{14}\text{C}/^{12}\text{C}$  and the associated errors along with the user inputs and plots can be downloaded.

Web applications can be designed for a wide variety of purposes and need not be installed prior to usage. They can be made highly interactive and easy to use and can be accessed through multiple browsers. SPADE is developed using Python and currently made available as a stand-alone executable for Windows, Linux and Mac operating systems. The advantage of such a stand-alone application is that it can be run without having to install Python, interpreter or any of the packages used. Unlike their commercial counterparts, in-house developed software offer the flexibility of modifications and feature additions as required by the users and multiple instances can be deployed anywhere free of cost. Such applications can also be hosted from PRL server and accessed as a web page by users from within/outside PRL as per the configuration. SPADE can also be extended to accommodate other dating techniques supported by PRL-AURiS. In-house software development using open source packages can be a great way to develop software that are easy to maintain, customize and ensure continued good performance.

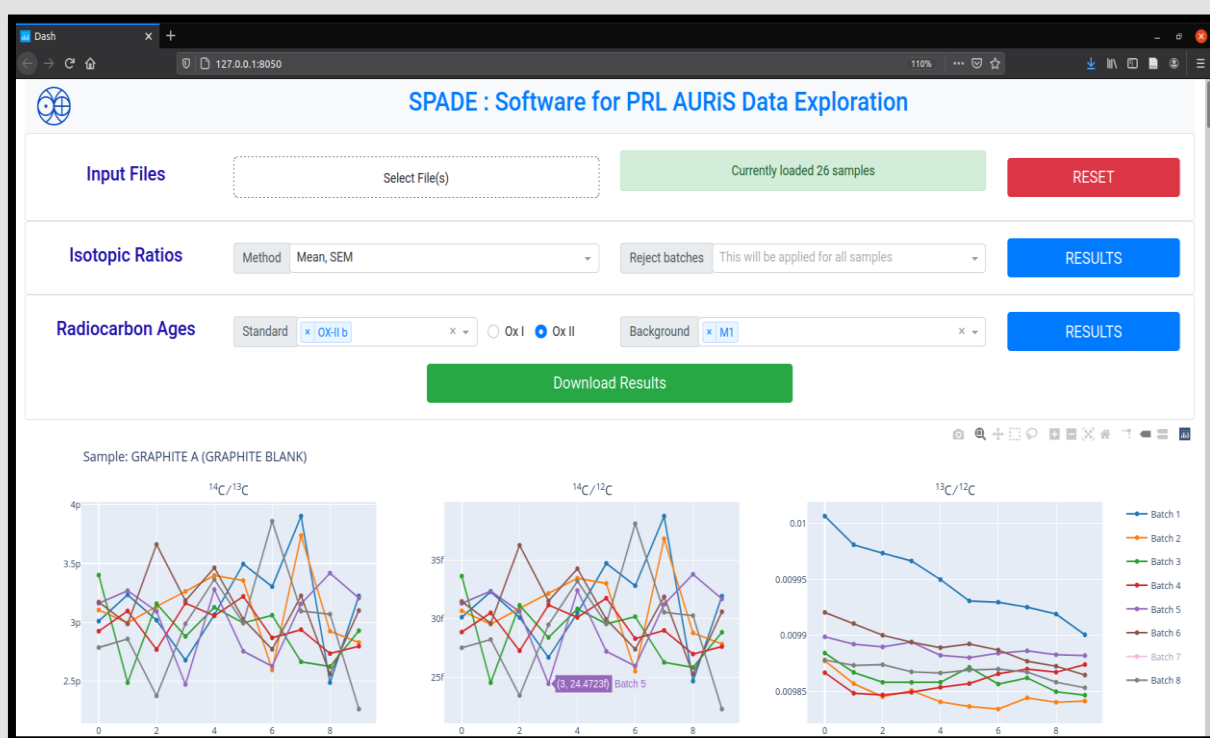


Figure:

User interface of SPADE: For any sample, batches can be dynamically selected or deselected using the interactive plots. Here, Batch 7 has been deselected for sample GRAPHITE A

## Library & Information Services

PRL Library plays a crucial role in facilitating research in the laboratory by making available latest books, journals, e-journals in the respective areas of research in all three campuses – Main Campus, Thaltej Campus and USO Campus of PRL. PRL library has a rich collection of about 22000 books, 36000 bound volumes of journals, 2500 CD/DVDs. RFID system has been implemented in all three libraries. Also, all the three libraries – Main, Thaltej and USO are now wi-fi enabled. In 2019, library collection and circulation has been migrated to Koha Library Management system. OPAC is accessible through the mobile app which can be downloaded from the 'New OPAC' from the library website. Recently redesigning of the library website was taken up and will be launched soon. Book exhibitions are being organized regularly by the Library to facilitate the students and staff to procure the books for book grant and library.

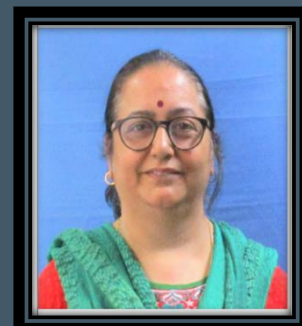
The Library homepage acts like a window through which it is possible to access the digital content subscribed by PRL as well as open access content. Primarily, it gives links to 100 online journals out of the 127 journals subscribed by the library. In addition to procuring the e-journals, PRL Library subscribes to full-text databases like AGU Digital Library, PROLA, GSA Archive and Science Archive. Antariksh Gyan – ISRO Libraries Consortium makes available the IEEE Digital Library, SPIE Digital Library, AIAA Journals, Springer Journals, Wiley Journals and Elsevier journals. Since 2016-17, Library has started carrying out similarity check (plagiarism check) for scientists and students using the *ITHENTICATE* tool as it is becoming mandatory for students to carry out the similarity / originality check before submitting the thesis and most of the journals carry out the originality check before accepting the article for publishing.

The PRL Library maintains an institutional repository which consists of journal articles published by the PRL authors from 1990 to present and is also linked through the Library homepage. More than 4000 articles by PRL authors are now part of the repository. Greenstone Digital Library Software is used to maintain the institutional repository. All the PRL theses from 1952 onwards are now available full text for PRL users. All the Technical Notes since 1977, published by PRL have been digitized and are available full text for PRL users. More than 550 e-books can be accessed through the library homepage. These collections can be accessed from library homepage (<http://www.prl.res.in/~library>). The Library has taken up the digitization of the photographs archive. Scanning of the photographs of about 300 albums is completed. Giving the captions and metadata for each photograph for easy retrieval is in progress.

Well qualified library staff of six (3 permanent and 3 temporary) and one office trainee help in running the library at optimum level.

PRL Library has tried to keep pace with latest technology tools to give best collection and services to its users and is one of the important libraries in physics and related fields in India.

## The Author:



Dr. Nishtha Anilkumar

### *About her:*

*Dr Nishtha Anilkumar is the Head, Library and Information services at PRL since 2007. She has been actively involved in the move towards Digital Library in PRL. Her main areas of interest are Copyright issues, Preservation of Digital Resources and Research Output Measurement.*





## The Author:



Hema Kharayat

### About her:

Hema kharayat is presently working as Post-Doctoral fellow in PRL. She is working in the Multi-wavelength study of solar eruptive phenomena and Modulation in Cosmic ray intensity in relation with solar activities and geomagnetic storm.

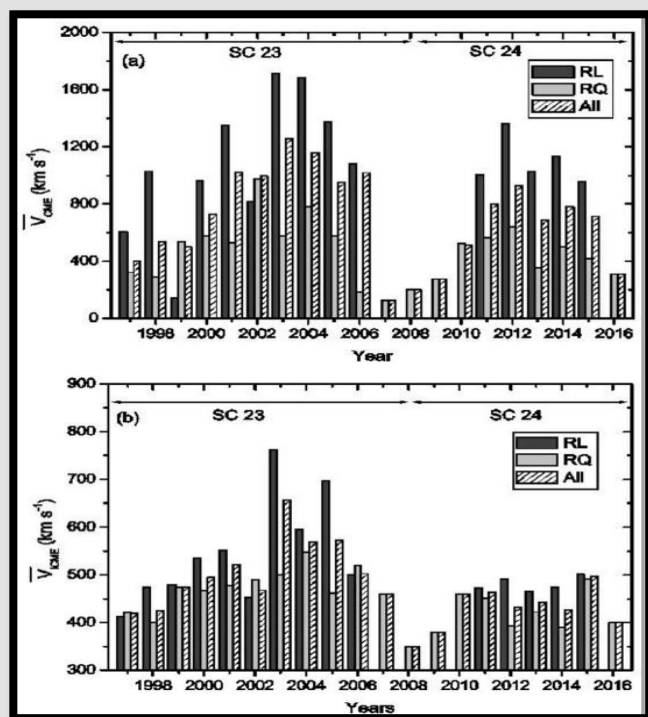
## Radio-loud and radio-quiet CMEs: solar cycle dependency, influence on cosmic ray intensity, and geo-effectiveness

(Hema Kharayat, Bhuwan Joshi, Ramesh Chandra)

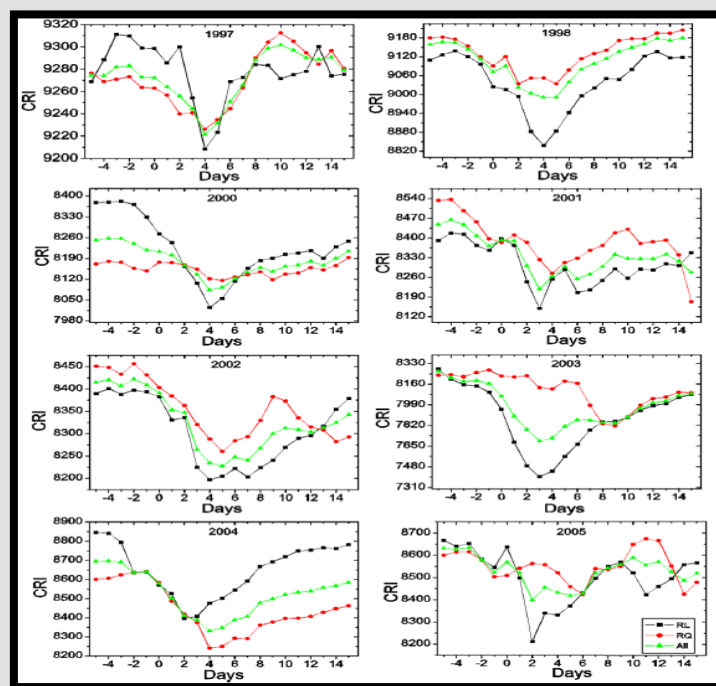
Coronal mass ejections (CMEs) largely influence the space weather and cause geomagnetic perturbations. Hence, the statistical studies pertaining to the occurrence of CMEs over the solar cycles and their consequence at the near-Earth region are extremely important. For an in-depth understanding, such studies need to be carried out considering various observational aspects of CMEs. With this motivation, we carried out a statistical study of radio-loud (RL) and radio-quiet (RQ) CMEs during solar cycles 23 and 24. We also assess their geo-effectiveness and analyze their influence on cosmic ray intensity (CRI). The RL and RQ CMEs constitute 40% and 60% cases, respectively, of the total population of CMEs that arrive the near-Earth region at 1 AU.

The mean speed of RL CMEs ( $\approx 1170 \text{ km s}^{-1}$ ) is found to be significantly higher (almost twice) than the mean speed of RQ CMEs ( $\approx 519 \text{ km s}^{-1}$ ) in the low corona while their speed became comparable ( $\approx 536 \text{ km s}^{-1}$  for RL and  $\approx 452 \text{ km s}^{-1}$  for RQ CMEs) at near-Earth region. The yearly-averaged speeds of Earth-reaching CMEs follow solar cycle variations. The CRI and geomagnetic Dst index are found to have good negative correlation with speed of Earth-reaching CMEs. RL CMEs were found to be more effective in producing CRI depressions and geomagnetic storms (GSs) in comparison to RQ CMEs; in about 70% cases RL CMEs produced CRI depression and GSs earlier than the RQ CMEs. Superposed epoch analysis suggests strongest depression in CRI occurs 2-5 days and 4-9 days after the onset of RL and RQ CMEs, respectively. Further, GS events show a time-lag of 1-5 days and 3-8 days, respectively, with respect to RL and RQ CMEs.

<https://doi.org/10.1007/s10509-021-03930-w>



Histograms showing yearly averaged speed of RL, RQ, and all Earth-reaching CMEs at near-Sun (panel a) and near-Earth regions (panel b) for solar cycles 23 and 24.



Yearly plots of superposed epoch analysis showing the variation of CRI during the period of 21 days with respect to CME onset day (5 days before and 15 days after the epoch day) for solar cycle 23.

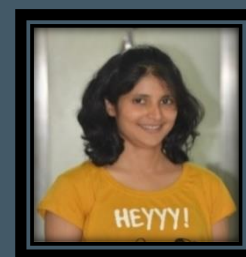
## Ambient air characteristics of biogenic volatile organic compounds at a tropical evergreen forest site in Central Western Ghats of India

(Nidhi Tripathi, Lokesh Kumar Sahu, Kashyap Patel, Ashwini Kumar and Ravi Yadav)

Volatile organic compounds (VOCs) play important role in the atmosphere and climate change by driving secondary organic aerosol (SOA) and ozone production in the troposphere. VOCs are reactive compounds and influence the oxidative capacity of the atmosphere. Plants manage their life under different environmental conditions through different defense mechanisms, VOCs emission is one of them (Figure 1). VOCs emitted from natural sources are known as biogenic VOCs (BVOCs). BVOCs emitted from the tropical forest comprise a significant fraction of global atmospheric VOC emissions. However, the measurements of BVOCs over tropical forests are very limited, especially over South Asian tropical forests. The ambient air concentrations of C<sub>2</sub>-C<sub>5</sub> non-methane VOCs (NMVOCs) were measured at a forest site (Bhagwan Mahaveer Sanctuary, BMS) in the central Western Ghats and also at an urban site Udaipur (UDR) of India during the late monsoon period. There is significant diversity in the forest vegetation of the Western Ghats covered by the tropical wet evergreen, tropical semi-evergreen, and tropical moist deciduous forests. The average percentage contributions of light alkenes (sum of ethene and propene) to the total measured NMVOCs were much higher of ~65% at BMS compared to 28% at UDR (Figure 2). In summary, the abundances of major NMVOCs show distinct contributions at biogenic and anthropogenic sites. The molar emission ratios of ethene/propene (2.9 ppb ppb<sup>-1</sup>) fall in the range of values reported for several biogenic sites of Asia while higher than those reported for the mid-latitude sites. The tropical forests are the major sources of biogenic NMVOCs in the global atmosphere. Therefore, the emission flux measurements of biogenic NMVOCs are necessary to parameterize and evaluate their emissions in the regional and global models. The ozone formation potential (OFP) and propylene equivalent concentration (PEC) of light alkenes and isoprene at BMS were significantly higher than those estimated for other NMVOCs. The comparison of data for both the scales of OFP and PEC highlights the predominance of biogenic NMVOCs. India is a tropical country with large and diverse forest coverage and tends to emit abundant amounts of biogenic NMVOCs, which need to be quantified by in situ measurement-based validations. Comprehensive measurements of VOCs and other reactive trace gases are required to understand the photochemistry leading to O<sub>3</sub> and SOA formation in the remote forest regions of South Asia.

<https://doi.org/10.1007/s10874-021-09415-y>

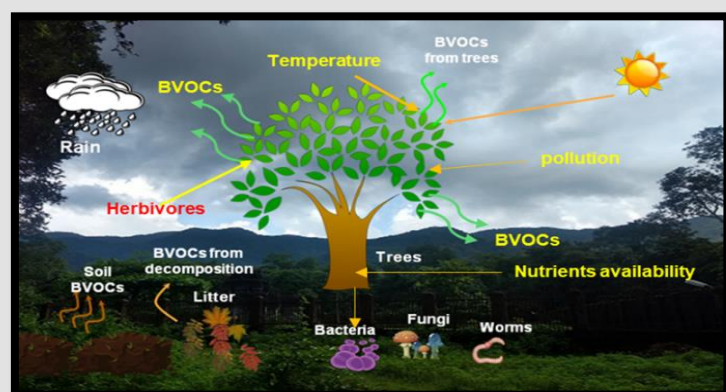
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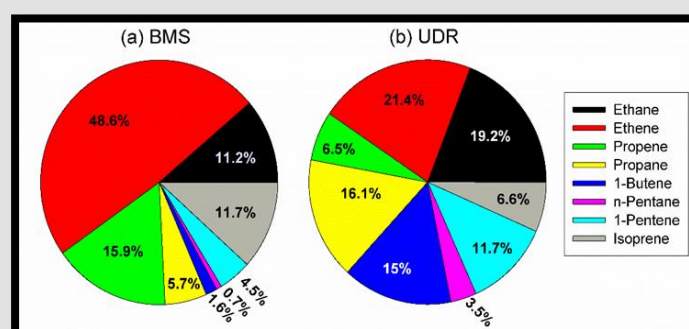
Nidhi Tripathi

### About her:

Nidhi Tripathi is presently working as Post-Doctoral fellow in PRL. She is working in the field of measurements of trace gases especially volatile organic compounds (VOCs) in the atmosphere. Her research focus is on the emission and atmospheric variability of biogenic VOCs (BVOCs) over different terrestrial (urban and forest) and surrounding oceanic (Bay of Bengal and Arabian Sea) regions of India using state of art instruments: PTR-TOF-MS, TD-GC-FID, C<sub>2</sub>-C<sub>6</sub> and C<sub>5</sub>-C<sub>16</sub> analyzer.



**Figure 1:** Plant are very sensitive to environmental conditions. They release a wide range of volatile organic compounds (VOCs) in response to different biotic and abiotic stresses.



**Figure 2:** The average percentage contributions among common VOCs measured at both BMS biogenic site in the central Western Ghats and at an urban site of Udaipur (UDR) in Rajasthan during the month of September.





## The Author:



Sourita Saha

### About her:

Sourita Saha is presently working as a Scientist/Engineer 'SC' in SPASC division in PRL after completing her B.Tech in Physical Sciences from IIST, Trivandrum. Her research work is based on the studies of the Earth's lower and middle atmosphere. Her current focus is on the investigation of Atmospheric Clouds, Dust, and Atmospheric Boundary Layer using PRL's ground-based multichannel Raman Lidar, Ceilometer Lidar, Satellite based observations and various other instruments.

## Probing Earth's atmosphere using PRL's multi-channel Raman Lidar

(Sourita Saha and Som Sharma)

PRL houses India's first Raman Lidar; it is a state-of-the-art Nd:YAG dual-polarization multi-wavelength ground based lidar. It is a powerful atmospheric probe that explores the atmosphere up to a height of 20-25km with very high vertical resolution of 7.5m. This Raman Lidar emits three wavelengths: 1064nm, 532nm and 355nm, and has seven receiving channels: 355p nm, 355s nm, 387nm, 408nm, 532p nm, 532s nm and 607nm.

The first breakthrough result using Raman Lidar has been published in Geophysical Research Letters (GRL), 2020. According to that study, Lidar observations, in support with satellite and model data showed that quasi-periodic gravity waves modulate the microphysical properties of cirrus clouds (Figure1). Why is this important? The shape and size of the ice crystals change about 30% of the albedo thus playing a significant role in radiation budget.

In a separate study it has been found that firecrackers during Diwali cause severe air pollution. An increase of 286%, 89.5%, and 60.5%, in BC, PM10, and PM2.5 concentrations, has been reported over Ahmedabad during Diwali as compared to pre-event days (Figure 2).

In another study, this Lidar has been used to study the vertical distribution and characteristics of aerosols over Ahmedabad (Figure3). The aerosols over this site has been classified using microphysical characteristics obtained from lidar observations.

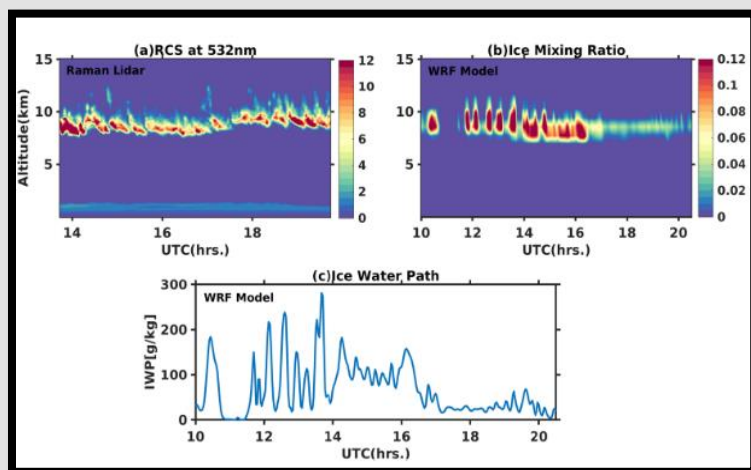


Figure1: Contour plot of Range Corrected Signal (RCS) in 532 nm. (b) Time-altitude map of ice mixing ratio. (c) Time series of ice water path

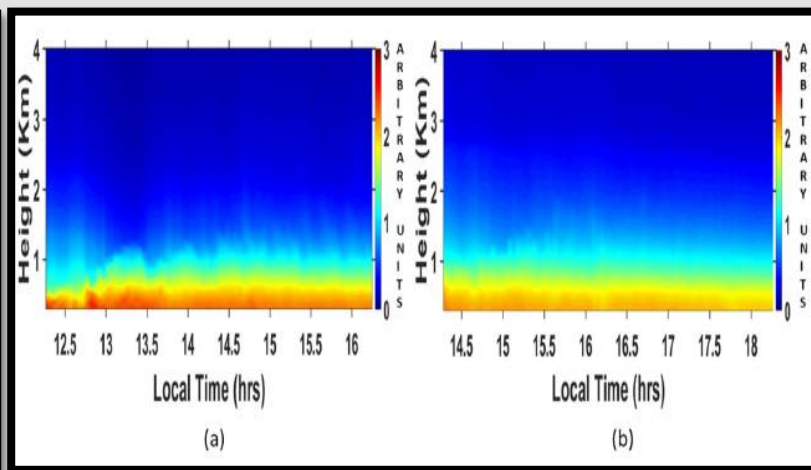
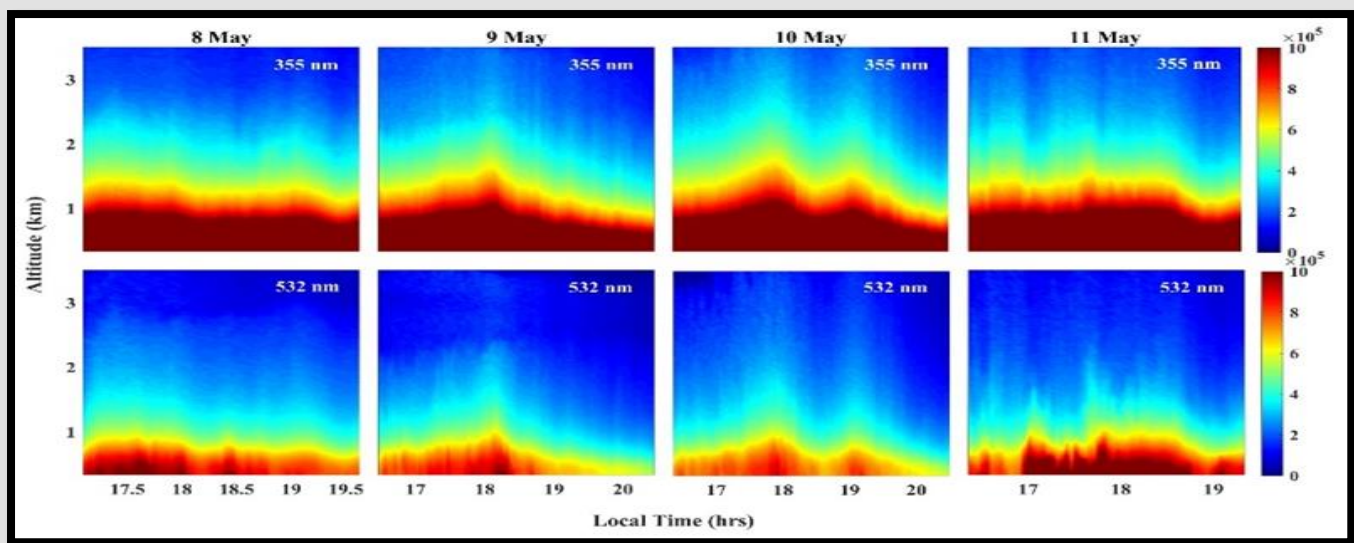


Figure2: Range Corrected Signal (a) 19th October 2017 (b) 17th October 2017.



**Figure 3:** Range Corrected Signal during 8-11 May 2018 over Ahmedabad.

## COVID-19 VACCINE

(Dr Shital Patel)

The world is facing the pandemic of SARS-CoV-19 virus which causes COVID-19 infection since last more than 1 year which has created lots of morbidity and mortality. It has not only affected health but impacted the various economical, social and emotional crisis.

But within very short span with the efforts of scientists worldwide, now we are in the position to deliver the COVID-19 vaccine globally. More than 200 different types of vaccines are under trial globally and more than 50 candidate vaccines are in the last phase of clinical development, out of them few are already in use.

Immunology of Corona infection & Vaccination:

The immune system of our body comprises of two varieties which help us to prevent or to fight against infection.

(1) *Innate Immunity*

It is nonspecific. It fights against all organism and depend upon the genetic constitutional make up. It may vary from individual to individual with age, nutrition & other disease etc.

(2) *Acquired Immunity*

It is organism specific immunity which develops after the exposure of specific organism.

It has two types.

(i) *Active Immunity* – This type of immunity is most important, potent and long lasting. This develops after infection or vaccination

(ii) *Passive Immunity* – The acquired immunity developed in an individual can be transferred to another. Plasma therapy in COVID-19 infection is a clerical example.

## The Author:



Dr. Shital Patel

### About her:

Dr. Shital Patel (MD, medicine) is the Medical Officer- SF at PRL. She has more than two decades of experience in medical field. Her areas of interest and expertise are prevention of life style diseases such as, Diabetes, Hypertension and Cardiac Diseases.





### **Concept for development of Vaccine:**

The immunity develops after natural infection is much strong and long lasting. So the most immunogenic vaccine is considered those which can give similar type of antigenic stimulation.

Live attenuated vaccine (in this type of vaccine Virus are live but the virulence is very low) is considered as most immunogenic. However, many efforts failed to develop such a vaccine for COVID-19.

So the second option is if we cannot attenuate then or inactivate them. This inactivated virus vaccine contains killed virus so they cannot multiply in the body & thus vaccines are safe. But here it is less immunogenic & may require frequent booster doses. Addition of adjuvant can help to increase the immunogenicity.

In India, Bharat Biotech in collaboration with ICMR has developed such inactivated viral vaccine (COVAXIN). The second method is only inactivated the sub limits of virus (Protein fragments), against which we want to develop antibodies.

All over the World the different kind of vaccines with different mechanism of actions are under trial.

The another option is genetically modified vaccine. They will enter within human cells & start expressing their gene products with the help of host cells' transcription / translation machineries so we can have profound & long term antigenic stimulation to stimulate immune system.

### **Viral Vector Vaccine:**

The nonpathogenic strains of Adeno virus are used in India by Serum Institute with support of Oxford University and AstraZeneca (COVISHIELD), Now widely used in India.

### **FAQ's regarding Vaccine:**

- Whether Vaccine will be safe? Effective? Which candidate shall be better?

WHO Strategies clarifies all these in every detail.

#### (1) Safety Profile:

It is the utmost priority of any vaccine. Several mild complications with Vaccine are usual & within the acceptable limit. i.e., Fever with or without chills, redness over the injection site, malaise, etc. It may elicit some hypersensitive response if an individual is prone to develop an allergic reaction.

#### (2) Potential of efficacy:

Majority of vaccines showing more than 90% protection rate in the clinical trial. Some may require booster doses to be active in the magnitude of the immune response. We can expect from the Vaccine that it will induce an antibody response.

#### (3) Shall take vaccine if already infected with COVID-19?

It is assumed that people who have gotten sick with COVID-19 may still benefit from getting vaccinated.

Due to the severe health risk associated with COVID-19 and the reinfection is possible, people may advise to get COVID-19 vaccine and again at this time experts do not know how long someone is protected from getting sick again after recovering from COVID-19.

#### (4) Protection against mutants.

There is certain degree of cross protection against the antigenic mutants as per the expert report.

The nationwide COVID-19 vaccination drive was launched on 16<sup>th</sup> January, 2021 for Health Care Professionals and Frontline Warriors. Now it expanded for the following age groups from 1<sup>st</sup> March, 2021.

- (i) All citizens above 60 years of age
- (ii) Those within age between 45-59 years with comorbidities

The COVID-19 Vaccination Centers must have health facilities to tackle first aid.

- (i) All Government Hospitals
- (ii) All Private Hospitals empaneled under CGHS

All beneficiaries must be advised to carry one of the Photo Id Documents, e.g.,

- Aadhaar Card
- Electoral Photo Identity Card
- The Photo ID Card specified at the time of registration
- Certificate of Co-morbidity (Signed by registered medical practitioner)
- Employment / Certificate or Official Identity with Photo.

The simplified process of registration:

- (iii) Advance Self Registration by downloading the CO-WIN (Winning Over COVID-19) 2.0 App developed by National Health Portal-MoHFW or Aarogya Setu App developed by NIC eGov Mobile Apps.
- (iv) On-site Registration:  
To walk into the identified COVID vaccination centers and get themselves registered on site.
- (v) Facilitated Co-Host Registration  
The government decide the target group of potential beneficiaries and mobilize them to the vaccination center.  
The vaccination will be free of charge in government, but private hospitals may take some nominal charge.

I would like to appeal to all the appropriate candidates to vaccinate themselves.

## COLLOQUIA @ PRL

- 🚩 Dr. Bhaskar Mukherjee (School of Physics, The University of Sydney, Australia and an Associate Scientist, Institute of Radiation Medicine of Helmholtz Institution, Munich, Germany) delivered a colloquium entitled as "Radiation Dosimetry and Radiation Protection in Space Missions" on 3rd February 2021
- 🚩 Prof. Srubabati Goswami (Senior Professor, THEPH Division, PRL) delivered the 3rd PRL-IAPT Dr. Vikram Sarabhai Lecture-2021 on 11<sup>th</sup> February 2021. The title of the talk was "Neutrinos: the invisible messengers."

## AWARDS & HONORS

- 🚩 Dr. Megha Bhatt, Reader, Planetary Sciences Division of PRL has been elected as a Vice-Chair of "Sub-commission B3: The Moon" for the duration 2021-2024 of COSPAR
- 🚩 Dr. Varun Sheel, Professor, Planetary Sciences Division of PRL has been elected as a Vice-Chair of "Sub-Commission B4: Terrestrial Planets" for the duration 2021-2024 of COSPAR
- 🚩 Prof. Nandita Srivatsava, Senior Professor and Deputy Head, Udaipur Solar Observatory, PRL has been selected as a Science Discipline Representative (SDR) to the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP).
- 🚩 Prof. Srubabati Goswami, Sr. Professor, THEPH Division, has been elected as the Chair of the Gender Physics Working Group of IPA. She has also been included in the inter-academy panel of women in Science. She has also been elected to the editorial board of the Journal Pramana.



भारत सरकार की राजभाषा नीति के श्रेष्ठ कार्यान्वयन हेतु भौतिक अनुसंधान प्रयोगशाला को पुरस्कार



रुमकी दत्ता  
हिंदी अधिकारी

भाषा ही वह एकमात्र साधन है जिसके माध्यम से मानव अपने विचारों, भावों आदि को प्रकट कर सकता है। अपने लगातार विकास के कारण स्वतन्त्रता के बाद हिन्दी, भारत की राजभाषा घोषित की गई तथा उसका प्रयोग कार्यालयों में होने लगा और एक राजभाषा का रूप विकसित हो गया। 'राजभाषा' भाषा के उस



रूप को कहा जाता है जो राज-काज में प्रयुक्त की जाती है। भारत के संविधान में राजभाषा से संबंधित भाग-17 के अनुच्छेद 343 से लेकर अनुच्छेद 351 तक राजभाषा संबंधी संवैधानिक प्रावधान किए गए। भारत सरकार के गृह मंत्रालय के अधीन राजभाषा विभाग का गठन किया गया। इसी क्रम में केंद्रीय सरकारी एवं उसके अंतर्गत आने वाली सभी कार्यालयों

में हिन्दी के प्रगामी प्रयोग से संबंधित वार्षिक कार्यक्रम निर्धारित किया जाता है। इस वार्षिक कार्यक्रम में क्षेत्रवार निर्धारित लक्ष्यों के अनुसार प्रत्येक कार्यालय नियमों का अनुपालन करते हैं एवं दिए गए लक्ष्यों की पूर्ति के लिए प्रयासरत रहते हैं। भौतिक अनुसंधान प्रयोगशाला में राजभाषा नियमों के सख्त अनुपालन के अतिरिक्त, वर्ष भर विभिन्न प्रोत्साहनलक्षी कार्यक्रमों का आयोजन किया जाता है। इसके साथ-साथ कार्यालय में राजभाषा की स्थिति का उल्लेख करते हुए कई प्रकार की रिपोर्टें अंतरिक्ष विभाग एवं राजभाषा विभाग को भेजनी होती है। इन सभी रिपोर्टों की समीक्षा की जाती है, एवं कार्यालयों को तदनुसार निर्देश दिए जाते हैं। भौतिक अनुसंधान प्रयोगशाला में हिन्दी के प्रचार-प्रसार एवं प्रोत्साहन के लिए सदैव ही अनुकूल एवं उत्साहपूर्ण वातावरण रहा है। संस्थान के निदेशक, डॉ. अनिल भारद्वाज एवं रजिस्ट्रार, श्री चावली सी.वी.आर.जी. दीक्षितुलु के नेतृत्व में, राजभाषा कार्यान्वयन समिति द्वारा यह विशेष ध्यान रखा जाता है कि नियमों का निष्ठापूर्वक पालन हो। हिन्दी के प्रचार-प्रसार को बढ़ावा देने के लिए, और भी कई समितियां गठित की गई हैं, जो राजभाषा संबंधित विभिन्न पहलुओं पर कार्मिकों का प्रोत्साहनवर्धन करती है। कार्यालय के अधिकांश सदस्य वर्ष-भर आयोजित किए जाने वाले कार्यक्रमों में बढ़-चढ़ कर भाग लेते हैं। हमारा कार्यालय हिन्दी के प्रोत्साहनलक्षी कार्यक्रमों का आयोजन केवल अपने तक ही सीमित न रखते हुए नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के लिए भी प्रतियोगिताओं का आयोजन करता है। साथ ही अन्य कार्यालयों द्वारा आयोजित हिन्दी के कार्यक्रमों के लिए पी.आर.एल. के सदस्यों को भी प्रतिभागिता का अवसर प्रदान किया जाता है। हिन्दी की सुरभि केवल कार्यालय परिसर तक ही नहीं, सदस्यों के परिवार-जनों तक भी पहुंचाया जाता है। विभिन्न कार्यक्रमों, योजनाओं एवं प्रतियोगिताओं तथा गृह-पत्रिका में कृतियों के माध्यम से उनका योगदान अमूल्य है। यह हिन्दी की प्रगति मार्ग को और प्रशस्त एवं गौरवान्वित करता है। यह विशेष उल्लेखनीय है कि वर्तमान कोविड महामारी परिस्थिति के मध्य भी हिन्दी के नियमित कार्यक्रमों के अलावा भी कुछ नई प्रतियोगिताएं आयोजित की गईं। इन सभी में कार्यालय के सदस्यों का उत्साह एवं सहयोग सराहनीय रहा है। सभी कार्यक्रम एवं प्रतियोगिताएं ऑनलाइन माध्यम द्वारा ही आयोजित किए गए। इनमें हमारे संकाय एवं वैज्ञानिक/तकनीकी/प्रशासन के सदस्यों ने पूर्ण सहयोग दिया। सभी के सम्मिलित प्रयास के फलस्वरूप ही भारत सरकार की राजभाषा नीति के श्रेष्ठ कार्यान्वयन हेतु नगर राजभाषा कार्यान्वयन स्तर पर भौतिक अनुसंधान प्रयोगशाला (पी.आर.एल.) को तृतीय पुरस्कार प्राप्त हुआ है। अहमदाबाद शहर के लिए राजभाषा कार्यान्वयन का दायित्व आयकर विभाग पर है। 23 फरवरी 2021 को अध्यक्ष, नगर राजभाषा कार्यान्वयन समिति, प्रधान, मुख्य आयकर आयुक्त, गुजरात अहमदाबाद के कर-कमलों से निदेशक, डॉ. अनिल भारद्वाज को शील्ड एवं प्रशस्ति-पत्र प्रदान किया गया। आप सभी से अपेक्षा है कि हिन्दी की सर्वतोमुखी प्रगति हेतु आप निरंतर प्रयत्नशील रहेंगे।

## Online CSSTEAP Short Course on Space and Atmospheric Science

A short course on “Space and Atmospheric Science” was conducted during December 7-14, 2020 by Physical Research Laboratory (PRL), Ahmedabad under the auspices of Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations. In view of the Covid-19 pandemic, the course was held online.

The objective of the course was to create an understanding of the basics and current research trends in the field of space and atmospheric sciences with major focus on (1) Structure of the Sun, Solar Eruptions (flares, CMEs), Space Weather forecasting, (2) Optical aeronomy, ionosphere, solar wind, magnetosphere, (3) Space Instrumentation, (4) Upper, Middle, Lower atmospheric dynamics and coupling, (5) Atmospheric composition and chemistry, (6) Aerosols and climate impacts. The lectures were delivered by experts from the Space and Atmospheric Sciences Division and USO (Udaipur Solar Observatory) of PRL.

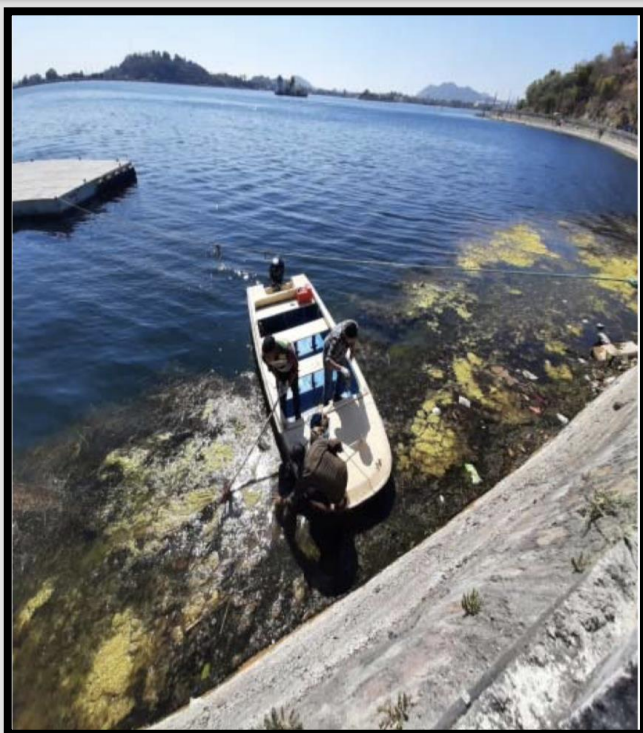
Altogether 61 people from 11 countries (Bangladesh, Ethiopia, India, Lao PDR, Mongolia, Myanmar, Nepal, Sri Lanka, Thailand, Uzbekistan and Yemen) participated in this course. Feedback from the participants was very positive.





### Swachhta Pakhwada 2021@USO

Swachhta Pakhwada 2021 was organized at USO-PRL with a focus on creating awareness on hygiene and sanitation. The Swachhta Pakhwada began by taking the Pledge by staff and students on 22nd February at the office premises, strictly adhering to all protocols and guidelines related to COVID-19. Apart from sanitation of office premises & staff residential colony, a special cleanliness drive has been initiated at the Observatory Jetty area on the shore-side of Fatehsagar Lake. As part of Swachhta Pakhwada , USO staff members also participated in mass tree plantation in the office premises & office housing colony along with the adoption of plant saplings. A small herbal garden has also been developed at USO main campus during this fortnight. Face masks were distributed among housekeeping workers of USO during the cleanliness drive.





### Highlights of Workshop 4 @ASI 2021

The 39th Meeting of the Astronomical Society of India commenced on 18th February 2021 with the four online Workshops. Workshop 4 (WS4), titled Recent Insights into Solar Active Region Dynamics was co-hosted by the Udaipur Solar Observatory-PRL and IIT-BHU. The Workshop Committee consisted of Dr. Rohan Louis, Prof. Nandita Srivastava, Prof. Shibu Mathew from USO-PRL along with Dr. Piyali Chatterjee from IIA and Dr. Bidya Binay Karak from IIT-BHU.

The focus of the Workshop was to provide students and early career scientists a common platform to share their research on solar active region dynamics, and initiate a direction to channel our efforts, both observationally and theoretically, into understanding our magnetic star comprehensively. The talks covered the interior of the Sun to the interplanetary medium with emphasis on synoptic and high-resolution observations from both ground and space, specialized diagnostic techniques, and advanced numerical simulations. There were a total of 18 presentations, which included 5 invited talks by Dr. Shravan Hanasoge (TIFR), Dr. B. Ravindra (IIA), Dr. Rahul Yadav (Stockholm University), Dr. Vemareddy (IIA), and Dr. Ranadeep Sarkar (University of Helsinki).

WS4 comprised 4 sessions which were dedicated to the -

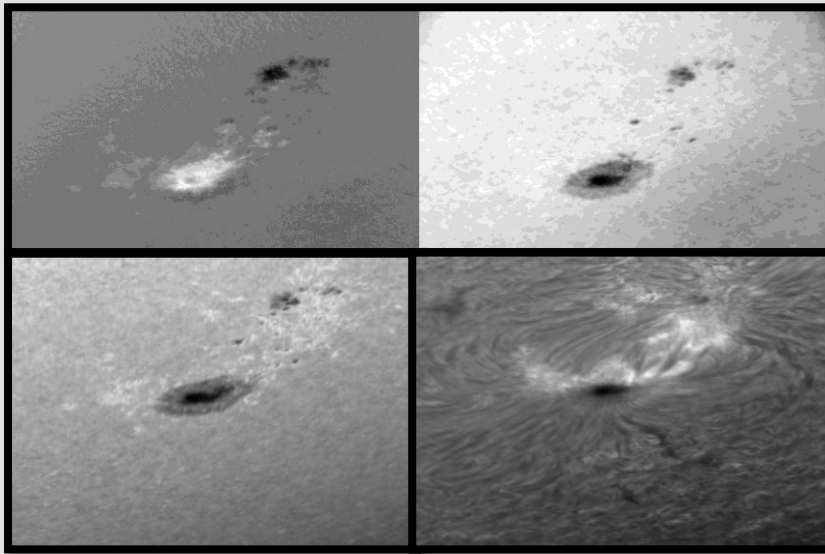
- 1) Physics of the Solar Dynamo and Sub-Photospheric Flows in Active Regions
- 2) Magnetic Flux Emergence and Transport
- 3) Solar Eruptions and their Propagation in the Interplanetary Medium
- 4) Numerical Simulations and Machine Learning to Investigate Active Region Dynamics

The Workshop was attended by nearly 60 participants.





## What is the Sun up to – Latest from MAST



Clockwise from top:

- 1) Stokes V/I (@617.3 nm) image taken on 26 Feb 2021, NOAA AR # 12804
- 2) Stokes I image for the same region
- 3) H-alpha
- 4) G-band images taken for the same active region.

### The Newsletter Team



Dr. Srubabati Goswami  
Guest Editor



Pragya Pandey



Deekshya Sarkar



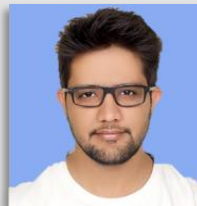
Garima Arora



A. Shivam



Rohan Louis



Prashant Jangid



Kartik Patel



Neeraj Srivastava



Vivek Mishra



Veeresh Singh



Bijaya Sahoo



Partha Konar



Som Sharma