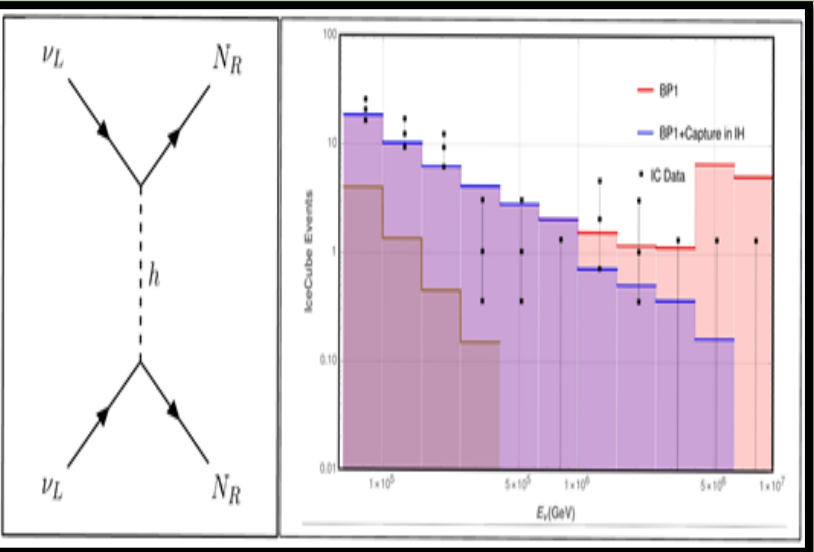
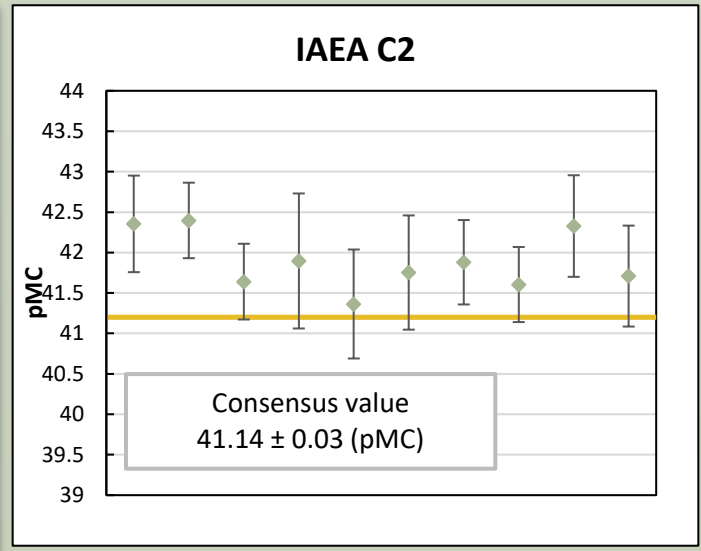




PRL NEWS – THE SPECTRUM

MAY 2019



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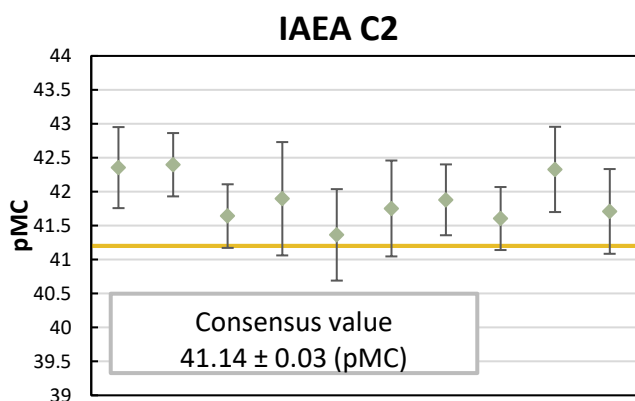
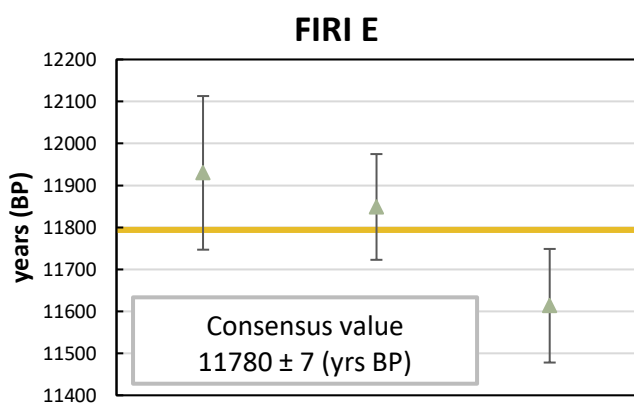
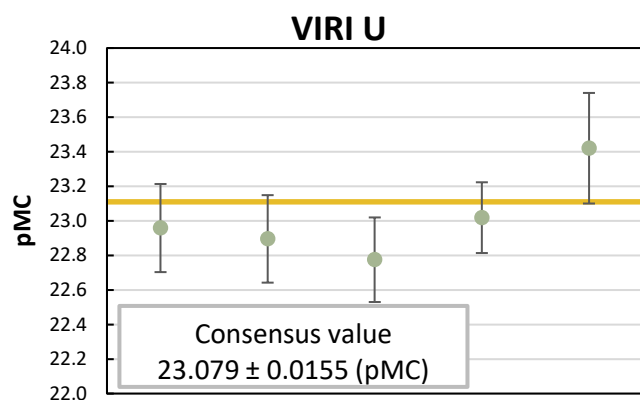
Accelerator Mass Spectrometer (AMS) facility at PRL

(Ravi Bhushan, M.G. Yadava, Manan S. Shah, Ankur J. Dabhi, A. Shivam, Harsh Raj, Upasana S. Banerji, Chinmay Shah)

Accelerators, initially used by nuclear physicists, have found a great application in form of accelerator mass spectrometry. Accelerator Mass Spectrometry (AMS) is a highly sensitive technique developed about four decades ago primarily for the measurements of cosmogenic radionuclides with half-lives exceeding a few hundred to thousands of years. The advent of AMS revolutionised the measurement of cosmogenic radionuclides such as ^{14}C , ^{10}Be , ^{26}Al , ^{36}Cl , ^{41}Ca , ^{129}I , $^{239,240}\text{Pu}$ and ^{236}U with very low natural abundances (10^{-12} to 10^{-16}). The greatest advantage of the AMS technique is that it is several orders of magnitude more sensitive than decay counting and is far less labour intensive and time consuming. AMS allows faster analyses of very small fraction of samples, thereby providing new avenues of research in various field of sciences. During the last decade, small and compact AMS were developed with terminal voltages of 1 MV or less, which require less space and are easier to maintain and operate and can provide competitive performance similar to large AMS.



Ravi Bhushan



PRL has procured 1MV AMS, which has been successfully tuned for the measurement of ^{14}C , ^{10}Be and ^{26}Al . The PRL AMS facility has been acronymed as AURiS (Accelerator Unit for Radioisotope Studies). The AMS facility at PRL comprises ion source, low energy bouncer-injector (BI) magnet, tandetron accelerator, high energy magnet, electrostatic analyser, rare isotope magnet, and gas ionisation detector. The facility has been successfully tested and put in routine operation and has demonstrated performance to accomplish high precision measurements with low background levels.

One of the areas of research which has been largely benefitted with the introduction of AMS is geosciences. Measurement of long-lived isotopes in varied samples with AMS provides information about rate, transport and chronology of natural events. Ventilation rates of deep ocean water masses, air-sea exchange rates, carbon budget of CO_2 and penetration of bomb ^{14}C on ocean wide scale are areas of research still wide open. AMS can provide large number of measurements on specific chemical species such as dissolved organic carbon, bomb pulse radioisotopes which can help in understanding of processes, which happened during the last 50kyrs. Groundwater dating of confined aquifers, process of soil erosion, sedimentation, peat bog dating, coral and marine nodule growth are fields of research which can be facilitated using AMS as earlier techniques required large sample size.

Figure Caption: Plots depicting the values of the international calibration standards as obtained by using the PRL 1MV Accelerator Mass Spectrometer.

Geochronology, a technique of assigning age to events or determining time scale for various processes till date has remained a matter of uttermost need for the Indian scientific community. AMS is one such technique which can provide solution and answer to many such unexplored areas of research.

The applications of cosmogenic isotopes such as ^{10}Be can be exploited to study earth surface processes to study terrestrial ages of meteorites. Temporal variations in ^{10}Be distribution in oceanic sediments can help understand impact of climate, productivity and magnetic field variations. ^{10}Be distribution in soil profiles can lead to information on chronology and erosion time scales. Geomorphologic application of *in-situ* produced ^{10}Be can be used to determine exposure history of rock surfaces. AMS measurement of cosmogenic nuclides in extra-terrestrial material can help in reconstruction of its exposure history. AMS measurement of cosmogenic nuclide content of meteorite that falls to earth helps in estimating the time elapsed since its arrival. The intensity of the cosmic ray flux incident on earth controls the production of cosmogenic radionuclides. Thus, by measuring the concentration of cosmogenic radionuclides in atmospheric and earth surface samples (eg. Radiocarbon in tree rings) can provide information about cosmic ray flux as a function of time. Measurement of ^{14}C and ^{10}Be in successive layers of ice cores taken from Greenland and Antarctica provides information about the past variation in its production and hence cosmic ray flux.

Several sediment cores collected from the northern Indian Ocean as part of paleoclimatic research programme have been radiocarbon dated with AURiS for estimating sedimentation rates either using foraminifera or organic carbon fraction. Radiocarbon dating of foraminifera from a marine sediment core (SK/304B-18 12°35.022'N; 93°52.127'E, core length ~2 m) collected from the Northern Andaman sea was done at PRL AURiS facility. Sedimentation rates determined using a linear interpolation age–depth model of the clam software was found to vary between 11 and 39

cm/kyr. Low sedimentation rate was attributed to reduced detrital influx due to weakened monsoonal activities and high sedimentation rate to monsoon intensification triggering high terrestrial flux in the region. This period of high sedimentation is known for warm climate and has been termed as Holocene megathermal maxima (HMM).

While AMS radiocarbon dating of archaeological and geological samples was once envisaged as the primary application of the method, studies of global change (atmospheric-oceanic-climatological changes in the past), with potentially important applications in providing inputs to predicative models on carbon dynamics through earth surface reservoirs is a major current research interest. Application of AMS encompasses wide range of research disciplines. AURiS would thus contribute towards various studies involving use of cosmogenic radionuclides in earth, planetary, oceanographic, atmospheric and biological sciences. PRL AMS facility which is fully operational, would open avenues for several new applications in various research areas.

References:

<https://doi.org/10.1016/j.nimb.2018.12.003>

<https://www.currentscience.ac.in/Volumes/116/03/0361.pdf>

CURRENT SCIENCE

Volume 116 Number 3

10 February 2019



Experiments in skill building for science communication

Transfer of research centres in information science

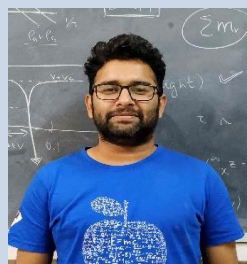
Recovery of precious metals from e-waste

Current Science Association ■ Indian Academy of Sciences

Figure Caption: PRL 1MV AMS featured on the cover page of Current Science, February 2019 issue.

A new explanation to cosmic ray neutrino flux cutoff

(Subhendra Mohanty, Ashish Narang, Soumya Sadhukhan)



Ashish Narang

The IceCube Neutrino Observatory is the first detector of its kind, designed to observe the cosmos from deep within the South Pole ice. Encompassing a cubic kilometer of ice, IceCube searches for nearly massless subatomic particles called neutrinos. These high-energy astronomical messengers provide information to probe the most violent astrophysical sources: events like exploding stars, gamma-ray bursts, and cataclysmic phenomena involving black holes and neutron stars.

The flux of these high-energy neutrino is observed to have a power law nature. A power law flux predicts the presence of a Glashow resonance (GR) at energy 6.3 PeV, and a dramatic increase in the number of events is expected. Till date, no GR, i.e., an excess of events at 6.3 PeV has been observed at IceCube.

A new scenario of cosmic ray neutrino (CR ν) absorption by the cosmic neutrino background (C ν B) is used to explain this long standing problem of the absence of GR at IceCube. We use ν 2HDM model which allows us to have a t-channel process (see figure) in which a CR ν interacts with the C ν B neutrino through a O(10) MeV scalar mediator, producing two right handed neutrinos. As a result of this process, dips occur in cosmic ray neutrino flux, of which the lowest energy one happens to cover 5–10 PeV bins. The occurrence of a dip also depends on the mass (m_R) of the right handed neutrino being produced and the depth of the dip depends on the mediator mass (m_h) and the coupling y . Fixing m_R , m_h and y to the values $m_R = 15$ MeV, $m_h = 10$ MeV and $y = 1$, the energy of the dip in the flux is fixed at the place of GR. This results in the depletion of events at IceCube around 6.3 PeV.

<https://doi.org/10.1088/1475-7516/2019/03/041>

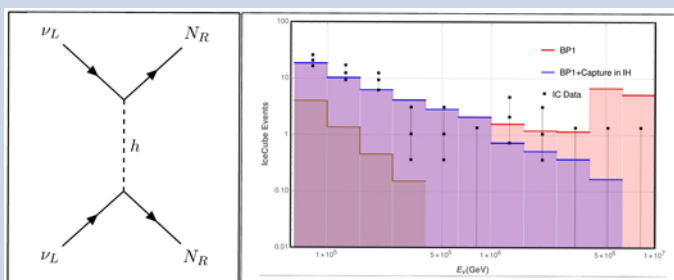


Figure Caption: Left panel shows the t-channel Feynman diagram for the CR ν absorption by C ν B. Right Panel shows the effect of the CR ν absorption on IceCube event spectrum.

Sources and characteristics of fine organic aerosol over Ahmedabad

(Atinderpal Singh, Rangu Satish, and Neeraj Rastogi)

We present the first highly time-resolved measurements of non-refractory submicron particulate matter (NR-PM $_1$) over a big urban city (Ahmedabad, 23.0°N, 72.6°E, 49 m amsl) of western India using a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) during the post-monsoon season. All the components of NR-PM $_1$ [i.e., organic aerosol (OA), SO $_4^{2-}$, NO $_3^-$, NH $_4^+$ and Cl $^-$] showed strong diurnal variation with the overall dominance of OA (58%) in NR-PM $_1$. A strong diurnal variation in O/C caused a large variability in OA/OC ratio (ranging from 1.2 to 2.3) during the study period, which suggests that a constant conversion factor for OA estimation (from OC) can be a source of large uncertainty in their load assessment over the study region. Three distinct sources of OA [i.e., primary OA (POA), semi-volatile oxygenated OA (SV-OOA), and low volatility OOA (LV-OOA)] were identified via positive matrix factorization (PMF) analysis. The OA mass was dominated by POA (42%), followed by LV-OOA (33%) and SV-OOA (25%). Diurnal variations in PMF factors suggest that OOA (SV-OOA + LV-OOA) were high during early morning and afternoon hours; whereas, POA was most abundant during traffic rush hours. Observations also revealed that the high OA loading events were dominated by POA during the study period. This study provides new insights on the atmospheric aging of OA, for the first time, over western India, which would be helpful in understanding the formation mechanism of secondary OA over this region.



Neeraj Rastogi

<https://doi.org/10.1016/j.atmosenv.2019.04.009>

National Science Day at Udaipur and Journey of Science Express

National science day was celebrated at Udaipur on 25 March 2019. On the occasion, the PRL—jointly with the Vidya Bhawan Society, Udaipur—organized a stimulating public lecture by Dr. Anil Bhardwaj, Director PRL. The lecture, entitled “Indian Planetary Missions” highlighted the achievements and discoveries by Indian space missions and was highly appreciated by the audience which mainly comprised of students from a wide range of socio-economic background. The science demonstration was planned and executed by the USO students and post-doctoral fellows along with the members of the science express team of PRL. The total number of audiences was well over 500. In addition, a press meet was organized where Dr. Bhardwaj interacted with the media. There was an active participation from the students from different academic institutions of Vidya Bhawan Society, showcasing their ingenious knowledge and interest in space sciences by presenting posters. The best ten posters were rewarded by Dr. Bhardwaj. The program also comprised an open session with the audience where interactions were focused on diverse aspects of science ranging from its societal to everyday impact.

So far, the Science Express has covered six places in Gujarat and Rajasthan namely Dhrol, Jamnagar, Rajkot, Kapason, Udaipur, Bhavnagar, Una and received stupendous views from teachers, students as well as general public with an estimated total number of attendees more than 6000. During the above event, it continued to mark its own impression on the young motivated students and common public. A group of nine volunteers from PRL, including Ph.D. students, scientists and project staff demonstrated nine innovative experiments in two phases with three hours' duration in each phase.



Scientific tour to Jaisalmer and Pokhran

Staff Welfare Committee (SWC) of USO, PRL organized a scientific tour to Jaisalmer and Pokhran during Feb 22 – 24, 2019. A total of 30 members including USO staff and their families participated in the tour. The SWC conducted guided tour to historical places including the fort and several Havelies of Jaisalmer and learned about the rich cultural heritage of the city. Interestingly, Jaisalmer fort is unique in India since this is the only fort where people still reside. The members visited sand dunes of Thar Desert and were acquainted with the structure and morphology of the region. Tours to Kuldhara (an archaeological village) and Pokhran were also conducted.



First aid Firefighting Lecture and Demo

A Fire Service Week was organized by CISF SAC/PRL Unit, commencing from 10/04/2019 to 15/04/2019 at SAC/PRL, Ahmedabad. As a part of awareness drive, there was a Lecture on First aid and fire-fighting by the Assistant Commandant, Fire Wing of CISF. This was followed by a demonstration on handling of various types of fire extinguishers. PRL staff members took hands on experience on how to handle fire extinguishers in the time of need



MATLAB session in PRL

Computer Centre, PRL in coordination with M/s. Automation Systems Engineers Pvt. Ltd. (ASEPL) and Mathworks organized a half-day technical session on MATLAB on Wednesday, 3rd April 2019 at Nenosims seminar hall in PRL main campus. Dr. Dilip Angom welcomed all the participants, briefed about the technical session and introduced the resource persons Dr. Rishu Gupta, Application Engineer, Mathworks - Kolkata, Anuj Goel, Mathworks - Delhi and Mr. Rakshit Bhatt, ASEPL, Ahmedabad. Fifty MATLAB users of PRL participated in this session. During the session, users were informed about the deep learning and workflow for computer vision applications using MATLAB, neural networks, parallel computing and MATLAB parallel server and other new features fruitful for their applications. The session, being interactive in nature, led to many discussions, and turned out to be very informative and helpful for all.



Hindi Technical Seminar

A one-day Hindi Technical Seminar was organized in PRL on 5 April, 2019. The subject of the seminar was “Scientific and Technical Advances at PRL: Vision of Prof. Vikram Sarabhai”. A Rajbhasha session was also included and the subject was “Practical Use of Hindi in Administration and Services”. A Poster session was also arranged in the Hindi Seminar for the first time. There were 16 PPT presentations and 12 posters. Prof. Anil Gupta was invited as Chief Guest. An invited talk was also delivered on Rajbhasha by Shri Sonu Jain, Hindi Officer, SAC, Ahmedabad. In the Inaugural program of the Seminar, Dr. Anil Bhardwaj, Director, PRL highlighted the importance of Hindi in our daily work and insisted on using Hindi in office work. Dr. M.G. Yadava, Chairman, Hindi Technical Seminar-2019 also spoke about different advantages of Hindi and encouraged the participants and audience regarding the use of Official Language in day-to-day work.



Annual Theory Physics Days (ATPD) 2019



This is an annual conference being organized by the THEPH Division at PRL since 2013. In this meet, faculty members from PRL as well as from other institutes in Ahmedabad come together to discuss about their research ideas and activities. This year ATPD was conducted on 22rd and 24rd March, 2019. Fifty-six participants attended the meet including members from Ahmedabad University and different divisions of PRL. Presentations were made on different topics of theoretical physics, such as, recent

Horizon Telescope observations of the center of the galaxy M87, effective field theory, neutrino oscillation experiments, baryogenesis, proton decay, quantum phase transitions, high-Tc superconductivity, color superconductivity and recent advancements in machine learning. Among the theoretical ideas from other divisions topics related to solar corona, atmospheric modeling, molecular spectroscopy, atomic many-body approach, meteoritic evidences of superflares of an early sun were discussed in a vibrant scientific atmosphere.

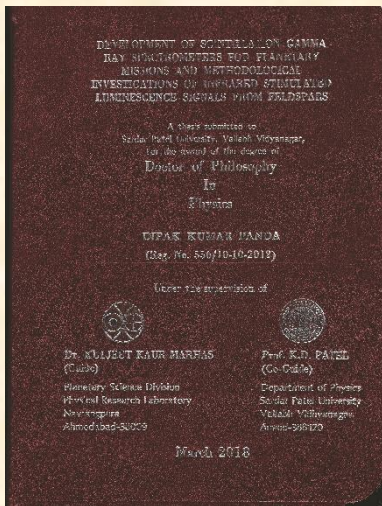
PRL Annual Table Tennis Tournament

PRL Annual Table Tennis Tournament for the year 2018-2019 for PRL employees was organized on 30/03/2019. Various events were conducted like Open Singles Men and Women, Open Doubles, Lucky Doubles and Area-wise team event. Many of the employees, Research Scholars and PDFs participated actively in the game. The results of the tournament are tabulated below.



EVENT CATEGORIES	Results		
	Winner	Runner up	Third Place
Open Singles	GOUTAM SAMANTA	ANIRBAN GHOSH	ATUL MANKE
Open Doubles	GOUTAM SAMANTA ATUL MANKE	SENTHIL BABU T J B G THAKOR	AMIT BASU ANIRBAN GHOSH
Lucky Doubles	ATUL MANKE ANIRBAN GHOSH	GOUTAM SAMANTA AKSHIT GUPTA	RAM LAKHAN ABHISHEK VERMA
Team Event	AMOPH GOUTAM SAMANTA ANIRBAN GHOSH UTKARSH DEVA	PSDN AMIT BASU TINKAL LADIYA ABHISHEK VERMA AKSHIT GUPTA	SPASC ATUL MANKE PRADIP SURYAWANSHI
Women Singles	MS. GARIMA ARORA	MS. ANKITA PATEL	--

Development of Scintillation Gamma Ray Spectrometers for Planetary Missions and Methodological Investigations of Infrared Stimulated Luminescence Signals from Feldspars.



This research work was initiated with a broad scientific objective to understand the origin and evolution of the solar system with the knowledge of chemical composition of planetary surfaces. The work focused on the development of a laboratory model of gamma ray spectrometer (GRS) with the ambition for a future planetary mission to measure the elemental abundance of Na, Ca, Mg, Si, Ti, Al, Fe, Al, K, U and Th etc. The performance of rare earth halide scintillation detectors (LaBr₃:Ce and CeBr₃) was tested with the in-house developed GRS instrument with different radioactive sources. An energy resolution of ~2.8 % and ~3.8% was achieved for LaBr₃:Ce and CeBr₃ respectively. The feasibility study of these detectors was carried out to find out the optimum operating conditions (like biasing voltage, shaping time, peak intensity variation with variation



Dipak Panda

of distance of source etc.) and suitability of these detectors for planetary science applications. The optimization of operating conditions was achieved by measuring peak intensity of fixed energy level with different biasing voltage and shaping time while the suitability has been tested by measuring the concentration of K, U and Th in soil and rocks. It was shown that LaBr₃:Ce has a very high background due to the intrinsic activity which inhibits the ability to estimate the concentration of K, U and Th. The total background of CeBr₃ in the energy range of 0.02 to 3 MeV is one order lower than that of LaBr₃:Ce. It was also shown that CeBr₃ can be used for space mission applications due to its high sensitivity as compared to LaBr₃:Ce and ability to estimate the concentration of K and U within 10% as measured by High purity Germanium detector (HPGE). This thesis work also contributes significantly towards methodological establishment of the applications of luminescence dating techniques and will provide a basis for routine application of the method.

Outreach

Outreach Activity @ USO



Vigyan Prasar and Kendriya Vidyalaya Sangathan jointly organized an **Astronomical Telescope Making Workshop** at Kendriya Vidyalaya Eklinggarh, Udaipur from 6th-10th April, 2019. The idea of the workshop was to provide a training platform to selected Kendriya Vidyalaya students of Classes 10th and 11th for making their own hand-made telescope. There was a total of 40 students and 4-5 teachers of KV. During this event, **Dr. Rohan Louis** gave a talk titled **Introduction to our Sun** on 9th April, 2019 as part of USO's Outreach Activity. The talk covered basic concepts of Solar Physics and the facilities available at USO for carrying out comprehensive investigations of our nearest star.

- ✚ **Srubabati Goswami**, Senior Professor, THEPH Division has been awarded a visiting Professorship by Levehulme Trust, UK to visit Imperial College London for three months.
- ✚ **Varun Sharma**, SRF AMOPH Division has been selected by the scientific review panel of the council for the Lindau Nobel Laureate meetings to participate in the 69th Lindau Nobel Laureate Meeting, 30th June – 5th July 2019, Lindau, Germany. He has also received the European Physical Society - Quantum Electronics and Optics Division (EPS-QEOD) travel grant student award to attend and present his work at the conference on Lasers & Electro-Optics / Europe – European Quantum Electronics Conference (CLEO/Europe-EQEC 2019) in Munich, Germany during 23rd-27th June, 2019. The award comprises a certificate and a cash award of 1000 Euros.
- ✚ **Srinivasa Prasanna V**, PDF, AMOPH Division has received the "ISAMP Best Thesis Award" for his paper entitled "The Search for the electric dipole moment of the electron in mercury halides using the relativistic coupled cluster method". The paper was presented at the National Conference on Atomic and Molecular Physics 2019 (NCAMP 2019), IIT Kanpur, 25th-28th March, 2019.
- ✚ **S. A. Haider**, Senior Professor, Planetary Sciences Division has been elected as the Main Scientific Organizer (MSO) of the Planetary Upper Atmospheres, Ionospheres and Magnetospheres Session in the Committee On Space Research (COSPAR 2020), to be held in Sydney, Australia, 2020.

Hearty Congratulations to all the colleagues conferred with these awards and honours

Colloquia @ PRL

- ✚ **K. P. Subramanian**, (Honorary Scientist, AMOPH Division, PRL) delivered a colloquium entitled "Quadrupole mass analyzer: Mathematical principle and COMSOL simulation" on 10th April, 2019.
- ✚ **Piyali Chatterjee** (Reader, Indian Institute of Astrophysics Bangalore) gave a colloquium entitled "Solar flares from delta sunspots: Insights from simulations, at USO on 22nd April, 2019.

Farewell

Mrs. Pauline Joseph, Senior Administrative Officer, PRL superannuated on 30th April, 2019, giving thirty-eight years of service to PRL. We, at PRL, gratefully acknowledge all the contributions made to the institution during her service and wish her a very healthy and peaceful superannuated life ahead.

