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भौतिक अनुसंधान प्रयोगशाला  
अहमदाबाद-380009  
भारत

# Messages



Dear Readers,

Season's Greetings & wishes for the New Year, 2019!

At the start of the new year, I take immense pleasure in introducing the newsletter, "PRL News – The Spectrum". This year – 2019 – has special relevance being the birth centenary of Dr. Vikram Sarabhai – the founder of PRL. On this occasion, this issue is dedicated as a humble tribute to this great scientist and visionary.

As the PRL fraternity continues to grow in their accomplishments, it becomes necessary to convey the developments taking place in the institute. The newsletter would encompass updated information, such as scientific research, social interactions, accolades, conglomerations, sports, newly joined members, superannuation, and other activities of the members of the institute. In a nutshell, it would act as a forum for familiarizing the readers with various happenings of PRL.

I am sure that this newsletter will be a great success, and hope that subsequent issues will continue to improve, with your ever-enthusiastic readership. Suggestions for improvements are always welcome.

Dr. Anil Bhardwaj  
Director



Dear All,

A happy employee is a productive employee, as the adage goes. To take it a step further, an informed employee is a happy employee. Enter the internal newsletter "PRL News – The Spectrum". When developed with care, an effective laboratory newsletter can: Keep the employees informed and up-to-date on what's happening around at periodical intervals and effectively counter disinformation campaign.

I am delighted to introduce this edition of the PRL newsletter. We intend to make it a regular publication and to use it to keep you in touch with news and developments which relate to the various facets of basic science research internally and its challenges in implementation, administrative and financial management, eGovernance, developments externally that has a bearing on our environment. In this and future editions, we shall be reporting decisions and discussions which take place at the institutional level of the PRL which imbibe and substance of its soul.

While often under-utilized or even outright ignored, an internal newsletter is actually a useful tool for boosting productivity and morale in the workplace. When developed with care, an effective newsletter can: Keep your employees informed and up-to-date on what's happening; break down barriers between employees, especially between teams or departments; reduce inbox congestion by succinctly covering what would normally require multiple emails among the staff; give employees consistent and brand-appropriate talking points that they can be shared with their families and social circles, helping generate positive word-of-mouth publicity for the activities around.

I wish the editorial team of PRL newsletter all the best in reinforcing and reinvigorate its echoes.

Chavali V.R.G. Deekshitulu  
Registrar

## DR. VIKRAM A. SARABHAI: CREATOR OF INDIAN SPACE SAGA



*“Countries have to provide facilities for their nationals to do front-rank research within the resources which are available. It is equally necessary, having produced the men who can do research, to organize task oriented projects for the nation's practical problems...”*

**Dr. Vikram A Sarabhai**

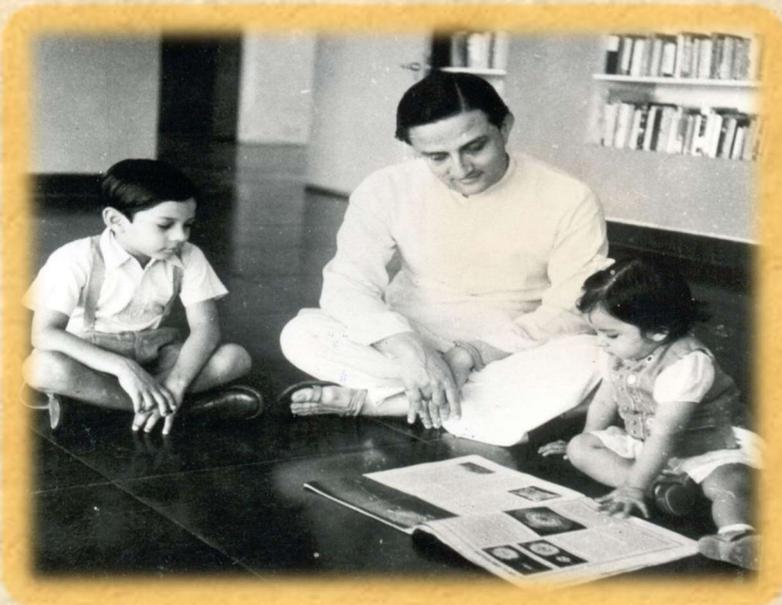
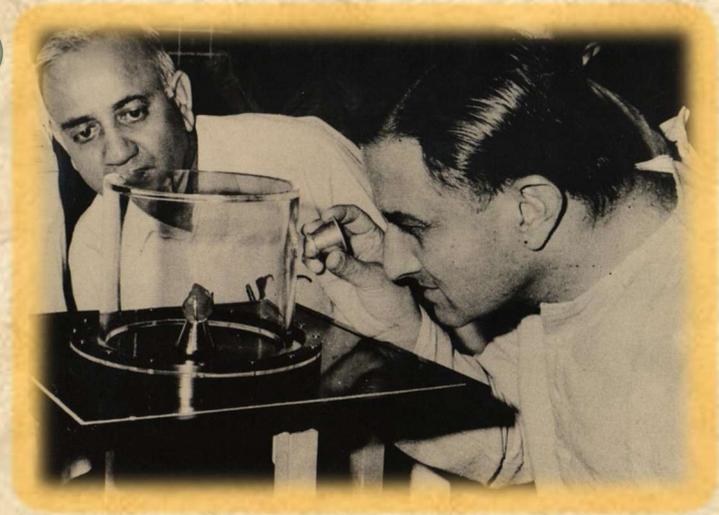
[12 August 1919 – 30 December 1971]

DR. VIKRAM AMBALAL SARABHAI, THE FOUNDER OF PRL, AND A DISTINGUISHED COSMIC RAY AND SPACE SCIENTIST, IS REGARDED AS THE FATHER OF SPACE PROGRAM IN INDIA. DR. VIKRAM SARABHAI WAS BORN ON 12 AUGUST 1919 IN AHMEDABAD. AFTER HIS EARLY EDUCATION IN AHMEDABAD, HE JOINED CAMBRIDGE UNIVERSITY, UK AND TOOK HIS TRIPOS IN NATURAL SCIENCES IN 1940. HE WORKED FOR HIS PH.D. UNDER THE GUIDANCE OF NOBEL LAUREATE SIR C. V. RAMAN AT THE INDIAN INSTITUTE OF SCIENCE, BANGALORE. IN 1947, HE WAS AWARDED DOCTORATE BY THE CAMBRIDGE UNIVERSITY. ON HIS RETURN TO INDIA, DR. SARABHAI FOUNDED PRL IN 1947. IN 1962, HE TOOK OVER THE RESPONSIBILITY OF ORGANIZING SPACE RESEARCH IN INDIA AS THE CHAIRMAN OF THE INDIAN NATIONAL COMMITTEE FOR SPACE RESEARCH (INCOSPAR). DR. SARABHAI SERVED AS THE DIRECTOR OF PRL FROM 1965 TO 1971 AND THE CHAIRMAN OF ATOMIC ENERGY COMMISSION DURING 1966-1971.

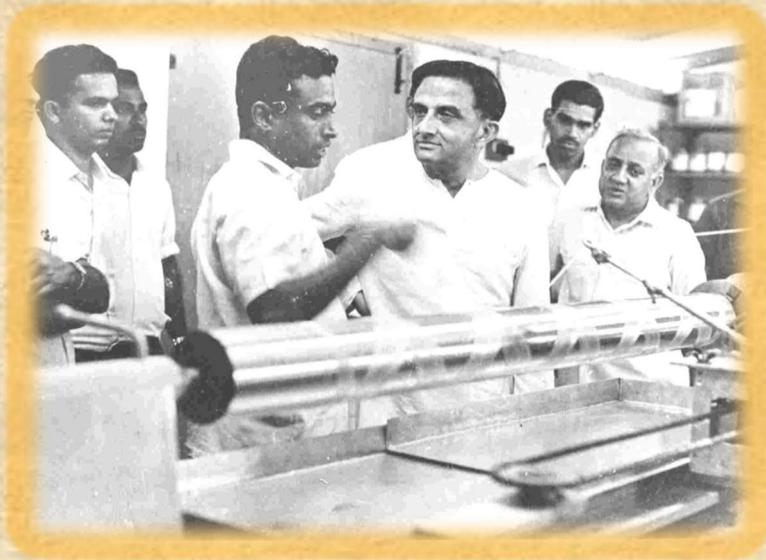
DR. SARABHAI WAS AWARDED THE SHANTI SWARUP BHATNAGAR AWARD FOR PHYSICS IN 1962 AND WAS HONOURED WITH PADMA BHUSHAN IN 1966. HE WAS AWARDED PADMA VIBHUSHAN POSTHUMOUSLY IN 1972. HE WAS A GREAT INSTITUTION BUILDER AND ESTABLISHED OR HELPED TO ESTABLISH A LARGE NUMBER OF INSTITUTIONS IN DIVERSE FIELDS, PROMINENT OF THEM ARE IIM-AHMEDABAD, ATIRA-AHMEDABAD, ECIL-HYDERABAD, SAC-AHMEDABAD AND FBTR-KALPAKKAM.

## Quotes by Dr. Vikram Sarabhai

“There is a need for a constant interplay between the basic sciences, technology and industrial practice if economic progress is to result from the activity undertaken.” - (1959-60)



“It is necessary in creative work, to be able to see squirrels and birds” - (April 1971)



“In implementing change, we need to apply ourselves to people before we can apply ourselves to problems” - (May 1966)

## What killed the dinosaurs - Deccan trap volcanoes, Comet impact or Dark Matter ?



Subhendra Mohanty

Dinosaurs dominated the Earth in the Jurassic-Cretaceous period 252-66 Ma (Ma = Mega-annums or million years ago). Some catastrophic event that occurred about 66 Ma ago wiped out all the dinosaurs, while the small mammals (the size of big rats) that survived got the resources to flourish and finally the humans developed from this branch at 5-7 Ma. The evidence for the extinction of dinosaurs exists in the K-T (now renamed as K-Pg (Cretaceous–Paleogene) boundary of sedimentary rock layers which have dinosaur fossils just below it and no fossils above the layer. The K-Pg layer seen all over the globe has been dated by radioactive K and U measurements to be  $66.043 \pm 0.043$  Ma. The idea that the K-Pg boundary was caused due to a sudden event of global scale was first proposed in 1980 by the team led by the physicist Luis Alvarez, geologist Walter Alvarez and nuclear-chemists Frank Asaro and Helen Michel. They found that globally K-Pg layers had a concentration of Iridium which was 30-100 times the concentration found on Earth's crust. It is well known that chondritic meteorites and asteroids had a much larger concentration of Iridium compared to the surface of the Earth. Alvarez et al suggested that a giant asteroid impacted the Earth 66 million years ago and the Iridium and from the debris rose high the atmosphere settled all over the globe. By measuring the concentration of Iridium in the K-Pg layer, Alvarez et al concluded that an asteroid of 10-15 km diameter impacting the Earth could explain the anomalous Iridium in the K-Pg layer - and also account for the catastrophic extinction of dinosaurs and other major life forms about 66Ma. A comet of 10 km diameter on impact would create a 200 km crater due to the shock waves emanating from the impact center. There was one such crater -the 180 km diameter Chicxulub crater in the Gulf of Mexico which has been known since the 1960s. Although half of the the crater was submerged in the ocean, its shape and depth was determined by measurements of the gravitational and magnetic anomalies over the crater region. Dating the crater by radioactive Argon measurements in 2013, yielded the date of the Chicxclub crater to be  $66.043 \pm 0.011$  Ma, well in agreement with the time of the K-T extinction event.

The era around 66 Ma seems to have been very eventful on planet Earth. The Indian plate had not yet collided with the Eurasian plate but volcanic activity in South-Western India spewed out basaltic lava which covered an area of half a million km<sup>2</sup> with a thickness of 2 km creating the Deccan Trap (Trap refers to the step-like structure of the hills). The date of the volcanic activity is again in the neighborhood of 66 Ma. However the question- whether the Deccan Trap was created in a sudden mega volcano (which spewed out large amount of Iridium from the mantle which then settled in the K-Pg layers) or a series of small volcanoes- is not conclusively settled. Discovery of an extinct volcano would support the mega volcano idea. An extinct volcano would be a hill with a hollow inner chamber through which the magma flowed out in the past. Probing the interior of the hills of the Deccan (for example the Pavagadh hill in Gujarat) with muon tomography can lead to the discovery of such an extinct mega volcano. Muon tomography is a technique where the muons produced by cosmic rays in the upper atmosphere can be monitored in the vicinity of the mountain. Measuring amount of muons absorbed by the mountain can tell us about the presence or absence of an inner volcanic chamber (and in active volcanoes the level of the lava in the chamber). Recent ideas are converging on the theory the Deccan Trap volcanoes may have been active before the comet impact which created Chicxulub crater, but the impact triggered a mega volcano whose massive lava outflow resulted in the Deccan Trap.

A new twist in this story was added by particle physicists Lisa Randall and Mathew Reece and their team at Harvard. Randall et al noted that evidence from fossils and impact craters around the world suggests that catastrophic mass extinctions of species happened not just once in 66Ma but is a periodic phenomenon with a period of 30 million years. The reason for this periodicity is that as the Sun moves around the Milky Way disc every 230 million years it also oscillates in the vertical direction with a periodicity of 30 million years. The time period of the oscillations is set by viscous dark matter which has settled in the disc of the Milky Way. The periodic oscillations of the Sun loosen comets from the Oort cloud (surrounding the Solar System) which then gravitate towards the Sun and occasionally hit a planet on the way. Analysis of data from the Gaia satellite observations will validate or refute the presence of dark matter in the galactic disc; and muon tomography of the Deccan trap Hills may lead to a discovery of an extinct mega volcano. And amazingly the two phenomenon may be related.



Lokesh Dewangan

### Investigating physical environments for formation of massive stars

The birth of massive stars ( $> 8 M_{\text{sun}}$ ) is still an open research question in astrophysics. Furthermore, the identification of the earliest stages of massive star formation (MSF) prior to an ultracompact (UC) HII region is extremely challenging task in MSF research. To investigate the physical processes in a promising massive star-forming site IRAS 17008-4040, we carried out an extensive analysis of the multi-wavelength data sets including high-resolution near-infrared adaptive-optics images (resolutions  $\sim 0.1$  arcsec) and radio continuum data (beam sizes  $\sim 3$ -8 arcsec). In the site IRAS 17008-4040, a previously known O-star candidate without an HII region is identified as an infrared counterpart of the 6.7 GHz methanol maser emission (i.e. IRcmme) (see Figure 1a). In Figure 1b, based on the adaptive-optics 3.8-micron image (resolution  $\sim 0.1$  arcsec), the source IRcmme is resolved into two objects (i.e. IRcmme1 and IRcmme2)

within a scale of 900 AU that are found to be associated with the ALMA core G345.50M. IRcmme1 is characterized as the main accreting HMPO candidate before the onset of an ultracompact HII region. In the IRAS site, the junction of the filaments (i.e. massive clump) is also investigated (not shown here), which is consistent with the “hub-filament” system.

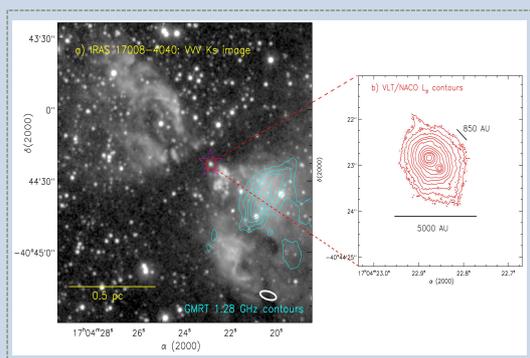


Figure 1: a) Overlay of the GMRT 1.28 GHz continuum contours (in cyan; beam size  $\sim 5.3$  arcsec X 1.7 arcsec; sensitivity  $\sim 0.4$  mJy/beam) on the VVV Ks image toward IRAS 17008-4040. The GMRT contours are shown with the levels of 3.5, 6.5, 9.5, 13, 16, 18, 25, 35, 45, and 52 mJy/beam.

b) A zoomed-in view of the source “IRcmme” using the VLT/NACO Lp image (resolution  $\sim 0.1$  arcsec; see a solid box in Figure 1a). shown by triangle (in blue).

Source: <https://doi.org/10.3847/1538-4357/aae9db>

### Into the mountains: Experiences of a scientific expedition

“It is 5 am, with freezing temperature in negative outside. We can still see the Milky Way through window pane and want to stay closest to the room heater. But we get up, prepare out stuff for the day, check the state of instruments and tools, have a stomach full meal, load everything in the cab, and ready for today’s sample collection.” This is how a field tour in winters look like.

We went recently on a field expedition in the sub Himalayan region (Auli, to Dehradun via Joshimath and Garhwal region in Uttarakhand state) to collect samples for our Ph.D. research. The objective was to address the climate change and its implications on the natural systems using different archives: soil and air. For this purpose, we collected samples from forests at different elevations of sub-tropical Himalayan mountain range. The collected soils would be analysed for nitrogen dynamics at different temperature and elevation gradients to understand its effect on the carbon sequestration capacity of plants. The air samples, which should be free from anthropogenic influences, were collected from deep inside the forests. These air samples would be analysed for volatile organic compounds emissions from plants and would be helpful in understanding the response of plants towards the changing climatic conditions.

To avoid anthropogenically affected areas during sample collection was a major challenge for us and landscapes like Himalayas added more to it. We had to climb on steep slopes, carrying our scientific stuff through dense plant canopies, to find a suitable place under desired GPS coordinates for sampling, and to carry samples safely with us through these difficult terrains. Sometimes we fell and got scratches and the other times we remained empty stomach all day. We also spent nights shivering in the guest house as power failure had stopped the room heater. What-so-ever came, we were happy at the end of the day as these experiences not only became a lifetime memory and helped us to understand *nature* more closely but also to grasp ourselves with the new unwanted difficulties which we faced during the field campaign. It was a very nice opportunity to acquire our research goals.

During field trip, we not only learnt new techniques for sample collection and to work in difficult terrains, but also started to feel connected to the work we do and inclined more towards our research. We are thankful to those who helped us during this campaign and also very grateful to Wildlife Institute of India, Dehradun for their kind support and help.

The field experiences go well with the sayings of an American writer Andy Rooney - “*Everyone wants to live on top of the mountain, but all the happiness and growth occurs when you are climbing it.*”



Niharika Sharma and Nidhi Tripathi



Venkatesh Chinni

### Spatial variability in dissolved iron concentrations in the marginal and open waters of the Indian Ocean

Iron is the most vital trace element in the ocean, controlling ocean productivity, sequestering atmospheric carbon thereby modulating the carbon di oxide. Hence, the biogeochemical cycle of iron has direct implication to the carbon cycle and global climate. Despite its global importance, very little was know about sources, sinks and its internal cycle of dissolved Fe in the Indian Ocean owing to its low concentration and problem associated with clean sampling of seawater for such studies. A gigantic task of establishing clean sampling system and measurement protocols for low level dissolved iron using flow injection system was accomplished for the *first time in India*. Indian ocean was sampled at unprecedented resolution between 28 °S and 21 °N by spending about 250 days on-board the ORV Sagar Kanya. 28 full vertical profiles in the Indian Ocean were analysed for dissolved iron with high accuracy and precision as part of the GEOTRACES-India programme to decipher the sources, sinks and internal cycling of iron in this unexplored region of the globe. Results indicate several new sources of dissolved Fe in the Indian Ocean such as continental shelves and hydrothermal vents situated at the Central Indian ridge in addition to the traditionally believed source, the atmospheric dust. High DFe concentrations in sub-surface waters of the Bay of Bengal and the Andaman Sea are attributed to desorption of soluble iron from resuspended sediments of the rivers and the remineralization of sinking particulate organic matter. This study, for the first time, identified a new source of Fe in the deep ocean, i.e., subduction zone along the Java trench in the Indian Ocean. The productivity in the Bay of Bengal and the Andaman Sea does not seem to be limited by availability of dissolved Fe.

Source: <https://doi.org/10.1016/j.marchem.2018.11.007>

### Orbital Altitude Dust at Mars, Its Implication and A Prototype for its Detection

Dust at orbital altitude on Mars could be mainly due to interplanetary source, cometary source or natural satellites of Mars. Recent work and MAVEN observations predict that dust at orbital altitudes could be interplanetary in nature. Since, the source of such particles is not understood unambiguously, it remains a puzzling question to space scientist about what is a source of it. An instrument on future Mars orbiter, which can measure the dust particle parameters like mass, velocity and flux, may be helpful to address such issues.

In this work, dust flux (Figure 1) at orbital altitudes on Mars is presented in the initial part. Typically, dust density for the incoming micrometeorites at Mars is  $10^{-7}$  #/m<sup>3</sup>. To study origin, abundance, distribution, flux and seasonal variation of dust at orbital altitude on Mars, a Mars Orbit Dust Experiment (MODEX) is proposed and development of its prototype (Figure 2) has been initiated. We have presented the impact plasma theory for the first time to explain detector target design. Also, a prototype dust detector, its front end electronics and initial testing results using a pulse laser is reported. The ions and electrons of impact plasma have been separated using biased electrodes. The results demonstrate the possible use of pulse laser for testing the impact ionization dust detector, prior to calibrating the dust detector using a dust accelerator facility.



J.P. Pabari

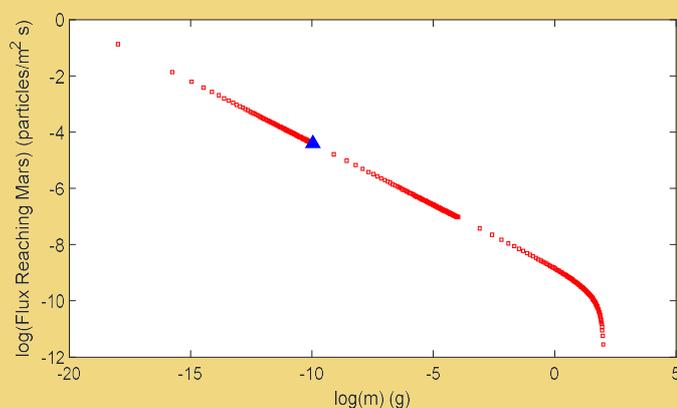


Figure 1: Interplanetary Dust Particle (IDP) Flux at Mars, which is in agreement with the MAVEN expectations, shown by triangle (in blue).

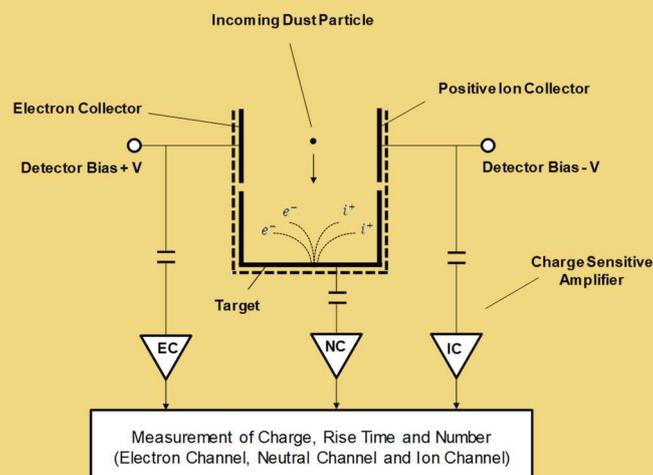


Figure 2: Dust detector schematic.

Source: <https://doi.org/10.1016/j.pss.2018.06.008>

**Noble gas, nitrogen composition and cosmic ray exposure history of two eucrites Vissannapeta, Piplia Kalan and one howardite Lohawat**



R. R. Mahajan

Two eucrites, Vissannapeta and Piplia Kalan (both Indian falls) were investigated for noble gas and nitrogen isotopic study. It was found that nitrogen isotopic ratio in both the eucrites are distinct. This indicates that there is local heterogeneity in the parent body of HED (Howardite, Eucrite, Diogenite) meteorites. The xenon isotope ratio  $^{129}\text{Xe}/^{132}\text{Xe}$  in both the eucrites are  $< 0.97$  as compared with 1.04 (solar). The decay product of  $^{129}\text{I}$  (decay to  $^{129}\text{Xe}$ ) was expected in the meteorite sample. Indiscernible amount of iodine-derived Xe in replicate samples of two meteorites studied, imply depletion of halogen in eucrites. Based on this, it is propose that the material which formed HED parent body was devoid of  $^{129}\text{I}$ . Therefore there was heterogeneous distribution of  $^{129}\text{I}$  (radiogenic extinct isotope, half-life 15.7 Ma) in the early stage of the solar system formation.

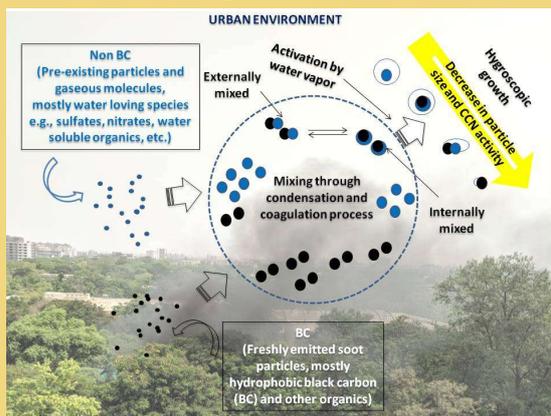
Source: <https://doi.org/10.1016/j.pss.2018.12.004>

**How black carbon particles influence hygroscopic properties of aerosols, and affect cloud formation?**



S. Ramachandran

Black carbon (BC) aerosols are produced from incomplete combustion of fossil fuel and biomass burning. BC particles are fine mode aerosol ( $< 50\text{-}1000$  nm, significantly smaller in size than the width of a human hair), and have short life (7-10 days) in the atmosphere. BC is abundant in the atmosphere because of continuous anthropogenic emissions. BC absorbs the solar radiation and warms the atmosphere. BC near the source is hydrophobic (insoluble in water) in nature, however, it becomes hydrophilic (soluble in water)



by mixing with nonBC (mostly hydrophilic inorganic and organics) particles and other condensable vapor due to coagulation and condensation process (as shown in figure). This likely results in different BC mixing states, namely, external and internal (figure). Because of different mixing behavior of BC, resultant optical and hygroscopic properties of these mixed particles differ when compared to pure BC particles. An experimental setup was designed that comprised robust and state-of-the-art instruments to quantify size selected BC mixing state and examine its influence on aerosol hygroscopic growth. Observations revealed that particles below 100 nm are mostly BC and more internally mixed which suppress the aerosol hygroscopic growth, whereas higher size (above 100 nm) particles are mostly nonBC particles that enhanced the hygroscopic growth. Further, based on chemical composition of size resolved aerosol we inferred that particles  $< 100$  nm contain

freshly emitted BC from roadway traffic and biomass burning, while particles in higher size are inorganic salts mostly originated from gas to particle transformation. These findings are important because BC mixing state and its impact on hygroscopic properties are determined directly over an urban region which have implications to cloud formation (i.e., cloud condensation nuclei (CCN)), and hence precipitation.

Source: <https://doi.org/10.1016/j.atmosenv.2018.12.001>

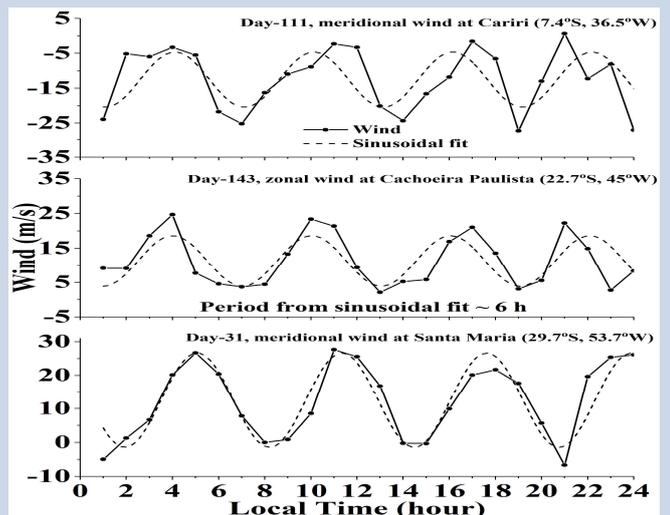


A. Guharay

**Signature of the quarter-diurnal tide in the low latitude mesosphere**

A weak, but consistent signature of quarter-diurnal tide (period 6 hour) with average amplitude  $< 3$  m/s is found in the low latitude mesosphere. A weak enhancement in amplitude is observed in late summer and fall intervals. The observed characteristics of the tide indicate an involvement of both migrating and nonmigrating modes.

Figure: Typical residual winds on removing diurnal and semidiurnal components showing prominent 6-h wave.



Source: <https://doi.org/10.1186/s40623-018-0910-9>

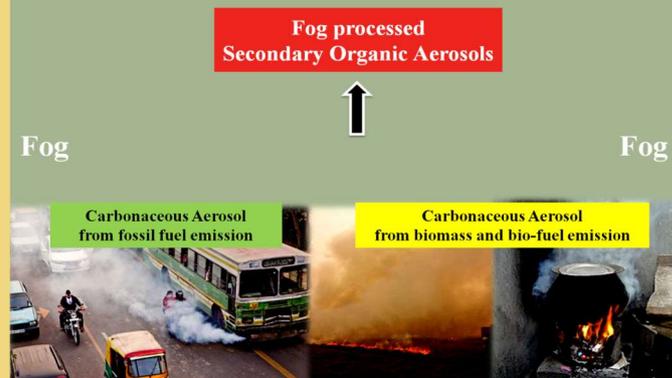
## Oxidative potential of ambient fine aerosol over a semi-urban site in the Indo-Gangetic Plain

Aerosol are suspension of solid and/or liquid particles in the ambient air with a size varying from a few nanometer (nm) to several micrometer ( $\mu\text{m}$ ). Aerosol are mainly consist of organic and inorganic compounds, salts, trace metals including heavy metals, and elemental carbon. They come to the atmosphere through variety of sources which can be natural as well as anthropogenic. Natural sources include biogenic emissions, sea salts spray, forest fires, wind-blown mineral dust, and volcanic eruption, whereas anthropogenic sources include emissions from industries, thermal power plants, vehicles, biomass burning and waste burning, etc. Aerosol affect Earth's climate (radiation budget and hydrological cycle), aquatic system (biogeochemistry of ocean and lakes), and air quality (human health and visibility reduction).



Anil Patel

Various epidemiological studies have suggested that the human exposure to ambient aerosol is associated with variety of health related issues. One of the widely proposed mechanisms related to how aerosol affect human health is that several types of aerosol, on inhalation, can produce reactive oxygen species (ROS) in-situ in human respiratory system. Production of ROS may cause imbalance between oxidants and anti-oxidants in the body and lead to several cardio-pulmonary diseases. Capacity of aerosol to produce ROS is also termed as their oxidative potential (OP).



**Figure.** Qualitative depiction of the oxidative potential (OP) of aerosol from different sources and environmental condition

In India, Indo-Gangetic Plain (IGP) receives emission from variety of anthropogenic sources. The OP (measured through dithiothreitol (DTT) assay) of soluble particulate matter smaller than  $2.5 \mu\text{m}$  aerodynamic diameter ( $\text{PM}_{2.5}$ ) was measured over Patiala ( $30.3^\circ\text{N}$ ,  $76.4^\circ\text{E}$ ,  $249 \text{ m amsl}$ ), a semi-urban site located in the IGP, during winter 2014. Biomass burning (BB) derived carbonaceous species were observed to have more OP than those derived from fossil fuel burning (FFB). Mass fractions of water-soluble organic carbon (WSOC) correlated positively whereas that of secondary inorganic aerosol (SIA, sum of the concentrations of sulphate, nitrate and ammonium) correlated negatively with mass normalized OP. Therefore, it is suggested to use WSOC/SIA ratio as a measure of OP of secondary aerosol over the study region. It was also observed that the intrinsic OP for secondary aerosol (i.e. WSOC/SIA ratio) enhances significantly in samples collected during days following foggy nights in comparison to that in samples collected during non-foggy period, which may be due to the production of redox-active species by fog processing. These results suggest a need of taking up online measurement of OP during foggy and non-foggy period to better understand and assess the role of meteorological condition in ROS generation capability of aerosol. Such studies have implications in assessing the effect of ambient aerosol on atmospheric chemistry, air quality and human health.

Source: <https://doi.org/10.1016/j.atmosenv.2017.12.004>



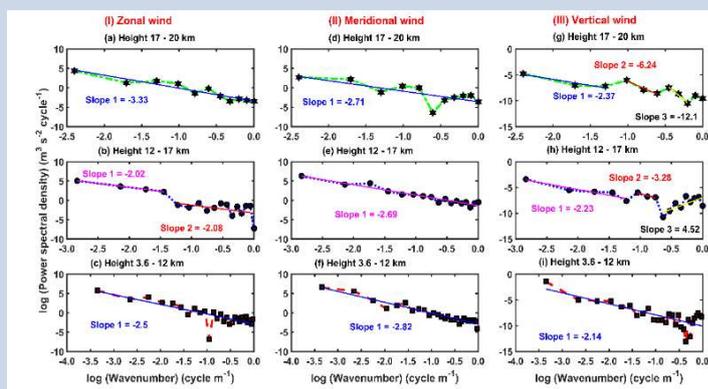
Priyanka Ghosh

## Anomalous Behavior of Vertical Wavenumber Spectra Over a Tropical Station of India

Atmospheric gravity waves (GWs) are generated when force of earth's gravity and magnitude of the stabilizing restoring force (buoyancy) introduced by density gradient become comparable with compressibility forces. Amplitudes of GW increase exponentially throughout their propagation from lower to higher atmosphere. Therefore, these GWs impart energy to the surroundings, while their power of wavenumber spectra and spectral slope gets saturated to preserve overall stability. The universal wavenumber spectra have three distinct regions: unsaturated (log-log slope of 2), saturated (log-log slope of -3), and turbulence region (log-log slope of -5/3). In present work, we report presence of positive slope at the higher end of the vertical wavenumber (VWN) spectra indicating the existence of unsaturated

GWs using Mesosphere Stratosphere Troposphere (MST) radar wind observations, a kind of which is not recounted so far. Much negative slopes ( $\sim -6$ ,  $\sim -9$ , and  $\sim -12$ ) are noticed at the end of the spectra beyond the turbulence region, which is also not testified in any earlier studies. Since the tropopause over Gadanki is at nearly 17-18 km, it can act as a new source of GWs. This can be the probable reason for positive slope in the vertical wind in the altitude range of 12-17 or 17-20 km. Moreover, vertical wind fluctuations usually have a relatively high frequency so when they grow upward from troposphere to lower stratosphere, they are not effortlessly absorbed by the "tropospheric jet-induced critical layer". This can be another plausible reason for the distinct behavior of the VWN spectra of vertical wind.

Source: <https://doi.org/10.1029/2018GL079934>



**Mesospheric temperature inversions (MTIs)**



R.P. Singh

Mesospheric temperature inversions (MTIs) are the narrow thermal layers showing an inversion in the vertical temperature gradient from negative to positive. These MTIs may appear in the mesosphere lower thermosphere (MLT) region at the low- and mid-latitudes at any time of the year. The lower/upper MTI are formed at around 70/85-100 km altitudes, respectively. The formation mechanisms of MTIs are quite complex and have been a subject of investigation since their first detection. For the occurrence of the upper MTIs both dynamics and chemistry play important roles, thus, it is difficult to assess the relative contribution of these mechanisms for their occurrences, let alone their seasonal/geographical dependencies.

Detailed investigations of upper MTIs have been carried out using 4.5 years of high cadence ground-based observations of O<sub>2</sub> and OH nightglow emission intensities and corresponding temperatures from, optical aeronomy observatory, Gurushikhar, Mount Abu (24.6°N, 72.8°E). It was revealed that although both wave dynamics and chemical heating by the exothermic reactions do work together, the in situ chemical heating process seems to be a more probable cause as compared to the vertical transport of energy from lower below. So far, such detailed statistics on MTIs does not exist in the published literature, and thus the results that came out in this work provides the necessary input for a greater understanding of the atmospheric temperature structure through modelling and simulation studies.

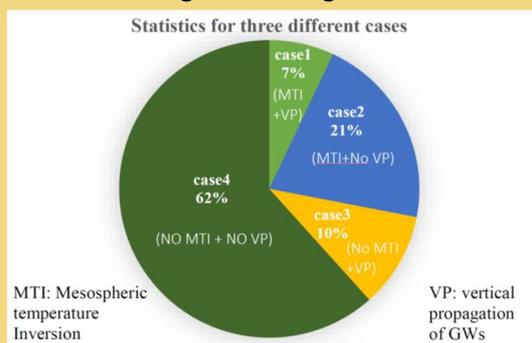


Figure: Pie chart showing the statistical distribution of the four different cases based on the difference in T(O<sub>2</sub>)-T(OH) and vertical propagation of waves in between OH and O<sub>2</sub> emission altitudes. It is found that those nights in which temperature inversion and vertical propagation both are not seen are maximum (case 4, 62%) followed by the nights in which the temperature inversion is seen but vertical propagation is not seen (case 2, 21%). Case 3 represents those nights in which temperature inversion is not seen but the vertical propagation is seen (10%). Around 7% nights represent case 1 in which both temperature inversion and vertical propagation are seen shown by triangle (in blue).

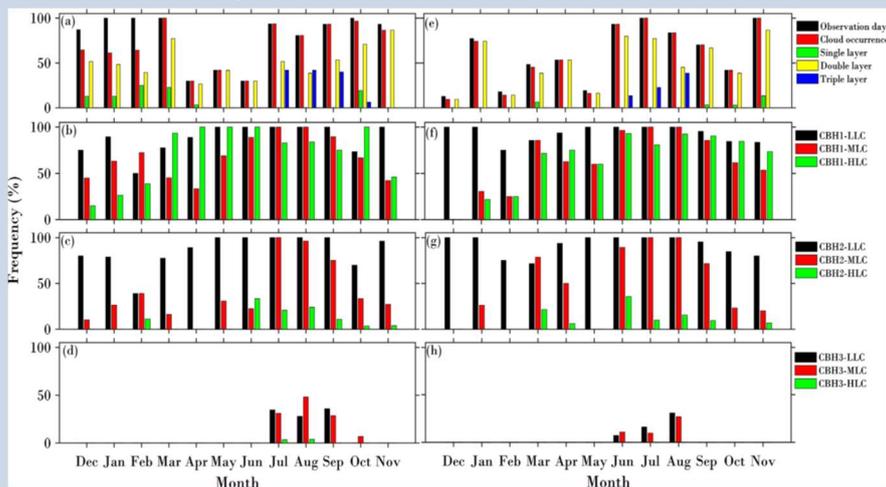
Source: <https://doi.org/10.1029/2018JA025703>



Som Sharma

**A comprehensive statistical study of cloud base height using ceilometer over western India**

A comprehensive statistical analysis of the cloud base height (CBH) measured by ground-based Vaisala ceilometer (CL31) has been performed to study different layers of the cloud in the lower troposphere up to 7.5 km height over Ahmedabad, western India during 2014 and 2015. The total observations (~69%) of cloud using ceilometer show annual cloud occurrence frequency of around 64%. Seasonal variation of CBH and cloud occurrence frequency reveal that the maximum/minimum cloud cover is found during southwest (SW) Indian summer monsoon/pre-monsoon season. Three CBHs (CBH1, CBH2, and CBH3) are presented in monsoon period due to high cloud occurrence, and two CBHs (CBH1 and CBH2) are observed in other seasons due to low cloud occurrence by ceilometer over the observational site. The highest cloud occurrence frequency is found during monsoon (June-September; ~90%) and the minimum cloud occurrence frequency is found during summer (March-May). Based on cloud types classification, results suggest that low level clouds are dominant during summer monsoon season. The CBH1 (~100–2000 m) and CBH2 (500–3000 m) are observed during SW monsoon and summer season, respectively. The CBH3 is occurred usually in SW monsoon season. Moreover, the cloud cover during the day and night time shows that the occurrence of cloud is more frequent in daytime than night-time during pre-monsoon and post-monsoon season. The statistical analysis of cloud with ground-based observations is also performed in this study that may be useful for the development/improvement of regional weather and climate models to reduce the uncertainty in the prediction.



Source: <https://doi.org/10.1016/j.asr.2018.11.006>

## 15<sup>th</sup> Young Astronomers' Meet (YAM) :



The 15<sup>th</sup> YAM, a student conference at the national level, was held at PRL from 24<sup>th</sup> - 28<sup>th</sup> September 2018. There were students from across the length and breadth of the country. A wide spectrum of topics were covered in this conference ranging from Astronomical Instrumentation, Sun and Planetary Science, Exoplanets, Stellar Astrophysics, Extra-galactic Astrophysics and IGM, Galactic Physics and ISM, Cosmology, General Relativity and Gravitational Waves and High Energy Astrophysics. From the healthy exchange of new research ideas and trends among the participants it is seen that the meeting was very successful.

## 3<sup>rd</sup> Student Conference on Optics and Photonics (SCOP)

The SCOP-2018 was conducted at PRL during 4-6 October 2018. The conference was attended by 70 students from all over the country who presented their works as both oral and poster presentations. Shri. A. S. Kiran Kumar (Chairman, PRL council) inaugurated the conference and delivered a plenary talk. SCOP-18 was enriched with an increased number of invited talks intended towards an enhanced academic benefit for the participants. 15 invited talks by young scientists were hosted from different institutes all over the country on topics across a wide spectrum of optics – ranging from physical optics to quantum optics. The conference hosted extensive poster sessions in which student researchers exchanged their ideas among peers and experts through rigorous interaction.



## 15<sup>th</sup> International Symposium on Equatorial Aeronomy (ISEA-15)



The ISEA-15 was held at PRL during October 22 – 26, 2018. ISEAs are held to bring together global scientists involved in research on various aspects of low- and equatorial latitudinal regions of upper atmosphere (altitude of 80 km and above the earth's surface) which includes the regions of mesosphere, thermosphere, and the ionosphere. The 3<sup>rd</sup> ISEA meeting was held in 1969 at PRL under the leadership of Prof. Vikram Sarabhai, the founder of PRL. This 15<sup>th</sup> ISEA meeting was a kick-off of the Birth Centenary celebrations of Prof. Vikram Sarabhai at PRL. This time, it brought together around 180 scientists from 22 countries involved in research of both fundamental and applications aspects. There was a sizeable participation from young scientists (under 30 years).

## Seasonal Influenza Vaccination Camp report

Seasonal Influenza infection is very common in India. Now-a-day it affects a lot of people and may compromise life in certain high risk group of patients. Patients like Diabetes, On Steroids and chemotherapy treatment, various lung diseases, cardiac problems, extreme of age and renal diseases are more vulnerable to this disease. To protect CHSS beneficiaries of PRL against seasonal influenza virus, a vaccination camp was organized at PRL Dispensary, Navrangpura Campus during 28<sup>th</sup> to 30<sup>th</sup> November, 2018. The vaccine Vaxiflu-4 (Tetravalent) was used to protect against the 4 subtypes of Influenza virus. About 315 vaccinations were given during the above period. We anticipate arranging such kind of camps every year at PRL.



Shital Patel

## Informal interactive session by Internal Complaints Committee (ICC)

On 30th November 2018 the ICC interacted with the women employees of PRL as a continuation of its activities on "Safety of women at the work place" and awareness programmes to sensitize the employees and to promote gender equality at regular intervals. The invited speakers were Ms. Indu Capoor, External Expert, ICC to talk informally and introduce gender sensitivity to the audience and Dr. Aarti Khodani, who is a nutritionist and wellness expert, to deliver a talk on wellness programme. Both these talks were appreciated by the audience and generated questions directed to the speakers.



## Swachhata Hi Seva program



PRL observed "Swachhata Hi Seva" program from 15.09.2018 to 02.10.2018. Under this program, mass pledge ceremony, promotional activities and tree plantations were carried out at PRL. Fumigation and pest control drive was conducted within the PRL campuses and it was aimed to make our campuses "NO PLASTIC ZONE". Many Activities for rural School Children were organized, where young students show cased their creativity in Drawing and Slogan Writing. A sanitation awareness lecture was delivered by PRL Medical Team at the Municipality Primary School, Vastrapur on 28.09.2018. PRL Medical team distributed First Aid Kits to the students and nearby Residents. On 01.10.2018 Prof. Deepa Maheswari from CEPT University, Ahmedabad gave a lecture regarding facts on how urbanisation and modern living in major cities drain out green ponds and canals, reducing them to small water pockets leaving birds and animals deprived of their natural food cycle. PRL has also initiated for a



Vermicomposting Machine for kitchen waste and green waste of vegetables from General Canteen and dry plant waste at PRL Main Campus.

## Udaipur Solar Observatory Foundation Day



The Foundation Day 2018 of the Udaipur Solar Observatory was organized to commemorate the rich history and growth of the Observatory which was established in 1975 on Lake Fateshagar under the arduous effort of Prof. Arvind Bhatnagar and his team, providing rich insight into the dynamic solar chromosphere and its associated phenomena. The event was held at USO in the afternoon with an inaugural address by Prof. Anil Bhardwaj, Director PRL, who emphasized the important role played by USO in several crucial aspects of Solar Physics, including Space Weather and Sun-Earth coupling. Prof. Ashok Ambastha, Honorary Scientist USO-PRL, gave a talk on the "The first 25 years of USO from its inception". Prof. Nandita Srivastava, Deputy Head USO-PRL, then spoke on the current activities and future research programmes at the Observatory. The special lecture of the day was delivered by the guest of honour Prof.

Amita Das, Senior Professor Institute for Plasma Research Gandhinagar, on **The Enigma of Magnetic Fields**. The Foundation Day gathering also included several PRL personnel, as well as faculty and students from local colleges and Universities.

## Vigilance Awareness Week 2018

The "Vigilance Awareness Week 2018" was observed at PRL from October 29, 2018 to November 3, 2018 wherein the Vigilance Awareness Pledge was administered to all the staff members. Banners and various pamphlets with regard to Vigilance Awareness were displayed. This year's theme was "Eradicate Corruption-Build a New India". An essay writing competition was organized on 01.11.2018 on this theme. A vigilance awareness lecture was delivered by Shri Jaypal Singh Rathore, Deputy Commissioner of Police, Zone-I on 02.11.2018 in PRL.



Vigilance Awareness Lecture on "Eradicate Corruption-Build a New India" held on 02.11.2018 in the NanoSIMS Lecture Hall, PRL.



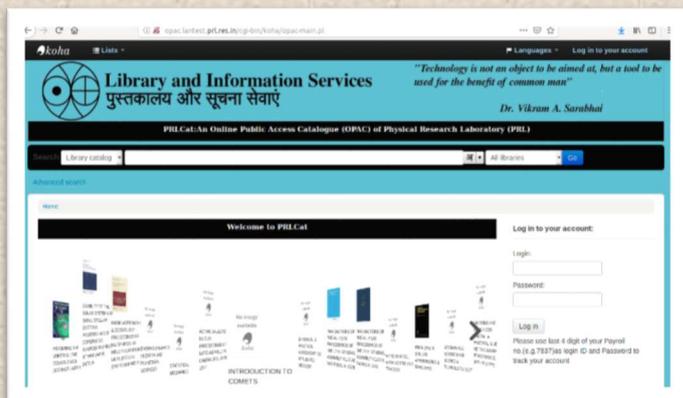
## Sports Gallery

### ISRO Inter Centre Sports Meet (ICSM-2018):

ICSM-2018 for Athletics and Indoor games was held in SDSC-SHAR in two phases from 27.08.2018 to 06.09.2018. PRL had active participation in both the phases of the tournament. In the second phase of the tournament, PRL table tennis team won third prize, stood second and third in the men's open doubles category. PRL team also won fair play award for the first time.



## PRLCat: A Next Generation WebOPAC at PRL Library



An initiative has been taken for in-house development and implementation of PRLCat using Koha – an open source Integrated Library Management Software (ILMS) in PRL Library. This is a pilot project with the Thaltej Library books collection and a few journals as sample. Koha testing and evaluation by real users and real searches as a part of library trials has been done successfully. This project will fulfil the mandate of Antariksh Gyaan (ISRO Library Consortium) and enhance the open source movement in India. This effort is to keep PRL library at par with the libraries of DOS/ISRO centres/units.

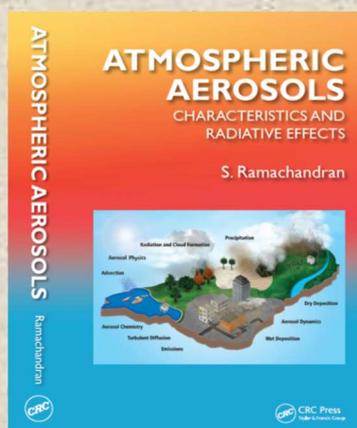


Nurul Alam

## Facility at Udaipur Solar Observatory

Compound Astronomical Low cost Low frequency Instrument for Spectroscopy and Transportable Observatory (**CALLISTO**) is a valuable tool for the observations of solar flares and coronal mass ejections in radio wavelengths. A unit of CALLISTO has been commissioned at USO in October 2018. The instrument natively operates between 45 and 870 MHz with a frequency resolution of 62.5 kHz. The radio spectrometer, attached to a Log Periodic Dipole antenna, is a programmable heterodyne receiver developed at ETH Zurich, Switzerland. The radio spectrum at meter and decimetre frequencies, obtained by the CALLISTO, can be used to investigate many important magnetic and plasma processes on the Sun. They provide the first signature of flare shocks (Type II events) and electron beams escaping from the Sun on open magnetic field lines (Type III bursts). In addition, they record unexplained emissions of active regions (Type I noise storms) and long-lasting emission after large flares (Type IV events). The data recorded by CALLISTO at USO is being stored on daily basis at local as well as central data servers.

## Books Published



A book entitled *Atmospheric Aerosols: Characteristics and Radiative Effects* has been written by Prof. S. Ramachandran, which offers a broad perspective on aerosols, highlights the different kinds of aerosols, their space-time variations, continental-maritime features, and their influence the Earth-atmosphere radiation budget, climate, health and agriculture. Measurement techniques, instrumentation and working principles of instruments that are used to measure a variety of aerosol characteristics including remote sensing are dealt with in detail. Aerosol-cloud interactions, aerosol-climate coupling through biogeochemical cycle and their impact on radiation and Earth-atmosphere system are also dealt with.

Taylor & Francis Group, CRC Press, USA, June 2018, 294 pages, ISBN-10: 1498750737



Mr. V. Ranganathan has written a book on his experiences in PRL during his career, which has been translated in Hindi and is e-published as "*PRL ke merey anubhav*". The same is available on PRL website under the Hindi section and can also be found from the following link.

[https://www.prl.res.in/prl-eng/documents/ranganathan\\_book.pdf](https://www.prl.res.in/prl-eng/documents/ranganathan_book.pdf)

## Science Express Started Its Journey

To mark birth centenary of Dr. Vikram A. Sarabhai, NSD-2019 team at PRL planned to organise science exhibition/demonstrations at different places of Gujarat in coordination with schools/community science centres. The motive is to reach out to the general public and students and share the excitements of science. First chapter of the effort started rolling out with two days visit during 22-23 December, 2018 at Dhrol, Jamnagar and Rajkot. Twenty seven volunteers from PRL, spent their Christmas weekend in a very special way demonstrating nearly 20 experiments and interacting with students and other visitors in general. The experiments were set-up to demonstrate different aspects of science as applicable in day to day life. The event at Dhrol started with a brief introduction and different science activities at PRL by showing a documentary followed by demonstrating the experiments. The effort was well appreciated with an impressive 600+ footfall in three hours in spite of the restricted audience by the local organisers. Next morning a similar demonstration was carried out at Rajkot. Unlike Dhrol, the audience here spanned over a wide range of age group, including school and college students, parents and teachers. In this full day activity we had 1000+ excited visitors. In several occasions delighted students thanked for this opportunity. We addressed many of their queries about science activities and opportunities at PRL. Some college teachers wished to have similar demonstrations/hands-on experiments at their respective campuses in near future. Science Express is a novel effort to bring the scientific exposure at the door of a student at far corners of Gujarat. This is to fulfil our social obligations towards our community by providing lasting impressions to cultivate the scientific inquisitiveness among the future generation. Moreover, such experience provided a learning exposure for all our young volunteers who faced all challenges with great energy and enthusiasm.



*(Image showing the Science Express team after demonstration at Dhrol)*

## World Space Week Celebrations

In its responsibility towards popularization of Science, PRL has always been on the front foot. About 900 students participated in the World Space Week celebrations at PRL during 8<sup>th</sup> and 9<sup>th</sup> October. In line with the Space Week celebrations at PRL, a one-day event was also organized at USO on 9<sup>th</sup> October 2018, around 50 school children (from 8<sup>th</sup> to 12<sup>th</sup> standard) and their teachers from five Government-run schools located in and around Udaipur were invited to this event. They visited the various facilities at the USO.



- ✚ **Rishitosh Sinha** and **S. Vijayan** won **first prize** in the poster category for the paper titled “**Study of layered deposits in the East Melas Chasma, Mars using MCC, HiRISE, THEMIS and MOLA data**” in the *National Symposium on Advancements in Geospatial Technology for Societal Benefits and Annual Conventions of Indian Society of Geomatics (ISG) & Indian Society of Remote Sensing* held in Space Applications Center Ahmedabad during December 05-07, 2018.
- ✚ **Anil Patel** won **Best Paper Award** for his paper entitled “**Reactive Oxygen Species Generation Capacity of Ambient Aerosol over the Arabian Sea**” at *Indian Aerosol Science and Technology Association (IASTA) Conference, IIT-Delhi*, November 26 - 28, 2018.
- ✚ **Nandita Srivastava & D. Pallamraju** were **Invited Experts** to review the next scientific program of the **Scientific Committee On Solar Terrestrial Physics(SCOSTEP)** at the *International Space Science Institute, Beijing, China* during November 13-17, 2018.
- ✚ **Rumkee Dutta** won the **Best Paper Award** in the Rajbhasha Session at the **inter centre Hindi technical seminar** at *NRSC, Hyderabad*, November 15-16, 2018.
- ✚ **Deepak Karan** won the **first Prize** and **Diptiranjan Rout, Sivakandan Mani & Kuldeep Pandey** were adjudged among top 5 presentations in the “**Young Scientists Competition**” that was held in the 15th *International Symposium on Equatorial Aeronomy (ISEA-15)* at *PRL* during October 22 – 26, 2018.

**PRL FRATERNITY HEARTILY CONGRATULATES ALL THE COLLEAGUES WHO HAVE BEEN CONFERRED WITH THESE AWARDS AND HONOURS.**

## Colloquium @PRL

- ✚ **Rajesh Gopakumar**, (Director, ICTS-TIFR, Bengaluru) gave a talk with the title “**Down-To-Earth String Theory**”, on November 19, 2018.
- ✚ **Debabrata Goswami** (Professor S. Sampath Chair Professor of Chemistry, IIT Kanpur) gave a talk on the topic “**Femtosecond Laser Induced Spatiotemporal Control and Photothermal Spectroscopy for Remote Sensing and Computing at Nanoscale**”, on October 03, 2018.
- ✚ **B. Ravindra** (Indian Institute of Astrophysics, Bengaluru) gave a talk regarding the “**Complex Evolution of Magnetic Helicity in Active Regions**”, on December 06, 2018.
- ✚ **Bhargav Vaidya** (Discipline of Astronomy, Astrophysics and Space Engineering, IIT Indore), presented on the topic “**Advances and Challenges in Space Plasma Modelling and Its Application to Space Weather Forecasting**” on December 16, 2018.

# Welcome and Farewell

## New Joinees



Ashish Kumar  
Scientist/Engineer-SC  
Date of Joining: 27.09.2018



Aseem Jaini  
Scientist/Engineer-SC  
Date of Joining: 24.09.2018



Surajit Mohanty  
Scientist/Engineer-SC  
Date of Joining: 20.07.2018



P. Narendra Babu  
Scientist/Engineer-SC  
Date of Joining: 24.09.2018



Girjesh R Gupta  
Reader  
Date of Joining: 25.09.2018



Deepak Painkra  
Scientist/Engineer-SC  
Date of Joining: 10.09.2018

PRL welcomes all the new members and wishes them a bright and enjoyable career ahead.

## Superannuation



Shri G.P. Ubale (Engineer – SG), attained superannuation on 31.07.2018. PRL fraternity wishes him a joyous and healthy life ahead.

## Obituary



Shri. Shikari Pinakin Surendrabhai, Senior Assistant at PRL, breathed his last on 15.11.2018. PRL fraternity prays to God that his soul may rest in peace and may his family get the strength to cope with this huge loss. A highly active person, he always wore a smile on his face and came up with solutions in every way possible. He will always be remembered for all the contribution made to PRL.



Editorial board:



Bijaya Sahoo



Som Sharma



Partha Konar



A. Shivam



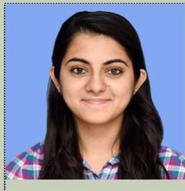
Neeraj Srivastava



Pragya Pandey



Prashant Jangid



Garima Arora



Rohan Louis



Kartik Patel



Deekshya Sarkar



Vivek Mishra



Veeresh Singh

Special Thanks to:

Nidhi Tripathi

Niharika Sharma

Harsh Raj

Akanksha Bharadwaj

Shefali Uttam

Amit Pandey

Srinivasa Pasanna

