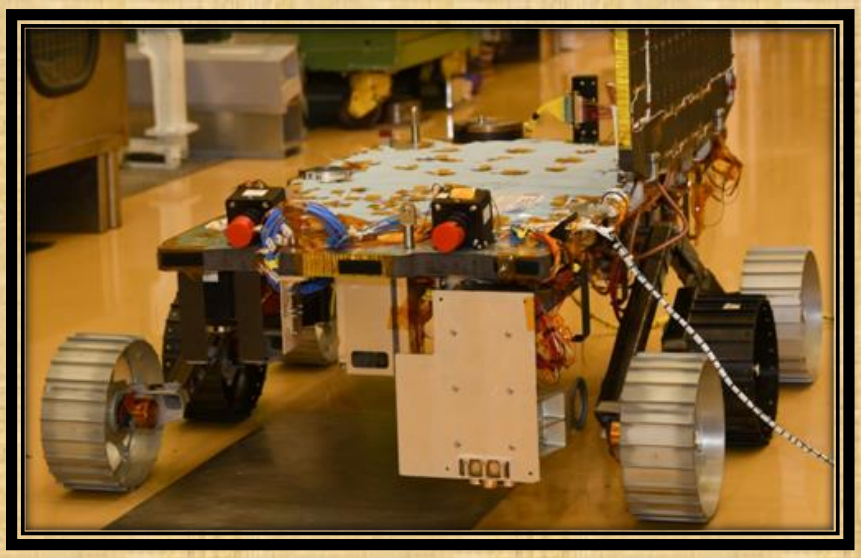
PRL News – The Spectrum

September 2019



Physical Research Laboratory
Ahmedabad - 380009
India

भौतिक अनुसंधान प्रयोगशाला
अहमदाबाद-380009
भारत

Website: https://www.prl.res.in/prl-eng/newsletter

Contact us: newsletter@prl.res.in

PRL Experiments on Chandrayaan-2 mission

Shanmugam M

(APXS and XSM: M. Shanmugam, S. V. Vadawale, Arpit R. Patel, Hitesh Kumar Adalaja, N. P. S. Mithun, Tinkal Ladiya, Shiv Kumar Goyal, Neeraj K. Tiwari, Nishant Singh, Sushil Kumar, D. K. painkra, Y. B. Acharya, S. V. S. Murty, Anil Bhardwaj and Team.)

(ChaSTE: K. Durga Prasad, Chandan Kumar, S. Mishra, P. K. S. Reddy, Janmejay Kumar, T. Ladiya, Anil Bhardwaj, S. V. S. Murty, Vinai Rai and ChaSTE Team)

Chandrayaan-2, the second Indian mission to the Moon, is a logical extension of the first Indian Moon mission – Chandrayaan-1. Chandrayaan-1 consisted of an orbiter and an impactor, which crash-landed on the lunar surface. Chandrayaan-2 now consist of a lander, named Vikram, which will soft-land on the Moon near its south pole. It goes a step further by having a rover, named Praygaan, which will explore the region surrounding the landing site. While the presence of a soft-lander and a rover makes Chandrayaan-2 far more complex technically, it is also equally advanced in terms of scientific instruments. It is well known that many scientific discoveries by Chandrayaan-1 lead to rewriting of the lunar science textbooks. Chandrayaan-2 aims to carry forward the same legacy with the help of a wide array of highly advanced scientific instruments for morphological, mineral, chemical and radar studies of the lunar surface on global scale; as well as chemical, thermos-physical and seismological studies on local scale. It is matter of great pride for PRL that we have scientific experiments on all three components of Chandrayaan-2 i.e. the orbiter, Vikram lander and Pragyaan rover.

Solar X-ray Monitor (XSM) On-board Chandrayaan-2 Orbiter

Figure 1: Flight model package of XSM Sensor package (left) and XSM Electronics Package (right).

One of the main objectives for Chandrayaan-2 is to generate global maps of elemental composition of the entire lunar surface. This will be achieved by employing the technique of remote X-ray fluorescence spectroscopy. This technique is ideally suitable for the atmosphere less bodies such as Moon, where the surface elements can be excited by incident solar X-rays. While identification of various constituent elements can be carried out by measuring the energies of the characteristic X-ray lines, quantitative estimation of the elemental abundances requires accurate knowledge of the exciting radiation, in this case solar X-rays. The Solar X-ray Monitor (XSM), designed and developed at PRL (Figure 1), fulfils this crucial requirement, thus enabling quantitative interpretation of the lunar X-ray spectrum measured by the companion instrument CLASS (Chandrayaan-2 Large Area Soft X-ray Spectrometer). Accurate measurement of the solar X-ray spectra by XSM will also address many important

questions of solar physics, such as - How non-thermal processes evolved during solar flares? If and how the elemental abundance in solar corona varies in response to the solar flares and CMEs? Do solar X-rays have any non-thermal component during quiet phases? etc. XSM will achieve this by measuring the solar X-ray spectra in the energy range of 1 – 15 keV with very high energy resolution (better than 180 eV @5.9 keV) using a 'state-of-the-art' X-ray detector known as Silicon Drift Detector (SDD). For the optimal performance, the SDD is cooled to -35°C and this temperature is maintained irrespective of ambient temperature variations. Another key feature of XSM is its ability to handle extremely wide range of solar X-ray intensity – It is well known that the solar X-ray intensity can vary by orders of magnitude within few minutes during large solar flares. XSM contains enough intelligence to automatically detect the large flares and activate on-board mechanism to appropriately change the energy range so as to maintain consistent energy resolution over large intensity range. However, the most important feature of XSM is its capability of measuring full energy spectrum with highest time cadence – XSM is designed to measure full solar X-ray spectrum at every one second. So far no other solar X-ray spectrometer, even on-board the mission dedicated for solar studies, measure solar X-ray spectrum with such a high time resolution. With such a unique capability, XSM on-board Chandrayaan-2 orbiter is certainly going to provide extremely fruitful observations.

ChaSTE (Chandra's Surface Thermophysical Experiment) onboard Vikram lander

Figure 2: ChaSTE Front-End Electronics – Flight Model

Lunar subsurface heat flow measurements are often perturbed by external thermal forcing due to solar insolation. Therefore, assessment of present-day internal heat flux on the Moon requires precise estimation of equilibrium boundary between external (solar) and internal (due to radioactive decay and accretion) heat fluxes which also aid in understanding the present thermal state of the Moon. Further, in order derive more accurate lunar thermal models, it is very important to know the extent and the spatial variability of the insulating fluffy layer and thermophysical properties of the top 10 cm of the lunar regolith. To address these aspects, ChaSTE (Chandra's Surface Thermophysical Experiment) payload has been developed, jointly by PRL and SPL, VSSC.

The principle objectives of ChaSTE are:

1. To obtain temperature profile and thermal conductivity within the top 10 cm of the lunar surface at the landing site
2. To understand the thermophysical properties of lunar surface and constrain the equilibrium boundary between the internal and external heat fluxes

ChaSTE will provide us the first in situ thermal profiling of the uppermost lunar surface and also the first-ever in situ thermal measurement at a high latitude region of the Moon. ChaSTE experiment consists of a thermal probe (to be inserted into lunar surface by a deployment mechanism), an electronics box (houses all the necessary electronics and placed in a controlled environment on the lander) and a deployment mechanism.

PRL is responsible for the development of ChaSTE Front-End Electronics card (Figure 2) which is the heart of ChaSTE payload which acquires the raw sensor data (acquired from all the 10, 4 wire RTD sensors and a heater mounted on the probe), signal conditioning and digitization of data for further processing by processing electronics (PE). The sensor used for temperature measurement is a custom-designed Platinum RTD (Resistance Temperature Detector) sensor. ChaSTE probe is realised out of a custom-developed composite material having extremely low thermal conductivity and high tensile strength. PE, Probe and the deployment mechanism are developed by SPL, VSSC. Based on the landing site constraints, the electronics is designed to measure surface/subsurface temperatures from ~ -200 to 100 ºC.

Alpha Particle X-ray Spectrometer (APXS) on-board Pragyan rover

Accurate knowledge of the elemental abundance of the lunar surface and its variation over a local scale is very important for understanding the local geology. Alpha Particle X-ray Spectrometer (APXS) on-board Pragyan rover is designed to carry out such measurements along the rover path in the vicinity of the landing site. APXS (Figure 3) will estimate the elemental conc entration by measuring the characteristic X-ray lines, similar to the remote X-ray fluorescence spectroscopy experiment on-board orbiter. However, for APXS, it is not appropriate to rely on the solar X-rays as excitation source due to relatively short duration of the rover operation for one lunar day (~14 earth days). Hence, APXS is designed to have its own excitation source in the form of a radio-active element Curium-244, which emits radiation in the form of alpha particles (5.8 MeV) and X-rays (14.3 & 18.4 keV). Both alpha particles and X-rays can excite surface elements to produce the characteristic X-ray lines but their effectivity depends on the atomic number of target element. The alpha particle induced X-ray emission (PIXE) is dominant for the low-Z elements (Z=11 to 20) resulting in enhanced sensitivity for the major rock forming elements such as Mg, Al, Si, Ca etc. APXS will be the first-ever instrument on the Moon to employ the PIXE process. It uses the same X-ray detector, SDD, as XSM but with optimized electronics resulting in higher energy resolution of ~135 eV @ 5.9 keV. Another key feature of APXS is an innovative mechanism, which takes both the SDD and the Cm-244 sources close to the lunar surface at a distance of ~5 cm as shown in Figure 3. This facilitates a fairly quick measurement (a typical measurement at 5 cm takes approximately 45 to 50 minutes compared to about 5-6 hours, if the detector and sources are about 15 cm distance) and thus larger number of measurements resulting in better utilization of the short life time of the rover. APXS, being the first experiment of its kind on lunar surface, is expected to provide unique data from the south polar region of the Moon.

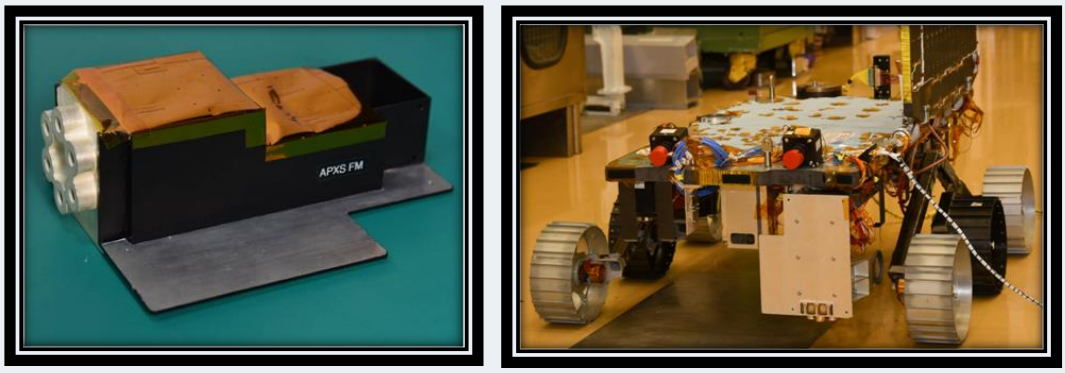


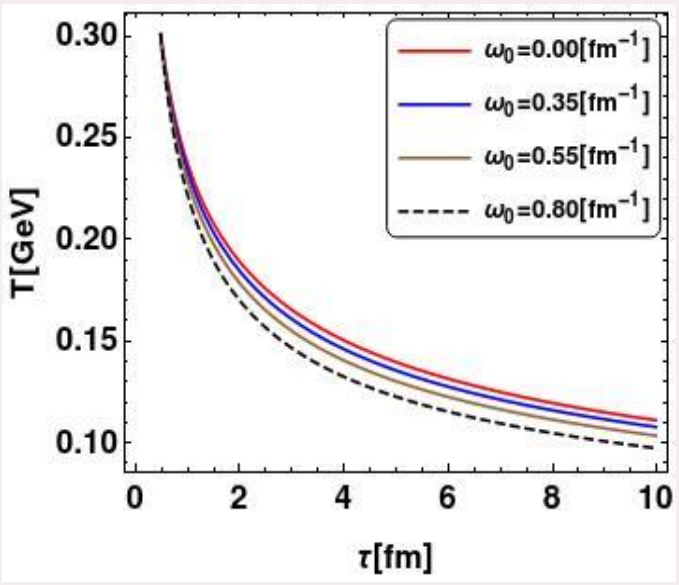
Figure 3: Flight model package of APXS (left) and APXS mounted on Pragyan rover in deployed condition (right).

Probing vorticity in heavy ion collision with dilepton production

(Balbeer Singh, J R Bhatt and Hiranmaya Mishra)

Balbeer Singh

The deconfined state of strongly interacting matter is created in Heavy Ion Collisions by colliding two heavy nuclei. Due to the shear forces between nuclei, finite angular momentum transfer is transferred from the interaction region to the Quark Gluon Plasma (QGP). This makes QGP a vortical fluid. In this regard, we study the effect of vorticity present in heavy ion collisions (HICs) on the temperature evolution of hot quark gluon plasma in the presence of spin-vorticity coupling. The initial global rotation entails a non- trivial dependence of the longitudinal flow velocity on the transverse coordinates and also develops a transverse velocity component that depends upon the longitudinal coordinate. Both of these velocities lead to a 2+1-dimensional expansion of the fireball. It is observed that with finite vorticity and spin-polarization the fireball cools faster.



Source: 10.1103/PhysRevD.100.014016

Figure Caption: Temperature evolution of the fireball with time for various values of initial vorticity.

PLANEX Program (2001-2018) *(Debabrata Banerjee)*

Debabrata Banerjee

A new initiative by Indian Space Research Organization (ISRO) for beginning a program of dedicated Space missions in Planetary and Space Sciences led to the announcement of the first Indian Moon Mission, Chandrayaan-1 in August 2003, and opened new opportunities for scientists and technologists within India to embark upon a new era of Planetary Exploration. In this context, the Advisory Committee on Space (ADCOS) suggested a comprehensive national program on Planetary Sciences be taken up as a thrust area of research in the country. A plan was prepared and submitted to ISRO, followed by reviews and a formal approval from ISRO to begin a program on Planetary Science and Exploration (PLANEX) with the Physical Research Laboratory being the nodal point.

The objectives of the PLANEX Program comprised (i) carrying out research on areas of Planetary Sciences and encourage young students to participate in Planetary Science research, (ii) provide discussion forum for Planetary Exploration Missions of ISRO for science objectives, payload design and data analysis, and (iii) provide facilities for research in Planetary Sciences at other academic institutions/universities.

To realize the above objectives, the PLANEX Program began supporting projects being undertaken at various institutions and Universities within India. Many new research groups have taken up planetary science projects on studies of meteorites, impact craters, spectral reflectance, laboratory studies of lunar analogues, analysis of data from planetary missions and planetary instrumentation.

Since the beginning of PLANEX Program, 57 projects have been supported which have produced important results in the field of planetary sciences, and resulted in nearly 200 publications in peer-reviewed journals. Sixteen workshops on Planetary science and instrumentation themes have been held at PRL and various other universities and institutions. The PLANEX Program has developed a keen interest and eagerness amongst young MSc/BE students who have been motivated to pursue research in planetary sciences.

Despite the initial success of the PLANEX program, payloads for planetary science missions are being proposed and developed almost entirely by groups within ISRO centres/units. It is noteworthy here that ISRO constituted a Solar System Exploration Study Team in May 2015 which provided an overview of the status of the current knowledge about the solar system, while focussing primarily on Mars and Venus, and outlined various scientific problems yet to be addressed in future missions. This report also outlined spacecraft systems and launch system capabilities for new ISRO planetary missions.

The solar system Exploration study team submitted a second report on planetary exploration between 2025-2050 towards the end of 2016. This report suggested five major missions in the next 3-4 decades: (i) a Mars lander/rover mission, (ii) balloon based atmospheric studies at 55-75 km above Venus surface, (iii) a lunar sample return mission, (iv) an asteroid sample return mission and (v) a Europa orbiter mission. In light of this, the national program on Planetary Sciences must be continued, and taken up as a thrust area of research in the country. As part of the PLANEX Program, new projects will primarily focus on studies that may directly feed into ISRO's program planning and observations.

There should be more projects which use remote sensing data from previous ISRO or other missions. Studies of laboratory analogues should be pursued in future as well. Meteorite studies and research on habitability or the possibility of life on Mars should be carried out in some projects. As sample return missions may be realized in future, curation or storage facilities for returned samples requires consideration. Workshops and training courses should be held once every year where around 30 participants from various institutions can undergo an orientation course.

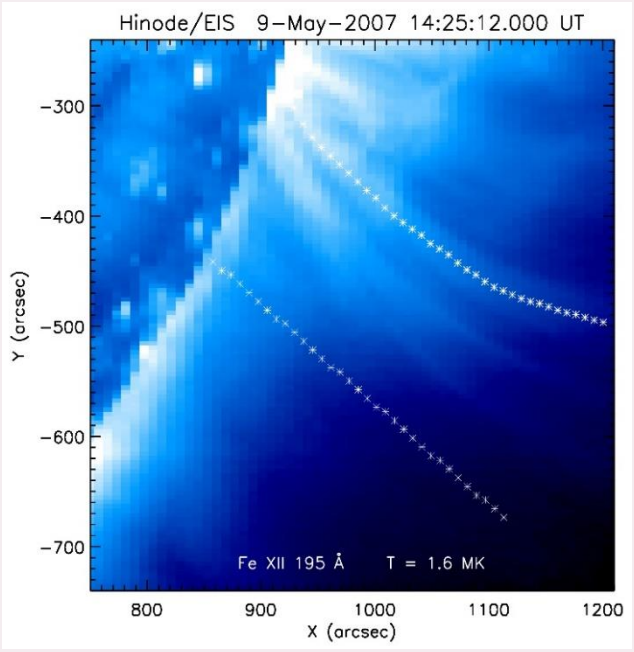
Other laboratories (besides PRL), that have interest and capabilities should be equipped with instruments for analysis of elemental and isotopic composition of existing planetary samples and should be made ready for sample return missions. In summary, a robust program in cosmochemistry and isotopic studies is an important prerequisite for planning space missions, and can provide the necessary knowhow in planning, execution, instrument development and analyses of samples obtained from lander/rover based, and sample return missions in future.

Exploring the damping of Alfvén waves along a long off-limb coronal loop up to 1.4 $R_{\odot}$

(G. R. Gupta, G. Del Zanna and H. E. Mason)

Girjesh Gupta

The definite physical processes responsible for the heating of solar corona (> 1 MK) have not yet been identified and remains one of the most puzzling problems in the astrophysics. There are several physical models exist to explain phenomena such as wave dissipation (AC) and magnetic reconnection (DC) mechanisms. Coronal loops are the basic building blocks of the solar corona and physical parameters along the loop are highly sensitive to heating mechanisms. Thus, to distinguish among the different heating models, accurate measurements of basic plasma parameters along the coronal loops, such as temperature, density, velocity, non-thermal velocity etc. are essential. In this work, we identified a very large offlimb coronal loop observed by Extreme-ultraviolet Imaging Spectrometer (EIS/Hinode) to perform the detailed analysis (see Figure 1). We employed several spectroscopic methods to obtain various plasma parameters along the loop such as line ratio method for the density (Ne), emission measure-loci (EM-loci) method for temperature (Te), spectral line broadening for Alfvén wave amplitude (Vnt). We further obtained proportional Alfvén wave energy flux (Ne1/2Vnt2, see Figure 2). Observed loop was found to be almost in hydrostatic equilibrium and isothermal across as well as along the loop length with a temperature of about 1.37 MK. Although we did not find any significant decreasing trend in the Alfvén wave amplitude with height, we found clear evidence of damping of Alfvén wave energy flux with height. The estimated Alfvén waves energy flux along the loop can contribute significantly for the coronal losses due to radiation.



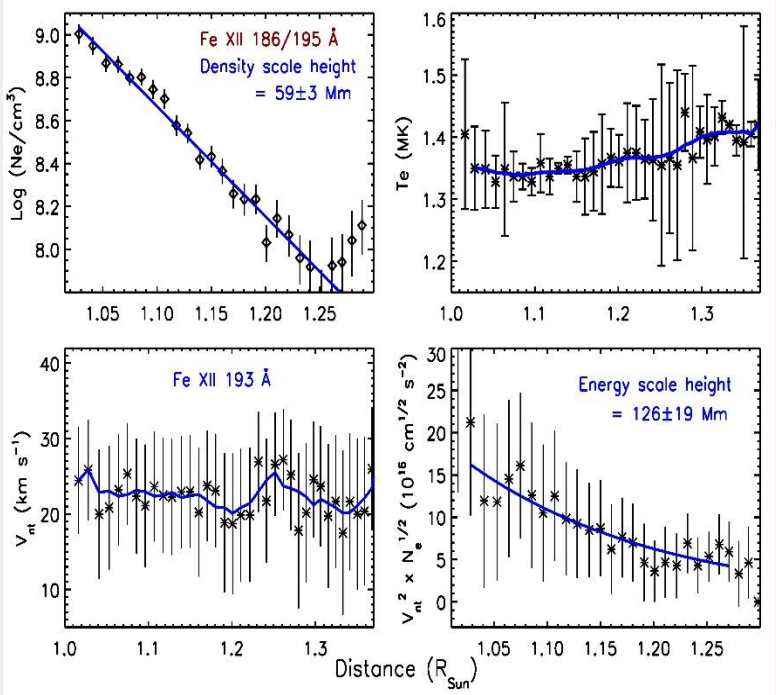


Figure 1 (Above): Intensity map obtained from Fe XII 195 Å spectral line showing the long coronal loop traced out for detailed study. The quiet Sun region is also traced out for determining the background.

Figure 2 (left): Top left panel: Electron densities obtained from the line pair of Fe XII λ186.88/λ195.12 and fitted with an exponential function to obtain the density scale height. Top right panel: temperature obtained along the loop using the EM-loci method. Bottom left panel: Alfvén wave amplitude obtained from the Fe XII 193 Å spectral line. Bottom right panel: Proportional Alfvén wave energy (α $Vnt^2Ne^{1/2}$) obtained along the coronal loop and fitted with an exponential function to obtain the Alfvén wave energy scale height.

Source: https://doi.org/10.1051/0004-6361/201935357

Independence Day at PRL

The 73rd Independence Day was celebrated with full fervour at PRL by the staff members and their families. The event commenced with the parade by the CISF and the hoisting of the National Flag by Dr. Anil Bhardwaj, Director, PRL. After the National Anthem, the Director gave an inspiring speech to the audience. He also awarded mementos to Prof. P. Janardhan and Mrs. Priti Poddar on completion of their 25 years of services at PRL. Three best CISF cadets were also awarded for their sincere services to the organization. Tricolour balloons were released in the sky by the children and PRL staff celebrating the joy of freedom.

Vikram Sarabhai Innovation Competition (VISION) 2019 *(Mudit Srivastava)*

Mudit Srivastava

Vikram Sarabhai Innovation Competition (VISION) 2019 is a national level competition organized by PRL to commemorate the birth centenary year of Dr. Vikram Sarabhai. The concept of VISION-2019 is to promote experimentation in the physical sciences among the science and engineering college students. Project proposals were invited from B.Tech./B.Sc./M.Sc. etc. students which could be executed within 6 months in their colleges. The project grants up to Rs. Three Lacs are to be given to the shortlisted proposals. First, Second and Third prizes of Rs. Three Lacs, Two Lacs and One Lac are also to be given to winner teams, on the successful completion of the projects. The competition opened in February 2019 and total 121 proposals were received in the VISION-2019 program from all over India including several IITs, IISERs, NISERs, NITs, Central and State Universities, government and private engineering colleges etc.

The proposals were comprehensively reviewed through a three-level screening process that spanned over one and half months and with the help of several PRL and external faculties. 29 PRL faculties from all the research divisions and 9 external reviewers (from IISc, NCRA-TIFR, VSSC-ISRO, National Institute of Hydrology-Roorkee, IIT-Kanpur, IIT-Gandhinagar, Ahmedabad University, NPRL-CSIR) reviewed the proposals as domain experts. Shortlisted proposals were further deliberated by a screening committee with both internal and external faculty members (from IIT Gandhinagar, IPR Gandhinagar, SAC-ISRO) and 11 VISION proposal teams were invited to PRL for their proposal presentation on 30th May 2019. The 11 invited teams were from IIT-BHU, IISERs (Kolkata and Tirupati), NITs (Tiruchirappalli and Durgapur), NISER-Bhubaneshwar, Osmania University, two private universities (Thapar University Patiala and GD Goenka University Gurgaon) and Rajalakshmi Engineering College, Chennai. All or some members of 10 Teams out of 11 have come to PRL for in-person presentations. One team from Osmania University, Hyderabad had presented the proposal via remote presentation option. Total 21 members out of 26 participants have participated in the VISION-2019 in-person presentations and other programs during 29th-31st May 2019. A 12 members Selection Committee (with 6 PRL and 6 external members from IIT Gandhinagar, IPR, SAC-ISRO) reviewed all the 11 proposal presentations and recommended 6 teams to be given VISION-2019 project grants. The Selected VISION-2019 Team are from Thapar University Patiala, IIT-BHU, IISER-Kolkata (two teams), IISER-Tirupati, and NIT-Tiruchirappalli. The requested project grants have been disbursed to the selected teams. The teams are currently working on the projects in their colleges/institutions and would be called again to PRL for final round of the competition by the end of the year.

Events and Activities

Green Initiative in PRL – Recruitment Activity *(Pradeep Sharma and Girish Padia)*

Paper saving is a high priority of the Environmental Paper Network. Reducing wasteful paper consumption and ensuring fair use should be first goal of every one of us. "Go Green," "Green Business," "Green Office," and Zero Landfill" are some of the buzzwords of the current era. Digitization and go online is one of the useful utilities to avoid use of paper and go paperless. PRL in its recent recruitment activity of a walk-in procedure adopted to go paperless. No paper copy of bio-data of candidates to the committee members were provided. A team comprising of Mr. Pradeep Kumar Sharma and Mr. Girish Padia evolved this mechanism first time in PRL for recruitment activity.

Technically, PRL's Nextcloud file sharing facility was used to achieve this paperless recruitment activity. An account for recruitment was created on PRL's Nextcloud server. The Nextcloud client software was installed and configured in two PCs in the recruitment section and all the scanned biodata were saved into the "Nextcloud" folder so that the biodata can be synced directly to Nextcloud server. Then a password protected link to the folder was shared among the committee members using which the committee members could view the biodata of candidates on their laptop/mobile and on a computer connected to projector in the committee room. Bio-data of about 200 candidates was shown online through PC projection/ laptop and even on mobile for interaction with the candidates. As an initiative and in its maiden the effort saved (200 candidates x 4-page biodata on an average of each candidate x 7 member) significant amount of paper. Only essential records were generated for marking scores by the committee members and preparing recommendations. This would continue for future processing also as PRL team recruitment is committed for not printing the documents that are basically used for informational purposes only. Efforts of all associated members of Committee, Team Administration and Computer Section are acknowledged.

Health and Fitness

Dental Check-up Camp *(Samir Dani)*

Samir Dani

Dental Check-up Camp was organized at Dispensary-Navrangpura on 21.08.2019 Wednesday. We have invited team of dentists from Aashu Dental Clinic (NABH accredited, CHSS empaneled). A fully equipped dental mobile van of Aashu Dental Clinic was parked outside the dispensary. Primary dental check-ups were carried out inside the dispensary and minor dental procedures were carried out inside the dental van.

This camp was attended by 180 beneficiaries including employees, retirees, trainees & contractual workers. The benefits of oral health care and dental hygiene were explained. Dental diseases like tooth sensitivity, cavities, tooth erosion etc. were detected. Minor procedures like scaling, filling, X-rays was covered under camp activities. The beneficiaries were referred to dental clinic for major procedures like root-canal treatment, dental bridges, dentures etc.

We, the colleagues of dispensary PRL are sincerely thankful to all the attendees, and all our other colleagues of PRL for their contribution making this dental check-up camp successful. Prevention is better than cure. So, we encourage our beneficiaries to attend such kind of screening medical camps. This may avoid major illness and reduce the overall morbidities.

Yoga: The key to Healthy Life *(Ranganathan V.)*

Ranganathan V.

International Yoga Day is celebrated on 21st June every year. As a person who has been practising yogasans for more than 30 years, I am satisfied to say that I have been immensely benefitted by it. Yogasan is rewarding both physically & mentally. The most important aspect of practising yoga is that it improves flexibility of body. Initially, poses that we may feel are not for us, become easier to perform with regular practice; our body parts become supple, aches and pains gradually disappear in time. Slowly we reduce our visits to doctors and hospitals. You start healing yourself of many physical issues. Divide the body into three parts; limbs, central body and head.

Limbs: Sitting pose without a chair - for strength to legs, specially thighs; Standing straight and bending forwards to strengthen hamstrings and getting our body ready for other poses; though difficult initially, over time one would be able to bend fully to such an extent that we can bury our heads into our knees; Triangle pose – standing with our legs 2-3 feet apart, touch one hand with other foot and raise the other hand up and vice versa gives flexibility to your entire body; Lying flat on your back, slowly raise your leg, one then the other; repeat to get strength to legs, specially thighs.

Upper body: Lie on your back, lift both legs, bend them and press the thighs onto your stomach; this squeezes all internal parts of your stomach and enable each part of your upper body work as they are supposed to. You can rock your back to give more pressure thus getting better effect – this takes care of indigestion, gas trouble, acidity. Bow pose: Lie on your stomach, slowly raise both your feet backwards, hold them with your hands, draw feet closer to your body, slowly swing your body back and forth – this reduces belly fat and helps in weight loss; also strengthens ankles, thighs, groin, abdominal organs and spinal cord.

Head: Breathing – everybody knows 'anulom-vilom' – by inhaling and exhaling consciously and alternatively, our lungs increase the capacity to hold more oxygen that results in removal of toxins from our body and increases metabolism; decreases respiratory troubles; helps in curing asthma and sinus; feeling overall wellness and peace is inevitable. Sarvangasan (considered to be the most beneficial of all asans only next to sirsasan) improves resistance power of our body, keeps face bright by removing dark circles, gives strength to biceps too. Sirsasan – though it takes a long time in mastering this asan, once done it relaxes your entire body, improves blood circulation, helps in maintaining balance to the body – immensely beneficial to the overall wellness of our body.

Finally, shavasan – lie down like a corpse, slowly loosen all your body parts one after another, consciously. You can try to empty your thoughts gradually, though this part needs practice for a long period in order to succeed. This posture will de-stress you from all pressure and tensions. Suryanamaskar – This is a set of twelve poses that takes

care of the entire body in briskness and flexibility. One round of suryanamaskar will activate the lower, middle and upper part of our body and will keep our accumulated calories burning; in turn we will feel energised and will be able to attend to our daily chores enthusiastically.

I would like to insist, please read below, before trying to practice the asans.

I) Use yoga mats to do asans on instead of doing on hard surface;

II) Asans should be practised on near empty stomach;

III) Open spaces are advisable but halls would suffice;

IV) Wear comfortable and flexible clothes;

V) If already suffering from certain ailments, consult a doctor and/or yoga guru before doing asans.

Yoga is a wonderful experience and it must be a part of your life style to have a healthy and happy life. However, it is very important you learn it slowly but correctly. When performing asans, if you feel something is wrong, come down to normal lying position; learn the pose properly and then practice – do not leave it altogether! I have seen many people interested in yogasan, start practising but do not continue doing them. Regular, timely practice is recommended; continuity is of paramount importance.

Happy and healthy life to one and all.

Colloquia @ PRL

- Sachin Gunthe (Associate Professor, IIT Madras) delivered a colloquium on the title "Atmospheric Aerosols in Indian Perspective: Climate and Ecosystem Health Implications" on 24 July 2019.

- Mahan Mj (Professor, TIFR, Mumbai) delivered a colloquium entitled "Hyperbolic Geometry and Chaos in the Complex Plane" on 21 August 2019.

Awards & Honors

- Anil Bhardwaj, Director, PRL, received the prestigious J C Bose Fellowship for 2019. This Fellowship, initially given for period of 5 years, is in recognition of his outstanding performance in his area of specialization.
- P. Janardhan, Senior Professor (H Grade), Astronomy and Astrophysics Division, and Dean, PRL, has been elected as a Fellow of the Indian National Science Academy, New Delhi.
- Deepak K. Karan, former PRL Ph.D student & Post Doctoral Fellow with Prof. D. Pallamraju, Space and Atmospheric Sciences Division, PRL received the International Association of Geomagnetism and Aeronomy (IAGA) Young Scientist Award on 15th July, 2019 in recognition of the work done in PRL.
- Sanjay K Mishra, Reader, Planetary Science Division, PRL has been awarded the Indian Physics Association (IPA), Buti Foundation Award for Excellence in Theoretical, Astrophysics and Biophysics, for the year 2018. He also got elected as 'Young Associate' of the Indian Academy of Sciences (IASc).
- Anirban Ghosh presented a paper entitled "Nonlinear generation of ultrafast, high power, higher order vector vortex beams", by Ravi Kiran Saripalli et al at the Summer school in Optics and Applied Photonics, Indian Institute of Science, Bangalore, 17 – 21 June 2019 and received the outstanding poster presentation award.

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

New Recruits @ PRL

Femics George
Assistant
Accounts Section

Mantu Meher
Assistant
Purchase Section

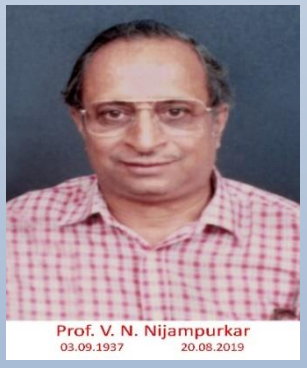
Jyoti Limbat
Assistant
Registrar Office

Kanhav Mulasi
Assistant
PPEG, Administration

Shreya Pandey
Assistant
Accounts Section

We heartily welcome the New Joiners to PRL and wish them a good career ahead!

Obituary



With a heavy heart we pay our tributes to Prof. V. N. Nijampurkar who breathed his last on 20th August 2019. With him PRL has lost not only an accomplished scientist but also an able mentor and guide. We, at PRL pray for the wellbeing of his bereaved family. May his soul rest in peace.

The Newsletter Committee

Bijaya Sahoo

Partha Konar

A. Shivam

Neeraj Srivastava

Prashant Jangid

Som Sharma

Garima Arora

Deekshya Sarkar

Pragya Pandey

Rohan Louis

Vivek Mishra

Kartik Patel

Veeresh Singh