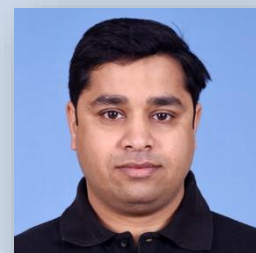


# Editorial

*Dear Readers,*

*We are happy to bring out the February 2019 issue of our monthly newsletter “PRL News - The Spectrum”. Carrying forward our aspiration, this issue features a variety of scientific and technical articles clubbed with brief information about major activities in PRL during the month of January 2019. It includes various developments, outreach activities, and happenings on various fronts in PRL.*



Bijaya Sahoo

*The present scientific and technological era has scaled great heights and has infused people with novel ideas and thoughtful strategies. PRL’s newsletter throws light on the interesting research along with important activities in our laboratory. We hope this issue will create awareness among our readers.*

*The newsletter editorial team is thankful to all the contributors of this issue. We eagerly look forward to the reader's suggestions and comments for further improvement.*



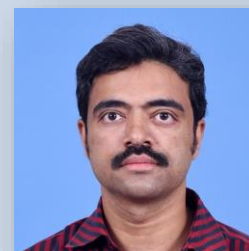
Partha Konar



Som Sharma



Pragya Pandey



Neeraj Srivastava



Garima Arora



A. Shivam



Deekshya Sarkar



Prashant Jangid



Vivek Mishra



Rohan Louis



Kartik Patel



Veeresh Singh

## Indian Middle Palaeolithic: Archaeological Prospects from Attirampakkam Using Luminescence Dating

(Kumar Akhilesh, Shanti Pappu, Haresh M. Rajapara, Yanni Gunnell, Anil D. Shukla, Ashok Singhvi)



Figure 1: Attirampakkam (red star) and the representative artefacts recovered from Layer 5 at the archaeological site. Photo by Prof. S. Pappu

Rich prehistoric presence from the Acheulian to the Mesolithic in very diverse geomorphological and ecological zones, India is being considered very important for Archaeological aspects. The chronology, adaption of Pleistocene climatic changes, interactive and cultural transitions are major areas that are being discussed in Indian archaeology.



A. K. Singhvi

Additionally, Geological location of India is vital when one consider the global population dispersal and has crucial importance while studying the chronological transitions (Figure-1). A multidisciplinary project led by Physical Research Laboratory (PRL), Ahmedabad, Sharma Center of Heritage Education, Chennai and University of Lyon, France has provided the whole new information that demand the remodeling of global population dispersal establishing comprehensive chronology of well excavated archaeological site: Attirampakkam. The outcome of this study was published

in very notable journal Nature (<https://doi.org/10.1038/nature25444>) titled as *Early Middle Palaeolithic cultures in India around 387-172 reframes Out of Africa Models* in February, 2018. PRL has provided the most important input: Luminescence ages based on post Infra-Red Infra-Red Stimulated Luminescence (pIR-IRSL) – a very challenging and strenuous method – to establish the chronology.

The excavations at Attirampakkam, Tamilnadu were studied using Luminescence dating and Geomorphological context to establish the chronology. Various stone tools – also known as Acheulian tools – like Handaxes (a typical pointed tools), Cleavers (broad edged tools), Blades and Bifaces etc. – was found at the base of thick sequence of stratified deposits (layers 8 to 6). These exclusively Early Acheulian assemblages (dating to approximately 1.7–1.07

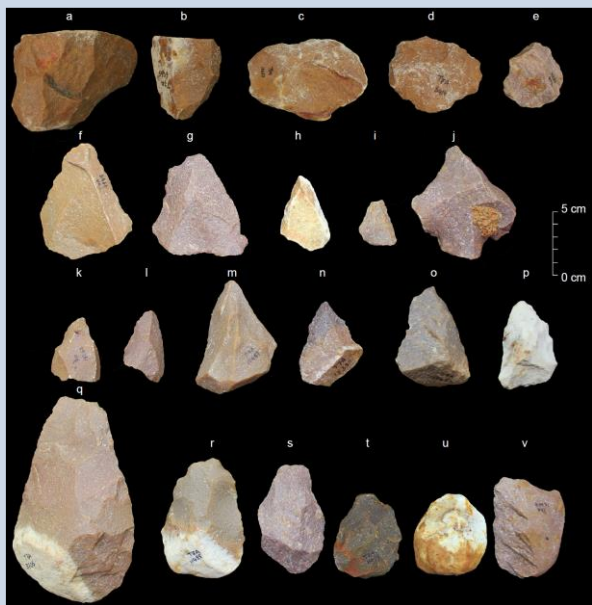


Figure 2: Acheulian Tools: Hand axes, blades and Bifaces

million years ago) have been the oldest reported so far from India (Fig. 2). These sequences were overlain by Middle Palaeolithic cultures in the overlying layers 5 to 2 in a sediment matrix of clay-rich silt alternating with ferruginous gravels (Fig. 3). During this phase, technological changes are noted, marked by a gradual discontinuance of the production of classic Acheulian large flake tools including handaxes and cleavers, with a shift towards manufacture of small tools along with use of other technologies (including Levallois and blade). Few sites with this culture have been dated in India, with age estimates falling in the range of around 140 or 125 thousand years (ka) and extending up to around 46 ka.

The chronology of the Middle Paleolithic cultures at this site was established using Luminescence dating. The measurement of radiation dose received by minerals (like quartz and feldspars) that constitute the sediments from ambient natural radioactivity, viz. U, Th and K. The method provides the date of burial of a sediment, and as the sediments bear the archaeological artefacts, the age of burial also reflects their time of deposition within the sediments. Methodological considerations required the use of post infrared - infrared stimulated luminescence signal (pIR-IRSL) from feldspar for

dating. Analysis of sediment samples from layers 5 to 1 yielded Middle Paleolithic tools indicate that the processes of transition from the preceding Acheulian culture and the emergence of a Middle Paleolithic culture occurred at  $385 \pm 64$  ka ago. This is about 200 ka earlier than conventionally presumed age around 140-125 ka or even younger for South Asia. Archaeologically, during this phase (Phase 1) a shift in the type of stone tool technologies that characterized the preceding Acheulian tools (marked by a predominance of large tools such as handaxes and cleavers, amongst others), towards the use of small tools and appearance of stone tool technologies such as the Levallois and blade reduction. The Middle Paleolithic continued at Attirampakkam until  $172 \pm 41$  ka (Phase 2) and the site was abandoned around 74 ka.

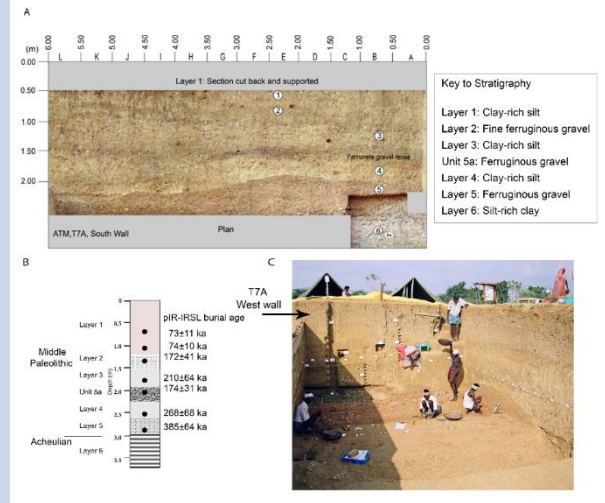


Figure 3: Excavation Site

These findings document a process of substantial behavioral changes calling for a re-evaluation of models that restrict the origin of Indian Middle Paleolithic culture solely to the incidence of modern human dispersals after approximately 125 ka. While it is not possible to speculate on who the tool-makers were, (owing to sparse hominin fossil evidence in India) nor as to the degree of local versus extrinsic influences, this research opens new perspectives into examining the evolutionary trajectories of Paleolithic cultures in India, by situating them within a sound chronological and archaeological framework. Hence the new ages appraised from Attirampakkam archaeological site challenges the existing paradigm of human migration -Out of Africa theory.

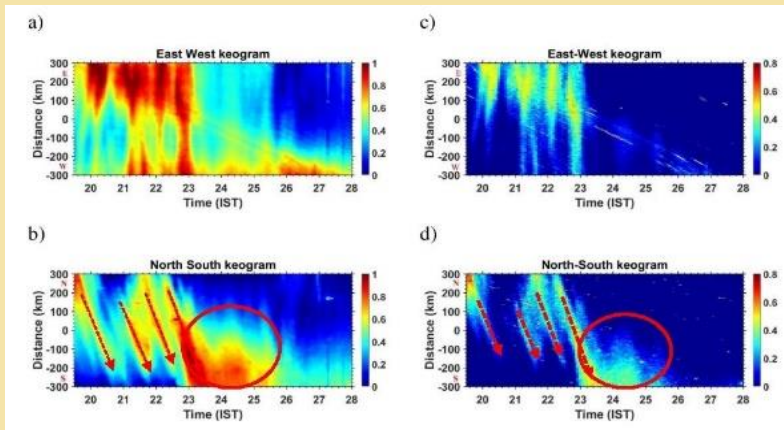
**Evidence for deep ingression of the mid-latitude MSTID into as low as  $\sim 3.5^\circ$  magnetic latitude** (M. Sivakandan, D. Chakrabarty, T. K. Ramkumar, A. Guharay, A. Taori, N. Parihar)



M. Sivakandan

An observational evidence of medium scale traveling ionospheric disturbances (MSTIDs) reaching to magnetic latitude as low as  $\sim 3.5^\circ$  over the Indian sector is provided for the first time based on OI 630 nm airglow imaging observation from a low latitude station, Gadanki ( $13.5^\circ\text{N}$ ,  $79.2^\circ\text{E}$ ;  $6.6^\circ$  MLAT) on 12 January 2016. The horizontal wavelength, horizontal phase velocity and period of the MSTID are found to be  $160 \pm 6$  km,  $138 \pm 14$  m/s and  $19.5 \pm 3$  minutes respectively. These phase fronts are observed to move towards southwest with a propagation angle of  $\sim 235^\circ \pm 1^\circ$

with respect to North. In addition to the MSTID, a strong quasiperiodic southward moving wave (QPSMW) from the evening to midnight interval and a small scale southward moving wave (SSSMW) structure with wavelength and periodicity different from the QPSMW are also detected on the same night. horizontal wavelength, horizontal phase velocity and period of the QPSMW are estimated to be  $367 \pm 14$  km,  $131 \pm 18$  m/s,  $46.7 \pm 13$  min, respectively and those of the SSSMW are found to be  $157 \pm 4$  km,  $121 \pm 17.8$  m/s,  $21.7 \pm 3.4$  min, respectively. Global GPS-TEC maps suggest that the weak and asymmetric Equatorial Ionization Anomaly (EIA) helped deep ingression of the MSTID on this night. The descent of the F-layer seems to have caused the dissipation of the MSTID and QPSMW closer to the dip equator on this night. Therefore, the present investigation shows that the mid latitude MSTIDs can influence the F-region plasma processes even over very low latitudes under favourable background conditions.



**Figure:** a) EW keogram of OI 630 nm normalised airglow emission intensity, b) NS keogram of OI 630 nm normalized airglow emission intensity, c) EW keogram of residual intensity, and d) NS keogram of residual intensity. In these figures (a-d) X axis denotes the time (IST) and Y axis denotes the distance (km) in the zonal (E-W, fig., 3a and c) and meridional (N-S, fig., 3b and d) direction. EW keogram clearly indicates the phase front alignment parallel to the EW direction and the NS keogram show the southward phase propagation that is highlighted by red dotted arrows. Further, NS keogram also show the midnight OI 630 nm emission intensity enhancement in the southern side of Gadanki that is highlighted by red circle.

<https://doi.org/10.1029/2018JA026103>



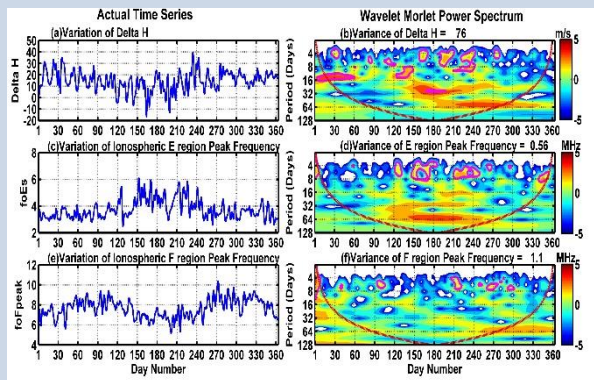
Priyanka Ghosh

**Vertical Coupling from the Lower Atmosphere to the Ionosphere using Multi-instruments over a Tropical Station of India** (Priyanka Ghosh , T. K. Ramkumar, A. K. Patra, Som Sharma, P. Pavan Chaitanya)

Simultaneous wind observations from Mesosphere Stratosphere Troposphere (MST) radar collectively with Global Positioning System (GPS) radiosonde over Gadanki, covering altitude range of 3.6–20 km (January–December 2009; 365 days), divulge the propagation of lower atmospheric waves up to the ionosphere. It is combined with temperature data (20–110 km) observed from Sounding of the Atmosphere using the Broadband Emission Radiometry (SABER) instrument on board Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED) satellite, ionosonde observations, and daily Outgoing Longwave Radiation (OLR) data acquired from the National Ocean and Atmospheric Administration (NOAA; centered around Gadanki [13.5°N, 79.2°E]) for the same time period.

Long-period oscillations with periodicities of ~64, ~32, and ~21 days are witnessed along with the well-known oscillations of ~16, ~6.4, and ~5.3 days. Most of the long-period oscillations are dominantly perceived during the summer months (April–June 2009), which can even exist up to September. These long-period oscillations are found to propagate from lower tropospheric heights up to ionospheric heights with large vertical wavelengths (~300–400 km, in some cases) near to transition zones of atmospheric layers (e.g., tropopause, stratopause, and mesopause). Signatures of vertical coupling of atmosphere through large vertical wavelengths (indicating possible intraseasonal connections) is clearly observed in the equatorial electrojet current and the peak plasma frequencies of ionospheric layers (E and F regions). Noticeable reduction of the wave oscillations in spatial scale with upsurge in spatial damping is evidently visible, in the tropical stratosphere and mesosphere, which can be attributed to stratospheric ozone.

<https://doi.org/10.1029/2018JA025897>



**Figure:** Variation of ionospheric parameters during January–December 2009. Time Series of (a) equatorial electrojet ( $\Delta H$ ), (c) E region peak frequency, and (e) F region peak frequency. Morlet wavelet power spectrum of (b) equatorial electrojet ( $\Delta H$ ), (d) E region peak frequency, and (f) F region peak frequency

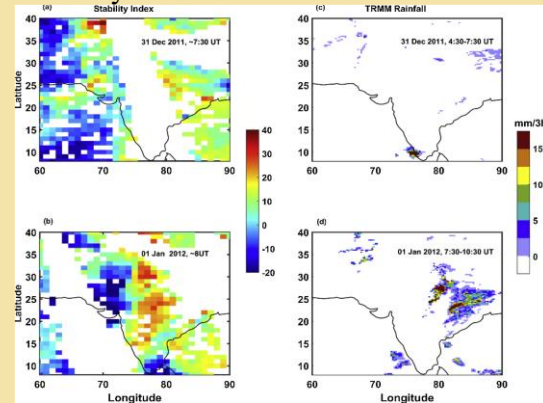


Som Sharma

**Influence of tropical-extratropical interactions on the dynamics of extreme rainfall event: A case study from Indian region** (K. Niranjan Kumar, D.V.Phanikumar, S.Sharma, G.Basha, M.Naja, T.B.M.J.Ouarda, M.V.Ratnam, K. Kishore Kumar)

A diagnostic investigation of an extreme rainfall episode that occurred over the central and north Indian region is carried out in this study using data from a suite of observations from space-borne instruments and the reanalysis datasets. This event is unique in the sense that the organized tropical and extratropical forcing stimulated the intense rainfall on 01 Jan 2012. The WindSat (multi-frequency polarimetric microwave radiometer) observations indicate the source of the moisture flux coming from the adjoining tropical Ocean. The dynamical and thermo-dynamical contributions are evaluated

based on the atmospheric instability analysis using the Atmospheric Infrared Sounder (AIRS) and reanalysis datasets by computing various stability indices such as total totals (TT) index, Potential Vorticity (PV), static stability and the Convective Available Potential Energy (CAPE). High TT index values (> 40 K) are observed both in satellite and reanalysis data indicating thermodynamic instability. PV intrusion to low latitudes is also observed with extreme rainfall occurrence ahead of the PV tongue. The vertical structure of PV intrusion shows remarkable features with enhanced upward motions ahead of the intrusion representing the dynamical instability. The reduced static stability, increased CAPE and upper-level cyclonic anomalies together with enhanced moisture in the lower troposphere coming from the adjoining tropical Indian Ocean regulate the amplitude and region of occurrence of the extreme rainfall. Therefore, this study identifies the significant implications of tropical and extra-tropical influences that generate the thermodynamical and dynamical instabilities for the occurrence of the extreme rainfall event over the Central and Northern parts of India



**Figure:** The Total Totals index derived from AIRS temperature and humidity fields on (a) 31 Dec 2011 and (b) 01 Jan 2012. (c) 3-hourly TRMM3B42 rainfall data on 31 Dec 2011 ~6UT (d) same as (c) but on 01 Jan 2012 ~9UT

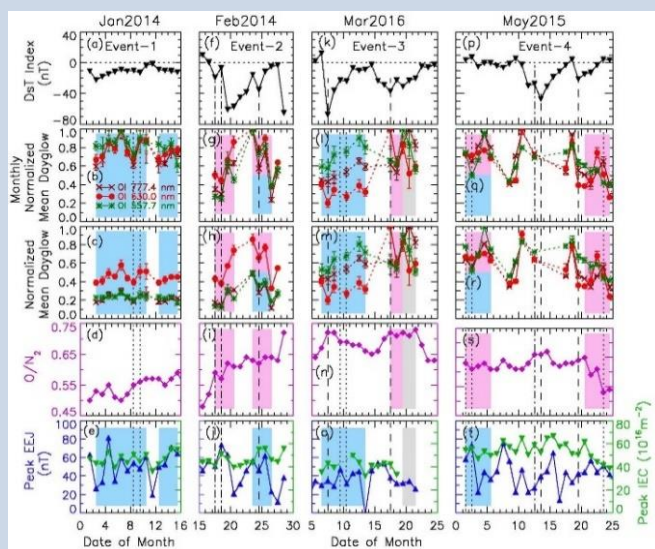
<https://doi.org/10.1016/j.dynatmoce.2018.12.002>

## Influence of geomagnetic storms on the daytime thermospheric wave dynamics over low-latitudes (Deepak Karan, D. Pallamraju)



Deepak Karan

Thermospheric behavior over low-latitudes are affected by solar forcing, waves propagating from lower atmosphere and equatorial electrodynamic processes. Depending upon the changes in background wind pattern and ambient densities, thermospheric behavior shows a seasonal variability. Interaction of the southward directed interplanetary magnetic field with that of terrestrial gives rise to geomagnetic storms. During such storms large scale waves propagating from high-latitudes also change the low-latitude thermospheric composition (characterized by O/N<sub>2</sub> ratio) and dynamics. We have investigated the seasonal variation of the effects of geomagnetic storms on daytime low-latitude thermospheric wave dynamics. An in-house built large field-of-view (~100°) spectrograph, called MISE (Multiwavelength Imaging Spectrograph using Echelle grating) is used to obtain neutral oxygen dayglow emission intensities, simultaneously at three wavelengths (OI 557.7, 630.0, and 777.4 nm) from a low-latitude location. The equatorial electrojet (EEJ) governs the equatorial electrodynamics. In the figure, the durations in which dayglow shows similar variation with EEJ/O/N<sub>2</sub> are shaded in blue/pink colors. Grey shaded region shows the days in which a mixed response is seen in the dayglow. During winter and summer solstice dayglow shows similar variation with O/N<sub>2</sub>. This is attributed to the effect of geomagnetic storms over low-latitude thermosphere. During equinox, dayglow variation is similar to that of EEJ strength, indicating a dominance of equatorial electric field over that of storm induced neutral wave dynamics. <https://doi.org/10.1016/j.jastp.2018.02.003>



**Figure:** Variations of daily mean Dst index, monthly normalized dayglow, normalized daily mean dayglow, daily averaged O/N<sub>2</sub>, peak EEJ and IEC during four events.

During winter and summer solstice dayglow shows similar variation with O/N<sub>2</sub>. This is attributed to the effect of geomagnetic storms over low-latitude thermosphere. During equinox, dayglow variation is similar to that of EEJ strength, indicating a dominance of equatorial electric field over that of storm induced neutral wave dynamics. <https://doi.org/10.1016/j.jastp.2018.02.003>

## On the Use of Brown Carbon Spectra as a Tool to Understand Their Broader Composition and Characteristics: A Case Study from Crop-residue Burning Samples (Satish R.V., Neeraj Rastogi)



Satish R.V.

Carbonaceous aerosol consists of organic matter (OM) and black carbon (BC). BC is known to exert a strong warming effect on global and regional climate. Some assessments suggest that the positive radiative forcing by BC is second only to carbon dioxide. Recent studies found that certain types of organic carbon (OC), termed “brown carbon (BrC),” also absorb radiation efficiently in near-ultraviolet (UV) and visible regions and contribute ~35% to direct radiative forcing by carbonaceous aerosol. BrC come into atmosphere by both primary and secondary sources. BrC species may consist of a variety of organic chromophores with variable concentrations and different absorbing characteristics. Absorption coefficient (babs) spectra of water-extracts or methanol-extracts of aerosol represent the bulk optical property of water-soluble or methanol-soluble (assumed to be total) BrC, respectively, as a function of wavelength. If the BrC composition is uniform from sample to sample, then the ratio of babs spectra for different samples shall be uniform (constant) as a function of wavelength. The magnitude of this constant would suggest the relative abundance of BrC chromophores in different samples. However, if the BrC composition is not uniform from sample to sample, then one can attribute the different ratio at different wavelengths to change in composition and concentrations of different chromophores. It is known that different types of chromophores absorb strongly at different wavelengths, for example, HULIS-type BrC (usually primary BrC) absorbs strongly at around 365 nm, whereas nitro-aromatic-type BrC (usually secondary BrC) absorbs strongly at a relatively higher wavelength (>400nm). The wavelengths at which non-uniformity in babs spectra ratio is observed would indicate the change in the type of BrC in a given sample. The beauty of the proposed approach lies in the fact that one can infer the broader composition and characteristics using only absorbance spectra as a tool, which otherwise need copious amount of work and expensive facilities.

<https://pubs.acs.org/doi/10.1021/acsomega.8b02637>

## Awards and Honors

- ✚ **Vijayan S**, Scientist D, Planetary Science Division, received the “**Young Scientist Award by Indian National Science Academy**” on December 28, 2018 at *Physical Research Laboratory*. His work contributes to first detailed document of a fluvial outflow channel on Jovis Tholus region of Mars.
- ✚ **Deepak Kumar Karan**, PDF, Space and Atmospheric Sciences Division, has been awarded with the “**International Association of Geomagnetism and Aeronomy (IAGA) Young Scientist Award**”. The ceremony will take place during the 27th IUGG General Assembly on July 8-18, 2019 at the Palais des Congrès in Montréal.
- ✚ **Hrushikesh Sable**, JRF, Theoretical Physics Division, has been awarded with the best poster presentation award for his poster entitled “Quantum phases of the ultra-cold bosons in hexagonal optical lattices” at the International Conference on Quantum and Atom Physics, held at IIT, Patna during 16-18 December 2018.

**PRL fraternity heartily congratulates all the colleagues who have been conferred with these awards and honours !**

## Colloquia @ PRL

- ✚ **Sushil Atreya**, (Director, Planetary Science Laboratory, University of Michigan, Ann Arbor, USA) gave a Special Colloquium with the title “Formation of the Icy Giant Planets: In Situ Exploration”, on Friday, 18 January 2019.



- ✚ **Wing-Huen Ip** (Professor, National Central University, Taiwan) gave a Public Lecture on the topic “Ice Skating on the Moon”, on Saturday, 19 January 2019.

## Welcome to PRL Family



Aman Khatri  
Scientist/Engineer-SC  
Date of Joining: 26.10.2018



Firoj Ahmed  
Scientist/Engineer-SC  
Date of Joining: 12.11.2018



Ketan Patel  
Reader  
Date of Joining: 10.12.2018

**PRL wishes you a bright and enjoyable career ahead !**

## 84<sup>th</sup> Anniversary General Meeting of Indian National Science Academy (INSA-AGM)

The 84<sup>th</sup> Anniversary General Meeting of Indian National Science Academy (INSA-AGM) was hosted by Physical Research Laboratory (PRL) during December 26-28, 2018. This prestigious event was co-hosted by Institute for Plasma Research (IPR) and Indian Institute of Technology, Gandhinagar (IIT-Gn), and two half-day sessions were organized at IPR and IIT-Gn on 27 December, 2018. The anniversary meeting was attended by around 200 delegates including INSA Fellows, other eminent scientists of the country from various disciplines, young scientist awardees, teacher awardees, newly inducted fellows.



This meeting was also graced by Shri A. S. Kiran Kumar (Chairman, PRL council of Management), other dignitaries from ISRO that includes Dr. B. N. Suresh (Vikram Sarabhai Distinguished Professor at ISRO-HQ), Shri P. Kunhikrishnan (Director, URSC), Dr. P. Diwakar (Director, EDPO, ISRO-HQ) as well as directors of a number of prominent research institutions of India. In view of the upcoming Birth Centenary Celebrations of Prof. Vikram Sarabhai, the founder of PRL and the Father of India's Space Programme, a special symposium entitled "Vikram Sarabhai Space Science Symposium (VS<sup>4</sup>): Innovations from Space Program" was planned as one of the seven symposia. Other six symposia were based on themes such as

"Sustainable Energy and Chemical Engineering Platforms", "Drug Discovery and Drug Development: The Indian Narrative", "Ethics in Science and Education", "Water Futures", "AI-Scaling Up Artificial Intelligence in India", "Food Security and Genomics". In addition to symposia on these societally relevant and nationally important themes, there were two special award lectures, namely, "Meghnad Saha Medal Lecture" on Navigating Complexity by Common Sense and "Aryabhatta Medal Lecture" on Need for Integration of Ayurveda with Modern Biology and Medicine. The INSA-AGM was a huge success in terms of the richness of scientific deliberations and the exemplary standards of planning and execution that went into arranging this meeting.



### Medical Lecture on Obesity - it's hazards, prevention and management

Obesity is one of the emerging metabolic disorder challenges world-wide. Obese persons are most vulnerable victims for heart diseases, diabetes, blood pressure, cancers, joint pains and likewise. Prevention is better than Cure. Pursuing this philosophy, Medical team from Asian Bariatric Hospital, Ahmedabad was invited to deliver an interactive talk on "Obesity-it's hazards, prevention and management" for our employees and their family members. Various aspects of life style modification, dietary tips and physical exercises were presented by Dr. Arya Singh, Clinical Nutritionist. An interactive session on medical and surgical management of obesity was delivered by Dr. Mahindra Narwaria, Bariatric surgeon. Useful tips over life style modification for diabetic and hypertensive patients were discussed during lecture. Live streaming of this program was also arranged for Udaipur and Mt. Abu beneficiaries. This program proved to be very informative for our beneficiaries. It would enable our employees to take positive action towards life style modification for prevention of overweight and obesity and the clinical issues owing to these.





**Republic day celebrations at PRL**

The 70<sup>th</sup> Republic Day of India was celebrated with great enthusiasm and fervour by PRL staff Members and their families. The programme commenced with hoisting of our National Flag followed by an inspiring speech by the Director, PRL. Prizes were distributed to the winners of essay competition held during Vigilance Awareness Week-2018 and exceptionally good CISF personnel were also awarded. January 2019 issue of PRLs Hindi magazine “Vikram” was released by the Director, PRL. The celebrations concluded with unleashing the Tricolor balloons by children in the sky. Thereafter, a visit of various laboratories in Thaltej Campus was arranged for the family members of PRL staff.



### Fire Safety Demonstration at PRL

A demonstration of fire safety was held at PRL on 4<sup>th</sup> January 2019. It was a highly informative lecture, which covered various aspects like different classes of fire, safety and evacuation methods in case of a fire breakout, varieties of fire extinguishers and demonstrating ways of using fire extinguishers.



### PRL's Inter Division Football Tournament – 2019

PRL's Inter Division Football Tournament was conducted during 26 December 2018 – 12 January 2019 at PRL Thaltej football ground on weekends. Five different teams namely AMOPH, A&A, GSDN, SPASC, and THEPH+PSDN participated in the tournament. It was a seven a side tournament with each match duration of 50 minutes. The finalists were AMOPH and SPASC. In a highly competitive match, team SPASC won the tournament. Sovan Saha (SPASC) became top goal scorer of the tournament with four goals. Here are some glimpses of the tournament:



## Training on “Platform Load Sharing Facility” for Vikram-100 HPC Users



High Performance Computing (HPC) is now an integral part of any research organization. Scientists/Engineers use HPC facility for solving complex computational problems. PRL, being a research organization, has its own HPC named “Vikram-100” providing 100 TF of sustained computing performance. It consists of 2 master nodes and 97 computing nodes and offers 2,328 CPU cores, 1,15,200 GPU Cores, a total 25 TB of RAM and 300 TB of high-performance parallel file system. More than 50 research papers have already been published utilizing the Vikram-100 HPC facility in last three years.

The Load Sharing Facility (LSF) is an IBM job scheduling and workload manager tool available on Vikram-100 to submit and monitor the computing resources and jobs submitted. LSF is useful for the users and System Administrator to monitor the status of the running jobs and the health of the HPC.

PRL Computer Centre, in coordination with M/s. Tata Consultancy Services (TCS), organized a training and discussion session on LSF on January 29, 2019 for the Vikram-100 HPC users. Dr. Namit Mahajan welcomed all the participants, briefed about the training program and introduced the speaker Mr. Abhishek from TCS, Pune. 40 HPC users participated in this programme.

During the training, HPC users were informed about the importance of Job Scheduling, Job Monitoring, Job Status Messages, various LSF commands and various options that LSF offers. Each of the important and more useful LSF commands were discussed in detail by Mr Abhishek. The session, being interactive in nature, led to lot of discussions, and turned out to be very informative and helpful, even for the experienced HPC users. Mr. Jigar Raval also co-related the commands and output with our Vikram-100 facility during the session.

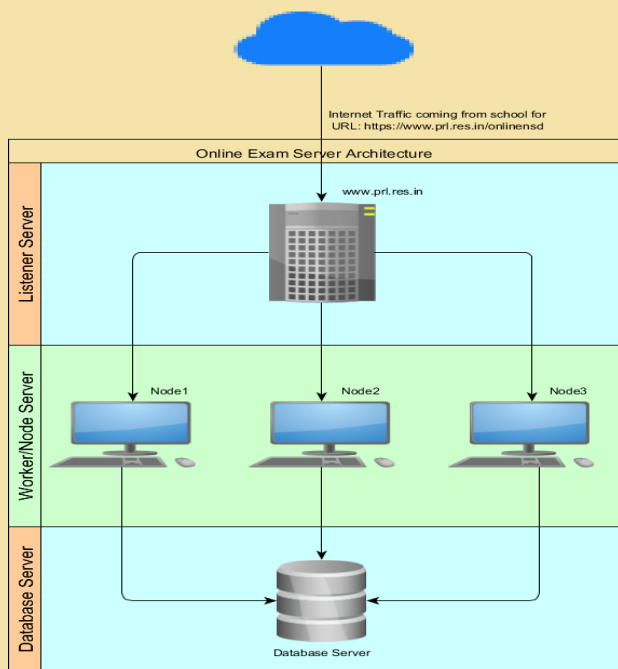
The programme was well received and HPC users provided positive feedbacks. There is a suggestion to have more such activities at regular intervals.

## National Science Day 2019 Online screening test at external centres – Challenges and solutions (Girish Padia, Atul Manke, Dinesh Mehta, Prashant Jangid, Srishti Sharma, Amarjass Sekhon)



Girish Padia

National Science Day (NSD) is one of the biggest outreach activities conducted annually by PRL where it is aimed to reach out to maximum schools and students in Gujarat. On this occasion, the “Aruna Lal” Scholarships are awarded to meritorious students selected based on the screening test, followed by a personal interview. The “Aruna Lal” scholarship has been instituted by Late Prof. Devendra Lal, former Director of Physical Research Laboratory, to encourage high school



students to pursue studies in Science and allied subjects. Since last several years, 11<sup>th</sup> standard science stream students of various schools across Gujarat participate in the offline OMR based screening test conducted at 14 test centres spread across Gujarat state. Over the years it is observed that many students find it difficult to appear to the dedicated test centres due to the long travel. To avoid such a problem, in 2019, PRL has initiated an online screening test in parallel to the offline OMR based test for the students. The schools having basic infrastructure of computer and internet can conduct the test for their students. All the schools were given the option to choose the mode (i.e. Offline or Online) of the test. In the past, PRL had already conducted online exams within PRL intranet during Hindi Pakhawada and Swachhata week. However, this time it was a maiden and successful attempt to test our technical capabilities for conducting an online test at external centres over the internet. The registration for NSD-2019 online screening test was opened during 19<sup>th</sup> December 2018 to 7<sup>th</sup> January 2019. In total 229 students registered from 47 schools and 196 appeared for the online test.

## Outreach

### Science-Express @ Udaipur and Kapasan

Science-Express continued its journey to share the excitements of science among general public and students. On 22<sup>nd</sup> January, the third stop of the Science-Express was arranged in Ravindra Nath Tagore School and College, Kapasan, a remote place, one and half hours of drive from Udaipur towards Chittorgarh, Rajasthan. An exhibition showcasing different scientific activities ongoing at PRL along with popular lectures by Prof. S. Mohanty and Dr. K. Acharyya, were organised. These were well received by more than 1000 students attending it.

On 23<sup>rd</sup> January, the Science-Express reached the Govt. Senior Secondary School, Badgaon, a remote corner of Udaipur. About 600 students attended the exhibition, starting from early morning. They were extremely excited to learn from this scientific exposure at their doorstep. The Express ignited curiosity in minds of all the children.

