No. 64 Patrika September 2016

Newsletter of the Indian Academy of Sciences

TWENTY-SEVENTH MID-YEAR MEETING

1 – 2 JULY 2016

Dipankar Bhattacharya (IUCAA, Pune) in his special lecture on 'The *AstroSat* Mission' said that *AstroSat* is a multi-wavelength astronomy mission on an IRS-class satellite in a 650-km, near-equatorial orbit with 6-degree inclination and period of 98 minutes, launched on

28th September 2015, the culmination of an effort spanning two decades of multi-institutional collaboration. Some of the key strengths of the *AstroSat* design, he said, are the detailed imaging of nearby galaxies at ultraviolet bands, individual photon recording and hard X-ray polarization. He added that it is an excellent tool to study newborn stars and remnants of stellar death. He concluded his interesting talk by listing out the wide range of issues that *AstroSat* has started to address such as the measurement of mass and radius of neutron stars and black holes; probing accretion under strong gravity in order to test the theories of gravity; measurement of the strength and geometry of magnetic fields of compact objects; exploration of the seismology

Inside...

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Published by
Indian Academy of Sciences
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This Newsletter is available on the Academy website at: www.ias.ac.in/patrika/

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Forthcoming Events

Eighty-second Annual Meeting, Bhopal — 4–6 November 2016

Refresher Courses

- Immunology laboratory techniques using fish model
  Vels University, Chennai — 5–17 December 2016
- Experimental Physics – 82
  Kakatiya University, Warangal — 6–21 December 2016
- Advanced quantum mechanics
  Government Arts College, Melur — 12–24 December 2016
- Experimental Physics – 83
  Mody University of Science and Technology, Sikar — 29 December 2016 – 13 January 2017

Lecture Workshops

- Scope on nonlinear physics
  Fatima College, Madurai — 5–6 January 2017
- Frontiers in material science
  Ravenshaw University, Cuttack — 6–7 January 2017
- Biotechnology, bioprospecting and conservation of bioresources
  St. Josephs College, Bangalore — 12–13 January 2017
- Recent perspectives in computational and experimental chemistry
  Uday Pratap College, Varanasi — 17–19 January 2017
- Frontiers in life sciences
  Nehru Memorial College, Puthanampatti — 17–18 January 2017
- Plant diversity and phytoremediation
  Periyar University, Salem — 19–20 January 2017
- Perspectives in biological research
  AVC College, Mannampandal — 23–24 January 2017
- Plant Taxonomy
  Bapuji Institute of Engineering and Technology, Davangare — 27–28 January 2017
- Innovations and Reserch in Biology
  Hindustan College of Arts and Science, Coimbatore — 2–3 February 2017
- Glimpses on plant sciences
  Nirmala College, Coimbatore — 2–3 February 2017
- Recent advances in physics
  St. Xaviers College, Kolkata — 10–11 February 2017
- Emerging trends in chemistry
  Saldiha College, Bankura — 17–18 February 2017
- Hyperbolic partial differential equation (HPDE) and conservation laws (CL)
  NEHU, Shillong — 22–25 February 2017

of compact stars and accretion flows; investigation of the process of star formation in the recent universe; study the emission process in quasars; and measurement of the polarization of high energy X-rays in order to reveal the mechanism of GRB emissions.

For a nation that is largely vegetarian, biological demand for proteins needs to be met with plant sources. The first wave of the Green Revolution in India may have appeased our physical huger but it did nothing for our nutritional hunger, said **K N Ganeshaiah** (UAS, GKVK, Bengaluru), in the introduction of his Special

Lecture, 'Feeling the 'Pulses' for protein revolution'. This lecture, in commemoration of the International Year of Pulses, focused on the need for our nation to pay greater attention to protein-yielding pulse crops, so as to meet the nutritional demands.

The first Green Revolution was a starch revolution. He brought to the attention of the audience that while there existed an All India Coordinated Research Project (AICRP) for each cereal such as rice, wheat, maize, sorghum, and even minor millets, more than a dozen pulses were clubbed under a single AICRP. There is a general misconception that pulses have a lower yield potential. It is for this reason, he asserted, that farming of pulses has not been given its due importance – either by farmers or by researchers.

Explaining the research undertaken in his lab, Ganeshiah showed how one can achieve a much greater seed yield. The second Green Revolution, when it occurs, will be with pulses – for their untapped potential, high protein content and nutritional prominence, claimed Ganeshaiah, which is what we should, as a nation, strive towards.

Pratap Bhanu Mehta's (Centre for Policy Research, New Delhi) public lecture on the 'Two ideas of India' was a discourse on the sociological standing of

current day India. The 'idea of India' is a term that is used quite often. There exists a sense that there are two different ideas at stake for India, often centered on three axes – it may be secularism *vs*. communalism, majoritarianism *vs.* minoritarianism, or diversity *vs.* singularity. People tend to place themselves on either side of this ideological divide. However, the real contrast that exists, according to Mehta, is of imagining India either as a federation of communities, or as a new zone of individual freedom; the primary unit of analysis in the first case being communities while in the second case, individuals.

The concept of the zone of individual freedom is not as popular as it should be; it is often said that a liberal individual is a Western construct not suited to India's diversity. One should not succumb to this argument, which is incredibly ridiculous, argues Mehta. We are currently in a peculiar situation where our identities are compulsive and inescapable – it is not for us to decide who we want to be. Religion, caste, etc., have become necessary parts of our identity that is forced upon us. Ideally, in a liberal society, one would hope that as a citizen, one is offered the biggest human dignity of being able to define oneself.

He spoke of the concept of tolerance that exists between different communities and ethnic groups, as long as each of them have their own space and stay in that space. This, however, does not capture new challenges of tolerance which is wearing away, giving way to acrimony at social and political levels.

With this, he left the audience with a new outlook of the social scenario in India.

One of the major attractions of the 27th Mid-Year Meeting of the Academy was a special symposium

on '**Gravitational Waves**'. The recent discovery of gravitational waves, hailed as one of the most crucial discoveries of all times, has begun a new scientific frontier of understanding the universe. The session saw the participation of experts involved in the LIGO and VIRGO projects from IUCAA, Pune, and ICTS, Bengaluru, who presented various aspects of gravitational waves including the LIGO experiment and the upcoming LIGO project in India. The symposium also elaborated on the importance and applications of the discovery of gravitational waves along with the technological challenges involved. The highlights of the symposium are as follows:

Tarun Souradeep (IUCAA, Pune) presented the introductory remarks and spoke on 'Beyond first discoveries with LIGO-India'. Elaborating on the

discovery of gravitational waves, he acknowledged the participation of over 60 Indian researchers in the International LIGO Science Collaboration and described in detail the geographic and demographic advantages India has in the context of detection and study of gravitational waves. It is expected that LIGO-India will provide the largest baseline covering 12,000 km and, in joint operation with the existing US-based LIGO detectors, will increase the sky-localization tremendously. Giving an overall view of the proposed global network of gravitational wave observatories, he also provided a glimpse into the engineering concept and design of LIGO-India at one of the shortlisted sites in India.

Bala Iyer (ICTS, Bengaluru), representing the Indian Initiative in Gravitational-wave Observations (IndIGO), presented the fascinating history of discovery gravitational waves in his lecture 'From prediction to detection: Highlights of the fascinating history of gravitational waves'. The quest for gravitational waves began with analysing their physical effects as determined by the equation of geodesic deviation. Tracing the arduous journey of the study of gravitational

waves from the Newtonian and Post-Newtonian era to Einstein's theory of general relativity, the speaker described how the advent of relativistic astrophysics, followed by the measurement of physical properties of gravitational waves, development of technologies like laser interferometers and finally the discovery of binary pulsar 1913+16 in 1974, has been consequential to the confirmation and direct detection of gravitational waves. The detection of gravitational waves can actually be traced back to the development of laser interferometry in 1963. This technology has slowly paved the way for the large and growing pool of sophisticated computational resources. The study of gravitational waves demands the development of more intense data analysis infrastructure and robust numerical simulation models.

Sukanta Bose (IUCAA, Pune) spoke on the title 'In the era of gravitational wave astronomy'. The talk summarized the nature of gravitational waves,

recently detected and characterized by LIGO which originated from a binary black hole merger 1.3 billion years ago. According to Bose, detecting gravitational waves is expected to remain a low signal-to-noise ratio challenge at least for the time being. The talk also demonstrated the extraction of gravitational wave signals from noise by the Hanford and Livingston detectors and elaborated on the science

of 'detector characterization'. The talk stressed on the importance of understanding the noise in LIGO detector and learning to differentiate between astrophysical signals and terrestrial noise. Detection of gravitational waves opens up challenging and exciting new avenues of studies such as coincidences of gravitational and electromagnetic waves, circum-merger environments and primordial black holes as components of dark matter, he added.

C S Unnikrishnan (TIFR, Mumbai) described the technological challenges associated with the detection of gravitational waves in his talk 'Interferometric

gravitational wave detectors: Challenges'. Detection of gravitational waves involves tremendous conceptual and technological challenges. The Michelson interferometer has emerged as a fundamental tool for precise detection of gravitational waves. Despite this, 'fringe splitting' has been observed as a general drawback which might compromise sensitivity and requires meticulous design and tuning to isolate noise and ambient disturbances. Fluctuating momentum transfer from light to the mirrors and thermal noise arising from the coating of the devices are also known to affect sensitivity. The talk elaborated on the technologies required to achieve such precision and sensitivity which includes lasers, optics, vibration isolation along with cleaning and contamination control.

P Ajith (ICTS, Bengaluru) said, 100 years after its prediction, Albert Einstein's general theory of relativity, one of the fundamental achievements of 20th century physics, stands to be tested with the confident detection of two gravitational waves. This was the focus of the talk entitled 'Testing the general relativity using gravitational wave observations'. The speaker elaborated on how the gravitational wave signals detected by the two detectors are consistent with that expected and predicted from the merger of two black holes. This offers the first

opportunity to test Einstein's theory in the highly relativistic regime of extreme gravity and velocities. Intricate details of how the discovery has facilitated the testing of post-Newtonian theory of gravity by modelling the dynamics and waveforms using perturbative expansions were discussed. The talk demonstrated that the signals obtained by the detectors are consistent with the predicted in-spiral, merger and ring-down stages of the binary black hole system. The tests have also thrown up evidence of constraints on the mass of the graviton due to lack of dispersion. The talk took a stock of future prospects such as testing the no-hair theorem and evidence of missing energy during merger of black holes. He stressed on the need of more precise technology to conduct future studies.

Varun Bhalerao (IUCAA, Pune) spoke on 'Multi-messenger astronomy with gravitational waves' and addressed the crucial question 'Did the merger

of black holes emit something visible?' Electro-magnetic emissions are known to carry complementary information such as precise location, nucleosynthesis and ejecta properties, which, along with gravitational waves, can provide a complete astrophysical picture and enhance our understanding of the universe. The talk centered on the need of detecting the electromagnetic counterparts of gravitational waves

and the Indian contributions towards the same. Bhalerao spoke about how the CZTI module of India's *AstroSat* has been aiding the detection of electromagnetic counterparts, acting as a wide angle monitor with a median area 190 sq.cm. for 29% of the sky. CZTI observed 30% of the localization of the detected gravity wave and has placed strong upper limits on an X-ray counterpart. The speaker also stressed on the need for highly co-ordinated ground-based global research, automated telescopes, specialized instruments and programs and that of a dedicated network of satellite to follow up gravitational wave sources. The speaker drew attention to the existing and upcoming Indian facilities like Devasthal telescope, Indian 10 meter class telescope, Thirty Meter Telescope, and other partner programs and the role they are likely to play in the coming days in expanding the horizons of astrophysics.

Lectures by Fellows/Associates of the Academy were as follows:

P B Sunil Kumar (IIT, Chennai) spoke on the 'Mechanisms governing shape changes in biological membranes'. In this talk, he introduced the audience to biophysical perspective of membrane dynamics. Biological membranes that surround cells and sub-cellular organelles are highly conserved across species – not only qualitatively, but also quantitatively (i.e. with respect to double membrane spacing, thickness, etc.). These membranes are subjected to a constant flux of molecules that traverse across the bilayer, and also fission/fusion events, all throughout which the morphological changes that membrane undergoes remains highly conserved, following which it unfailingly restores its architecture.

Kumar's talk acquainted the audience with the underlying physical principles that govern morphogenesis in biomembranes. Kumar also described the computational simulation approaches that he uses to study membrane remodelling, curvature fluctuations (caused by the binding and unbinding kinetics of proteins associated with biomembranes) and the dynamics of fission – fusion events, which regulate cell membrane shapes. He illustrated this using phase diagrams of changes in steady state shapes of naturally emerging vesicles, in response to non-equilibrium curvature remodeling events, such as tubes and discs – shapes that cell organelles are most frequently found to conform to.

T Punniyamurthy (IIT, Guwahati) spoke on 'Carbon–carbon and carbon–heteroatom bonds formation and their application for medicinally significant heterocycles'. He touched upon carbon–carbon and carbon–heteroatom bond formation, cross–dehydrogenative coupling and directed C-H activation. He also presented examples of biologically important benzofuzed Azoles and methods of benzofuzed Azole synthesis along with the drawbacks and advantages. He explained his team's contribution towards the development of novel strategies for the construction of carbon–carbon and carbon–heteroatom bond formation and their applications in medicine and biological sciences.

The 'Young Scientist' award winner **K N Uma** (VSSC, Thiruvananthapuram) presented interesting information on 'Tropical mesoscale convective systems and their associated dynamics'. She spoke of the evolution and the internal structure, dynamics and microsphysics of TMCS (Tropical Mesoscale Convective Systems) during different phases of monsoon, the role of convection in controlling the stratospheric water vapour over global monsoon regions, the impact of synaptic-scale convection in stratospheric intrusion of ozone and convection-generated gravity waves. She touched upon the characteristics of convection, active and break phase of monsoon, obstacle effect and global monsoons.

Suman Chakraborty (IIT, Kharagpur) delivered a talk on 'Liquid water may stick on hydrophobic surfaces'. According to general perception, on a wetting surface (hydrophilic), liquid water is believed to adhere to the surface causing multilayer sticking, whereas on a non-wetting surface (hydrophobic), water is believed to glide across the surface leading to slip. He demonstrated that the relationship between intrinsic wettability and stick/slip is not obvious. Furthermore, he summarised, a hydrophobic surface is not synonymous with slip and neither a hydrophilic surface means sticking of water. He explained the effect of salt concentration on slip over hydrophobic surfaces using the example of a game of land and water (known as *Kumir Danga* in Bangla). He said that wettability can be a dynamic parameter that can be altered without altering the chemical composition of the surface.

Mahak Sharma (IISER, Mohali) spoke about 'Molecular mechanisms regulating endosome–lysosome tethering and fusion'. Lysosomes are responsible for receiving, degrading and recycling macromolecules derived from

endocytosis, phagocytosis and autophagy. Sharma discussed recent studies on the role of Arl8b, a member of the Arl (Arf-like) family of small GTPases, in regulating lysosomal trafficking and endosome-lysosome fusion. The focus of her talk was interaction of the HOmotypic fusion and Protein Sorting (HOPS) complex with the GTP-bound Arl8b, particularly via the hVps41 subunit. Studies of molecular regulations of endosome-lysosome tethering and fusion can not only shed light on salmonella-mediated pathogenesis but also on other medically significant biological processes, where the lysosome plays an important role, such as bone resorption, MHC II-Ag complex formation, ECM degradation, etc., she said.

What makes the DNA 'readable' is the fact that it is a stretch of nucleotide sequence that serves as a code for transcription, possibly ensuing translations and even binding of various DNA-binding proteins including transcription factors. But what if the sequence is no longer readable and the long stretch of DNA strands knots itself up? In his talk 'Knotty DNA: Another dimension to gene regulation', **Shantanu Chowdhury** (IGIB, New Delhi) offered a glimpse of his work in the context of secondary structures in DNA as important elements of gene regulation.

Debashish Goswami (ISI, Kolkata) spoke on 'Quantum group symmetry of classical and non-commutative geometry'. Quantum groups are generalizations of groups which naturally appear as symmetry objects in various branches of mathematics and physics. After briefly introducing C* algebraic compact quantum groups and their co-action the speaker explained quantum groups and quantum isometry groups, and gave a few non-commutative examples. He discussed quantum group actions on classical spaces and its application.

Kanishka Biswas (JNCASR, Bangaluru) in his talk titled 'Origin of ultra-low thermal conductivity in complex chalcogenides: Effect of intergrowth nanostructures, lone pair, and anharmonic rattling' touched upon chemical aspects of topological insulators and thermoelectrics. He explained the Peltier effect, the Seebeck effect and the importance of thermoelectrics. He concluded that low thermal conductivity can be achieved by phonon scattering through intergrowth nanostructures, lone pair-induced bond anharmonicity, and anharmonic rattling modes/bonding asymmetry.

The Ramanujan prize winner, **Amalendu Krishna** (TIFR, Mumbai) delivered his talk on 'Grothendieck Riemann–Roch theorem: Reminiscences and generalizations'. The work of Riemann and Roch and the generalizations were discussed. He stated Grothendieck Riemann–Roch theorem and Grothendieck's discovery of the group of cycles on an algebraic variety called the Chow groups. He then elaborated on Euler characteristic of vector bundles and Quillen's K-theory along with Bloch's discovery of motivic cohomology. Touching upon Bloch's Riemann-Roch, Equivariant K-theory and Riemann-Roch for equivariant K-theory, he explained the results he had proved. He showed that the Riemann-Roch theorem of Grothendieck and Bloch could be generalized for varieties with group action as well. Finally, he made some remarks on the most recent generalization of Riemann-Roch theorem.

Armed with an atypical organelle that it inherited from an algal ancestor following a secondary endo symbiotic event, the malarial parasite, *Plasmodium*, has captured the attention of many. In her talk 'A relict organelle that changed the way we thought of malaria' **Saman Habib** (CDRI, Lucknow) introduced the audience to the significance of this heirloom component for the parasite, and how it is an extremely enticing target when it comes to designing antimalarial drugs.

The apicoplast – a four-membrane, non-photosynthetic plastid found in plasmodium – with a 35 kb genome has been linked with parasite survival. The vitality of the organelle is associated with its role in the major housekeeping functions and metabolic path-ways of the organism. In her talk, Habib presented fascinating pictorial evidences of how, although the apicoplast is a very small spherical structure to start with, in liver stages of the organism's life cycle, it evolves into a large and complex web-like form, which is quite unlike that observed in plant plastids.

Habib went on to talk about her studies, the results of which have helped identify molecular participants and events involved in apicoplast division and its biogenesis, the genome organization, DNA Replication and protein translation within the organelle, and the sulfur mobilization pathway of Fe-S cluster biogenesis.

R Prabhu (IIT, Patna) spoke on 'A glimpse into quantum information science'. The principles of quantum mechanics have revolutionized the way materials are understood and novel systems are designed. While the fundamental concepts of quantum mechanics have given rise to many integrated and interdisciplinary areas of study, the most recently

emerging field is that of Quantum Information Science (QIS). A unique amalgamation of information technology and quantum mechanics, QIS, plays a central role in storing, processing and communication of data using 'Qubits'. The speaker elaborated on the two protocols of QIS, namely quantum communication and quantum computing, and their roles in secured communication systems like cryptography, dense coding and teleportation. Explaining the concepts of quantum correlation, which are subtler than that of classical physics, the speaker described how these principles are applied in highly secure information transfer and faster computing. The talk focused on understanding the connection between quantum information protocols and quantum correlation in multipartite quantum systems. Quantum channels reduce the required number of dimension states, as opposed to classical channels of information transfer and holds immense promise of novel technologies of the future.

Subhra Chakraborty's (NIPGR, New Delhi) talk was titled 'Understanding biomolecular networks modulating nutrient response and immunity in plants'. She introduced the subject by stressing upon the need for better, higher yielding food crops to meet the global nutritional demand, and how abiotic stresses, in an agricultural field, can adversely affect plant growth, development and most notably the overall harvest.

Her work focuses on plant transcriptomes, proteomes and metabolomes – all of which, unlike the genome, is very dynamic, and a key indicator of the physiological state of the plant part. In this context, her initial efforts looked at the development of sub-cellular proteomes. Of late she has been working on investigating the biomolecular networks pertaining to fungal pathogenicity, specifically *Fusarium* wilt in legumes and *Sclerotinia* rot in tomato. To learn more about the molecular mechanism involved and more particularly to delineate the role of oxalate decarboxylase in fungal tolerance, she developed transgenic tomato plants that express oxalate decarboxylase and are fungal resistant. Touching upon the findings of this study, she concluded that studies such as these, in general, these will prove to be very useful in identifying plant biomarkers and developing healthy stress-resistant crops.

How is it that some oceanic ecosystems show less photosynthetic productivity even if they are high on nutrients such as nitrates and phosphates? The answer lies in trace elements, isotopes and their concentration, the significance of which was realized only after the discovery of 'high nutrient, low chlorophyll' regions in vast areas of the oceans of the world. With this preface **Sunil Kumar Singh** (PRL, Ahmedabad) delved into his talk 'Biogeochemistry of trace elements and isotopes in the Indian Ocean'.

Biogeochemical cycling of trace elements has direct implications on the marine carbon cycle, which in turn influences ocean ecosystem dynamics and climate change. Data on trace elements is scarce, particularly in the deep ocean, limiting the understanding of biogeochemical cycles in the ocean. Geotraces – an international research programme – was established in order to resolve this issue. Sunil Kumar spoke of his research endeavors as part of the Geotraces–India venture, highlighting, most interestingly, the state-of-the-art equipment that his team uses, in order to collect oceanic water samples and process them. He mentioned his work with the seawater-Fe testing facility which currently exists in only a few labs worldwide. To exemplify the research strategies involved in a study such as this, he elaborated on one of his projects that focused on the measurements of dissolved Nd concentration and its isotope composition in waters of the Bay of Bengal, the Arabian Sea and the eastern Indian Ocean, concluding that these studies can help provide a better understanding of various oceanographic processes.

Using the analogy of an aircraft, **K V Venkatesh** (IIT, Mumbai) introduced the concept of systems biology, where an aircraft and a biological system, such as a cell, have multiple components, interactions, feedback loops, etc. A major distinction, from a technical perspective, is that while engineered systems have manuals, the complex dynamics that exists between various components of most biological systems, such as a single cell or a complex organism, are yet to be characterized. With this opening, he commenced his talk on 'Systems engineering perspective of human metabolism: A multi-scale model for disease analysis'.

Venkatesh explained the need to use a combination of mathematical modelling, genomic, proteomic, metabolomic and interactomic data to study a biological system. He also mentioned the challenges that exists in modelling disease states at a systemic level.

Venkatesh explained his research interests that included the development of a multi-scale composite model for whole-body human metabolism, incorporating

tissue-specific metabolism and regulation, in order to analyse the effects of lifestyle, such as diet and exercise, on metabolism and analyze disease states such as metabolic syndrome and cancer. Using his work as an example, he illustrated a whole body metabolism model that he developed to study insulin resistance, and how, once characterized, he could obtain a simulation of the effect of typical lifestyle parameters including diet and exercise on various components of the system (say, plasma glucose). He also demonstrated how he applied such models to study metabolic syndrome. The motivation to develop such a model is to gain systems level insights that could aid hypothesis generation, model testing, target identification, disease indication, etc., he said.

D S Pandey (BHU, Varanasi) spoke on 'Aggregation-induced emission: Optical and morphological insights'. With the patronage of AIE it has been possible to control aggregate build-up by strategic tuning of intermolecular interactions leading to nano-structures of new morphology and tunable solid state emission. The unique phenomenon of metal-driven AIE is relatively scarce and the speaker's group has attempted to explore it in cyclometalated cationic iridium complexes. They have successfully achieved a distinction between molecular and nano-aggregation through fabrication of gold nano-particles capped by cyclometalated cationic iridium complexes. Various aspects of AIE highlighted in this talk were aggregation-caused quenching, architectural diversity, the driving force behind it and its applications. Application includes sensors, latent finger printing recognition, viscosity sensor, DNA sensor, peptide sensor, dual colour cell imaging probes, cellular apoptosis probe, fluorescent nano particles, etc. He explained morphological tuning in AIEgens, the discrete emission behaviour of AIEgens, the effect of crystal packing patterns and live cell imaging. The speaker said that his group is interested in restricting intramolecular rotation by aggregation and supplementing the complexes with long alkyl chains to achieve micelles and vesicles in aqueous solution, which could eventually lead to emission enhancement. They have chosen zinc and cyclometalated iridium complexes, as these are being widely used in molecular recognition, fluorescent sensors, photonic, optoelectronic and biological fields.

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ACADEMY PUBLIC LECTURE

The Black Hole Event Horizon Telescope

Ramesh Narayan

Thomas Dudley Cabot Professor of the Natural Sciences Harvard University, Harvard-Smithsonian Center for Astrophysics, Cambridge, USA

22 June 2016, Indian Institute of Science, Bengaluru

A black hole is an object which is so compact, and whose gravitational pull is so strong, that nothing – not even light – can escape from its interior. The universe contains countless numbers of black holes, some that weigh only about ten times the mass of the Sun and others as much as a billion times more. Even though light cannot escape from inside a black hole, gas flowing towards the hole does emit very intense radiation: radio waves, light, X-rays, and gamma rays. Astronomers study such radiation on a daily basis using telescopes on the ground and in space. However, until now, no telescope has had the angular resolution necessary to produce an actual image of the region close to a black hole. This will change in the next couple of years when a new facility, called the Event Horizon Telescope (EHT), will begin operations, said Ramesh Narayan. The EHT will, among other things, provide new ways of testing Einstein's general theory of relativity in the strongly curved space-time near a black hole. The talk reviewed this exciting new frontier.

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EIGHTY-SECOND ANNUAL MEETING

IISER, Bhopal

4 – 6 NOVEMBER 2016

PROGRAMME

4 November 2016

1000 – 1045 **Presidential Address**

Ram Ramaswamy, JNU, New Delhi
Chimeras: A Spontaneous Emergence of Dynamical Disorder

1045 – 1130 **Book release:** *A Life in Science* by Prof. CNR Rao
Published by Penguin Random House, India

Inaugural Lectures of Fellows/ Associates

1200 – 1220 **Arun Chattopadhyay,** IIT, Guwahati
Decorating the Surface of a Quantum Dot with Molecules

1225 – 1245 **Sanjib K Agarwalla,** IoP, Bhubaneswar
Neutrino Oscillation Parameters: Present Status and Future Roadmap

1400 – 1420 **Javed N Agrewala,** IMTECH, Chandigarh
Caerulomycin A Suppresses Arthritis Symptoms by Expanding Regulatory T Cells

1425 – 1445 **A Raghuram, FASc,** Pune
From Calculus to Number Theory

Walter Kohn Memorial Symposium

1530 **T V Ramakrishnan,** BHU, Varanasi
Walter Kohn and the Rise of Condensed Matter Physics

1600 **Swapan K Ghosh,** BARC, Mumbai
Density Functional Theory for Materials Modeling at Different Length Scales: A Legacy of Walter Kohn

1630 **Tanusri Saha-Dasgupta,** SN Bose National Centre for Basic Sciences Kolkata
Beyond the Conventional DFT: Life with "U"

1700 **Umesh V Waghmare,** JNCASR, Bengaluru
Electrons in a Crystal: Localized versus Extended Orbitals

1800 – 1900 **Public Lecture**
Rajendra Singh, Tarun Bharat Sangh, Alwar (Rajasthan)
Indigenous Knowledge System of Water Management in India

5 November 2016

0900 – 0940 **Special Lecture**
Sunil Mukhi, IISER, Pune
Academic Ethics in India: What We Must Do

Inaugural Lectures of Fellows/ Associates

0940 – 1000 **Pradyut Ghosh,** IACS, Kolkata
Recognition, Sensing Separation of Anions

1005 – 1025 **Ankur A Kulkarni,** IIT, Mumbai
Towards a Convex-Analytic View of Impossibility Results in Stochastic Control and Information Theory

Symposium "Our Second Genome"

1050 **Partha P Majumder**, NIBMG, Kolkata
An Overview of Our Second Genome

1110 **Sharmila S Mande,** TCS, Pune
Gut Microbiome and Human Health

1140 **Vineet K Sharma,** IISER, Bhopal
Novel Insights into the Human Microbiome

1210 **Souvik Mukherjee,** NIBMG, Kolkata
The Microbiome in Skin Health and Disease

1240 **Shekhar C Mande,** NCCS, Pune
The Indian Human Microbiome Initiative

Inaugural Lectures of Fellows/ Associates

1400 – 1420 **G C Anupama,** IIA, Bengaluru
Time Domain Astronomy – Explosive Transients

1425 – 1445 **S Ganesh,** IIT, Kanpur
Role of Non-coding RNAs in Cellular Stress Response

1450 – 1510 **K N Balaji,** IISc, Bengaluru
Mycobacteria Scapegoat Host Epigenetic Factors and Non-coding RNAs to Sneak Through Host Immune Responses

1515 – 1535 **Anshu Pandey,** IISc, Bengaluru
Chemistry with Bigger Atoms

1800 – 1900 **Public Lecture**

Ravi Korisettar, Dr VS Wakankar Archaeological Research Institute, Dharwad
Importance of the Vindhya Basin in the Prehistory of the Indian Subcontinent

6 November 2016

Inaugural Lectures of Fellows/ Associates

0900 – 0920 **Krishna P Kaliappan,** IIT, Mumbai
Domino Strategy to Synthesis of Natural Products and Heterocycles

0925 – 0945 **Appa Rao Podile,** University of Hyderabad, Hyderabad
Transglycosylation by Bacterial Chittnases

0950 – 1010 **N Ravishankar,** IISc, Bengaluru
Intriguing Structure and Transport Behaviour of Ultrathin Single Crystalline Gold Nanowires

1015 – 1035 **B Anand,** IIT, Guwahati
Homing Mechanism of the CRISPR-Cas Adaptive Immune System

1100 –1120 **Tirthankar Bhattacharyya,** IISc, Bengaluru
What Do Analytic Functions Look Like?

1125 – 1145 **Pratap Raychaudhuri,** TIFR, Mumbai
Low Temperature Scanning Tunneling Spectroscopy

1150 – 1210 **G R Tripathy,** IISER, Pune
Re-Os geochronology: Clues for Past Marine and Atmospheric Conditions

1215 – 1300 **Special Lecture**

Amitabh Joshi, JNCASR, Bengaluru
Experimental Ecology and Evolution in the Laboratory

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ASSOCIATES – 2016

Subhro Bhattacharjee
ICTS, Bengaluru
Quantum Many-Body Systems, Quantum Magnets, Topological Phases of Condensed Matter

Atanu Bhattacharya
IISc, Bengaluru
Ultrafast Science, Surface Science, Molecular Beam Experiments

Sagar Chakraborty
IIT, Kanpur
Nonlinear Dynamics, Turbulence, Magnetohydrodynamics

Swetaprovo Chaudhuri
IISc, Bengaluru
Propulsion, Combustion, Energy

Yogeshwaran Dhandapani
ISI, Bengaluru
Probability, Stochastic Geometry, Random Topology

C T Dhanya
IIT, New Delhi
Water Resources Engineering, Climate Change Impact Assessment, Hydroclimatological Modelling

Radhika Ganapathy
TIFR, Mumbai
Representation Theory, Number Theory, Algebraic Groups

Rohini Garg
NIPGR, New Delhi
Plant Epigenomics, Biotechnology, Gene Regulation

P Jayanth Kumar
AIIMS, New Delhi
Noncoding RNA, Acute Lymphoblastic & Myeloid Leukemias, RNA Building Proteins

Sameena Khan
THSTI, Faridabad
Structural Biology, Cell Biology

Praveen Kumar
IISc, Bengaluru
Mechanical Behaviour of Materials, Electromigration, Microelectronic Packages

Sabyashachi Mishra
IIT, Kharagpur
Theoretical & Computational Chemistry, Enzyme Catalysis, Molecular Physics

Jagannath Mondal
TIFR-CIS, Hyderabad
Computational Chemistry, Theoretical Chemistry

Samrat Mondol
Wildlife Institute of India, Dehra Dun
Molecular Ecology, Conservation Genetics, Wildlife Endocrinology

V K Prajapati
Central University of Rajasthan,
Kishangarh Infection Biology, Parasitology, Chemical Biology

B Uday Kumar Reddy
IISc, Bengaluru
Compiler Optimisation, High Performance Computing, Automatic Parallelisation

Ranjit Thapa
SRM Research Institute,
Kattankulathur Density Functional Theory, Metal-free Catalyst, Hydrogen Storage

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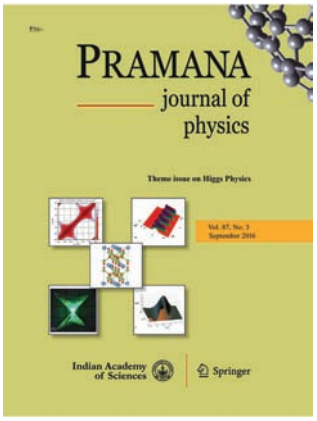
SPECIAL ISSUES OF JOURNALS

Theme Issue on Higgs Physics

Editor : Debajyoti Choudhury

Pramana – Journal of Physics
Volume 87, Issue 3, September 2016



With the discovery of a 125 GeV resonance by the ATLAS and CMS Collaborations at the Large Hadron Colliders (LHC), we have entered a new era in High Energy Physics. While the particle seems to have properties very close to what the Standard Model (SM) predicts, we are still to ascertain, beyond any reasonable doubt, that this is indeed the case.

In light of all the results from the LHC so far, it is not easy to answer whether the SM is all that there is to physics at the TeV scale or if the new discovery bring, along with it, some hints of new physics beyond the SM. The first step of answering this question would be to re-examine not only the Higgs discovery analysis (not limiting ourselves to the $\gamma\gamma$ and ZZ channels), but also consider how sensitive our conclusions may be to the (model) assumptions that, inherently, are part of any such deciphering of complex experimental data. This is of particular relevance, on the one hand, in deciding whether the remaining 'discrepancies' in the Higgs observations are of any importance and, on the other hand, in understanding possible post-Higgs signals such as the purported excess in the $\gamma\gamma$ final state at 750 GeV, reported in December 2015. Another important question that haunts the community of particle physicists now is the following: if the discovery is indeed that of the SM Higgs, what keeps it light and protected from large quantum corrections? Apart from supersymmetry, does there exist a *natural* resolution of the hierarchy problem? Or should we be happy enough with extensions that may not be seem as natural?

Equally valid is another query: if the discovered particle is only approximately the SM Higgs, then is

the electroweak breaking mechanism driven by an extended scalar sector? This question assumes particular significance in the context of the aforementioned excess at 750 GeV. Is new physics (at the few TeV scale), then, well-approximated by a simple two-Higgs doublet model or should we consider more elaborate structures such as the minimal super-symmetric SM?

Should our pursuit of understanding physics at higher energy scales be guided by notions of symmetry and/or a more fundamental construct or should we be happy enough with the more agnostic frame of effective theories that allow us to explore the unknown in small steps? This, again, could be related to the very first questions raised in this preface. And, finally, what does this discovery (and/or the theoretical explorations associated with it) tell us about other questions related to symmetry breaking, whether it is the understanding of the QCD vacuum or the resolution of the puzzle related to the observed baryon asymmetry in the Universe?

This is a collection of reviews on the state of the field, which examine some of these questions and, in attempting to answer them, raises other intriguing ones.

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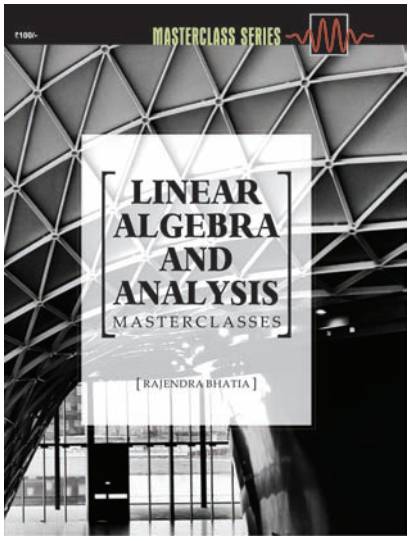
MASTERCLASS SERIES



The Masterclass series of eBooks brings together pedagogical articles on single broad topics taken from *Resonance*, the Journal of Science Education, that has been published monthly by the Indian Academy of Sciences since January 1996. Primarily directed at students and teachers at the undergraduate level, the journal has brought out a wide spectrum of articles in a range of scientific disciplines. Articles in the journal are written in a style that makes them accessible to readers from diverse backgrounds, and in addition, they provide a useful source of instruction that is not always available in textbooks.

The second book in the series, *Linear Algebra and Analysis Masterclasses*, is by Prof. Rajendra Bhatia. A celebrated mathematician, Prof. Bhatia's career has largely been at the Indian Statistical Institute, New Delhi, where he has been for over three decades and is currently a Distinguished Scientist. He has contributed pedagogical articles regularly to *Resonance*, and these comprise the bulk of the present book. Only two of the ten articles in the book have not appeared earlier in *Resonance*.

Professor Bhatia's work has made significant inroads in a variety of areas, including mathematical physics, computer science, numerical analysis and statistics. The book, which will be available in digital format and will be housed as always on the Academy website, will be valuable to to both students and experts as a useful handbook on Linear Algebra and Analysis.

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HINDI WORKSHOPS

The Indian Academy of Sciences and the Raman Research Institute jointly conducted a workshop on 'Noting, Drafting and Computing in Hindi' on 24 June 2016 by Dr S N Mahesh, Sr. Hindi Translator, Centre for Artificial Intelligence and Robotics, Bengaluru. This was followed by Hindi Vocabulary Quiz.

Hindi Fortnight was jointly observed during 14-26 September 2016. Various competitions such as quizzes, story-telling, Hindi typing, knowledge of Administrative Glossary, Hindi dictation and Hindi songs were held. The fortnight concluded with Hindi Day Celebration on 26 September 2016. A lecture by Dr Niru Sinha, Maharani Lakshmi Ammani College for Women, Bengaluru, was followed by prize distribution.

SUMMER RESEARCH FELLOWSHIP PROGRAMME FOR STUDENTS AND TEACHERS

This is a major activity of the Academy under its Science Education initiatives. Started in 1995, it has grown rapidly in size. This is particularly so after the Indian National Science Academy (New Delhi) and the National Academy of Sciences India (Allahabad) joined with this Academy in 2007 in conducting this programme.

The table below gives information on the number of applications received; the number of fellowships awarded and availed in 2016.

Sl. No.	Subjects	No. of applications received		No. of fellowships offered		No. of fellowships availed	
		Students	Teachers	Students	Teachers	Students	Teachers
1	Life Sciences (incl. Agri. Sciences)	2954	121	482	64	434	50
2	Engineering Sciences and Technology	8488	155	570	40	439	25
3	Chemistry	1733	78	294	31	251	21
4	Physics	1935	75	230	28	198	17
5	Earth and Planetary Sciences	748	07	139	02	124	01
6	Mathematics	810	18	116	08	90	06
	TOTAL	**16668**	**454**	**1831**	**173**	**1536**	**120**
	GRAND TOTAL	**17122**		**2004**		**1656**	

Many institutions in the country helped the programme by hosting Summer Fellows and providing them the necessary facilities, such as laboratory support, accommodation, etc. The following tables give information on (a) the cities in which ten or more Summer Fellows were placed and (b) institutions that hosted ten or more Summer Fellows in 2016.

(a) Cities in which ten or more Summer Fellows were placed in 2016:

Sl. No.	Cities (as hosts)	No. of SRFs
1.	Bengaluru	346
2.	New Delhi	206
3.	Mumbai	175
4.	Hyderabad	163
5.	Kolkata	94
6.	Pune	76
7.	Chennai	73
8.	Thiruvananthapuram	59
9.	Bhubaneswar	39
10.	Guwahati	34
11.	Mohali	34

Sl. No.	Cities (as hosts)	No. of SRFs
12.	Varanasi	26
13.	Kharagpur	21
14.	Ahmedabad	17
15.	Ropar	17
16.	Kanpur	16
17.	Durgapur	15
18.	Gandhinagar	15
19.	Karaikudi	15
20.	Lucknow	12
21.	Dehradun	11

(b) Institutions that hosted ten or more Summer Fellows in 2016:

Sl. No.	Institutions (as hosts)	No. of SRFs
1	IISc, Bengaluru	249
2	IIT, Mumbai	83
3	BARC, Mumbai	55
4	IIT, Chennai	48
5	UOH, Hyderabad	47
6	IIT, Guwahati	34
7	IISER, Mohali	31
8	IIT, New Delhi	29
9	IIT, Hyderabad	27
10	BHU, Varanasi	26
11	CDFD, Hyderabad	24
12	UOD, Delhi	24
13	NCL, Pune	23
14	ISI, Kolkata	22
15	NPL, New Delhi	22
16	IISER, Pune	21
17	IISER, Thiruvananthapuram	21
18	IIT, Kharagpur	21
19	NISER, Bhubaneswar	21
20	ICT, Mumbai	20
21	JNCASR, Bengaluru	18
22	NCCS, Pune	18
23	NGRI, Hyderabad	18
24	ICGEB, New Delhi	17
25	IIT, Ropar	17
26	IISER, Kolkata	16
27	IIT, Kanpur	16
28	UOD(SC), New Delhi	16
29	CMERI, Durgapur	15
30	PRL, Ahmedabad	14
31	NII, New Delhi	13
32	CECRI, Karaikudi	12
33	CCMB, Hyderabad	11
34	IACS, Kolkata	11
35	NCBS, Bengaluru	11
36	NIPGR, New Delhi	11
37	Univ. of Calcutta, Kolkata	11
38	Bose Institute, Kolkata	10
39	CDRI, Lucknow	10
40	IIST, Thiruvananthapuram	10
41	IIT, Gandhinagar	10
42	ILS, Bhubaneswar	10
43	Jamia Millia Islamia, New Delhi	10
44	NIIST, Thiruvananthapuram	10
45	RGCB, Thiruvananthapuram	10
46	WIHG, Dehradun	10

(c) Many institutions in the country were also benefited by the programme as several of their own students and teachers were selected under the programme and had the opportunity to work at institutions elsewhere. The following is a list of such institutions from where ten or more summer fellows were selected in 2016.

Sl. No.	Institutions benefitted by SRFP	No. of SRFs
1.	NIT, Tiruchirappalli	26
2.	NITK, Surathkal	24
3.	Pondicherry Univ., Puducherry	23
4.	IIT, Kharagpur	19
5.	ISM, Dhanbad	19
6.	CUSAT, Cochin	19
7.	Central Univ. of Tamil Nadu, Thiruvarur	18
8.	Univ. of Delhi, New Delhi	18
9.	BHU, Varanasi	18
10.	Univ. of Hyderabad, Hyderabad	17
11.	NIT, Rourkela	17
12.	Bharathidasan Univ. Tiruchirappalli	16
13.	St. Stephen's College, New Delhi	16
14.	NIT, Warangal	16
15.	IIT, Roorkee	16
16.	RGUKT, Nuzvid	15
17.	MSRIT, Bengaluru	14
18.	IISER, Pune	14
19.	Jadavpur Univ., Kolkata	14
20.	Thiagarajar College, Madurai	14
21.	Tezpur Univ. Tezpur	13
22.	SASTRA Univ., Thanjavur	13
23.	VIT Univ., Vellore	13
24.	PESIT, Bengaluru	13
25.	IIT – Madras, Chennai	13
26.	Christ Univ., Bengaluru	12

Sl. No.	Institutions benefitted by SRFP	No. of SRFs
27.	Presidency Univ., Kolkata	12
28.	SJCE, Mysuru	12
29.	NIT, Agartala	12
30.	IIT, Guwahati	12
31.	IISER, Bhopal	12
32.	SPP Univ., Pune	12
33.	Anna Univ., Chennai	12
34.	SVNIT, Surat	12
35.	SSN College of Engg ., Chennai	11

Sl. No.	Institutions benefitted by SRFP	No. of SRFs
36.	IIT – Bombay, Mumbai	11
37.	BITS – Pilani, Rajasthan	11
38.	IIT, Bhubaneswar	11
39.	IIT, Kanpur	10
40.	Central Univ. of Rajasthan, Ajmer	10
41.	Miranda House, New Delhi	10
42.	IISER, Mohali	10
43.	SRM Univ., Chennai	10

The mentors–summer fellows' ratio for the year 2016 is provided in the following table.

Sl. No.	Subject-wise	Number of Mentors	Summer Fellows		Total Candidates
			Students	Teachers	
1	Life Sciences (incl. Agri. Sciences)	381	434	50	484
2	Engineering Sciences & Technology	247	439	25	464
3	Chemistry	227	251	21	272
4	Physics	159	198	17	215
5	Earth & Planetary Sciences	092	124	01	125
6	Mathematics	051	90	06	96
	TOTAL	**1157**	**1536**	**120**	**1656**

This activity of the Academies has received enthusiastic response from both the faculty, who acted as guides, as well as the students and teachers, who availed the fellowship.

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‘WOMEN IN SCIENCE’ PANEL PROGRAMME

A lecture workshop was organised by the Women in Science (WiS) Panel, Indian Academy of Sciences, Bengaluru, in association with Azim Premji University, Bengaluru, under the **"WiS: A Career in Science"** programme on **17 September 2016** at the **Azim Premji University, PES Campus, Electronic City, Bengaluru**. The programme was attended by around 100 participants comprising undergraduate students and faculty members of both genders participated from Azim Premji University (APU) and nearby colleges.

The program began with an introduction to the Women in Science program given by Dr Beena DB. The first speaker, Rama Govindarajan, from International Centre for Theoretical Sciences, Bengaluru, began her talk entitled "Fluid mechanics of clouds and other things". Govindarajan gave a very informative talk on cloud science; what causes clouds to form, what role does altitude play on cloud formation, how aerosol particles act as nucleation points, etc. Interestingly, she highlighted the fact that much remains unknown about clouds, and how climate change is affecting cloud patterns, and especially monsoons in India.

Varsha Singh, Department of Molecular Reproduction, IISc, gave a talk on "Secrets behind longevity in worms: Sensory perception and caloric restriction". Audiences were introduced to different model organisms, each lending themselves to specific areas of study. In *C. elegans*, Singh outlined how caloric restriction results in increased lifespan, and made connections to the neural system. She spoke about pattern formation in *Pseudomonas* bacteria, and raised many interesting questions regarding emergence of "multicellular behaviour" in a unicellular system.

Kaneenika Sinha, Indian Institute of Science Education & Research, Pune, gave a lecture entitled "Certain functions of Ramanujan". Sinha skilfully used Srinivas Ramanujan's life and mathematical interests to demonstrate not only the significance and ingenuity of his discoveries but also how simple methods can be used by students to solve important problems.

Veena Srinivasan from the Centre for Environment and Development, ATREE, spoke on "Problem driven water science: Framing research to address critical social problems". Srinivasan spoke on the approach taken at ATREE on solving water-related issues. Due to the complex nature of water shortages due to overuse of water, increased extraction, climate change, changes in livelihood practices, etc., rather than taking a hypothesis-driven approach, the first step was to identify the issues that contribute to the broader social and ecological problems of water resource management.

Yasmin Jayathirtha, Centre for Learning, Bengaluru, gave a lecture entitled "The sceptical chemist: Education for a scientific attitude". She spoke on the nature of the current education system, and the lack of promoting questioning and understanding versus the exam-driven system. Giving examples from her own experience in teaching chemistry, she spoke about how science is truly a tool to question the universe.

A panel discussion was held on various issues related not only to women in science but careers in science in general. The panel included Aruna Rajan, Flipkart, Bengaluru; Varsha Singh; Priyanka Jamwal, ATREE; Usha Rajaram, APU; and Rajaram Nityananda, APU. Topics included career options in science after BSc (academic, industry and other options), work–life balance in a career in science, and issues faced by women in early stages of an academic career in scientific research/teaching and in a corporate career.

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REFRESHER COURSES AND LECTURE WORKSHOPS

Jointly sponsored by IASc (Bangalore), INSA (New Delhi) and NASI (Allahabad)

REFRESHER COURSES

Two-week Refresher Courses are aimed at helping teachers to add value to their teaching and are designed to have direct relevance to the study materials covered in the graduate and undergraduate syllabi followed in universities and institutions in the country. The following courses were held from April to September 2016.

A. Refresher Courses in Experimental Physics

The Refresher Courses in Experimental Physics were held under the direction of R Srinivasan, who was instrumental in the conceptualisation and designing of the experiments. He has so far held 79 Courses in different parts of the country since 1999. These experiments are useful for laboratory programmes at BSc and MSc levels, and many universities in the country have adopted these experiments as part of their curricula. In order to conduct the Refresher Courses, a user-friendly kit containing several components has been developed and manufactured under licence by M/s Ajay Sensors and Instruments, Bengaluru.

The following is the list of Experimental Physics Courses held from April to September 2016. Complete information is provided in our website *http://web-japps.ias.ac.in:8080/SEP/refresher_course__completedlist.jsp*.

Sl. No.	Title	Venue	Duration	Director	Co-ordinator
1	Experimental Physics – 79	Panjab University, Chandigarh	25-09-2016 10-10-2016	–	J.S. Shahi
2	Experimental Physics – 78	Thiagarajar College of Engineering, Madurai	05-07-2016 20-07-2016	R. Srinivasan	M. Mahendran
3	Experimental Physics – 77	K. L. University, Guntur	14-06-2016 29-06-2016	R. Srinivasan	N.V. Suresh Kumar
4	Experimental Physics – 76	Goa University, Goa 25-05-2016	10-05-2016	K.R.S. Priolkar	K.R.S. Priolkar
5	Experimental Physics – 75	University of Kashmir Srinagar	12-04-2016 27-04-2016	R. Srinivasan	Gowher Bashir

B. Other Refresher Courses

The following is the list of Refresher Courses in Other Topics held from April to September 2016. Complete information is provided in our website *http://web-japps.ias.ac.in:8080/SEP/refresher_course__completedlist.jsp.*

Sl. No.	Title	Venue	Duration	Director	Co-ordinator
1	Mineralogy, Petrology, Thermodynamics, Organic Geochemistry and Ore Geology	IASc Facility, Jalahalli, Bangalore	17-09-2016 01-10-2016	Alok K. Gupta	T. D. Mahabaleswara
2	Plant Taxonomy – Orthadox and modern aspects	Yogi Vemana University, Kadapa	15-09-2016 29-09-2016	R.R. Rao	A. M. Reddy
3	Differential Equations and Their Applications in Science and Engineering	Indian School of Mines, Dhanbad	04-07-2016 16-07-2016	Phoolan Prasad	M. K. Singh

Sl. No.	Title	Venue	Duration	Director	Co-ordinator
4	Mathematics	The Maharaja Sayajirao University of Baroda, Vadodara	06-06-2016 18-06-2016	V.M. Shah	Haribhai R. Kataria
5	Quantum Mechanics and Nuclear Physics	Dayananda Science College, Latur	15-04-2016 30-04-2016	Sulabha Kulkarni	R.H. Ladda
6	Mountain Hydrology and Climate Change	GB Pant University of Agriculture and Technology, Pantnagar	28-03-2016 08-04-2016	P.P. Mujumdar	H.J. Shiva Prasad

LECTURE WORKSHOPS

The following is the list of Lecture Workshops held from April to September 2016. Complete information is provided in our website *http://web-japps.ias.ac.in:8080/SEP/lecture_workshop_completedlist.jsp.*

Sl. No.	Title	Venue	Duration	Convener	Co-ordinator
1	Current developments in biology	Cauvery College for Women, Tiruchirappalli	26-09-2016 28-09-2016	S.K. Saidapur	H. Abirami
2	Ordinary and partial differential equations	Bishop Cotton Womens Christian College, Bangalore	23-09-2016 24-09-2016	M. Lakshmanan	Muniraja Gopal
3	Recent developments in biochemistry	Kongu Arts and Science College, Erode	23-09-2016 24-09-2016	R. Ramaraj	A.K. Vidya
4	Special topics in condensed matter physics	St. Philominas College, Mysore	22-09-2016 24-09-2016	R. Srinivasan	D. Revanna Siddaiah
5	Recent advances in life sciences	Gulbarga University, Kalaburgi	22-09-2016 23-09-2016	R.R. Rao	G.R. Naik
6	New horizons in chemical and biochemical sciences	Indian Academy Degree College, Bangalore	22-09-2016 23-09-2016	C. Durga Rao	K. Prashanthi
7	Chemistry: an innovative driver in materials science	Raghunathpur College, Puralia	22-09-2016 23-09-2016	Samar Kumar Das	Bhaskar Biswas
8	Trends in modern biology	Dr NGP Arts and Science College, Coimbatore	16-09-2016 17-09-2016	D.N. Rao	J. Karthikeyan
9	Emerging and re-emerging infectious diseases	St. Joseph's College, Bengaluru	16-09-2016 17-09-2016	Soumitra Das	Popy Dutta

Sl. No.	Title	Venue	Duration	Convener	Co-ordinator
10	Role of plant taxonony in conservation of biodiversity	Kuvempu University, Shimoga	11-09-2016 07-09-2016	R.R. Rao	Y.L. Krishnamurthy
11	Some recent trends in physics	Kumaraguru College of Technology,Coimbatore	07-09-2016 09-09-2016	M. Lakshmanan	R. Balamurugan
12	Role of mathematical science in digitalization	St Joseph Degree and PG College, Hyderabad	07-09-2016 08-09-2016	V. Kannan	Lakshmi N.
13	An introduction to the solution of ordinary differential equations	Christ University, Bengaluru	02-09-2016 03-09-2016	Mythily Ramaswamy	Mayamma Joseph
14	Biodiversity and bioremediation	Karpagam University, Coimbatore	01-09-2016 02-09-2016	R.R. Rao	A. Sangilimuthu
15	Chemistry – Current Focus	Madras Christian College,Chennai	26-08-2016 27-08-2016	V. Subramanian	P. Wilson
16	Mining Metabolites – Microbes in Plants	VIT University, Vellore	25-08-2016 27-08-2016	R. Uma Shaanker	Siva Ramamorthy
17	Prospects of bioscience	Hindusthan College of Arts and Science, Coimbatore	23-08-2016 24-08-2016	D.J. Bagyaraj	G. Rajalakshmi
18	Recent trends in Biological Sciences	Kamaraj College, Thoothukudi	17-08-2016 18-08-2016	D.J. Bagyaraj	A. Doss
19	Hyperbolic partial differential equation (HPDE) and conversion laws (CL)	University of Calcutta Kolkata	10-08-2016 12-08-2016	Phoolan Prasad	Susmita Sarkar
20	Lecture workshop on “analysis”	Miranda House, Delhi	10-08-2016 12-08-2016	Ajit Iqbal Singh	Daulti Verma
21	Numerical methods and scientific computing	KSR College of Arts and Science, Tiruchengode	10-08-2016 12-08-2016	P. Kandasamy	S. Padma
22	Plant Taxonomy – concepts and changing trends	Government Degree and PG College, Wanaparthy	08-08-2016 09-08-2016	R.R. Rao	B. Sadasivaiah

Sl. No.	Title	Venue	Duration	Convener	Co-ordinator
23	Introduction to theoretical physics	Government Arts College, Melur	04-08-2016 05-08-2016	G. Baskaran	A. John Peter
24	Advances in biotechnology	KLE Socities S. Nijalingappa College, Bangalore	29-07-2016 30-07-2016	M.R.N. Murthy	Prathibha K.S.
25	Advances in microalgal research and its relevance to climate change	Sathyabama University, Chennai	21-07-2016 22-07-2016	T. Subramoniam	T. Sasipraba
26	Applications of flow cytometry in health and disease	NIRRH, Mumbai	14-07-2016 15-07-2016	Tarala D. Nandedkar	Sarbani Mukherjee
27	Frontiers in Biosciences	M.R. Government Arts College, Mannargudi	11-07-2016 13-07-2016	R.R. Rao	R. Velayudhan
28	Mathematical Physics	PSGRK College for Women, Coimbatore	22-06-2016 24-06-2016	M. Lakshmanan	P. Meena
29	Emerging technologies based on nanoscience – a popularization workshop	Mody University of Science and Technology, Sikar	22-04-2016 23-04-2016	A.K. Ganguly	Amlan Kumar Das
30	Chemistry and biology interface	Vidyasagar University Midnapore	21-04-2016 22-04-2016	Anunay Samanta	Amiya Kumar Panda
31	Internet of things: A research perspective for smart environment	Dr GRD College of Science, Coimbatore	15-04-2016 16-04-2016	Krithi Ramamritham	S. Sujatha
32	Recent advances in life sciences	MACFAST, Tiruvalla	1-04-2016 112-04-2016	Sateesh C. Raghavan	Biju Dharmapalan

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TRAINING PROGRAMMES FOR PUBLICATION STAFF

In an effort towards capacity-building of the publication staff of the Academy, an in-house training programme on LaTex was held during February-March 2016. An in-house copyediting training programme was also organised in June 2016. An Academy copy-editors' manual is in preparation for standardization of copy-editing and proofreading of the journals.

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WORKSHOP ON 'CURRENT TRENDS IN JOURNAL PUBLISHING'

A workshop on the 'Current Trends in Journal Publishing' was held for the Bengaluru-based Chief Editors, Associate Editors and the publication staff of the Indian Academy of Sciences on the 23 June 2016, at the Academy auditorium. The workshop was an interactive session meant, primarily, to acquaint the academy staff with the latest advances in the academic publishing industry.

The workshop was inaugurated with a formal note by Prof. T N Guru Row, Editor of Publications, Indian Academy of Sciences. He spoke of the changing scenario in manuscript publishing from the early 70s, when correspondence with the publisher would be via the postal system, to the current day, where technology has greatly accelerated and simplified the entire process.

Ms Surabhi Shukla, Senior Publisher, introduced the workshop with her talk 'The world is changing for the researcher; what can we do?' She spoke mainly of the challenges faced by researchers in the digital age and the opportunities a publisher can seize in such a scenario for its growth. Mr Sameer Gupta, Publisher, spoke on Continuous Article Publishing, comparing and contrasting it with the existing print technology while discussing its various advantages. He also discussed the use of e-proofing tool by author and journal office, and the use of multimedia to make an article interesting to attract readers. There was also a live demonstration of MENDELEY – a reference manager tool by Dr Gopakumar V, Chief Librarian, Goa University, who also spoke of its various merits.

Mr Manish Uniyal, Marketing Manager for Research Solutions, discussed SCOPUS – a database of peer-reviewed literature, its range of contents and how it can help researchers, authors and editors. He also highlighted the importance of metrics for scholars and therefore the necessity of making content widely available and easily accessible

Prof. Durgadas P Kasbekar, Associate Editor of Publications, Indian Academy of Sciences, concluded the session by summarising the major points that were conveyed in the workshop, and thanking the speakers.

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PROMOTION OF ACADEMY JOURNALS

As part of promotion of the Academy's journals, the Academy participated in the 34th Annual Meeting of the Astronomical Society of India (ASI) at Srinagar during 10–13 May 2016, the ICAARS 2016 (International Conference on Advancements in Automation, Robotics and Sensing) at PSG College of Technology during 23–24 June 2016 at Coimbatore, and the CRSI meeting held at North Bengal University, Siliguri, during 13–16 July 2016. The Academy journals were displayed and fliers were distributed. The Academy awarded two prizes for the best posters at each of these events.

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SUPERANNUATED ACADEMY STAFF

G Chandramohan

G Chandramohan joined the Editorial Department of the Academy on 13 May 1973. He superannuated on 30 April 2016 as the Executive Secretary of the Academy.

Ranjini Mohan

Ranjini Mohan joined the Academy on 14 April 1978. She superannuated on 30 June 2016 as Senior Administrative/Accounts Assistant.

M Rajlakshmi

M Rajlakshmi joined the Academy on 18 October 1995 as Assistant Editor for *Resonance* journal, and she served until 31 August 2016.

Sujatha Mohankumar

Sujatha Mohankumar joined the Academy on 21 May 1997 as Assistant Editor for *Resonance* journal, and she served until 31 August 2016.

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OBITUARIES

Sailendra Nath Roy Chaudhury
(Elected 1974)

Air Vice-Marshal Sailendra Nath Roy Chaudhury, Founder Director of the Gas Turbine Research Establishment in Bengaluru from November 1961 to March 1981, passed away in the city on 18 May 2016 at the age of 93 years.

The gas turbine engine technology prior to 1950s was largely commanded by very few countries such as USA, UK, Russia, Germany and France. India did not figure in this map. Then, under the leadership of the Defence Minister, the late V. K. Krishna Menon, with full support of the then Prime Minister, Jawaharlal Nehru, it was envisioned to have an indigenous base for developing gas turbine engines for aircraft, to be produced by the new set-up at Hindustan Aircraft Limited (HAL). Sailendra Nath Roy Chaudhury, a fresh Air Force pilot, trained at the Cranfield Institute of Technology, UK, in the field of propulsion, was identified by the Ministry of Defence to take the lead for nurturing gas turbine technology in the country. The story begins in 1959, when the Gas Turbine Research Centre (GTRC) took birth at the Air Force Station in Kanpur, where Roy Chaudhury was posted as a Squadron Leader after his return from Cranfield, UK. The dedicated team under Roy Chaudhury's leadership developed and tested the first indigenous centrifugal type gas turbine engine of 1000 kg thrust at the Kanpur base on 4 April 1961. The same year GTRC was relocated to Bengaluru under the Defence Research and Development Organisation, and renamed Gas Turbine Research Establishment (GTRE). The team at GTRE took up re-engineering of the RD-9F Russian engine, a candidate power plant for the HF-24 in association with the HAL team. Subsequently, a 1700 K reheat system was developed for Orpheus-703 engine to meet the power requirement of HF-24. Roy Chaudhury's contribution towards thrust augmentation of Orpheus-703 engine and the development of type-certified reheat system at GRTE were some of his achievements.

Under Roy Chaudhury's leadership, the team was motivated to take up further projects of developing GTX series engines, i.e. GTX-37U and GTX-37UB with innovative flat rating concept, which was successfully demonstrated during the 1980s. GTRE thus emerged as a full-fledged laboratory committed to the development of aerogas turbine engine systems suited to specific Indian requirements. GTRE now has facilities for full-scale engine tests, testing engine components, mechanical analysis, experimental stress analysis and vibration engineering. Roy Chaudhury remained active towards the betterment of GTRE. He was instrumental in starting the annual gas turbine seminar at GTRE. From a mere 20 to 30 personnel at GTRC (Kanpur) in 1961, the strength of GTRE increased to almost 1600 engineers and technicians by the time Roy Chaudhury superannuated in 1981.

He was a firm believer in the utilization of bio-energy for tackling energy deficiency and uplifting rural economy. After retirement in 1981, he was passionately involved in the application of bio-energy for rural development. His efforts resulted in the approval, by the Department of Non-Conventional Energy Sources of the Ministry of Science and Technology, of a demonstrator project on the use of small gas turbine for Mandya Sugar Mill in Karnataka. The project demonstrated successfully the use of alcohol from the sugar mill to run the engine while the power generated was used for running the bagasse dryer. The hot gas exhaust from the drier was used for drying the bagasse and, in turn, the dried bagasse was burnt in the boiler for steam generation for various process applications, increasing the thermal efficiency to the extent of 34-36%. This was demonstration of the real merit of using total energy concept – new to our country then. The concept of decentralization and co-generation using small gas turbine fuelled by biomass, biogas, etc., to make the rural population of India energy-sufficient was close to Roy Chaudhury's heart.

His passion for doing something for the benefit of people never stopped till the very end. He set up a small laboratory at home to demonstrate the use of a small

set-up for generating electricity for a rural home. He also developed an electronic gas-flow meter with distant reading facility and auto-billing. He wrote a book *Restoration of Split Milk* to bring out the complete dimension of his efforts, deeds and persuasion to achieve his goals.

Roy Chaudhury was the first Indian Air Force Fellow of the Royal Aeronautical Society, London, UK; Honorary Fellow of Energy Institute, UK, and Fellow of the Indian Academy of Sciences, Bengaluru. He was awarded the prestigious J. Omprakash Bhasin Award in 1984.

He is survived by his wife, two sons, a daughter and their families.

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Ahmed Hassan Zewail
(Elected 2002)

Ahmed Hassan Zewail, known as the 'father of femtochemistry', died in USA on 2 August 2016. He leaves behind many science breakthroughs and an enduring legacy. A military funeral was held for Zewail on 7 August 2016 in Cairo, Egypt. It was attended by senior academics, military generals, members of the judiciary, family, friends and high-ranking Egyptian officials. Those attending included President Abdel Fattah el-Sisi, Prime Minister Sherif Ismail, along with former Presidents and Prime Ministers.

Zewail was born on 26 February 1946, in Damanhour in the delta of the river Nile, Egypt. He grew up in Alexandria. He obtained BSc (1967) and MSc (1969) in chemistry from Alexandria University, Alexandria, Egypt. He then moved to the United States, where he completed his PhD (1974) from the University of Pennsylvania, Philadelphia, under the supervision of Robin M Hochstrasser, well-known for his pioneering work in molecular spectroscopy. For his postdoctoral research, Zewail joined the group of Charles Bonner Harris at the University of California, Berkeley, USA. Zewail and Harris worked on the theoretical and experimental aspects of the spectroscopy of pairs of molecules. At Berkeley, Zewail and collaborators extended the concept of coherence to multidimensional systems. He joined California Institute of Technology (Caltech), Pasadena, as a faculty member in 1976. At Caltech, he introduced the idea of shaped pulses to examine molecular processes using molecular coherence. The works on molecular coherence eventually led to the birth of femtochemistry. This work earned Zewail the tenured position at Caltech within two years. He became a naturalized citizen of the USA on 5 March 1982. He became the first Linus Pauling Chair in Chemical Physics (1990). At the time of his death, Zewail held multiple positions: the Linus Pauling Professor of Chemistry, Professor of Physics, and Director of the Physical Biology Center for Ultrafast Science and Technology at the California Institute of Technology.

By studying chemical reactions in terms of the starting ingredients and the final products and occasionally by examining the transitory products, it is not possible to observe the actual dynamics, as the process of chemical bonding is very swift. It was then thought that the chemical reactions occurred at the time scales of molecular vibrations. A vibration of an atom in a molecule takes about 10-100 femtoseconds (10-15 sec). The study of chemical reactions required femtosecond lasers, which became available in the 1980s. Zewail made brilliant use of the new lasers by using them as strobe lights. He used two laser pulses for studying the chemical reactions. The stronger pulse was used to initiate the chemical reaction and the weaker pulse was used to probe this chemical reaction. The measurements were conducted with varying time interval between the two laser pulses. This enabled the reconstruction of the different stages of the chemical reactions. Thus, one could visualize the motion of atoms in a molecular system in 'real time'. Zewail demonstrated his technique for a variety of chemical reactions from simple to very complex. The technique pioneered by Zewail is now a very widely used procedure in chemistry, biology, condensed matter physics and materials science. Using the real time information about the molecular processes, it is now possible to manipulate chemical and biological reactions. The technique has wide applications impacting the development of faster electronics. The technique developed by Zewial is likened to Galileo's use of his telescope, which revolutionized modern astronomy. Zewail received the 1999 Chemistry Nobel Prize unshared. The citation said, 'for his studies of the transition states of chemical reactions using femtosecond spectroscopy'. He is the first and only Arab to win the Nobel Prize in science. On that occasion he said, 'If you can understand the landscape of a chemical change or a biological change, you might be able to alter the landscape'.

In 2008, Zewail once again impressed the scientific community when he and his team developed 'four dimensional electron microscopy'. By incorporating the fourth dimension (namely, time) to the traditional 3D electron microscopy, it is possible to obtain resolutions that are 10-100 times better than those of conventional electron microscopes. With this technology, it is possible to capture and recreate the movement and dynamics of fleeting changes in the structure and shape of matter, in real-time, and real-space. In recent years, Zewail conducted a wide range of studies using 4D electron microscopy, electron diffraction and related methods. Femtochemistry is based on laser–light. The 4D electron microscopy is based on electrons and opened new avenues in biology, chemistry, materials science and nanoscience. This would have been Zewail's path to another Nobel Prize for his outstanding achievements using electron-based techniques.

For his numerous achievements (over 600 scientific papers and 16 books), Zewail received more than a hundred prizes. His many awards include the 1989 King Faisal International Prize for Science (in the subcategory physics), which he shared with Theodor Wolfgang Hänsch from Germany. In 1999, Egypt bestowed upon him the highest state honour, the Grand Collar of the Nile. Egypt issued postage stamps in his hounour. His Indian honours include: Honorary Doctorate by Jadavpur University, Kolkata (2001); Sir C. V. Raman Award, Indian Institute of Science Education and Research, Kolkata (2002); Honorary Fellow, Chemical Society of India (elected 2001); Member, Indian Academy of Sciences (elected 2001); Foreign Fellow, Indian National Science Academy (elected 2002). Zewail delivered the 'Rajiv Gandhi Science Lecture' on 17 October 2002 in Bangalore. In this lecture he acknowledged the scientific tradition and achievements of India.

After receiving the Nobel Prize, Zewail devoted time to improving scientific research in Egypt. He will be remembered for his public service through tireless contribution to the science and education sphere as well as for his scientific feats. In 1999, Zewail initiated the major project known as the Zewail City for Science and Technology in Giza, Egypt (http://www.zewailcity.edu.eg/). The Egyptian Cabinet has proclaimed the project as 'National Project for Scientific Renaissance'. He was one of the speakers at the Opening Ceremony of the 2015 International Year of Light and Light-based Technologies. He held high-profile political appointments including: United States First Science Envoy to the Middle East (2009-2011), President Obama's Council of Advisors on Science and Technology (2009-2013) and UN Secretary General Ban Ki-moon's Scientific Advisory Board (2013). Several prizes, schools and even localities have been named in honour of Zewai?.

He is survived by his wife, a doctor, Dema Faham; his two daughters, Maha and Amani; and two sons, Nabeel and Hani.

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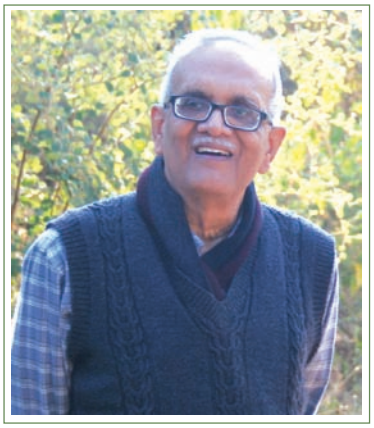

Deepak Kumar
(Elected 1987)

Deepak Kumar, born in New Delhi on 1 April 1946, passed away on 26 January 2016. He grew up in Delhi, where he had his schooling. He studied in the St. Stephen's College of Delhi and obtained his BSc degree with honours in 1965. He completed his Master's degree in 1967 from the Physics Department of the University of Delhi. The same year he joined the graduate school of the Department of Physics in University of Pennsylvania, USA. There he worked for his thesis on theoretical condensed matter physics under the guidance of A B Harris and obtained his PhD in 1972. Soon after completing his PhD he returned to India and joined the Physics Department of the University of Roorkee. He taught and pursued a very active research programme with several colleagues for the next sixteen years in University of Roorkee. In 1985, JNU started building up its new School of Physical Sciences. It was aimed towards having a programme with emphasis on research in areas of condensed matter physics. In 1988, Deepak Kumar started working in JNU as a Professor. He remained associated with the School of Physical Sciences till the very last day of his life. The faculty of the School had recently nominated his name to the University for Emeritus Professorship.

In his doctoral research, Deepak Kumar studied the theory for the dynamics of an antiferromagnet at low temperature. A key aspect of this work lies in linking the microscopic description with the long wavelength macroscopic hydrodynamic behaviour of the antiferromagnet. Indeed, it was these two approaches, often adopted in theoretical condensed matter physics, that Deepak Kumar time and again explored in his research of later years.

During his years in the University of Roorkee, he worked in collaboration with A Mukherjee, Vijay Kumar, S K Joshi, on surface segregation in random alloys. In 1986, from University of Roorke, with Kamlesh Kumari, Deepak Kumar presented a spherical model of Ising spins, placed on sites arranged in a cluster hierarchy. The critical exponents for a ferromagnetic transition in the system were shown to be non-universal, while for antiferromagnetic interactions, the system has no transition, demonstrating that condensation cannot occur in localized systems. During his initial years in New Delhi, he studied microscopic models of hopping conduction in a system with Coulomb interactions. In a paper with his student S Lamba, he calculated within the linear-response regime, the conductivity and the dielectric functions in terms of the density-density response function. He pursued in the later years his interest on discrete models and transport in simple systems. With G Santosh and R Ramaswamy, he studied transport and phonon renormalization in a chain with transverse and longitudinal vibrations. He worked with R K Brojen Singh, on self-consistent study of localization in thin films, and with another student V Malik on thermodynamics and excitations of Coulomb glass. With his student A Tripathi he worked in recent years on the behaviour of velocity correlations and mobility in single- file diffusion. In 2004, with R Mehrotra of National Physical Laboratory, Delhi, he took the approach of classical hydrodynamics to study the pattern formations in melting snow. Deepak Kumar followed a very versatile approach in his research working on different problems of theoretical condensed matter physics. On one hand, he pursued with keen interest hierarchical models of spins, microscopic hopping models of transport, study of spin glasses, and at the same time worked on coarse grained models of classical thermodynamics as well as hydrodynamics, looking into problems ranging from surface segregation, phase transition in mixtures, heat conduction and pattern formation in melting snow. He collaborated rather extensively with a large number of his colleagues not only in the Universities where he worked, but also working in other Institutes in India. During his years in Roorkee, he collaborated with S Dattagupta, to study the non-equilibrium susceptibility of superparamagnetic particles, with M Barma on the critical properties of diluted anisotropic magnets near percolation threshold, and with S Shenoy on relaxational dynamics of disordered ultrametric models. During his JNU years, he worked with S Sarkar to study phase diagrams of binary mixtures using methods of classical statistical physics. He collaborated extensively with S Puri and his group again on problems of classical statistical mechanics, and studied models of phase separation, dynamics, aging in ternary mixtures. And over the same years, he was also very active in research collaboration with R Ghosh and her group on measurement problem in quantum mechanics, studying environment- induced decoherence in the Stern-Gerlach measurement, effect of decoherence on Bell's inequality. While he worked with theoretician colleague R Rajaraman on the nature of the flow in re-normalization-group equations with respect to Umklapp processes for electrons, he also took keen interest in studying the data on magnetism of transition metal cluster compounds with his experimentalist friend A K Rastogi.

His contribution to science has been recognized by several organizations. He was Alexander von Humboldt fellow in Germany during 1978-79. He was elected a member of the Indian Academy of Science, Bengaluru, in 1987. In 1990 he received the Shanti Swarup Bhatnagar Award for Physical Sciences from CSIR. He was Senior Research Associate of International Center for Theoretical Physics, Trieste, Italy. He was also a member of Indian Physics Association and Material Research Society of India. Deepak Kumar was always a University teacher. All these years, even after his formal retirement from the University he never gave up his teaching and helping out the interested learner who approached him. He constantly worried about improvement of standards of university education, and thought of ways of getting qualified people to join University system. His article in *Current Science,* entitled 'University science set to decline: a new caste system' (25 July 2011, 101(02), 149) is very relevant in this respect.

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Paramasivam Natarajan
(Elected 1987)

Paramasivam Natarajan, who was a pioneer in inorganic photochemistry specializing in the photochemistry of coordination compounds, passed away on 18 March 2016 at the age of 76. Besides his scientific contributions, he was an institution builder. He established the Chemistry Department at the Post-Graduate Centre in University of Madras, Tiruchirapalli, which later became the Bharathidasan University. He

served as the founder Director of the DST-funded National Centre for Ultrafast Processes at the University of Madras for ten years (1997-2006). His institution building did not stop with universities, but continued at the Central Salt and Marine Chemicals Research Institute (CSMCRI), a CSIR Laboratory at Bhavnagar in Gujarat.

Natarajan was born on 17 September 1940 in Madras (now Chennai) to Paramasivam and Chellammal. After graduation in chemistry from the University of Madras (1959), he worked there as a lecturer for two years (1959-61). He completed his post-graduation from Banaras Hindu University, Varanasi, in 1963 and then worked as a lecturer in NGM College in Pollachi (1963-64). He continued his academic career at Varanasi working as a junior research fellow (1964-65) and as lecturer, and then moved to the Jawaharlal Nehru Institute of Post-Graduate Medical Education and Research in Pondicherry (1965-66). He then went to the University of Southern California, first as an NSF trainee, then as a research assistant and teaching assistant (1966-71) before completing his PhD at the University in 1971. He moved to the Wayne State University in 1971 as a post-doctoral research associate with J F Endicott.

Returning to India in 1973, he became a CSIR Pool Officer and then reader in physical chemistry at the University of Madras (1973-77). In 1977 he was appointed as professor and head of the Department of Chemistry at the Madras University PG Centre in Tiruchirapalli (1977-82). In 1982 he moved over to the main University in Tiruchi (Bharathidasan) to take up the position as professor and head of the Department of Inorganic Chemistry and continued in this position until 2001. During this period, he took lien from the University to take over as Director of CSMCRI (1991-97). He also founded the National Centre for Ultrafast Processes in the University of Madras in 1997 and continued there until 2006.

His research focus was on the use of flash photolysis and single photon counting fluorimetry in the study of photochemical reactions. One of the highlights of his contributions is chemically modified electrodes for polymeric photovoltaic application, which was published in *Nature*. He mastered inorganic photochemistry, working with A W Adamson, who is considered as the father of inorganic photochemistry and initiated research in this unique subject in India after his return from USA. Natarajan started his research career in inorganic photochemistry and subsequently contributed to many diverse fields in the area of photochemistry such as polymer dynamics in aqueous solution using fluorescence techniques, photophysics and photochemistry in organized media, flash photolysis studies of organic and inorganic systems using pico- and femto-second lasers and photoelectrochemistry with applications to solar energy conversion.

Natarajan showed that when macromolecular dyes are coated onto an electrode and photolysed, the characteristics of the electrode reaction change completely and high current density is observed even when film thickness is just 10 μm. Normally polymer films of 10 μm thickness have very high resistance and charge migration is practically nil through such films. The first report about this cell, published in Nature, shows much potential for solar energy conversion using chemically modified electrodes. His contributions have been published in journals like *Nature, JACS, JPC, Inorganic Chemistry, Chemical Communications* and others. He published more than one hundred papers and has several patents. He served as member of the editorial boards of several journals. More than thirty students obtained their PhD degrees under his supervision. As the Director of CSMCRI, Natarajan contributed to promote new areas of research, commercialized the technologies developed, the most notable being the transfer of knowhow developed by CSMCRI scientists for detergent grade zeolite to NALCO. He was a member and Chairman of PAC for Inorganic Chemistry at DST and Chairman of Research Committee for Chemical Sciences in CSIR and a member of SERC in DST and IUPAC committees. Natarajan was awarded the Shanti Swarup Bhatnagar Prize for chemical sciences (1984) and elected to the fellowships of the Indian Academy of Sciences (1987), Indian National Science Academy (1988), IUPAC, Society of Biosciences and other state Academies. He was given the Best Teacher Award by the Government of Tamil Nadu, the Jawaharlal Nehru Birth Centenary Lecture Award of INSA, Acharya P.C. Ray Award by the Indian Chemical Society, the DST-Ramanna Fellowship, Sigma-XI Society award in USA, INSA-Senior Scientist and INSA-Honorary Scientist. He held the Sir M Visvesvaraya Chair at the Mysore University and Pandit Jawaharlal Chair at the University of Hyderabad.

Natarajan leaves behind his wife (Sivabagyam), two daughters (Shiva Sukanthi and Shakthi) and their families.

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Charusita Chakravarty
(Elected 2006)

Born in Cambridge, Massachusetts, USA on 5 May 1964 as the only daughter of the economists Sukhamoy and Lalita Chakravarty, Charu grew up in a liberal academic environment in Delhi. Charu was brilliant in her studies and this was reflected in her topping the Delhi Higher Secondary Board. She was selected as a National Science Talent Scholar and also cleared the highly competitive Joint Entrance Examination (JEE) of the IITs in 1982. She competed her BSc (Hons) in chemistry in St. Stephen's College, Delhi. After graduating from Delhi University with a gold medal in 1985, she joined Cambridge University, UK, to do the Natural Sciences Tripos, receiving the BA (Hons) degree in Natural Sciences in 1987. She then joined the PhD programme at Cambridge under the guidance of David Clary. Her thesis was on the spectra and dynamics of Ar-OH, an open shell system that involved a lot of nuances. After receiving her PhD degree in 1990, she went to the University of California, Santa Barbara, USA, for postdoctoral training with Horia Metiu. She returned to India for good in 1994.

IIT Delhi offered her the position of an assistant professor in the Chemistry Department, where she rose to the rank of a Professor in 2006 and stayed on till the end. Charu's initial research centred around the characteristics of atomic and molecular clusters, anomalous properties of water and ionic liquids, phase transition in classical and quantum clusters, diffusion in constrained media and related phenomena. She guided a number of MSc and PhD students. Single-author papers were the hallmark of Charu's research during the period 1995-2005. She was an expert in using path integral Monte Carlo simulation to unravel quantum mechanical effects in the properties of atomic and molecular clusters. She has published more than 90 research papers in refereed national and international research journals. The quality of her research output is reflected in the large number of citations her papers received and in the recognition from her peers. She was a referee for several scientific journals. She was a member of the Editorial Board of *Pramana – Journal of Physics* (2006-08), *Journal of Chemical Sciences* (2008-11), and *Physical Chemistry and Chemical Physics* (2012). She was a member of various scientific committees in the country, particularly of the Science Academies and DST and the Council of Scientific and Industrial Research (CSIR), New Delhi.

She was awarded the Young Scientist Medal of the Indian National Science Academy (INSA), New Delhi in 1996, and selected as Young Associate of the Indian Academy of Sciences, Bengaluru. She was made an Associate Member of the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy (1996-2003). She received the B. M. Birla Science Prize in 1999 and the Swarnajayanti Fellowship in 2003. The coveted SS Bhatnagar Prize in Chemical Sciences from CSIR followed in 2009. She was elected Fellow of IAS, Bengaluru, in 2006 and INSA, New Delhi, in 2015.

In a country in which women scientists have difficulty in pursuing their careers, Charu managed to balance work with family. She succumbed to cancer and breathed her last on 29 March 2016. She leaves behind her husband Prof Ram Ramaswamy and their daughter Kirthi.

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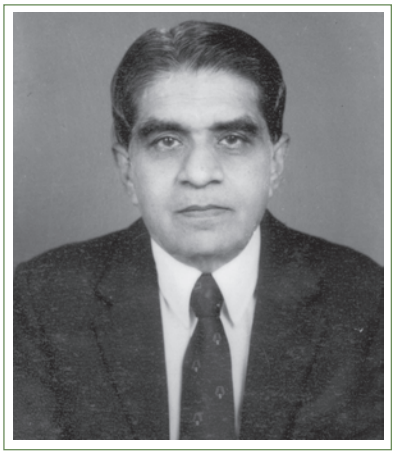

M V Bhatt
(Elected 1981)

Mangalore Vivekananda Bhatt passed away in Bengaluru on 19 April 2016. He was born on 1 February 1924 in Mulki, to Taranath Krishna Bhatt and Tulsi Bai Bhatt.

Young Vivek was sent to his paternal grandfather's home in Mulki, near Mangalore, to go to the village school there. By his own accounts, Vivek did rather poorly in school. He later went to Aloysius College in Mangalore for the pre-university class (12th standard) as it was called then. Subsequently, Vivek moved to Tiruchirapalli

(Trichy) in Tamil Nadu, and joined the St Joseph's College. In Trichy, Vivek became deeply interested in chemistry and mathematics and soon his interest turned into fascination. He graduated (BSc) with a first class and first rank. Soon after, as a teenager (19) in 1943, he joined the Organic Chemistry Department of the Indian Institute of Science (IISc), Bengaluru, as research assistant. MVB completed his Associateship of IISc in 1948 and PhD in 1954. From 1954 to 1957, he was a postdoctoral fellow with D K Banerjee at IISc. He travelled on a Fulbright Fellowship to Washington University where he did his post-doctoral work with C D Gutsche from 1958 to 1959. MVB's second postdoctoral stint from 1959 to 1960 was with Herbert C Brown (1979 Chemistry Nobel Laureate) at Purdue University, USA. He also spent a year (1977-78) in Brown's group as a visiting faculty. Brown must have been quite impressed with MVB as many of the students of MVB subsequently worked with Brown as post-doctoral associates.

MVB returned to IISc in 1960 as Lecturer and was promoted to Associate Professor in 1965. From 1969 to 1984, he served as a professor, during which time he was also Chairman of the Department and Dean of the Science Faculty. From 1984 to 1989 he was an Emeritus Scientist.

MVB was a self-taught physical organic chemist as this area of chemistry was in its infancy, especially in India, when he started his independent research group at IISc. Major contributions of his group were in the areas of ring-chain tautomerism, new reagents and reactions and quinone studies. He also collaborated with faculty members from the departments of Chemical Engineering, Biochemistry and Microbiology and Cell Biology at IISc. He published papers on kinetics and mechanistic studies in these areas. Notably, he published a series of papers on different aspects of ring-chain tautomerism in American Chemical Society and Royal Society of Chemistry journals. His initial studies in ring-chain tautomerism pertained to the structure of ortho-benzoyl benzoic acid. This acid exists in equilibrium with the hydroxylactone form in solution. He extended the studies to understand the reactions of ortho-benzoyl benzoyl chlorides with nucleophiles and studied the kinetics of hydrolysis of esters and amides of orthobenzoyl benzoic acid. The results of this piece of research encouraged MVB to extend the studies to other gamma-keto acids and their derivatives. By now he had realized that the studies in tautomerism that he initiated had grown into a new area of research for which he coined the phrase 'neighbouring group effects' (to distinguish these effects from the classical 'neighbouring group participation') although the series title of journal publications was maintained as 'Aspects of tautomerism'. Subsequent research in this area was aimed at unravelling the effects of one functional group on the reactions of another functional group present in close proximity, in the same small organic molecule. His opinion was that an understanding of 'neighbouring group effects' in small organic molecules would aid unravel complexities of reactions in biological systems. He was ahead of his time in designing isotopic (D, N^{15} and O^{18}) labelling experiments to understand mechanisms of organic reactions developed by his group. He practised and advocated research in physical organic chemistry in the larger interest of understanding and exploiting the efficiency and specificity of chemical reaction that occur with unparalleled efficiency in living systems.

He also published several reviews and book chapters. He was involved in summer school programmes for teachers and some of his PhD students were teachers who had joined IISc on the Faculty Improvement Program (FIP).

MVB was a Fellow of the Indian National Science Academy (1984), Indian Academy of Sciences (1981) and served as Indian representative of IUPAC. He published around 135 papers, review articles and book chapters, obtained 10 Indian and 2 foreign patents and guided 26 PhD students including 2 from Egypt.

He was married to Sarojini Nayak in 1955 and they had four children. In 2005, Sarojini passed away.

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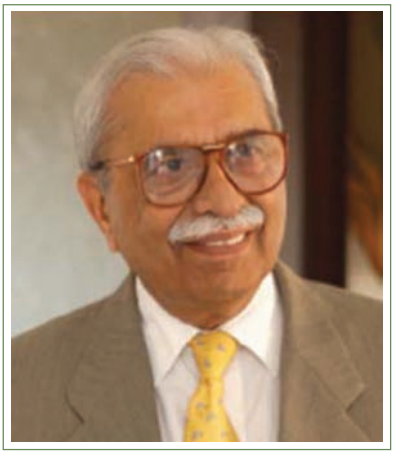

Noshir Hormusji Wadia
(Elected 1983)

Noshir H Wadia, a pioneer and avantgarde neurologist, considered the grand old man of Indian neurology, and revered by hundreds of his patients, students, colleagues, friends and family, passed away on 10 April 2016.

He was born to Hormusji and Dinamai Wadia, as one of five children in Surat, Gujarat. He embarked on his journey to the UK in 1951 to train in neurology, after the seamless completion of his undergraduate and postgraduate medical education (1943-50) from Grant Medical College and Sir Jamsetjee Jejeebhoy group of

hospitals, Mumbai. In the next five years in the UK, Wadia worked as house physician in the department of neurosurgery, Newcastle General Hospital, as resident medical officer in, the National Hospital for Nervous Diseases, London and as registrar to Russel Brain in the department of neurology of the London Hospital. He won, despite stiff competition from British residents, the opportunity to train under the illustrious Walter Russel Brain, the author of the standard text book of neurology *Diseases of the brain*. The training under Lord Brain, the long-time editor of the reputed neurology medical journal *Brain* and the President of the Royal College of Physicians London, left a deep impact on young Noshir and culminated in an association that they both nurtured for several years. Walter Brain's strong words of support earned him the opportunity to become the first Asian to be a registrar and tutor at the London hospital. The ensuing promotion to senior registrarship based on research and publications, set him on the right course of academics and clinical research in a career spanning more than five decades. His very first publication on typical features in acoustic neuroma was published in the journal Brain.

On his return to India, Wadia was appointed to the JJ Group of Hospitals as honorary assistant neurologist and lecturer in neurology in Grant Medical College in January 1957. The 32-year-old neurologist dedicated himself to developing the department of neurology, starting with very limited facilities. By nurturing the growth of the departments of neurosurgery, neuroradiology and neuropathology around it, he transformed it into a full-fledged neuroscience centre that attracted several eminent faculty and generated excellent clinical and research output. Quick to recognize the difference in the frequencies and types of neurological disorders in India versus the UK, he delved into the study of tuberculosis of the brain and spinal cord, the neurological complications of manganese toxicity, the varied neurological manifestations of craniovertebral anomalies, the nutritional disorders affecting the nervous system, and the spectrum of presentations of Wilson's disease, to name some. His large body of work spanning several different areas of neurology speaks of the diligent researcher he was. However, most neurologists would consider as his seminal contributions, the description of two novel neurological entities from India: (a) 'utosomal dominant cerebellar ataxia with slow eye movements' which was later renamed as 'spinocerebellar ataxia type 2 (SCA2)' caused by mutations in the ATXN2 gene and (b) EV70 disease. He described a polio-like illness in two of his patients following acute haemorrhagic conjunctivitis, which he was convinced, was related to the conjunctivitis. Many years later, when the enterovirus EV40 was isolated from Japanese patients with conjunctivitis, he, along with the Japanese team, injected the virus into the theca of monkeys and reproduced the hind limb paralysis, thus confirming his clinical suspicion. During his illustrious career, he served several institutions, as consultant neurologist for life for the JJ Group of Hospitals and Grant Medical College, director of neurology and director of research, Jaslok Hospital and Research Centre, consultant neurologist for B. D. Petit General Hospital, Bhabha Atomic Research Centre, Tata Institute of Fundamental Research and the Breach Candy Hospital and Research Centre. He published over 100 research papers and book chapters, many of them in journals such as *Brain,* The Lancet, British Medical Journal and *Neurology*. He delivered 10 orations, 25 international lectures and was on the Editorial board of 4 journals. Recipient of the Padma Bhushan award, he was also conferred with several accolades by both national and international scientific bodies, notable among them being the Certificate of Appreciation for Services to Neurology, by the World Federation of Neurology.

Over the years, he trained several neurologists who are now spread across the world besides India. He was elected to several national and international scientific societies and member of various national and international research committees. He was a member of several hospital boards and academic committees of several institutions (both national and international). He served as the chairman of the Governing Body and President of the Institute Body of the Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram, Kerala. The institute was close to his heart, a sentiment stemming from long years of his association with it in various capacities.

He leaves behind his wife, a noted clinical neuro-physiologist, Piroja Wadia, his two step sons and two brothers.

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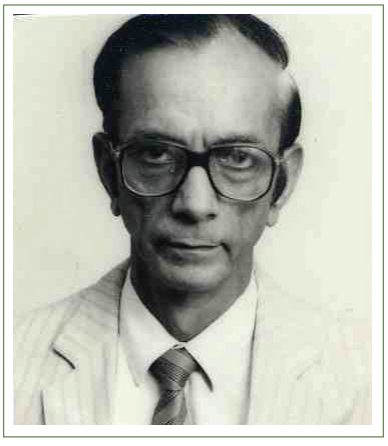

Bahadur Chand Nakra
(Elected 1995)

Bahadur Chand Nakra, born on 31 March 1939, passed away on 12 April 2016. A detailed obituary note will appear in a future issue of *Patrika*.

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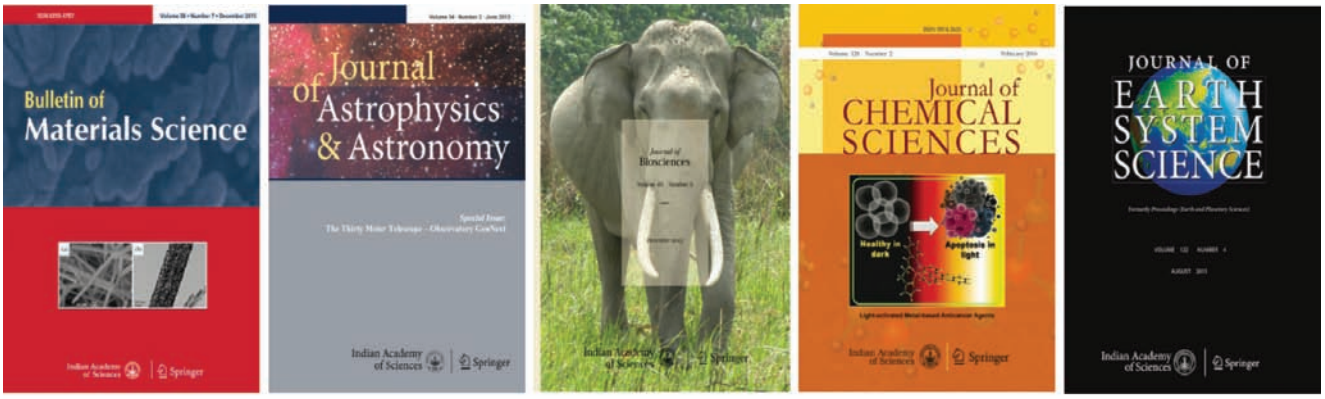
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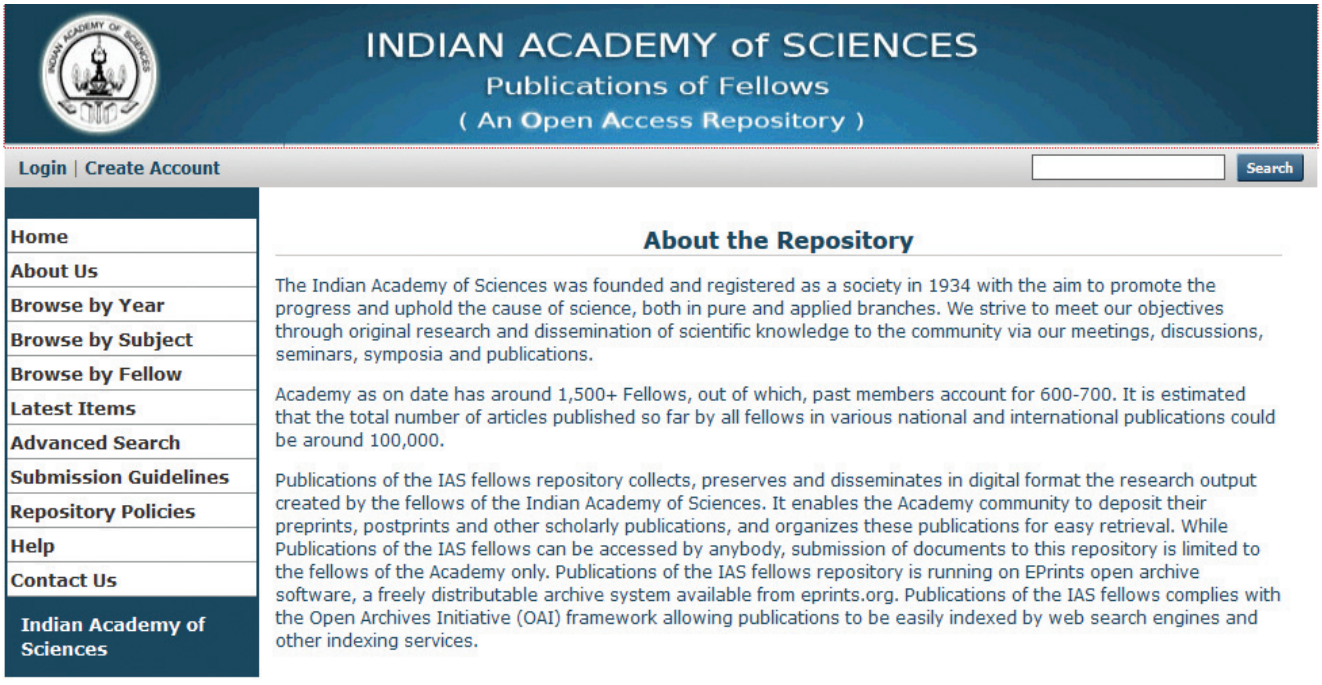
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