Connect

WITH THE INDIAN INSTITUTE OF SCIENCE

A Brief History of Light:
The physics of light in a historical context

Arnab Bhattacharya:
Mumbai's own *Chai Pe Charcha*

Divecha Centre:
Confronting the climate crisis

Plant Nursery:
A hidden treasure

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Front Cover: Fireworks during Durga Pooja in a town in the Sunderbans (Chirantan Pramanik)

Back Cover: Watercolour of the Divecha Centre for Climate Change (Bhama Sreedharan)

Front Inside Cover: Approach to the Main Building (Vinayak Kamble)

Back Inside Cover: Verditer flycatcher on campus (Natasha Mhatre)

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From the CONNECT Team

"If learning the truth is the scientist's goal… then he must make himself the enemy of all that he reads."

-- Ibn-al-Haytham

The UN General Assembly has proclaimed 2015 as the *International Year of Light and Light-based Technologies* (IYL 2015) to celebrate the centrality of light in sustaining life as we know it, its role in our everyday lives and the potential of light-based technologies in solving global challenges in energy, education, agriculture and health. The proclamation also celebrates many significant anniversaries. The most important among them is the 1000th anniversary of a seven volume treatise on vision and light called the *Book of Optics* by Ibn-al-Haytham.

Born in modern day Iraq during what historians call the golden age of the Islamic Civilization, al-Haytham, by all accounts, was a fascinating man. Like many curious thinkers, he had his ideas and theories about the workings of nature. But what made al-Haytham stand out was his insistence on rigorous and systematic experimentation to verify his ideas. This practice, an integral part of what we know today as the scientific method, allowed him to make scientific breakthroughs in the understanding of vision and the nature of light. Often called the "Father of Optics", he is thought to have written 96 books, of which only 55 have survived. Besides his *Book of Optics*, he also wrote other books on light: *The Light of the Moon, The Light of the Stars, The Rainbow and the Halo*, *Spherical Burning Mirrors*, *Parabolic Burning Mirrors*, *The Burning Sphere*, *The Shape of the Eclipse*, *The Formation of Shadows* and *Discourse on Light*. al-Haytham was also an astronomer and a mathematician; and his legacy influenced many Renaissance scholars in Europe.

To celebrate IYL 2015, CONNECT will shed some of its own light, albeit metaphorical, on this field of study in the current and the remaining issues of 2015. We begin with an article that discusses the physics of light in a historical context. It also highlights the contributions to this science by Indian researchers, including those associated with the Indian Institute of Science (IISc).

This issue has other good reads as well: a conversation with Arnab Bhattacharya who runs a science café in Mumbai called *Chai and Why?*, a glimpse into the Divecha Centre for Climate Change, a rendezvous with the plant nursery of the Institute and much more.

In the last few weeks, we have also had an opportunity to reflect on our journalistic practices which are constantly evolving. This opportunity has come about because of an error on our part. CONNECT as a magazine is two issues old. In these two issues, we have ensured that all photographs are credited. If we do not know who took a particular photograph, we acknowledge whoever lent it to us. In the previous issue, we published a photograph of IISc's Main Building that was taken from an online public forum. Though we did acknowledge the photographer, Nitesh Bhatia, a student of the Institute, he wrote to us saying that we should have sought his permission before publishing it. We agree with him and apologize for the mistake.

Happy reading!

In This Issue...

A BRIEF HISTORY OF LIGHT

Courtesy: JACOB LEWIS BOURJAILY

Ibn-al-Haytham on an Iraqi currency bill

To celebrate the International Year of Light and Light-based Technologies, CONNECT ***is bringing out three special features on light this year; the first in this series takes a tour of the history of the physics of light, while also highlighting contributions of Indian physicists towards our understanding of optics***

✍ **MADHUKARA PUTTY**

Legend has it that Ibn-al-Haytham's insight into how we see came under dramatic circumstances. al-Haytham (b. 965 – d. 1040 AD) had offered to build a dam across the Nile, near where the Aswan stands today, to prevent it from flooding. But he changed his mind after realizing the technical difficulties involved. Fearing the wrath of the Caliph of Cairo for his decision, he feigned madness to avoid the death sentence. But he was imprisoned in a dark room in his own house for many years. The room was said to have a small hole to allow light in, and it was here that al-Haytham came up with his idea of how we see. His house arrest ended once the Caliph died, after which he tested his theory with careful reasoning and experimentation in a lab that he built for his research. He eventually posited that in order for us to see, light reflected from an object must enter the eye. Though his discovery that the eye behaves as an optical system may seem trivial today, it had important implications in understanding the behavior of light. al-Hathyam also made several other observations and discoveries about light including the principles of reflection and refraction. These were recorded in his comprehensive seven-volume treatise called the *Book of Optics*.

Particle or Wave?

After Ibn-al-Haytham, it took several centuries for any meaningful progress to be made in field. In the seventeenth century, Francesco Maria Grimaldi, an Italian Jesuit priest, conducted many experiments on light and discovered diffraction. Not long after, Isaac Newton, the famous physicist and mathematician passed sunlight through a prism

Courtesy: WIKI COMMONS

Isaac Newton

The United Nations has proclaimed 2015 as the ***International Year of Light and Light-based Technologies*** to raise global awareness about the central role of light in the modern world as well as to celebrate noteworthy anniversaries. It is exactly a thousand years since Ibn-al-Haytham published the first comprehensive discourse on light, 200 years since Augustin-Jean Fresnel proposed the wave theory of light, 150 years since James Maxwell discovered that light is an electromagnetic wave moving at a constant speed of 300,000 kilometers per second, 50 years since Arno Penzias and Robert Woodrow Wilson discovered the cosmic microwave background (CMB) and also 50 years since Charles Kao helped establish optical fibres as a medium of telecommunication. The proclamation has been endorsed by the International Council of Science and a number of international scientific unions. The year-long events planned across the globe were kick-started at UNESCO's headquarters in Paris in January 2015.

Courtesy: IYL 2015, GLOBAL SECRETARIAT

and split white light into several colours. Newton deduced correctly that white light comprises a mix of light rays, each with a different colour. He also claimed that light had to be made of particles (or corpuscles as they were then called). Newton became even more convinced of the particle theory of light when he passed the coloured light coming out of the first prism through another, and obtained white light. He argued that the "coloured particles" of light got separated in the first prism, but recombined to form white light in the second prism.

But many other scientists of his day were not convinced. They believed that light was made up of waves. Sunlight, they said, contained white waves that got corrupted as it passed through the prism and thus produced different colours. The "wave theorists" included Robert Hooke, the English philosopher and scientist, who had been studying diffraction. In 1678, Dutch mathematician Christian Huygens showed that the laws of reflection and refraction could also be derived from the wave theory of light. Taken aback by these challenges, Newton withdrew from the debate for a few years. However, in 1704, after the death of Hooke and when he was the President of the Royal Society, Newton published Opticks in which he reiterated his idea. But the debate over the nature of light was far from settled.

In 1801, a study by British Polymath Thomas Young added to our understanding of the nature of light. He studied the patterns made by a beam of light and convincingly demonstrated that light travels as a wave much like the succession of crests and troughs on the surface of water. In 1818, Augustin-Jean Fresnel, a French physicist, was also able to explain diffraction based on the wave theory of light. Together, these studies lent credence to the idea that light is made up of waves.

Courtesy: WIKI COMMONS

Thomas Young

Significant Indian contributions to the physics of light

An important problem in the early days of quantum theory involved understanding how energies are distributed among sub-atomic particles. In 1924, Satyendra Nath Bose, then a researcher at Dhaka University, discovered the rules for distribution of energy among zero and integer spin particles like photons. Bose's contribution to quantum mechanics was immortalized by the scientific community when such particles were named 'bosons'. The boson family comprises photons, the particle manifestation of light with zero spin, among other particles.

Courtesy: SN BOSE NATIONAL CENTRE FOR BASIC SCIENCES

SN Bose with PC Mahalanobis (left) and RA Fisher (right)

Around the same period, another Indian physicist, CV Raman, also working in undivided Bengal, was making waves in optics. In 1921, he was invited to meet with English physicists JJ Thomson and Lord Rutherford. On his way back from England to Bombay, his ship, the *SS Narkunda,* sailed on the Mediterranean waters. During the 15-day voyage his inquisitive mind became occupied by the problem of why the sea was blue. Even as his ship was docked in Bombay, he wrote his thoughts down in the form of a letter to the editor of *Nature*. In February 1928, along with KS Krishnan, he was able to conclusively show that the colour of the water was blue not just because it was reflecting the colour of the blue sky, but also because of the way in which water molecules scatter sunlight. The significance of his work was realized immediately and was considered one of the more convincing proofs of the quantum theory. For this discovery which came to be known as the *Raman Effect*, he won the Nobel Prize in Physics in 1930. More than eighty years after its discovery, Raman scattering is still relevant and is finding use in many emerging technologies.

Courtesy: ARCHIVES AND PUBLICATIONS CELL

CV Raman

Courtesy: RRI ARCHIVES

KS Krishnan

Courtesy: RRI ARCHIVES

Nagendra Nath

Apart from his Nobel winning discovery, Raman along with his student Nagendra Nath made another crucial breakthrough in the field of optics. Though light travels with an unwavering speed in vacuum, it slows down in material media. Also, its speed decreases as the medium becomes denser. So Raman (who was also interested in acoustics) and Nath studied the consequences of passing a light wave through a sound wave which has regions of varying densities. The theoretical explanation they provided for the acousto-optic effect, called the *Raman-Nath theory*, is considered to be Raman's most significant

work during his time at IISc.

In 1948, Raman moved to the Raman Research Institute (RRI) which he set up just across the road from IISc. Here, in 1954, he recruited a young researcher, S Pancharatnam, also his nephew, when he came on a social visit. At RRI, Pancharatnam studied how polarized beams of light interfere with each other. Vibrations in polarized light occur differently from ordinary light. He formulated what came to be known as the *Pancharatnam phase*, a fundamental effect in optics. But the significance of his work was not recognized until Micheal Berry of the University of Bristol rediscovered it in 1984 and it came to be known as the *Berry phase*. Raman believed that Pancharatnam would one day fill his shoes. Unfortunately, Raman's wish was not fulfilled; the young physicist's promising career was cut short when he died in Oxford in 1969.

Light, Electricity and Magnetism

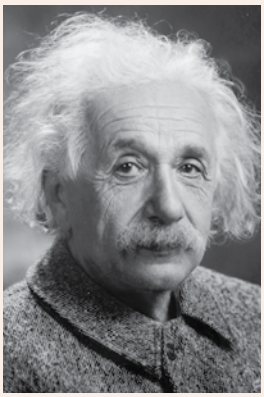
Courtesy: WIKI COMMONS

James Clerk Maxwell

If light is a wave, what kind of wave is it? The answer came from James Clerk Maxwell, a Scottish physicist, who was interested in problems in magnetism and electricity. In 1863, Maxwell discovered that by manipulating equations for electricity and magnetism, it was possible to extract a value that corresponded to the speed of light. Surprised by this result, he began to suspect that light, electricity and magnetism were the same. Maxwell developed new equations in 1865 that showed that light is indeed an *electromagnetic* wave. About two decades later, Heinrich Rudolf Hertz experimentally demonstrated the accuracy of Maxwell's equations. We now know that all kinds of electromagnetic radiations—radio waves, microwaves, visible light, x-rays and gamma rays—have the same structure and travel with the same speed, differing only in the frequency of oscillation of the electric and magnetic fields.

Particle or Wave? The Debate Revisited

When most scientists believed that the debate about the nature of light was over, Hertz, in one of his experiments, observed that when light hit a metal surface, it spewed out electrons, a phenomenon called the photoelectric effect. This perplexed physicists because it was not possible for a light wave to dislodge an electron from a metal surface. The explanation was provided by German physicist Max Planck, who was studying a different phenomenon called the 'blackbody radiation'. He stunned the world by making a radical suggestion: electromagnetic waves could only be emitted as small packets of energy that he named "quanta" and not as a continuous form of energy that the wave theory predicted. Building on this idea, fellow German Albert Einstein proposed in 1905 that light was made up of particles, eventually christened "photons", but also retained its wave characteristics. Einstein's photons, it must be emphasized, are different from the particles Newton envisaged centuries ago. These particles do not obey the classical laws of physics; we need quantum laws to understand them. Not surprisingly, there was an initial reluctance among many to accept the dual nature of light. Today physicists agree that light is both a wave and a particle.



Courtesy: WIKI COMMONS

Albert Einstein

KABERI KAR GUPTA: SAVING URBAN LORISES

✍ **MANEESH KUNTE**

Kaberi Kar Gupta, a visiting scientist at the Centre for Ecological Sciences, Indian Institute of Science (IISc), is the brain behind a unique citizen science initiative in urban ecology. Called the *Urban Slender Loris Project*, it aims to study an elusive primate, the slender loris, in and around the city of Bangalore. Kar Gupta is also an adjunct assistant professor at the California State University, Fresno, USA.

The slender loris is one of the smallest primates—an adult is typically about 20 cm long and weighs about 200 g. It is mostly arboreal, living in trees, and until a few decades ago, thrived in green spaces, including in Bangalore city. However, with steadily declining vegetation cover in Bangalore due to urban deforestation, the loris population has dwindled, and the ones that have survived have been isolated to small pockets of greenery in the city.

Kar Gupta, who started working on urban ecology and conservation a few years ago, picked the slender loris as the focus of her conservation efforts for two main reasons. The first is the more obvious one. "It is considered a cute animal or sort of like a charismatic species among urbanites," she says.

"It is considered a cute animal or sort of like a charismatic species among urbanites"

Another reason for choosing the slender loris as her study species is because she believes that its population in a city like Bangalore indicates the health of urban biodiversity. Unlike its monkey cousins, lorises do not swing or jump, but crawl from one branch to another. Moreover, they prefer to sleep in areas of dense vegetation with continuous tree cover. And when it comes to food, lorises eat insects and feed on fruits as well. Not surprisingly, therefore, one is more likely to find them in densely wooded areas where trees are connected to each other and which have a high abundance of insects

MD MADHUSUDAN

and fruits. "If we can identify and conserve the patches where lorises are found, we may be able to conserve a lot of other urban biodiversity within those patches," Kar Gupta points out. Studying the loris would also shed light on the secretive social life of this prosimian which has a unique evolutionary history.

"If we can identify and conserve the patches where lorises are found, we may be able to conserve a lot of other urban biodiversity within those patches"

Urban ecology has gained traction among biologists and conservationists in the last few years, with recent studies from Europe and USA showing that urban habitats are not as low in biodiversity as previously thought. But unlike conservation of the wilderness, efforts to protect urban habitats will have to involve people who are a major part of urban ecosytems. "They should have some kind of ownership or stewardship about the habitat they live in," insists Kar Gupta.

This insight led to the project taking the citizen science route. Initially, an online survey was posted on the project homepage to gather some first-cut data on known loris populations, both past and present, within the city. Prospective volunteers

ANGAD ACHAPPA

Slender Loris on the campus of IISc

were asked to indicate their interest in the form. It also sought answers to a few questions to test their familiarity with lorises in particular and conservation in general. Of the 130 people who have signed up for this project, about 60 have been trained as volunteers and 20 are now part of a core group.

"They should have some kind of ownership or stewardship about the habitat they live in"

IISc is lucky to have retained a healthy loris population. Besides the Institute, a few other sites with loris populations have also been identified, and the volunteers are in the process of scouring for more. Apart from anecdotal reports of loris sightings and information from wildlife rescuers, satellite imagery is also being used to locate green patches in the city for further exploration.

As part of the training activities, Kar Gupta has been taking the volunteers on twilight walks—the time when the lorises become active—through known habitats to help them spot lorises. On one such walk on the campus of IISc, we spotted 5-6 lorises in the Jubilee Garden. Unless one knows where to look, the animals are almost impossible to spot. But their unique calls are clearly identifiable. To spot them, you shine the light from where the call emerges; you may then be able to see a pair of bright orange embers shining back at you. This is because the eyes of the loris contain a reflective membrane much like that of a cat. These lights disappear as this shy animal, seemingly peeved at the intrusion of its privacy, turns its head away even as it freezes, a standard response to the threat of predation.

In the locations where lorises have been found, the volunteers are estimating its population abundance—the number of animals sighted per kilometre on a census walk. Other data that they are collecting include: the type of habitat where a loris population is found, an individual's exact location based on GPS measurements, the species of plant on which it is found and the height at which it is spotted. The data, when analyzed, would give a comprehensive idea of the population structure of lorises, their behavioural preferences, and other locations where they are likely to be found.

If things go according to plan, Kar Gupta and her team should be ready with a set of recommendations to ensure that the growth of Bangalore in the future is sensitive to its biodiversity. She also hopes to conduct more training exercises, increase the volunteer base and expand the project to other cities across the country.

SUDHIR JAIN: BUILDING AN INSTITUTION

✍ **MEGHA PRAKASH**

In 2009, Sudhir Jain, an earthquake engineer and a professor at IIT Kanpur, was appointed as the first Director of the Indian Institute of Technology Gandhinagar (IITGN). Jain, who was at the Indian Institute of Science (IISc) recently, spoke to CONNECT *about the challenges of building an institution from the ground up and his vision for IITGN.*

Working with Students

As the first director of an institute that was being built from scratch, Jain had to deal with many challenges. Among them were the hurdles that the first batch of students faced, including the lack of resources. This, he believed, required his immediate attention and he worked directly with them to address their concerns. He also believed that this would help build their morale. "For a first year student to be able to work with the director was empowering," Jain says.

Jain also took a personal interest in helping students find internships at the end of their first and second year. To do this, he tapped into his well-knit network to help them find paid summer internships both in India and abroad. "This system was unique to the existing IIT system. It enabled a first year student to do a project on fire engineering, for example, that was not even taught in the class. Such an initiative mobilized the students, made them confident and began to make them feel that there are advantages of being at IITGN," recalls Jain.

"For a first year student to be able to work with the director was empowering"

Faculty Recruitment

Jain's next challenge was to scale up faculty recruitment. Unfortunately, in its early years, IITGN did not always receive applications from the most competent candidates for faculty positions. Jain

Courtesy: IITGN

roped in retired professors from the IIT system to assist in teaching and running the Institute. "I had to persuade retired professors to come to Ahmedabad and join us. We also invited talented teachers from local institutions to come and teach courses," he says. Besides making use of local talent, Jain also got scientists and scholars from foreign universities to teach at IITGN as visiting faculty.

Global Philanthropic Foundation

Jain's earlier experience as the Dean of Resource Planning and Generation at IIT Kanpur made him believe that in order for IITGN to compete with the best, the Institute needed to attract and retain the best talent from around the world. So he facilitated the creation of a charitable foundation with the help of well-wishers of IITGN in the United States. The foundation helps raise funds both from within the country and abroad. The funds enable the Institute to pay some of the faculty members top-up money in addition to structured government salaries.

Outreach

From his first day at IITGN, Jain took an active interest in devising a strong communication strategy. The first step in this direction was to start a newsletter called *Connections*. According to Jain, the newsletter is being sent to about 35,000

people. He also visits universities in the US, Europe and Singapore to meet potential faculty candidates and to spread the word about IITGN. According to him, this outreach effort has helped the Institute bring in outstanding faculty members, who bring with them a fresh vision for the Institute.

Attracting Bright Young Minds

In order to get quality students to join the Institute's PhD programme, Jain's team came up with a number of initiatives. One such scheme is called the 'Start Early PhD Programme'. As part of this initiative, IITGN targets toppers of the best undergraduate colleges after their third year. Once they graduate, they could join IITGN for a PhD directly. This programme also provides students a scholarship of INR 10,000 per month in addition to government scholarships. "This enabled us to bring many top rankers from good engineering colleges to our PhD programme," says Jain.

Courtesy: IITGN

Students enjoying a classroom session

Coursework

Some of the programmes offered at IITGN like an MA in *Society & Culture* or an M.Sc. in *Cognitive Science* at IITGN may seem out-of-place in a technology institute. Even the B.Tech engineering programmes at IITGN have a strong component of humanities and social sciences as part of the curriculum. Jain offers an insight into why these disciplines are important in today's world. "When I was young, technological needs were different. We had to learn how to build a dam or an electronic device. But today, the needs are different. We now know that the dam will not be built if the societal issues of the affected people are not adequately addressed. So the training too has to be different. If our students do not understand the society, they cannot be technology leaders, and in that case they can only aim to be the best technicians working under other technology leaders. This is why it is important for a technology-driven institute to have a strong focus on the humanities and social sciences in the curriculum. It is equally important to hire very high quality faculty to teach these disciplines," he says.

"If our students do not understand the society, they cannot be technology leaders, and in that case they can only aim to be the best technicians working under other technology leaders"

Changing the Mindset, Changing a System

Bringing in changes into a well-established IIT system was not easy. According to Jain, the biggest hurdle he faced, and continues to face, was not any opposition to these changes, but the mindset of people both within and outside the Institute. "We often look down upon ourselves thinking, 'Oh, we are not MIT or Harvard,' or that 'we are a poor country'. We don't aspire to be in the top league of academic institutes. This is particularly true for an institute in its infancy," Jain elaborates.

"We often look down upon ourselves thinking, 'Oh, we are not MIT or Harvard,' or that 'we are a poor country'. We don't aspire to be in the top league of academic institutes"

Future vision

Jain is clear about his priorities for IITGN for the next few years. He says, "I would like to continue what we started in the first few years of developing the Institute. Secondly, better connect with industry. Industrial relations will only help us bring in new perspectives, ideas and resources, besides boosting our research activities. At IITGN, we also look forward to giving our students a global education experience by having very vibrant student and faculty exchange programmes with international universities."

ATTA-UR-RAHMAN: THE CHEMIST FROM KARACHI

✍ AMOGH KINIKAR AND ABHISHEK SHAHI

CONNECT

Born in Delhi, five-year old Atta-ur-Rahman moved to newly-born Pakistan in 1947. He excelled as a student at the Karachi Grammar School. After a Bachelor's (Chemistry Honors) and a Master's degree (Organic Chemistry) from the University of Karachi, Rahman moved to the University of Cambridge for his PhD where he studied the chemistry of natural products. He was elected as a Fellow at King's College, Cambridge, where he carried on his research for another five years before moving back to the University of Karachi. Rahman has published hundreds of research articles and dozens of books. He also has many patents to his credit. He is a Fellow of the Royal Society (London) and has won numerous awards and honours for his scientific contributions. Rahman is currently an Emeritus Professor of Chemistry at the University of Karachi and also the Patron-in-Chief of the International Centre for Chemical and Biological Sciences (ICCBS). CONNECT *caught up with him when he came to the Indian Institute of Science (IISc) recently to attend a conference.*

Q Could you tell us a little bit about your research?

I started as a synthetic organic chemist. My work has been connected with the bio-active substances present in medicinal plants and also the synthesis of bio-active constituents. My current research is in the field of neuroscience to understand how the brain works—the chemistry of memory and the molecular basis of thoughts. Recently I have written two comprehensive reviews in *The Neuroscientist* that include my new theory regarding how memory can be encoded by hydrogen bonding.

"My current research is in the field of neuroscience to understand how the brain works—the chemistry of memory and the molecular basis of thoughts"

Q The breadth of your work is tremendous! How did you get interested in research in the first place?

I like challenges in life. And I have always been curious about why things are the way they are. In my O-levels exam, I topped in every subject except chemistry (laughs). Therefore I thought, chemistry would be a challenge for me. Everybody goes for their stronger subjects, but I selected chemistry, did my A-level and then went on to do my Master's and PhD in organic chemistry. And the deeper I went, the more fun it was. I was only 29 years old when I disproved the work of the Nobel laureate, Sir Robert Robinson, in a paper published in 1972 [*Journal of Chemical Society Perkin 1*; p. 936]. Another work that I more recently took up as a challenge is to understand the molecular basis of

thought in the brain, perhaps the most complex object in the universe.

"I like challenges in life. And I have always been curious about why things are the way they are"

Q There is a significant lack of scientific collaboration between India and Pakistan. What can we do to improve the situation?
It is another challenge! As the President of the Pakistan Academy of Science, I invited the former President of INSA, Dr. Krishan Lal, to Pakistan to discuss possibilities of collaboration. He was kind enough to accept [the invitation], and he came with his team of scientists. We signed an MoU to increase collaborations between the two countries. I also came to Delhi to attend a meeting at INSA with my team. Recently, we organized a conference in Karachi as part of the International Year of Crystallography celebrations. A delegation of 12 Indian scientists including 3 professors from IISc, led by Prof. Gautam Desiraju, who was at that time the President of the International Union of Crystallography, came. So we have started working together; this must continue and should be expanded.

We have to build bridges through science; we should fight not against each other, but against hunger, disease and poverty as comrades in arms. We have similar problems in our countries. We need to increase the standard of living, provide clean water, improve agricultural productivity and provide jobs and food to the poor. To do this, our governments have to ease the channels through which we communicate. Scientists from both sides should be able to commute easily. And to facilitate interactions between scientists and engineers, visa restrictions should be relaxed. This step will also promote cultural exchanges and bring the countries together.

"We have to build bridges through science; we should fight not against each other, but against hunger, disease and poverty as comrades in arms"

Q This is your second visit to Bangalore. How has your experience been?
I think Bangalore is a wonderful city. It represents a beautiful and fantastic face of India. The brightest in India come here to study and you have some very fine institutions, including IISc. It has become a hub of the IT industry. The people are very polite and cultured. Since the last time I visited there have been many positive changes—lots of new constructions, more buildings, the roads are more organized and the airport is much bigger.

"I think Bangalore is a wonderful city. It represents a beautiful and fantastic face of India"

Q Have you had a masala dosa here?
Actually I had gone for a cup of coffee to your coffee shop this morning with Gautam [Gautam Desiraju] and he said, 'You must try our masala dosa.' I did and I loved it (laughs)!

Q What do you do with any spare time you have?
I have a constant thirst for learning. I am the Editor-in-Chief of 10 European journals in chemistry and I write a lot. I am editing a series of books on natural product chemistry called *Studies in Natural Product Chemistry,* 45 volumes of which have already been published by Elsevier in the last 20 years; so that is continuing. I love to watch cricket, listen to music and go to good films and plays. I also love playing table tennis and play it often with my students. I love reading English literature as well. It widens your horizons; one should not be too narrow in their studies. Arts, humanities and music have an enriching experience on one's scientific life. One should have a broad approach, and ultimately the approach should be about caring for others. Caring for fellow human beings should be the motto for all of us.

"Caring for fellow human beings should be the motto for all of us"

ARNAB BHATTACHARYA: BREWING THE PERFECT BLEND—ONE PART SCIENCE, ONE PART FUN

✍ KARTHIK RAMASWAMY

CONNECT

I met Arnab Bhattacharya for an interview immediately after his plenary lecture during an international conference on emerging electronics held at the Indian Institute of Science (IISc). Clad in a black kurta and a brown khadi waistcoat, he sported an impressive moustache to go with his long hair. Bhattacharya broke into an easy smile as I greeted him. He then grabbed his backpack and we hurried towards another building for the interview even as he dodged people waiting to talk to him during the tea break.

Bhattacharya, an associate professor at the Tata Institute of Fundamental Research (TIFR) in Mumbai, studies gallium nitride, a semiconductor used to make blue LEDs, the invention of which fetched Isamu Akasaki, Hiroshi Amano and Shuji Nakamura the 2014 Nobel Prize in Physics.

Bhattacharya was, however, going to tell me about another of his passions—*Chai and Why?*, the popular science café he runs in Mumbai. Also the Chair of the Science Popularization Committee at TIFR, he has been interested in science outreach from his student days. After he joined TIFR as a faculty member, he had an opportunity to attend a science communication workshop in the United Kingdom as part of the Edinburgh Science Festival.

"During the workshop, we discussed the concept of *Café Scientifique*," Bhattacharya says. The concept involves getting scientists to engage with the public in an informal setting like a café. He immediately realized that he wanted to do something on the lines of *Café Scientifique* back home, but also recognized that this model would have to be modified if it had to succeed in a city like Mumbai.

A Chance Encounter

A few years later, Bhattacharya happened to meet eminent theatre personalities Sanjna Kapoor and Sameera Iyengar from Prithvi Theatre in Mumbai when they were looking to host a play on the life of Srinivasa Ramanujan at TIFR's Homi Bhabha auditorium. Although this never materialized, the meeting led to a fruitful conversation between them. When Kapoor and Iyengar asked Bhattacharya about his work and interests, he told them about his idea of organizing a science café in Mumbai. Bhattacharya recollects, "Kapoor and Iyengar were very supportive of this idea and Sanjna said, 'Look, I can give you Prithvi.'"

A delighted Bhattacharya took up Kapoor's offer. He felt that having a science café in a venue like Prithvi Theatre would help make science more accessible to people because the setting is informal and outside a research institute. "It's not associated with science. It is a neutral sort of place where people come anyway," he says.

"It's not associated with science. It is a neutral sort of place where people come anyway"

Bhattacharya also wanted an equally informal name for the science café. "Anything with the word 'science' in it is perceived as being 'not-for-me' by the public.

And since having a cup of *chai* is a quintessentially Indian ice-breaker, we came up with the name of *Chai and Why?*," says Bhattacharya about the origin of the name.

Chai and Why?

The first session of *Chai and Why?* was held on 2 January, 2009 at Prithvi Theatre. When it started, Bhattacharya was not certain as to how it would be received and thought that he would do it once a month for just six months.

But *Chai and Why?*'s popularity ensured that it comfortably surpassed his initial expectations; it has now completed six years. The sessions are held not only at Prithvi Theatre (on the first Sunday of the month), but also at Ruparel College (on the third Sunday of the month). Over the years, a few sessions have also been held at other venues too.

Elaborating on the nature of *Chai and Why?*, Bhattacharya says that it is a forum to enable informal discussions of interesting scientific issues outside the traditional academic setting. It is aimed at those people who are interested in science, but do not have an opportunity to discuss it with scientists and ask them questions, he adds. Citing an example, Bhattacharya says, "For years, you may have wanted to know about how the tail of a comet behaves. Here you find someone who actually studies comets for a living and is happy to talk to you about it."

"For years, you may have wanted to know about how the tail of a comet behaves. Here you find someone who actually studies comets for a living and is happy to talk to you about it"

A Typical Session

When asked about what a typical session is like, Bhattacharya says, "It is usually 20-30 minutes of the big picture, a break for *chai*, followed by an hour-and-a-half of discussion." When it began, faculty members of TIFR hosted most sessions. However, that is changing. "Increasingly, these sessions are done by our PhD students. Talking about something in science excites them," he says.

Chai and Why? also has 'Summer Special' sessions aimed primarily at children such as *Science in the Kitchen*, *Science in the Bathroom*, *Science in the Playground* and *Science on the Beach*. They are much more hands-on in nature where children experience the joy of doing science by themselves. Special sessions are also held during festivals like *Holi* and *Diwali*, and these explore topics like colour perception or the science of fireworks. Explaining the rationale behind the special sessions, Bhattacharya points out, "The biggest problem I see for science in India is that it is completely bookish. Textbooks describe experiments that kids never get a chance to do. So we give them a chance to try out something new, yet simple. And they are wowed by the fact that they can do it."

"The biggest problem I see for science in India is that it is completely bookish. Textbooks describe experiments that kids never get a chance to do. So we give them a chance to try out something new, yet simple. And they are wowed by the fact that they can do it"

2G, 3G, Yeh Sab Kya Hai Ji?

Before the interview, Bhattacharya had sent me a list of all the sessions held so far. It did not take me long to realize that the *Chai and Why?* team works hard at having catchy titles to go with the themes of the sessions. For instance, the one on carbonated drinks was called *Why This Cola Very Di* and the session on terahertz spectroscopy was called *Ab Tera Kya Hoga?*.

DEBJYOTI BARDHAN

Learning the science of ice cream at a *Chai and Why?* session

DEBJYOTI BORDHAN

Children experimenting with candles in the "Candle Candle Burning Bright" session

Bhattacharya says, "A few years back 2G, 3G was all over the media when the scam broke. Everybody was discussing it, but most people did not know what 2G and 3G meant. We thought that it would be a good time to discuss the fundamentals of wireless communication. If you titled it *The Fundamentals of Wireless Communication*, people won't show up. So we decided it was going to be *2G, 3G, Yeh Sab Kya Hai Ji?*. It helped bring in a crowd who may have otherwise not come," he adds.

"If you titled it 'The Fundamentals of Wireless Communication', people won't show up. So we decided it was going to be 2G, 3G, Yeh Sab Kya Hai Ji?"

Beyond Mumbai

While the success of *Chai and Why?* has given Bhattacharya a reason to smile, he seems particularly pleased with one of the outcomes of this programme—a science demonstration kit, *A Wonderful Lab Called Home* for school children. The kit is a compilation of some experiments that were developed for the special sessions for children using everyday items. It allows the *Chai and Why?* team to take hands-on experimentation to other parts of India. "Initially, we got invitations to do this in a few schools around Mumbai, and later we got invitations from other cities across India," Bhattacharya says.

What has helped make this initiative popular, particularly in rural and semi-rural Maharashtra, is that *A Wonderful Lab Called Home* now comes in a Marathi version. "Outside Mumbai, people are genuinely glad to try out the experiments. With these demos, we've been reaching out to 7000 to 10,000 kids every year. The 'aha' experience you see is just phenomenal," Bhattacharya says excitedly, as the interview draws to an end.

"The 'aha' experience you see is just phenomenal"

After we finish our chat, Bhattacharya obliges me with a photograph on the way back to the entrance of the conference venue. Here he is scheduled to meet an old friend of his from his undergraduate days. He finally spots him—Kaushal Varma, a mathematics professor at IISc. After a warm greeting and a bearhug, the two of them head towards *Prakruthi* for a cup of, not *chai*, but filter coffee.

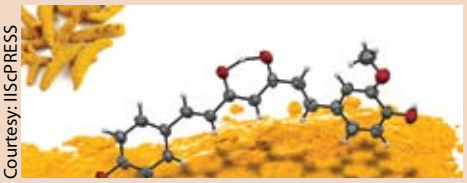
To learn more about *Chai and Why?*, go here: **https://www.facebook.com/chaiandwhy**

HOT OFF THE PRESS

This section highlights recent research from the Indian Institute of Science (IISc). These research snippets have been compiled by the SCIENCE MEDIA CENTER, a joint initiative of IISc and Gubbi Labs

INFECTIOUS DISEASE

Pulverized curcumin more effective in treating malaria



Courtesy: IISc PRESS

Turmeric is a ubiquitous spice in Indian culinary traditions which has also been used in *ayurveda* for centuries. In recent years, lab studies have demonstrated the potential of the active ingredient in turmeric—curcumin—in fighting several ailments including infections like malaria. One problem with curcumin, however, is that it does not dissolve fully in water and so is not readily absorbed by the body's cells—it has low "bioavailability". A group of researchers from the Molecular Biophysics Unit (MBU), IISc, Bose Institute Kolkata and the University of Pune have found a way to increase curcumin's bio-availability by pulverizing it into nanoparticles with a diameter of 20-50 nm. This "nanotised" curcumin was found to be more effective than native curcumin in treating mice infected with malaria.

Published in: *International Journal of Nanomedicine*
Read more at: http://goo.gl/W6FNZe

WILDLIFE CONSERVATION

A new surveillance technology for wildlife monitoring

Monitoring the movement of an animal is important in wildlife conservation and preventing human-animal conflict. But this requires expensive surveillance technology. Researchers from the Department of Instrumentation and Applied Physics in IISc in collaboration with Analog Devices India have developed a surveillance device that is not just affordable, but also compact, rugged and easy to use. With its two sensors and a retroreflector screen, it can detect any animal moving between the two adjacent sensors. It can also measure the distance, height, speed and "profile" (or shape) of the detected animal. This device can also be used to measure vehicular traffic.

Published in: *IEEE Sensors Journal*
Read more at: http://goo.gl/YDN5O9

ELECTRONIC SYSTEMS ENGINEERING

Novel inverter technology for industrial applications

Inverters, devices that convert Direct Current (DC) to Alternating Current (AC), have both domestic and industrial uses. A team of researchers from the Department of Electronic Systems Engineering, IISc, University of Seville (Spain), Government Engineering College, Thrissur and the Norwegian University of Science and Technology (Norway) have developed two novel circuits for use in inverters to drive huge electrical machines deployed in industries. These circuit configurations can be viable options for medium voltage high power drives, whose applications include steel mills, electric locomotives and electric cars.

Published in: *IEEE Transactions on Industrial Electronics*
Read more at: http://goo.gl/WGH0HC

MATERIALS ENGINEERING

Superalloys that help aero engines run on cheaper fuels

Courtesy: KAMANIO CHATTOPADHYAY

The machines that power jumbo jets, huge ships and massive power plants are made from special materials called "superalloys" which have extraordinary strength. But at temperatures beyond 900°C, even superalloys tend to break or corrode as they become susceptible to certain chemical reactions. This is true for the fuel used in aircraft engines as well. To deal with this problem, aircrafts have to use expensive high-grade fuel that is low in its sulphur content. But now, a team of researchers from the Department of Materials Engineering has developed a new class of cobalt-based materials which when added to aircraft fuel, ensures that it does not degrade even at 1600°C. This innovation will allow aircraft engines to run on fuel that is considerably cheaper.

Published in: *Acta Materialia* and *Scripta Materialia*
Read more at: http://goo.gl/YOZQWQ

GEOLOGY

The Nepal earthquake: why did it happen and why now?

The Indian tectonic plate is constantly pushing against the Eurasian plate causing accumulation of intense geological strain in the Himalayan region. Every few centuries, this strain is released as a high-magnitude earthquake (> magnitude 8). Back in February 2015, two months before the earth shook Nepal and killed over 8000 people, geologists from the Centre for Earth Sciences at IISc and the Jawaharlal Nehru Centre for Advanced Scientific Research, showed that the last high-magnitude earthquake in the central region of the Himalayan arc was over 700 years ago. Due to the long period of accumulated strain locked in the earth in the central Himalayan region, they also warned about the possibility of an imminent high-magnitude earthquake. "Considering this long elapsed time, a great earthquake may be due in the region," they wrote.

Published in: *Journal of Geophysical Research*
Read more at: http://goo.gl/78K94U

MANAGEMENT

Making India's electricity system sustainable

India, which now produces less than 250 GW of power, plans to increase power generation to 800 GW by 2032 to meet the demands of our growing economy. How can this be achieved without destroying our environment? Researchers from the Department of Management Studies suggest moving towards a sustainable electricity system that takes into account economic, social and environmental concerns. As a first step towards this transition, they have developed an indicator-based framework as an analytical tool for sustainability assessment of electricity systems, and validated it for India's national electricity system. This multidimensional framework can be used to examine the social, economic and environmental implications of the current Indian electricity system as well as to set targets for future development.

Published in: *Advanced Materials*
Read more at: http://goo.gl/z7KYIW

NEUROSCIENCE

Peering into the hardware that makes our brains tick

Courtesy: VIJAY NATARAJAN

The human brain comprises millions of neurons which form billions of connections with each other. Studying the function of these cells and the networks they form will yield clues to how the brain functions and the origins of the cognitive sophistication that makes human brains unique. However, the enormous complexity of the brain has posed challenges in answering fundamental questions about this organ.

Researchers from the Department of Computer Science & Automation and the Molecular Biophysics Unit have taken a step closer towards addressing these challenges by developing a framework to reconstruct 3D neuronal structures. In comparison with commercially available softwares that also perform this task, this new technology requires minimal processing and manual effort. The algorithm used to generate neuronal structures also takes into account the natural variation seen in neurons of the human brain.

Presented in: *Indian Conference on Computer Vision, Graphics and Image Processing*, December 2014
Read more at: http://goo.gl/HAC3gc

MEDICINE

A potential therapeutic for septic shock

Severe sepsis or septic shock is a rising cause of mortality worldwide. It is caused by the uncontrolled expression of several inflammatory genes in the host. The sudden onset and excessive expression of these genes leads to accumulation of harmful metabolic end products, and can even cause multiple organ failure. In a recent study, a library of inhibitors to fight stress activated proteins expressed during sepsis has been identified. The study was carried out by researchers from various departments: the Solid State and Structural Chemistry Unit, Department of Microbiology and Cell Biology, Department of Physics and the Supercomputer Education and Research Centre.

Published in: *Nature Scientific Reports*
Read more at: http://goo.gl/vzEz38

NANOSCIENCE

Silver nanoparticles adorn graphene to utilise light efficiently

The most ubiquitous form of energy around us, light, is surprisingly underutilised as a source of electricity. This is largely because photo-based devices are inefficient in absorbing light and then converting it into a useful electrical signal. Now researchers from the Centre for Nano Science and Engineering and the Department of Physics have designed a novel device that shows enhanced response to light and is also colour sensitive. This device, made from graphene and metal nanoparticles, may foster applications like colour based ultra-sensitive photodetectors, efficient solar cells and single-molecule detectors.

Published in: *Advanced Materials*
Read more at: http://goo.gl/z7KYIW

KEEPERS OF THE GREEN

BHARTI DHARAPURAM

The Philippine Ground Orchid at the plant nursery

The article profiles one of the most treasured activities of the Indian Institute of Science (IISc)

✍ **BHARTI DHARAPURAM**

Secret Garden

The rusting gates stand in stark contrast to what greets the visitor next—a path lined by pink flowers. On the left are chandeliers of yellow fruit dropping down several feet from a fish-tail palm. Ahead, there is an old, stately white building adorned by an over-enthusiastic bougainvillea with its bright pink flowers falling over itself. Adjacent to the white building, is a glass-house, also old, with a *Petrea arborea* out front, painted over by a riot of blue flowers with elegant violet collars. This is the plant nursery, tucked away in a quiet corner of IISc, dressed in its spring-time best.

There is more. Neatly arranged pots put out flowers of every imaginable colour playing host to a variety of dawdling butterflies and impatient bees. And the tilted gaze of a scare-crow watches over the garden abuzz with life.

ASHOK KUMAR MALLIK

A variety of flowering plants at the nursery

The plants in the nursery make an eclectic collection—orchids and aroids, begonias, bonsai *Ficus* trees, *Thunbergia mysorensis* climbers with yellow chalice-like flowers, the gymnosperm *Zamia* from the Americas with beautiful shiny leaves, turmeric plants with sweet-smelling white flowers,

a *Bolusanthus* tree from Africa which drapes the ground with small blue flowers in spring, and the spectacular South American scarlet-flame passion flower, *Passiflora vitifola*, to name a few. There are a number of edible fruiting trees as well—star-fruit, sapota, mango, papaya, amla, water-apple, litchi, karaunda, custard apple, amtekai and Surinam cherry. The vegetation here supports a diverse animal community; insects, birds, snakes, and even slender lorises call this home.

Reaping the Fruits of the Past

The activities of the nursery are overseen by B Sridhar who joined the Institute in 1986 soon after his Masters in Horticulture from the University of Agricultural Sciences, Bangalore. According to Sridhar, the old white building housing the nursery was once home to a radio transmitter, part of the British war effort. After the war, a lecturer from the Department of Electrical Technology, Sisir Kumar Chatterjee, conducted his research in this building. Sridhar credits Chatterjee with sowing the seeds of organized horticultural activity in the Institute when he started a garden around the building.

BHARTI DHARAPURAM

Nursery office

The reins of the garden that eventually evolved into a nursery were then passed on to BS Nirody. Not only did Nirody make the garden into a nursery, he was also largely responsible for transforming the campus into what it is today.

From small town beginnings, Nirody followed his passion for plants to obtain a Master's degree in Agricultural Sciences from the United States. On his return to India, Nirody initially worked as a Kannada-English translator, taking up horticulture projects

Courtesy: JYOTSNA DHAWAN

BS Nirody

on the side. When the war broke, he grew "English" vegetables in the Nilgiris to feed the army in the plains. Later, when his family decided to settle in Bangalore, they made their home in Malleswaram, just outside the gates of IISc. During this period, Nirody came in contact with the German botanist, Gustav Krumbiegel, one of the architects of Lal Bagh and the planner of many of Bangalore's avenues. Nirody's passion and talents were recognized by AG Pai, the then Registrar of the Institute, who asked him to take over the nursery and also conduct plant breeding research on campus.

"He was an incredibly enthusiastic person," says Jyotsna Dhawan, Nirody's grand-daughter and a stem-cell biologist at the Centre for Cellular and Molecular Biology (CCMB), Hyderabad. "He could identify plants with his eyes closed," she adds, vouching for his botanical skills.

"He could identify plants with his eyes closed"

He brought some of the first *Tabebuia* trees to campus, bred his favourite begonias using tricks he invented, planted *Cassia* and *Jacaranda* trees and grew different kinds of ferns. He also had a collection of many varieties of *Gerbera* in the nursery. He trained the first head *maalis*—Thimma and Mudda who passed on their skills to future gardeners. His infectious enthusiasm for plants spread not just

Courtesy: JYOTSNA DHAWAN

Nalini Nirody Dhawan

among his employees, but also his friends. Among them was Homi Bhabha, the well-known nuclear physicist, who was then at IISc. He brought back plants to Nirody from his travels around the world, including the country's first white bougainvillea plants from Brazil.

"Everyone in that family was totally plant mad. There was an immense excitement about plants, about their Latin names and where they come from," Dhawan fondly reminisces. Her mother and Nirody's daughter, Nalini Nirody, kept alive her father's legacy in the nursery for several years. A cytogeneticist by training, she eventually married an aeronautical engineer, Satish Dhawan who went on to head the Institute for over two decades.

The nursery was a place where Nalini Nirody Dhawan could meditate. "If mum could not be found in the house, she was in the nursery," Jyotsna Dhawan recalls.

Both father and daughter were hands-on people and loved working in the soil themselves, finding new ways to propagate plants. One can still see the same spirit of gardening in the nursery today.

Another person who, Sridhar says, has made a difference to the nursery is the former Director of the Institute, CNR Rao. According to him, Rao was responsible for building a compound around the nursery premises. Sridhar adds that during Rao's tenure, grazing by cattle which came from outside the Institute—a routine occurrence until then—was also banned. He still remains a kind patron of the nursery, says Sridhar.

MOHAN REDDY

Campus vegetation is also maintained by the nursery

Green Campus

The Institute's gardeners are also responsible for nurturing the greenery on the more than 370 acres of campus.

They work tirelessly to maintain its landscape and ensure that visitors to the campus carry with them lasting memories—of *Tabebuia aurea* trees bursting into cheerful yellows in the spring, of sunlight filtering through the leaves of its old trees, on hazy mornings, or of the brilliant hues of the annual flower show.

When the Institute was established in 1909 on land donated by the erstwhile Maharajah of Mysore, Krishnaraja Wodeyar IV, the landscape was different—scrubs and open grasslands dotted the relatively barren landscape. Today it is densely wooded with trees of all kinds, with many of them coming from foreign lands. The transformation is because of the tireless work of its gardeners, both past and present.

Landscaping

Unfortunately green spaces on campus have shrunk over the years as new buildings have sprung up to accommodate new labs, departments and hostels. However, Sridhar and his team see opportunities in such projects. They seek to add colour to these otherwise drab structures by landscaping and adding gardens. "We are here to take up any challenge," says Sridhar who believes that utility can go hand in hand with aesthetics. A glowing example of his work is the landscaping around the Centre for Nano Science and Engineering (CeNSE). It consists of various garden elements—mounds, creepers,

BHARTI DHARAPURAM

Lawn around the Centre for Nano Science and Engineering (CeNSE)

pergolas, fencing and a pretty, stone path winding through the lawns. It makes a pleasing sight, and is the envy of many departments nearby.

Annual Flower Show

Though the gardeners work inconspicuously for most of the year, their efforts take centre-stage during the Founder's Day celebrations in March. It is marked by an elaborate flower show in front of the Main Building as a tribute to JN Tata—the founder of IISc. Preparations for the flower show start months in advance, as early as in October. The large plot within the nursery is used to grow annual flowering plants of various colours and varieties. They are short-lived plants which require bright sunlight to grow well. Several varieties of flowers need to bloom at the same time during the flower show. "By practice, we have staggered planting in several lots," Sridhar explains.

But Sridhar and his team are dependent on the vagaries of nature as they prepare for the flower show. "During September-October, if we get off-season rains, our plants die because of fungus [infestation]. Sometimes, we fail," he concedes. The occasional failures, however, do not deter Sridhar from experimenting with colours and patterns every year, adding new flowers to present something novel. "I design the show. But ultimately they [the gardeners] are the people who transform my ideas. I need to completely acknowledge their efforts," he says.

"They [the gardeners] are the people who transform my ideas. I need to completely acknowledge their efforts."

Unsung Heroes

Even when the gardeners are not working on landscaping or preparing for the flower show, there is always work to be done. There are routine chores including cutting, planting, collecting seeds, sowing and grafting. There are only four other permanent gardeners; the rest hold temporary positions. Many of them come from families who have worked with the soil for generations. They come from places like Yelahanka, Nelamangala and Hesaraghatta on the outskirts of Bangalore, where agriculture is giving way to construction.

Over the years, Sridhar has seen a shrinking workforce; the nursery once had up to 70 permanent gardeners. "If we lose them, we'll lose all our tradition... the knowledge will be gone," he laments. He hopes that in the future the Institute will invest in "good gardeners".

"If we lose them, we'll lose all our tradition... the knowledge will be gone"

But the nursery has learnt to use the available resources and man-power as efficiently as they can. Sridhar says earnestly, "My duty is to take care of the vegetation on campus. I want to conserve this place and also add species to its collection, be it a tree or a creeper. The show goes on here."

BHARTI DHARAPURAM

Plant nursery staff with their work on Founder's Day

AT THE FRONT AND CENTRE OF CLIMATE CHANGE

RANJINI RAGHUNATH

The Divecha Centre for Climate Change at the Indian Institute of Science (IISc) has been at the forefront of studying one of the most critical challenges of our times

✍ **RANJINI RAGHUNATH**

The problem with climate change awareness in India, says J Srinivasan, is that many people think that it is an issue only for the developed world and not for a developing country like India. This misconception needs to be corrected, believes Srinivasan, who is the Chairperson of the Divecha Centre for Climate Change at IISc. He argues that climate change is as much our problem as it is of the West, and many aspects of this global challenge also have to be tackled locally. For instance, the global mean temperature in March has risen by around 0.8°C in a century, but Bangalore's average minimum temperature in March has gone up by almost 2°C during the same period, says Srinivasan. To him, this indicates that local factors such as urbanization and land use change also influence Bangalore's climate.

Origins

Targeting such gaps in awareness is a part of the

Courtesy: DIVECHA CENTRE

Arjun Divecha inaugurating the Centre at CAOS building in 2011

mission of the Divecha Centre for Climate Change, an interdisciplinary initiative focusing on global and local climate change issues. The Centre was established in 2009 with an annual funding amounting to $3 million over 5 years from US-based philanthropists Arjun and Diana Divecha and the Grantham Foundation for the Protection of the Environment, founded by British investor Jeremy Grantham. The Centre also gets additional support from the Department of Science and Technology, the Ministry of Earth Sciences and the Department of Space through research grants to its faculty members.

The Grantham Foundation had initially funded the setting up of the Grantham Institute for Climate Change at Imperial College, London, in 2007. At that time, Srinivasan and his colleagues at the Centre for Atmospheric and Ocean Sciences (CAOS) were already working on understanding climate change issues—particularly the vagaries of the Indian monsoon. When the Grantham Foundation started looking towards Asia for collaborations, IISc was chosen, and Arjun Divecha, Grantham's colleague at his investment firm GMO, was roped in. "Jeremy asked me if I would join him in jointly funding the Centre. That is how I got involved," says Divecha. He formally inaugurated the Centre on the top floor of the Centre for Atmospheric and Oceanic Sciences (CAOS) building in 2011.

Cutting-edge Research

Divecha and Grantham envisioned that the Centre would work on collaborative research projects with Imperial College, raise awareness through outreach activities and eventually contribute to shaping climate change policy in the country. "I think the Centre has evolved quite nicely. This year, we've decided to extend the funding for another five years," Divecha adds.

"I think the Centre has evolved quite nicely. This year, we've decided to extend the funding for another five years"

Faculty members from multiple departments including CAOS, Civil Engineering, Ecological Sciences and Earth Sciences work on climate change-related projects at the Centre. Apart from monsoons and aerosols, the Centre also focuses on novel research in glaciology, geo-engineering and renewable energy.

RANJINI RAGHUNATH

Faculty members at the Centre work on diverse areas of climate change

One of the Centre's first new research initiatives, spearheaded by faculty member Anil Kulkarni, was to study glacier retreat in the Himalayas. He and his team use satellite data and climate models to understand what drives the rapid disappearance of Himalayan glaciers and how this will affect melt water availability for perennial rivers in North India.

Understanding glacier retreat is important, Kulkarni points out, because 60% of India's food production depends on rivers fed by glacier melt water. "In Pakistan, it is almost 90%. We need to understand these crucial issues and take measures ahead of time to secure our food and water availability," he says. Figuring out these factors could also have policy implications. For example, knowing when glacier melt could give rise to new lakes is valuable information for the strategic planning of land use in the Himalayan region, explains Kulkarni.

SMRITI BASNETT

Moraine, a dammed lake at the terminus of the Tista Khangse glacier in Sikkim, is causing the glacier to melt

Another emerging area of climate change research is geo-engineering, a largely theoretical field that proposes radical measures to tackle the after-effects of climate change. For instance, one such tactic involves the use of giant mirrors or atmospheric aerosols to reflect sunlight back into space.

"We need to understand these crucial issues and take measures ahead of time to secure our food and water availability"

"Think of it as the planet having a disease. Instead of addressing the root cause, geo-engineering schemes try bandaging," explains faculty member Govindasamy Bala. Bala's team develops models to test the feasibility of such techniques, particularly using sulphate aerosols in space. "We want to know: Is it a viable strategy? How long it will take to cool the planet? Are there side-effects? Which part of the atmosphere should we inject them in? And so on," he explains.

Apart from developing solutions to meet this global challenge, the Centre is also attempting to make a difference within the Institute. A 20 KW solar power plant was set up on the JRD Tata Memorial Library rooftop by faculty member Sheela Ramasesha's research group in 2013. In one year, the plant generated 28,900 units of electricity and has been powering part of the Main Building for the past 18 months.

Ramasesha's team is also working on developing and testing the efficiency of novel concentrated photovoltaics (CPV). They are currently using their CPV module, one-of-a-kind in the country, to assess the suitability of a triple junction solar module for a place like Bangalore which has high cloud coverage and aerosol content in the atmosphere. Her co-workers are also working with Southern Railways to set up solar panels on a Bangalore-Delhi and a Chennai-Mysuru train to offset diesel costs. That project is "estimated to save around 80,000 litres of diesel per year on one train," says Ramasesha.

SHRAVANTH VASISHT

Solar power plant set up on JRD Memorial Library rooftop by Sheela Ramasesha's group

In addition to independent projects, the Centre's researchers also work with their counterparts at Imperial College, London, on solar power, aerosols and water resources. One such project, led by Pradeep Mujumdar at IISc and Wouter Buytaert at Imperial College, studies the impact of human activities on river flow in the Gangetic basin and how this feeds back to the climate. The team uses models to predict how flow rates and other properties such as soil moisture will respond to future climate conditions. Mujumdar is also working with researchers from around the country to develop a unified model to predict river flow for all Indian rivers.

Reaching Out

When the Centre was founded, one of its priorities was to raise awareness. Elaborating on this, Srinivasan says, "It is necessary to go out and talk about issues related to climate change to a wider audience including students, policy makers and journalists." To that end, the Centre's faculty members give over a hundred talks a year on various issues related to climate change. Training programmes and workshops have been organized at schools, colleges, government organizations, NGOs and corporate houses in various towns and cities in India.

"It is necessary to go out and talk about issues related to climate change to a wider audience including students, policy makers and journalists"

A popular annual quiz competition is also organized for undergraduate students from local colleges aimed at testing and strengthening their knowledge and awareness about climate change. Participating in such competitions "gets students excited about the science behind climate change and would encourage them to take it up as a career," says Bala, who is involved in organizing it.

As part of its outreach efforts, the Centre also brings

eminent international researchers to the campus through its Jeremy Grantham lecture series. These annual talks highlight pressing issues related to climate change.

Srinivasan believes that such awareness initiatives are necessary because the number of people studying climate change in India is disconcertingly low. He adds, "For a country like India, whose agriculture depends so much on climate and climate variation, the number of institutions which do climate research is not more than 5-10, which is shocking."

The Centre has also been working with private players such as Tata and Wipro to raise awareness. For instance, an event organized by IISc and Wipro EcoEnergy in 2010 highlighted innovative steps taken by Indian companies to conserve energy and water.

Graduate students at IISc are also encouraged to improve their understanding of climate change issues through fellowships and exchange programmes. A Jeremy Grantham Fellowship programme for students at CAOS supports their research and allows them to present their work at national and international conferences. The Centre also has an MoU with the University of Iceland that allows IISc students to travel there for training programmes on glaciology.

Future Directions

Looking ahead, Srinivasan and Divecha hope that more of the Centre's research would translate to framing better climate policies. "What would be ideal," Divecha says, "is that, as the Government of India is thinking about climate change policy, they would see the Centre as a place to provide expert opinion on the science behind it."

However, this would require recruiting more faculty members with policy expertise and interacting more frequently with policy makers, says Srinivasan. "Our strength right now is basic research on climate change. Ideally, for the Centre to grow in the next 10 years, we must have an equal number of faculty in all three areas: policy; impact, mitigation and adaptation; and science."

Courtesy: DIVECHA CENTRE

Participants at the annual Climate Change Quiz organized by the Centre

Another concern that Srinivasan has is the 'disconnect' between climate scientists and policy makers, although some progress has been made on that front. In 2013, at the National Climate Parliament in New Delhi, the Centre worked with policy makers to ensure support for wind power generation. Due to their efforts, a condition supporting it was attached to a Bill that was passed later in 2013-14. In 2010, discussions with 20 Parliament members and Jairam Ramesh, the former Minister for Environment and Forests, resulted in a national project on the impact of black carbon aerosols on the climate. Srinivasan also hopes that the Centre, which started as a project, becomes an integral part of the Institute, one that will be able to offer independent Master's and PhD programmes for students.

Courtesy: DIVECHA CENTRE

J Srinivasan, Chairperson, Divecha Centre for Climate Change

HELLO!

Faculty members who have joined the Indian Institute of Science (IISc) recently tell us about themselves

SWAGATA MUKHERJEE

BIPLOB BHATTACHERJEE (Assistant Professor, Centre for High Energy Physics)

I obtained my PhD in particle physics from Kolkata University. After my postdoctoral research at the Tata Institute of Fundamental Research, I moved to Kavli IPMU (University of Tokyo) for three years. My research covers theoretical aspects of high energy particle physics with a primary focus on the phenomenology beyond the standard model and their collider signatures in the context of the Large Hadron Collider and the International Linear Collider. I have also worked on dark matter and flavour physics.

Take Five

- **I love science because…** it can be understood, at least to some extent, by logical reasoning.
- **My favourite subject in school was…** Physics.
- **I would like to be best remembered…** as an honest human being.
- **The person I admire the most…** my parents.
- **My role model in science…** I do not have any particular role model.

CONNECT

PRERNA SHARMA (Assistant Professor, Department of Physics)

I had my early education in Jaipur and spent my teenage years and beyond in Delhi. I did my PhD in Physics at the Tata Institute of Fundamental Research, Mumbai, on measurements of interactions and dynamics that occur at interfaces. My postdoctoral work at Brandeis University, Massachusetts, USA, was on self-assembly of colloidal rafts in membranes. My research interests include studying fundamental aspects of colloids, polymers and membranes.

Take Five

- **The thing I dislike most about Bangalore...** the high volume of traffic on the roads.
- **I have a weakness for..**. international cuisines such as Turkish and Mexican.
- **My most memorable holiday was in...** Taupo, New Zealand.
- **If I could change one thing about India...** it would be to end the unprofessional attitude of India's workforce.
- **My favourite movie is...** *Chhoti Si Baat*.

PUNITHAVATHI

SHANKAR KUMAR SELVARAJA (Assistant Professor, Centre for Nano Science and Engineering)

After studying optical communication for my Master's at Anna University, Chennai, I did another Master's in microelectronics and microsystems at the University of Twente, The Netherlands. For my PhD at Ghent University-IMEC, Belgium, I worked on developing wafer scale silicon photonic integrated circuits for optical interconnect applications. I continued my research there as a postdoctoral fellow, and then as a silicon photonics integration engineer. Now at IISc, I seek to develop high-speed optical links beyond 100 Gbps for the next generation on-chip and short-distance communication.

Take Five

- **When I was young, I wanted to become…** I was not looking far ahead in time. All I was interested was to learn new things.
- **The most challenging thing I've done in my life is…** so far nothing really; I believe the most challenging thing is yet to come.
- **The subject I hated most in school was…** biology because I simply couldn't stand all the Latin names that I needed to remember.
- **The most influential book I've read is…** I am not an avid reader, but I like books on social philosophy.
- **What I like most about my job is…** freedom, my students and the work environment.

Courtesy: MAHAVIR SINGH

MAHAVIR SINGH (Assistant Professor, Molecular Biophysics Unit)

After my Master's from Delhi University, I did my PhD from the Max-Planck Institute for Biochemistry, Germany; here, I studied how the major tumor suppressor protein pRb interacts with its cellular and viral proteins partners. During my postdoctoral work at the University of California, Los Angeles, I got interested in understanding the structure and functions of non-coding RNAs and their interactions with proteins in Ribonucleoprotein complexes. At IISc, I am investigating the role of non-coding RNAs in telomere length maintenance and gene regulation.

Take Five

- **In school I was interested in…** history as well as chemistry and biology.
- **Besides money, my wallet will always have…** my driving license, institute ID… and our pediatrician's phone number.
- **My favorite animal is…** totally influenced by my 5-year-old son's interest. I would say I am fascinated by the lion, tiger, puma, cheetah, leopard and jaguar.
- **Science to me means…** experimenting on things you are curious about!
- **The most memorable day of my life was the day…** the day we landed in India from US; it was a very difficult journey that ended in success.

Courtesy: CeNSE

SUPRADEEPA VR (Assistant Professor, Centre for Nano Science and Engineering)

I grew up in Bangalore. After obtaining my PhD in Electrical and Computer Engineering from Purdue University, USA, I worked at OFS Laboratories, Somerset, New Jersey, with the fiber lasers and amplifiers group. I am currently interested in studying nonlinear optical phenomena in low power integrated devices to high power lasers and systems and engineering them for practical applications.

Take Five

- **What I remember learning from my favourite teacher...** separating facts from opinions.
- **The food that never fails to make my mouth water...** idly and vada with lots of chutney from Brahmin's Coffee Bar in Shankarpuram in Bangalore.
- **I would like to be remembered as...** just being remembered is good enough for me.
- **The best thing about my job is...** freedom and the opportunity to make a fundamental contribution.
- **When I need to relax, I...** play badminton, watch movies or just do nothing.

SWAGAT BORAH

DIGBIJOY NATH (Assistant Professor, Centre for Nano Science and Engineering)

My early life was spent in Golaghat in Assam. I received my PhD from Ohio State University, USA where I worked on gallium nitride–materials epitaxy and devices. I remained at the same University for my postdoctoral research on 2D layered materials. At IISc, my research focuses on devices for deep UV applications, high speed transistors and novel semiconductor devices made from gallium nitride which continues to fascinate me.

Take Five

- **The most embarrassing moment in my life…** when my PhD advisor had to remind me that quitting even without giving one shot at a problem was not what he had expected of me.
- **If I had to eat something every day I would choose…** river water fish cooked in Assamese style.
- **My fondest college memory is…** walking outside the gates of our BITS (Pilani) campus at dawn along with friends, after having put a night out, to have tea and watch the sun rise.
- **A word that best describes me is...** dream lover.
- **My favourite pastime is…** reading articles/news on astronomy when I am not watching movies or playing badminton.

WOMEN IN SCIENCE

Women in Science, a seminar to showcase research done by women scientists in India under the auspices of the Indo-French Centre for Promotion of Advanced Research (CEFIPRA) was organized at the Indian Institute of Science (IISc) from 3-5 February, 2015.

Courtesy: CEFIPRA

Before the seminar, two broad areas of research—health & life sciences and physical & mathematical sciences—were identified for presentations. In addition to the scientific talks by star principal investigators of the CEFIPRA projects, the seminar also saw two keynote addresses and a panel discussion on issues that women in science deal with.

In her talk, Manju Sharma, former Secretary, Department of Biotechnology (DBT), emphasized the role senior women faculty could play in mentoring young women in science at the PhD level. "If they're nurtured, they become innovative scientists," she said.

Anne Pepin (Head, Mission for the Place of Women at the French National Centre for Scientific Research (CNRS)) reflected on the experiences of women researchers in France. She said that CNRS strives to provide role models for young women in science, help them develop collaborations with other researchers, engage in outreach and boost gender equality. She also talked about the steps taken by CNRS to make science more attractive as a career option for women, CNRS initiatives like adopting the Gender Action Plan to create awareness about gender equality and sexual harassment in the workplace, and policy changes undertaken to make the research environment more women-friendly. These changes include having at least one woman presenter at a CNRS conference and ensuring that meetings are not scheduled after 7 pm, she added.

Vineeta Bal, a former member of the Prime Minister's task force for Women in Science under the Department of Science and Technology (DST), presented her views on the situation in the Indian context. Painting a dismal picture, she pointed out that there had not even been a systematic effort to collect data about women in science and the issues they were dealing with; non-availability of data is a fundamental barrier in bringing about a desperately-needed change in the situation, she said.

During the panel discussion, Usha Vijayraghavan (Dean, International Cell, IISc) spoke about the efforts being made at IISc to encourage women researchers through its international PhD programme. The discussion ended with several recommendations made by panelists and the audience to address this important problem.

Speaking to CONNECT, Rohini Godbole (Professor, Centre for High Energy Physics and Chair, Women in Science Panel, Indian Academy of Sciences), said that the seminar helped in creating a dialogue between the French and Indian experiences which in turn could help us arrive at best practices for increasing participation of women in science in India. The seminar also provided a platform for young women researchers working in different areas of science to present their work, interact with other scientists and science administrators, she added.

✍ **MEGHA PRAKASH**

FARADAY DISCUSSIONS

Named after the famous English scientist Michael Faraday, the **Faraday Discussions** have been organized by the Royal Society of Chemistry (RSC) since 1903. The 177th edition of this series was organized from 12-14 January, 2015 at IISc; it was held in India for the first time.

The theme of this edition, 'Temporally and Spatially Resolved Molecular Science', brought together crystallographers and spectroscopists from chemistry, physics and biology to promote interdisciplinary research. It also sought to improve our understanding of structural dynamics from complementary approaches and techniques in the emerging areas of 'time resolved studies'. Discussion themes from the event included: Dynamics of the Chemical Bond, Time and Space Resolved Methods, Local and Global Dynamics and Future Challenges and Emerging Techniques.

The focus of Faraday Discussions is on the rapidly developing fields of chemistry and its interfaces with other scientific disciplines. Discussion summary and

Courtesy: IPC

research papers from the meetings are published in the *Faraday Discussions*, a journal of RSC.

This edition was convened by S Umapathy (Professor, IISc), Judith Howard (Professor, University of Bristol) and Mike Ashfold (Professor, University of Bristol and President, Faraday Society). One of the invited speakers, E Arunan (Professor, IISc), reflecting on the history of the Faraday Discussions, revealed an IISc connection. The Institute's first Director, Morris Travers, served as the President of the Faraday Society during 1936–1938.

✍ **MEGHA PRAKASH**

SPECTRUM

Spectrum, the three-day cultural, sports, literary, science and technology festival of IISc, was held from 27-29 March this year. All the events were jointly organized by various clubs of the Institute.

Besides the cultural and literary flavour that Spectrum typically offers, this year's focus was on sports. Events like Triathlon Science Man and Science & Technology (SnT) Run 2015 were organized for sports lovers.

Rangmanch, the dramatics club, produced a play called 'Chandramukhi' and I-Beats, the dance club, performed a high-octane mix of classical and Bollywood hip-hop. A fashion show was also organized as part of the festival.

NAVEEN JAMES

A dance performance

Students both from within and outside the Institute participated in large numbers making this edition of Spectrum bigger than previous ones.

✍ **MANBEENA CHAWLA**

PRAVEGA

Pravega '15, the second edition of the science, technical and cultural festival organized by the undergraduates of IISc, was held from 30 January-1 February earlier this year. This year's attractions included S&T events, workshops, lectures and a cultural extravaganza.

Fast emerging as one of the country's premier science fests, this year's edition also had an activity for school children called 'Idea Presentation for School Students' in which participating students were asked to come up with innovative ideas towards solving everyday problems.

Speaking to CONNECT, Naren Manjunath, a member of the organizing team said, "Pravega '15 is an attempt to showcase IISc as a multi-faceted, multidisciplinary institution through a combination of events from science, technology and culture."

Courtesy: PRAVEGA ORGANIZING COMMITTEE

A participant trying her hand at archery

Pravega '15 saw a footfall of over 12,000 visitors and more than 6000 participants from about 200 colleges from all over India.

✍ **DEBADRITA PARIA**

KNOWLEDGE PRODUCTION IN PRE-MODERN INDIA

To celebrate its tenth anniversary, the Centre for Contemporary Studies (CCS) organized a national seminar on **Methodological Aspects of Knowledge Production in Pre-Modern India** from 24-26 January this year. It was inaugurated by the Director of IISc, Anurag Kumar.

Well-known historian Romila Thapar, Professor Emerita, Jawaharlal Nehru University, gave the opening lecture in which she refuted the notion that early India lacked a sense of its own past. Diverse historiographies, she claimed, reveal that a notion of historical consciousness did exist. In his plenary talk, MS Valiathan, National Research Professor, Manipal University, highlighted the contributions of the legendary physician Charaka to medicine. Other talks dealt with topics as diverse as mathematics, astronomy, philosophy, grammar, architecture and metallurgy in ancient India.

Rajan Gurukkal, Visiting Professor at CCS and the organizer of the event, told CONNECT that he organized the seminar in response to the general belief that there was no serious methodological pre-occupation in how knowledge was produced and validated in early India. He said that it is often unquestionably accepted today that the east and the west both produced knowledge in different ways. A seminar analyzing ancient Indian knowledge systems would help us understand that knowledge production in both the east and west emphasized deductive reasoning and confirmation of knowledge, Gurukkal added.

MILIND KOLATKAR

Romila Thapar, well-known historian, giving the opening lecture

✍ **KARTHIK RAMASWAMY**

HEALTHCARE DEVICES

ANANYA JANA

Parama Pal (Head, Medical Devices, Robert Bosch Centre for Cyber Physical Systems, IISc) making a presentation during the workshop

Hand-held Point-of-Care (POC) devices are changing the way healthcare is being delivered, particularly in rural areas. To discuss recent technological trends in such devices, a two-day workshop titled **Healthcare Devices: Technologies and Translation** was organized at the Centre for Nano Science and Engineering (CeNSE) on 26 and 27 March, 2015. It was a joint initiative of the Department of Instrumentation (IAP) and Cambridge University under the UK-India Education Research Initiative (UKERI). It was funded by the Department of Science and Technology (DST), Govt. of India, and the British Council.

The event, aimed at strengthening ties between research institutes, hospitals and industry, saw the participation of academicians, entrepreneurs, healthcare professionals and potential investors. Sanjiv Sambandhan, Professor, Department of Instrumentation and Applied Physics, and the organizer of the event, told CONNECT, "It is important to translate academic research into viable commercial products to benefit society. To develop these products, industry has a crucial role to play." He pointed out that though many researchers including him have developed designs of healthcare devices, most of them remain relatively unknown. To bridge this gap, business incubators and technology translators were brought together through the workshop, Sambandhan added.

During the workshop, several talks and discussions were held on finding ways in which the laboratory designs could be developed as commercially available products. Hand-held medical devices currently available in the market as well as prototypes of new devices were also displayed.

According to the organizers, the long term goals of the workshop include: conducting training programs in nano-electronics, increasing interaction with society, and having greater student participation. As a follow-up to this event, more such workshops are being planned, including one in Cambridge later this year.

✍ **ANANYA JANA**

ADVANCEMENTS ON POLYMERIC MATERIALS

The 6th annual international conference on **Advancements on Polymeric Materials** was held on 20 and 21 February, 2015 at IISc. It was organized by the Central Institute of Plastics Engineering and Technology (CIPET), Chennai, in association with IISc and the Central Power Research Institute (CPRI). The conference was inaugurated by Hansraj Gangaram Ahir, Minister of State for Chemicals & Fertilisers, Govt. of India.

The theme of this year's event, 'Marching towards smart product design and development with

Courtesy: CIPET

Left to Right: SK Nayak (Director General, CIPET), Avinash Joshi (Joint Secretary, Department of Chemicals and Petrochemicals (DCPC)), Surjit K. Chaudhary (Secretary, Govt. of India, DCPC), Hansraj G Ahir (Minister of State for Chemicals & Fertilisers), Rajiv Yadav (Additional Secretary, Govt. of India, DCPC) and Anurag Kumar (Director, IISc)

multifunctional materials', provided a platform for researchers and industrialists from across the globe to discuss recent developments in the field of plastic and product development. The conference also fostered interaction between the industry and academia, according to Suryasarathi Bose, Professor, Department of Materials Engineering at IISc.

The conference featured several interesting talks. Tony McNally (Professor, Warwick University) discussed the potential uses of light-weight materials such as carbon nanotubes for biomedical applications and the challenges in processing them. Mohini Sain (Professor, University of Toronto) explained the consequences of human consumption on the environment and the ways in which it can be minimised through use of light-weight materials like polymers. Ramanujalu Janardhan (SABIC Asia Pacific), in line with this year's theme, talked about his company's research on a new generation of plastics that could replace metals in the future. A poster session and student talks were also organized as part of the conference.

SUBHAM MRIDHA

METABOLOMICS

Courtesy: METABOLOMICS TEAM

Left to right: Utpal Tatu (Professor, Department of Biochemistry), Ajit Kamath (Pfizer India), Appaji Rao (former Chair, Department of Biochemistry) and Shikha Laloraya (Professor, Department of Biochemistry)

The study of metabolism has been a focal area of research at the Department of Biochemistry in IISc since its establishment in 1921. One of the pioneers in this field is Naropantul Appaji Rao, the former Chair of the Department of Biochemistry. To mark his contributions to metabolism studies and to celebrate his 80th birthday, a two-day conference, **Metabolomics 2015,** was organized on 12 and 13 January, 2015 at IISc. Utpal Tatu, a professor in the same department, was instrumental in organizing the event.

Metabolomics is a technique to measure metabolites—intermediates and products of metabolism like glucose—in biological samples using mass spectroscopy. The presence or absence of a metabolite can indicate whether or not an individual has a particular condition. Metabolomics has, therefore, become a useful tool in diagnosing some genetic disorders.

On day one of the conference, invited talks were delivered by researchers from both India and abroad. Following the talks, a poster session served as an interactive platform for young researchers to display their work. On day two, a brainstorming session on 'Applications of Metabolomics' and a training workshop on the use of mass spectroscopy was organized for participants at Agilent Technologies, Bangalore.

CHAITANYA JOSHI

OPEN DAY

IISc hosted **Open Day 2015**, its annual outreach event, on 28 February this year. Various departments of the Institute provided a glimpse of their research, while also demonstrating the principles of science using hands-on methods. Thousands of visitors thronged the campus on that day to see science in action.



Models of satellites, rockets, and aeroplanes built in India attracted many to the Department of Aerospace Engineering. It also organized an air show which featured Unmanned Aerial Vehicles (UAVs)



Innovative designs and models of products built by students of the Centre for Product, Design & Manufacturing (CPDM). They included an electric bicycle, a foldable bicycle, solar cooker models and much more



Demonstration of how lightning and sparks are produced as a result of differences in voltage and current at the High Voltage Engineering Lab

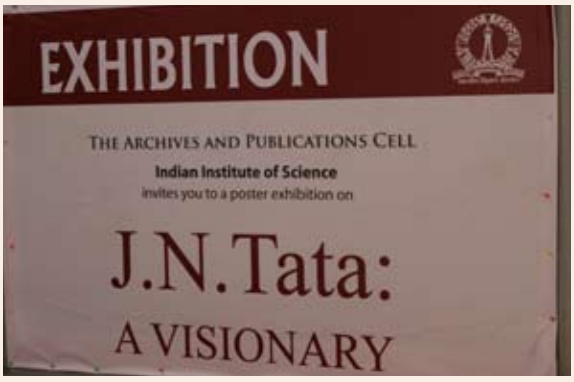


Demonstration of physical principles like diffraction of light and angular momentum were some of the attractions in the Department of Physics

A collection of rocks and fossils on display at the Centre for Earth Sciences

Different stages of the mouse embryo and a model of stem cell lineage on display at the Division of Biological Sciences

The CRAY XC40, IISc's new supercomputer at the Supercomputer Education and Research Centre



An exhibition on the life and work of JN Tata organized by the Archives and Publications Cell (APC)

✍ ANKIT RUHI & DISHA MOHAN

DESIGN CONFERENCES

In January, 2015, three international conferences on the science of design and creativity were organized by the Centre for Product Design and Manufacturing (CPDM) at IISc.

Courtesy: CPDM

Amaresh Chakrabarti, Professor, CPDM, at ICoRD '15

The **5th International Conference on Research into Design (ICoRD '15)** was held from 7-9 January. It was endorsed by the Design Society and the Design Research Society, the two major international peer societies for design research. In line with its theme, 'Design Across Boundaries', the conference focused on designs that transcend all the boundaries of culture, race and the economy, to create value for people from all walks of life. The conference saw 118 papers authored by over 275 researchers from across the globe and was attended by over 200 people. During the conference five workshops and two panel discussions (*Publishing Research Papers* and *Practice of Design*) were also organized.

The **3rd International Conference on Design Creativity (ICDC'15)**, the official conference of the special interest group on design creativity of the Design Society was held from 12-14 January. This was the first time this conference was held in India. ICDC serves as a forum for open discussion on design creativity, from both theoretical and methodological viewpoints. A panel discussion on "How can we train designers to be creative?" was also organized.

A two-day **International Workshop on Cultures of Creativity and Innovation in Design (CoCreaID '15)** was held on 19 and 20 January. CoCreaID'15 was the first workshop organized by an international creativity network constituted by IISc, University of Northumbria, UK, and Sapienza University of Rome, Italy. Creativity has a major role in socio-economic development and this novel network brings together a number of leading "creativity" researchers from design, engineering, education, cognitive science, psychology and architecture to investigate creativity across different national and cultural borders. The inaugural workshop had a series of talks and discussion sessions and was attended by over sixty people.

Courtesy: CPDM

Cultural event at ICDC '15

Amaresh Chakrabarti, Professor at CPDM and Chair of all three design conferences, told CONNECT that, based on the enthusiastic response from all the three conferences, it was clear that there is a need to organize more such interdisciplinary meetings and discussions to help bridge the gap between the social sciences and the science of design.

✍ **DEBALEENA BASU**

Prime Minister Modi visits the Indian Institute of Science

Prime Minister Narendra Modi visited the Indian Institute of Science (IISc) on 18 February, 2015. During his visit, he unveiled the foundation stone of the new Centre for Brain Research (CBR) and dedicated the Centre for Nano Science and Engineering (CeNSE) to the nation. He also witnessed the signing of an MoU between the Oil and Natural Gas Corporation Limited (ONGC) and the Super Wave Technology Pvt. Ltd. (SWTPL), a company started by researchers from the Institute under its Faculty Entrepreneurship Programme (FEP).

Courtesy: PUBLIC RELATIONS OFFICE

Foundation stone of the new Centre for Brain Research being unveiled by Modi. It seeks to study neurological diseases and illnesses, thus complimenting basic research being carried out at the Centre for Neuroscience (CNS), IISc.

Courtesy: PUBLIC RELATIONS OFFICE

In 2014, the Centre was born out of a philanthropic fund raised by Kris Gopalakrishnan, the Executive Vice Chairman and one of the founders of Infosys. The proposed Centre is funded by Gopalakrishnan's Pratiksha Trust.

Courtesy: CeNSE

Modi dedicating CeNSE to the nation

Courtesy: PUBLIC RELATIONS OFFICE

MoU being signed by Shashi Shanker (Director, Technology & Field Services) on behalf of ONGC and KPJ Reddy (Professor, IISc) on behalf of SWTPL.

✍ **MEGHA PRAKASH**

A SKY FULL OF STARS

Courtesy: WIKI COMMONS

The Joint Astronomy Programme is a one-of-a-kind initiative that brings together many research institutions to train future astrophysicists

✍ **RHINE SAMAJDAR AND SUHAS MAHESH**

"Astronomy is useful because it raises us above ourselves; it is useful because it is grand."

-- Henri Poincaré

When we gaze at the night sky dotted by the dazzling glow of distant stars, the profound vastness of the universe rarely fails to humble the human psyche. Nor does it fail to evoke the sense of grandeur that the French mathematician Poincaré alluded to in his book *The Value of Science*. The experience of awe that comes from staring at the night sky is enhanced when one begins to unravel the secrets of the cosmos and comprehend its immensity. To help those young men and women who nurture the dream of solving cosmic mysteries, a unique initiative was started by a consortium of institutes more than three decades ago: the Joint Astronomy Programme (JAP).

The programme, aimed at training graduate students in astrophysics, is run jointly by several institutes: the Indian Institute of Science (IISc) that also serves as the nodal establishment for the programme, the Raman Research Institute (RRI), the Indian Institute of Astrophysics (IIA), the Indian Space Research Organisation (ISRO) and the Tata Institute of Fundamental Research (TIFR). The programme's guidelines are decided by a policy committee constituted by the directors of the five institutes. All the students selected for the programme have a common curriculum developed by faculty members of these institutes. After the successful completion of their course work, students are free to join the lab of a research supervisor from any of the collaborating organizations. "The main strength of the programme is that the choice for supervisor selection is not limited to one institute," says Biman

Courtesy: JAP

The astrophysics and astronomy community of Bangalore, including members from the collaborating institutes of JAP

Nath, a professor from RRI, who is also part of JAP.

Those admitted into the programme receive research fellowships from IISc. JAP also encourages interested postdoctoral scholars to apply for a DST-supported fellowship or the Centenary Postdoctoral Fellowship awarded by IISc.

The courses offered by JAP provide all-round training in modern astrophysics—from foundation classes to subjects such as General Relativity and Cosmology, Galaxies and the Interstellar Medium, and Stellar and High Energy Astrophysics.

Because of its collaborative nature, the model has been both popular and enormously successful. Besides sharing teaching expertise, JAP allows students access to resources from all the participating institutes.

JAP has five faculty members from IISc, all theoretical astrophysicists: Arnab Rai Choudhuri, Chanda J Jog, Banibrata Mukhopadhyay, Tarun Deep Saini and Prateek Sharma. Choudhuri, Professor, Department of Physics, and former Convenor of JAP, spoke to CONNECT about the history of the programme, its success and whether such a model can be replicated elsewhere.

Courtesy: JAP

Arnab Rai Choudhuri, Professor, Department of Physics and former Convenor of JAP

Q What was the motivation behind starting such a programme in India?

It started in 1982, a few years before I joined. I suppose, before 1982, nowhere in India was there a system of training PhD students in astrophysics through regular course work. Since astrophysics has become such a vast subject, students who want to do astrophysics research have to take courses on subjects like Stellar Structure, Radiation, General Relativity and Cosmology. At that time, Bangalore had the largest concentration of astrophysicists—in RRI, IIA and Govind Swarup's Radio Astronomy group. V Radhakrishnan, Director of RRI, and Profs. Govind Swarup and Vainu Bappu were the main people who took the initiative of starting JAP. It was felt that instead of each institute starting its own course, it would be meaningful to have a joint programme where the courses would be taught by the faculty of these institutes. At that time, IISc did not have any faculty members in astrophysics. But since it is a degree granting institute, it was requested to host the programme.

"It was felt that instead of each institute starting its own course, it would be meaningful to have a joint programme where the courses would be taught by faculty of these institutes"

Q How successful has the programme been so far?

For nearly a decade after JAP was started, it was the only graduate program in the country in astrophysics. Then in the early 1990s, a graduate programme was started in Pune under IUCAA (Inter-University Centre for Astronomy and Astrophysics) and NCRA (National Centre for Radio Astrophysics). I think that the number of students from our JAP who became faculty members in different institutes in India is larger compared to the Pune programme. Several current faculty members of NCRA and IUCAA are ex-students of JAP. Apart from this programme, IIA and RRI have their own students who have also been taking the JAP courses. If you include them, maybe about 75% of successful astrophysicists in India are products of this programme.

"If you include them, maybe about 75% of successful astrophysicists in India are products of this programme"

Q How many faculty members were involved in this programme initially?

When Prof. S Ramaseshan was the Director of IISc, he was very interested in the programme. He was succeeded by Prof. CNR Rao who also felt that IISc should have an astrophysics group and took the initiative of creating one. At that time, some senior faculty members from the Physics Department were not too supportive of this effort because they felt that it would be better if it remained mostly a condensed matter physics department. Prof. CNR Rao overruled the opposition and went ahead. He wanted one senior and two young people. It was then that Prof. S Ramadurai came from TIFR, and a little later, Prof. Chanda Jog and I joined the group.

Courtesy: JAP

The auditorium in the IISc Physical Sciences Building where some of the lectures of JAP are conducted

Q What were the main challenges to setting up the programme?

Initially, running the programme without any astrophysics faculty in IISc was difficult. As you may know, a student has to be registered with a faculty member in IISc. At that time, Prof. N Kumar, who later became RRI's Director, was very sympathetic to the programme. When I joined, there were 20 students in the programme and all of them were registered under Kumar and he had to arrange their comprehensive examination and all the other procedures.

Between 1990 and 2005, one of the many challenges was that bright students in India were not pursuing basic sciences. During the time I completed higher secondary level in West Bengal, around 6-7 out of the twenty top students would enroll in the physics honours course at Presidency College, Kolkata. But a few years later, bright students in India preferred to join engineering and other professional courses. But we are lucky that after IISERs and IISc started their undergraduate programmes, there has been a change in the last 5-6 years. However, even during the lean period, JAP attracted a handful of very motivated students.

"Between 1990 and 2005, one of the many challenges was that bright students in India were not pursuing basic sciences"

Q Can such a programme be replicated at other universities?

In this programme, students usually take 7-8 basic courses in astrophysics. We are lucky that when this programme was started in Bangalore, we had various institutes with a large number of astrophysicists. Pune too could start a similar program as NCRA and IUCAA has a large astrophysics community. If you go to the websites of top American universities, you will find that astrophysics groups often have 20-30 faculty members.

At the time I returned to India, most institutions were unwilling to take astrophysicists as they thought of astrophysics as different from physics. Now I'm happy that the perception has changed. Prof. Narlikar started IUCAA with the goal that universities should change their perspective and astrophysics should flourish in India. I think this has been done to a large extent now. All the IITs and IISERs, when they hire a faculty member in physics, also hire a separate faculty member in astrophysics. However, all the IISERs put together have had no more than a couple of astrophysicists so far. In such a case, it would be difficult to replicate this programme. To replicate such a programme, at least half a dozen faculty members in astrophysics will be needed. Hopefully, the Indian astrophysics community will grow. Right now, I think Bangalore, Pune and Mumbai are the only cities with more than 10 working astrophysicists.

"Right now, I think Bangalore, Pune and Mumbai are the only cities with more than 10 working astrophysicists"

COLLOQUIUA

Faculty members who have made a significant and sustained contribution to research in their respective fields were honoured with a colloquium by the Indian Institute of Science (IISc)

✍ **RANJINI RAGHUNATH**

ARNAB RAI CHOUDHURI

Courtesy: ARNAB RAI CHOUDHURI

In spite of its centrality to our existence, the sun has mysteries that are yet to be solved. One such mystery is how the magnetic field of this spherical ball of hot plasma is generated. For over two decades now, this phenomenon has been studied by Arnab Rai Choudhuri, a theoretical physicist and professor in the Department of Physics. This was also the subject of his colloquium presented on 20 January, 2015.

In the first part of his talk, Choudhuri discussed how he and his team improved upon the solar dynamo theory, a theory postulated to explain the magnetic fields of the sun. The modified theory, he showed, more accurately described the nature of the sun's magnetic field.

For centuries, astronomers have observed dark spots, simply called sunspots, on the solar surface. Choudhuri's research on sunspots, which are regions of intense magnetic field activity and follow an 11-year cycle, was the subject of the second part of his talk. He and his lab have been developing models to predict the intensity of sunspot cycles because, at their peak, sunspots can disrupt radio communications and damage power lines and electronic equipment on satellites. Using their models, Choudhuri and his team accurately predicted that the sunspot cycle which peaked in 2013-14 would be the weakest in a long time. He concluded his talk by briefly describing other solar disturbances such as solar flares and coronal mass ejections.

Choudhuri has also recently written a popular science book on sunspots titled 'Nature's Third Cycle: A story of sunspots.'

R GOVINDARAJAN

CONNECT

Emerging developments in computer architecture, compilers, and high performance computing have fascinated R Govindarajan for decades. An IISc alumnus and Chairperson of the Supercomputer Education and Research Center (SERC), he gave the Institute colloquium on 29 January, 2015.

Before the talk began, Anurag Kumar, the Director of IISc, lauded Govindarajan's efforts in acquiring and commissioning IISc's new high-performance computer, the Cray XC40.

Govindarajan began his talk by explaining how processor architecture capabilities have expanded exponentially—from a single processing unit in the eighties to 16 cores on just a single chip now. He described his lab's research on compiler and runtime techniques for programming high-performance processors called *accelerators* which work in tandem with traditional CPUs. Notable accelerators include Graphics Processing Units and Intel's patented Many Integrated Cores architecture.

Though these advanced systems offer superior performance, there are several programming challenges that need to be overcome. Among them are challenges in compiler and runtime systems that Govindarajan's work has focused on. He talked about his lab's contributions to compiling existing programming languages such as StreamIt and MATLAB to "synergistically" execute on these heterogeneous systems. He also spoke about his lab's work on memory system design and cache performance for multi-core architectures.

USHA VIJAYRAGHAVAN

RAJEEV JHA

Understanding the growth and development of stems and flowers in plants has been the focus of over two decades of research for Usha Vijayraghavan, who gave her colloquium on 24 February, 2015. A professor in the Department of Microbiology and Cell Biology, she has been addressing fundamental questions in plant developmental biology using rice and *Arabidopsis* as model systems.

Vijayraghavan began her talk by describing how complex organisms develop from a single cell. She went on to explain how, despite the impressive evolutionary radiation of flowering plants, the genes that define the logic of flowering development are largely conserved.

Vijayraghavan and her team have been working on identifying gene regulatory networks that control development of different plant parts from the rice plant's meristems, or "growing tips." Her team showed how a conserved protein called *RFL* in the rice plant acts as a "master regulator" of the plant's architecture. *RFL* regulates flowering time and branching, which are important for the plant's survival and reproduction. Their work also shows how evolutionary-related transcription factors can acquire new or altered developmental functions. Vijayraghavan also spoke about her team's research on a rice plant gene called *OsMADS1*. Their research has revealed important roles that this gene plays in the development of rice flowers on short branches of the flowering stem. Their findings on the downstream effects of such transcription regulators on all genes of the rice plant would allow one to build gene-regulatory networks.

PS SASTRY

RANJINI RAGHUNATH

As we collect large quantities of data in every sphere of life, finding meaningful patterns in data sets has become one of the most important scientific endeavors in computer science. Mining such data sets has been the subject of research for PS Sastry, who gave his colloquium talk on 4 March, 2015. Sastry, a professor in the Department of Electrical Engineering, is an alumnus of the same Department.

He began his talk by introducing the basics of data mining. Sastry's research interests lie in mining large sets of sequential data to find frequently-occurring patterns. He described his lab's work on such datasets where data points occur sequentially in time— for example, spikes from firing neurons or time-stamped fault report logs from manufacturing plants. Identifying these frequently-occurring patterns would help describe the nature of the data accurately and predict future patterns, he explained.

With the help of illustrative examples, Sastry described a method called the *Frequent Episodes* approach to identify useful patterns in sequential data. He also highlighted some issues in mining these data sets, such as coming up with efficient algorithms, deciding on "how frequent is frequent" and deducing what subset of the discovered patterns accurately characterizes the data. Sastry demonstrated how he and his team used some of these algorithms and approaches to analyze status logs from assembly plants, user behaviour in a browsing session and neuronal spike train data, among other applications.

MYSORE SANDAL SOAP: THE IISc CONNECTION

Technologies for the extraction of sandalwood oil and the manufacture of soap using sandal oil originated in the Indian Institute of Science (IISc)

✍ KARTHIK RAMASWAMY

Much like the sweetness of mangoes in the summer or the cacophony of blaring horns on the streets, the aroma of sandalwood is integral to the collective Indian experience. The ubiquity of this experience is in large part due to the sandalwood products—soap, oil, perfume, incense, talcum powder—made by factories run by the government of Mysore (and eventually Karnataka).

M Visvesvaraya and the Maharaja of Mysore

Courtesy: ARCHIVES AND PUBLICATIONS CELL

M Visvesvaraya

The story of sandalwood oil and the *Mysore Sandal Soap* began here at IISc over a hundred years ago when India's most famous engineer, Sir M Visvesvaraya, was nominated to the Council of the Institute. His nomination, in 1913, came about because he had just succeeded T Ananda Rao as the Dewan of the State of Mysore; the Dewan served as the representative of the Maharaja, Krishnaraja Wodeyar IV, on the Council of IISc.

Industrialize or perish, Visvesvaraya was fond of saying. The dictum found resonance with the handful of researchers who were part of the four-year old Institute. He urged the Institute's researchers to carry out studies that would help his dream of an industrialized Mysore, one that he shared with the Maharaja.

Courtesy: ARCHIVES AND PUBLICATIONS CELL

Maharaja of Mysore, Krishnaraja Wodeyar IV

Visvesvaraya's association with the Institute had an immediate impact on the nature of research at IISc. In less than five years, six factories were started as a direct result of the investigations carried out here: an acetone factory in Nasik, a thymol factory in Hyderabad (Sind), a factory to make straw boards from bamboo in Bangalore, a soap factory in Bangalore and sandalwood oil factories in Bangalore and Mysore city. The Institute also provided technical help to the State of Hyderabad for producing alcohol from *mahua* flowers and to the Mysore Spinning and Weaving Mills in Bangalore to make a durable textile dye using sappan wood (wood from a local leguminous tree) and catechu (an acacia extract).

The most successful of these were the sandalwood oil factories and the soap factory. Together, these factories ensured that sandalwood and its products became synonymous with the state of Karnataka.

Sandalwood Oil and Soap

Research at IISc on this much-valued wood began in 1914 when the Mysore State found itself with surplus sandalwood; World War I had broken out and exports to Europe ceased. The Government of Mysore then requested IISc to carry out research to extract oil from sandalwood as well as other woods

found in the region. The experiments were led by JJ Sudburough, a professor in the Department of General Chemistry, who had moved from the Department of Organic Chemistry, and HE Watson, an assistant professor from the same department. They were joined the following year by Venkataranga Iyengar and K Parthasarthi. The Maharaja was so impressed with this research that, in 1916, he provided funds to establish an experimental factory in the vicinity of IISc to manufacture sandalwood oil.

Courtesy: OLDINDIANADS.COM

A 1928 advert for Mysore Sandal Soap

The Mysore Government also offered scholarships and deputed two students, B Rajagopal and B Sunderaraj Iyengar, to undergo training in the Institute. In 1917, they were given jobs as Assistant Chemists in the sandalwood oil factory nearby. Sudburough and Watson were also appointed as Consulting Chemists of this factory, thus strengthening the bond between IISc and Mysore's ambitious sandalwood initiative. In 1917, the Government set up the second sandalwood oil factory in the city of Mysore.

In the meanwhile, another team of researchers comprising J Chakraborty and GA Mahmadi conducted experiments on making soap with local oils. Again, pleased with the results, the Mysore Government set up a 5-tonne soap plant near the Institute. Much of the soap produced during these years was sent to British troops in Mesopotamia by the Red Cross Society. This experimental unit gave way to a bigger and newer soap factory in early 1918. Later that year, the first *Mysore Sandal Soap* was introduced in the market.

Sandal Spike Disease

Research on sandalwood in the Institute continued and diversified after the establishment of the Department of Biochemistry in 1921. In the 1920s and 1930s, the focus of research was on the dreaded sandal spike disease. Caused by a phloem bacterium, it is transmitted by sap-sucking insect vectors. Early research into the disease was conducted by RV Norris, a professor in the Department of Biochemistry, and Varadaraja Iyengar who joined the Department as a junior assistant. Research gained steam after generous grants from the Madras Government and the Chief Commissioner of Coorg in 1927. In 1931, a senior assistant in the same department, M Srinivasaya, conducted several field studies to understand why certain strains of sandal were resistant to the disease. Experimental cages were also set up on the campus of IISc by NC Chatterjee and C Dover to investigate the transmission of the disease.

Courtesy: ARCHIVES AND PUBLICATIONS CELL

The Sandalwood Oil Factory

Karnataka Soaps and Detergents Limited

In spite of the disease and rampant smuggling of sandalwood—still prevalent today—the manufacture of sandalwood oil and soap continued to make progress. A third sandalwood oil factory was set up in Shimoga in 1944. After the unification of Karnataka, these factories came under the jurisdiction of the Government of Karnataka. In 1980, the Government decided to merge these factories and incorporate them under a public sector enterprise called the Karnataka Soaps and Detergents Limited. The sandalwood soap factory setup in 1916 still exists today, about four kilometers west of the campus of IISc.

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AND THE WINNERS ARE...

Members of the Indian Institute of Science (IISc) community were honoured with awards recently

✍ **MANU RAJAN**

Aloke Paul

Aloke Paul (Associate Professor, Department of Materials Engineering) was selected as the **Metallurgist of the Year** (2014) by the Ministry of Steel, Govt. of India. He is interested in diffusion mechanisms in super alloys and bond coats in jet engine applications, electronic packaging systems, refractory metal silicon systems and intermetallic superconductors.

Annapoorni Rangarajan

Annapoorni Rangarajan (Associate Professor, Department of Molecular Reproduction, Development and Genetics) was awarded the **Young Woman Bioscientist Award** (2013) of the Department of Biotechnology (DBT), Govt. of India. She studies the development of cancer using cancer stem cells. The main focus of her laboratory is to decipher the mechanisms that regulate self-renewal in normal and cancerous stem cells.

Prabeer Barpanda

Prabeer Barpanda (Assistant Professor, Materials Research Centre) won the **Dr. RL Thakur Award** (Young Scientist Award) of the Indian Ceramic Society. Barpanda intends to build a laboratory to study the synthesis, structure and electrochemistry of novel battery materials and is specifically interested in studying Li- and Na- ion batteries.

Soumya Das

Soumya Das (Assistant Professor, Department of Mathematics) received the **INSA Young Scientist Award** (2014) of the Indian National Science Academy. Primarily interested in Number Theory, Das' specific interests include Analytic Number theory, Elliptic and Siegel modular forms (algebraic and analytic aspects), Jacobi forms and Differential operators on Symmetric spaces.

Chandan Srivastava

Chandan Srivastava (Assistant Professor, Department of Materials Engineering) received the **Certificate of Excellence Award** (2014) of the Ministry of Steel, Govt. of India. He works on many areas of materials engineering, including the synthesis of isolated nano-solids and nano-structured materials and the application of electron microscopy technique for structural and compositional characterization of materials.

DD Sarma

DD Sarma (Professor, Solid State and Structural Chemistry Unit) was conferred the title of the ***Knight of the Order of the Star of Italy*** by the President of the Republic of Italy for his seminal contributions in designing and understanding a wide range of materials and properties, particularly on nanomaterials.

Sai Siva Gorthi

Sai Siva Gorthi (Assistant Professor, Department of Instrumentation and Applied Physics) got the **Best Innovator's Pitch Award** (2014) instituted by the Biotechnology Industry Research Assistance Council (BIRAC) of the Govt. of India. Gorthi is involved in the development of Innovative Optofluidic Technologies for Affordable Point-of-Care Diagnostics.

Shiva Kumar HR

Shiva Kumar HR (PhD student with Prof. AG Ramakrishnan, Department of Electrical Engineering) won the **Gandhian Young Technological Innovation Award** of SRISTI for developing an automated book reader for Indic languages for visually challenged people.

Amit A Vernekar

Amit A Vernekar (PhD student with Prof. G Mugesh, Department of Inorganic and Physical Chemistry) won the **Gandhian Young Technological Innovation Award** instituted by SRISTI for his work on nanomaterials that can function as enzymes to combat oxidative stress related disorders such as cancer, diabetes and arthritis.

Sharath U

Sharath U (PhD student with Prof. S Asokan, Department of Instrumentation and Applied Physics) was awarded the **Gandhian Young Technological Innovation Award** of SRISTI for developing a methodology to acquire the radial arterial pulse pressure waveform using a Fiber Grating Pulse Recorder. This provides information that can be employed to evaluate vital parameters like blood pressure and arterial compliance in conjunction with a sphygmomanometric test.

Note: All photographs are courtesy of the awardees

Campus Critters

A verditer flycatcher

DIVECHA CENTRE FOR CLIMATE CHANGE