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Connect

WITH THE INDIAN INSTITUTE OF SCIENCE

Light
Why light matters to life

Institute Messes
Serving the dining needs of students

Acetone
Early translational research

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Front Inside: Campus mail van (MANOJ SUDHAKARAN)

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FROM THE CONNECT TEAM

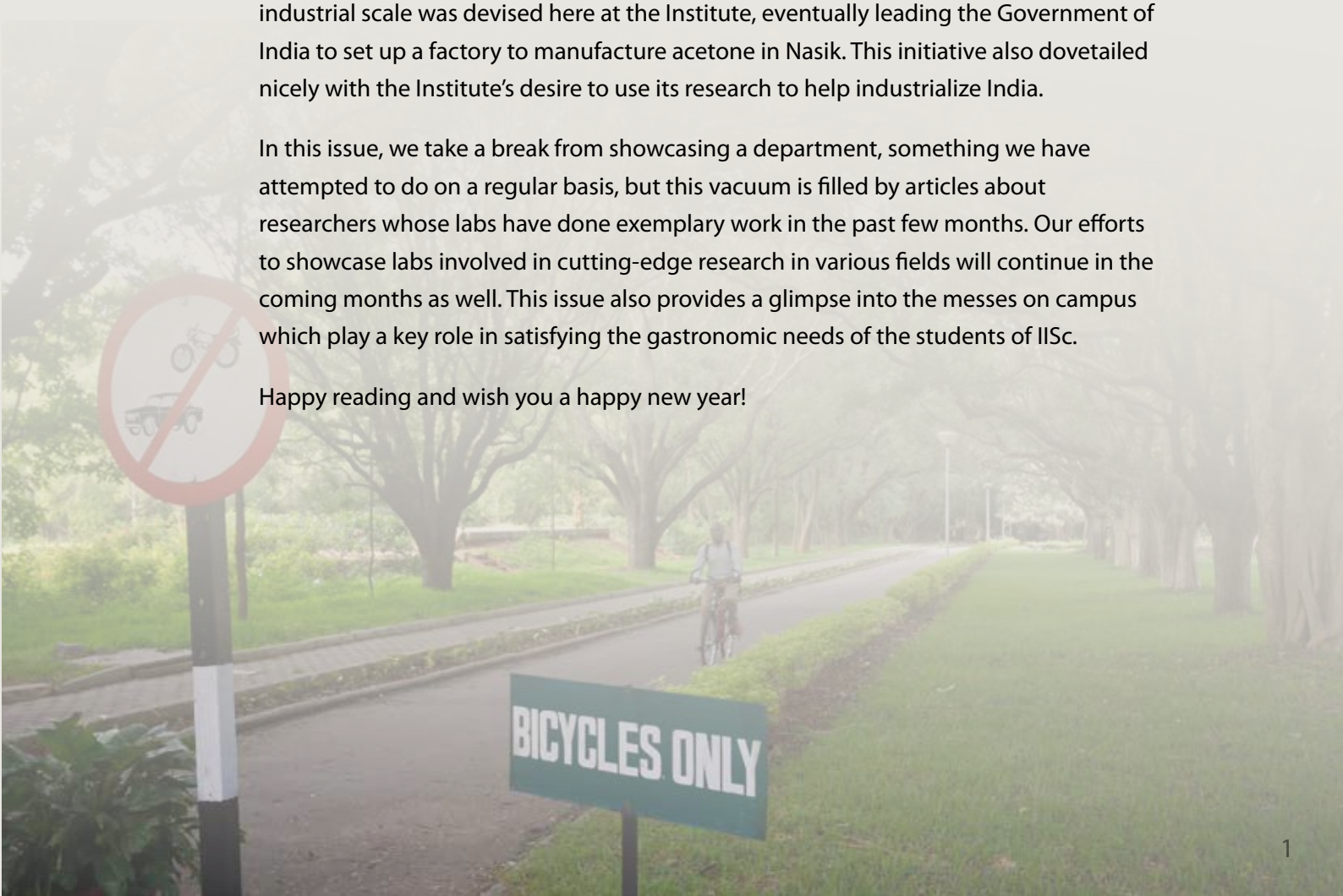
"The stars, that nature hung in heaven, and filled their lamps with everlasting oil, give due light to the misled and lonely traveller."

With all due to respect to John Milton who wrote these evocative words, light from celestial bodies does so much more than just help travellers find their way. For millions of years, light has been sustaining life on our home planet. In the coming decades, it may even help humanity tide over the environmental crisis it has created. The relationship between light and life is the theme of the final installment of our series on light that pays homage to the International Year of Light and Light-Based Technologies.

Another highlight of this issue is an article which reveals one of the first attempts made at the Indian Institute of Science (IISc) to translate research done in its labs into manufacturing technology. The early years of IISc coincided with the period when Europe and many countries across the world were about to plunge into the insanity of the first truly global war in our history. The Government of India, controlled by the British throne, was keen that it had enough ammunition to ward off any attack on its soil as the war was breaking out. And for this, it needed a factory to make massive amounts of cordite that was replacing gun powder as the explosive of choice. But the manufacture of cordite required acetone. The technology to make acetone on an industrial scale was devised here at the Institute, eventually leading the Government of India to set up a factory to manufacture acetone in Nasik. This initiative also dovetailed nicely with the Institute's desire to use its research to help industrialize India.

In this issue, we take a break from showcasing a department, something we have attempted to do on a regular basis, but this vacuum is filled by articles about researchers whose labs have done exemplary work in the past few months. Our efforts to showcase labs involved in cutting-edge research in various fields will continue in the coming months as well. This issue also provides a glimpse into the messes on campus which play a key role in satisfying the gastronomic needs of the students of IISc.

Happy reading and wish you a happy new year!



In This Issue...

LIGHT AS LIFE

CHIRANTAN PRAMANIK

In this, the third and final article in the series celebrating 2015 as the International Year of Light and Light-Based Technologies, we look at how light is not merely vital for our survival, but could be at the forefront in our battle to sustain life as we know it for future generations

✍ **NITHYANAND RAO***

We are creatures of light. It is what breathed life on Earth, and it is what animates life on it today, the thread that connects its myriad forms across four billion years of evolution. It pervades every aspect of our lives, not least because it allows us to see the world. Light has therefore come to symbolize so much more—eminence, purity, divinity, wisdom, hope. Not surprisingly, our ancients worshipped the Sun, the major source of natural light for us here on Earth.

Light Sparking Life

The energy that light from the Sun carries began its journey from deep within the Sun's core, born from the nuclear fusion of hydrogen, the most primordial of all elements, to helium. Eons ago, the helium inside other stars fused to form higher elements that were then spewed out as the stars died, seeding the cosmos and preparing it for life. It is of these elements that we are made.

Light from the Sun was also crucial in giving rise to life itself on our planet. In its youth, the Earth's atmosphere did not have the ozone layer that now protects us from the ultraviolet part of the solar spectrum. Recent research suggests that ultraviolet light, harmful to us today, supplied the energy required for the formation of crucial compounds that eventually gave rise to life.

* With inputs from **Edd Gent**, a freelance science writer based in Bangalore

Light from the Sun was crucial in giving rise to life itself on our planet

Light Sustaining Life

Today on Earth, the Sun's near-eternal fires, directly or indirectly, provide sustenance to virtually all life —plants use sunlight to produce the food on which all animals depend. Light also influences life forms in so many other ways.

As the Earth rotates on its axis, only one part of it is illuminated by the Sun, giving rise to the day-night cycle, to which our own body clocks have become synchronized. But the length of the day—and indeed the ambient temperature—also depends on the latitude, and, except at the equator, it varies through the year with the seasons, a result of the tilt of the Earth's axis. This, in turn, has shaped the evolution of life forms and their behaviour, most dramatically manifest in the overland seasonal migration of animals.

The more recent history of life on our planet has been dominated by humans seeking to improve the quality of their lives and expanding their dominion over the planet. This, too, has been fuelled by the energy of the Sun—in the form of coal and petroleum—that still dwells in the remains of the plants and animals that died millions of years ago. But as we burn more and more of these fossil fuels, we end up releasing gases that trap more and more of the Sun's heat, leading to climate change.

Energy From the Sun

To mitigate the impact of this global environmental challenge, we again have to turn to the Sun. Every day, our parent star burns down 180,000 tera watts of energy on us, about ten thousand times the amount produced by all the power plants in the world put together. Ironically, generating electricity from solar energy isn't cheap. The panacea to producing affordable solar energy lies in new technologies like those related to photovoltaic materials—materials whose electrons can absorb the energy of sunlight and generate electricity—and solar thermal plants, two areas of research that the Indian Institute of Science (IISc) has been at the forefront of.

The panacea to producing affordable solar energy lies in new technologies like those related to photovoltaic materials and solar thermal plants, two areas of research that IISc has been at the forefront of

IISc is leading a major Indo-US research effort called SERIIUS (Solar Energy Research Institute for India and the United States), under the leadership of Kamanio Chattopadhyay, who is the Co-Director of this initiative from the Indian side and also an honorary professor in the Department of Materials Engineering at IISc. One of the major research thrusts of SERIIUS is to develop better photovoltaic materials and devices.

Better and Cheaper Photovoltaics

For any material, the energy required to liberate an electron from the clutches of its atom is known as its band-gap. The band-gap of photovoltaic materials like semiconductors are smaller than those of insulators, but larger than those of good conductors like metals. The first solar cells required a relatively thick layer of semiconductor material to be able to capture enough energy. Today, researchers from IISc and elsewhere use thin-film solar cells, which are lighter and cheaper, wherein one or more thin layers of a suitable photovoltaic material are deposited on a substrate such as glass.

Another approach that is part of the SERIIUS project, led by Praveen Ramamurthy, an associate professor in the Department of Materials Engineering, is to

PRAVEEN RAMAMURTHY

A solar panel pedestal

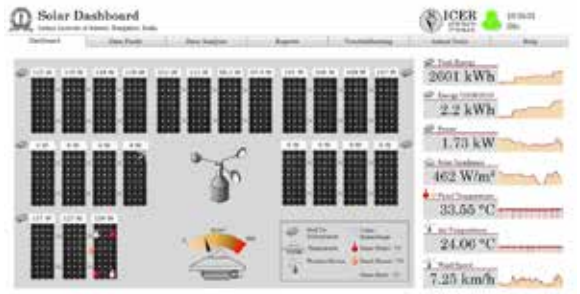
use organic polymers or small organic molecules instead of the traditional inorganic semiconductors. If the promise of this approach is fulfilled, it can lead to cheaper photovoltaic materials.

Solar cells are also expensive because traditional methods of production require the use of a vacuum. To overcome this hurdle, researchers at IISc are working on atmospheric-based processes that can produce solar cells on flexible glass substrates.

The Sun's energy in the form of heat can also be utilized by collecting and focusing it onto a small area. This concentrated heat can then be used to drive a turbine to generate electricity, usually with steam as the heat-carrier. A key component of this is a heliostat, essentially a mirror which turns so as to keep the reflected sunlight focused at the desired target.

PRAVEEN RAMAMURTHY

The photovoltaic test-bed at Challakere



PRAVEEN RAMAMURTHY

The "dashboard" that gathers and displays data from the various sensors that monitor the solar panels at the Challakere test-bed

PRAVEEN RAMAMURTHY

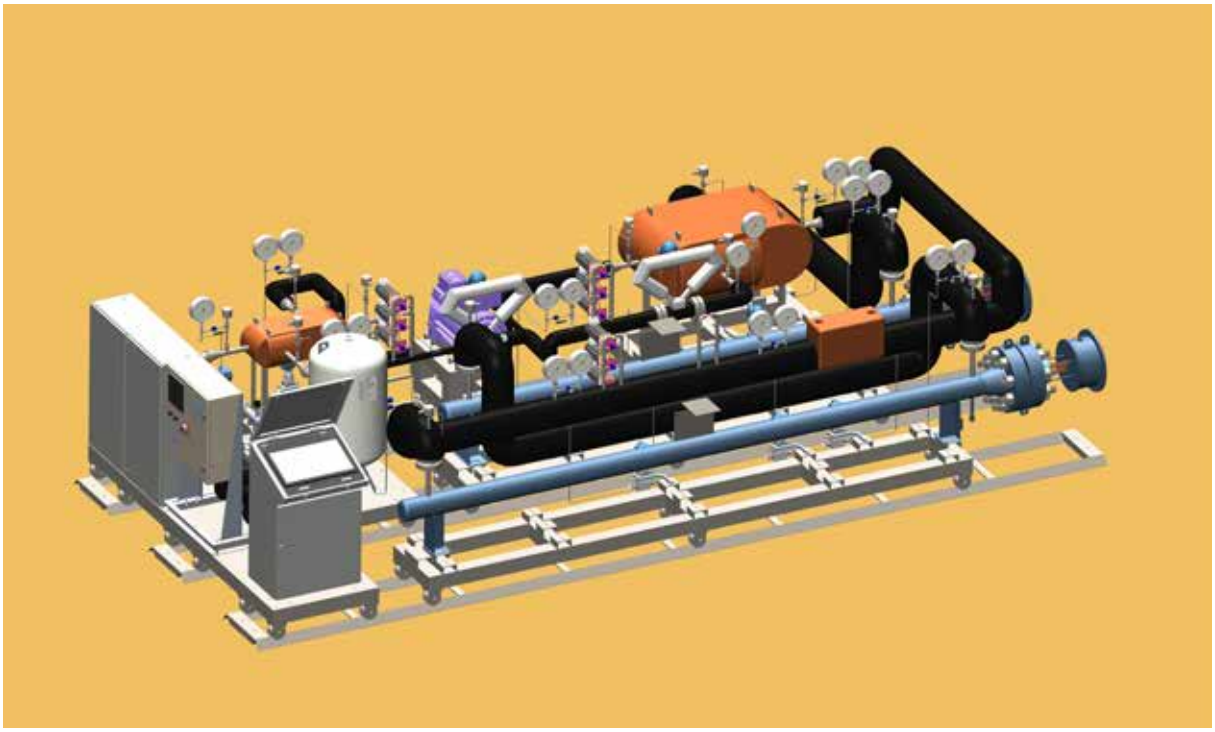
Kamanio Chattopadhyay (second from left), Co-Director of SERIIUS, at the Challakere plant

One of SERIIUS's projects is to develop low-cost heliostats using various reflective materials, as well as heat-transfer fluids other than water. This can help in setting up small-scale solar thermal power plants for distributed power generation—currently being tested at a plant setup at IISc's new campus in Challakere.

Solar Thermal Plants

IISc is also taking a lead in addressing another crucial problem in energy generation. Conventional thermal power plants, irrespective of whether they are based on fossil fuels or the Sun's heat, use steam to carry heat from the source and turn a turbine to generate power. It turns out that power generation can be made more efficient if, instead of steam, supercritical CO_2 (S-CO_2) is used. The term "supercritical" describes the state of carbon dioxide above a temperature of 31°C and a pressure of 73 atmospheres, respectively. This, however, requires that we use components which can work under these conditions.

Another strategy to improve the efficiency of energy conversion in this process would be to use a smaller turbine, one that is cheaper than a conventional turbine. An IISc research group is setting up the world's first S-CO_2 solar power plant at laboratory



Courtesy: PRAMOD KUMAR

A model of the supercritical CO_2 test loop facility at IISc

scale, incorporating these advances. This effort is led by Pradip Dutta, Deputy Managing Director of SERIIUS from the Indian side as well as the leader of the concentrated solar power research thrust.

An IISc research group is setting up the world's first supercritical-CO_2 solar power plant at laboratory scale

Light Connecting Life

Light can carry more than just energy; it can carry information too. It carries our voices across the planet to enable telecommunications. It races through the fibre optic cables that criss-cross the oceans and form the pipes of the internet, bounces off the ionosphere to enable radio communications, and comes down to our television sets from satellites. It may soon do even more. The information age was enabled by integrated circuits using electrons to carry information, but these may one day be replaced by circuits in which photons —light in its particle avatar—do the job instead. Researchers at IISc like Shankar Kumar Selvaraja from the Centre for Nano Science and Engineering are working on photonic integrated circuits that can transfer and process data faster than electronic ones, offering a window into the future.

In time to come, civilization will no doubt progress to do things with light unimaginable to us today. But in about three billion years from now, the Sun that ignited life on Earth will extinguish it too—if we haven't done it ourselves by then. As the nuclear fusion inside the Sun produces successively higher elements, it will fail to squeeze enough energy from them to stop the implosion brought upon by the gravitation of its own mass. Before it shrinks to become a white dwarf, it will swell to become a red giant, swallowing the inner planets. And with it, the Earth.

RACHEL LEE: CHRONICLING THE ARCHITECTURE OF A GERMAN IN BANGALORE

✍ KARTHIK RAMASWAMY

ALAKA KAVALLUR

Originally from Scotland, Rachel Lee is an architectural historian at the Technical University in Berlin. For many years now, Lee has been studying the architecture of Otto Koenigsberger, a German who lived and worked in Bangalore for several years.

Lee was in the city in September this year when she led a guided tour of Koenigsberger's buildings in Bangalore, including ones at the Indian Institute of Science (IISc). The event was organized by the Centre for Public History, Srishti School of Art Design and Technology, and the Centre for Contemporary Studies, IISc. Her visit also saw the launch of a book she recently wrote on Koenigsberger's architecture and his vision for urban planning in India. At the book launch, speaking to CONNECT, *she discussed what her research about Koenigsberger—particularly during his time in Bangalore—has revealed.*

Discovering Koenigsberger:

After graduating from architecture school, I was working on a book called *Modern Architecture in India* with one of my former lecturers. I then stumbled upon Madhavi Desai's *Architecture and Independence* which had a couple of images of Koenigsberger's work, including the Dining Hall at IISc. I thought, "Gosh! How did a German end up working in Bangalore?" So my lecturer said, "You know, Rachel, you would be a very good candidate for a PhD and this could be a good subject." I knew I wanted to do something in India. And so I came here to study his work.

Koenigsberger's Passage to India:

In 1933, the Nazis swept to power in Germany. Not long after, like many Germans of Jewish extraction, Koenigsberger lost his job. He was then working on a university hospital building in Berlin. For a few years, he moved to Egypt where he studied the architecture of ancient temples with the Egyptologist Ludwig Bochardt. Unfortunately, Koenigsberger, who suffered from tuberculosis, became really sick in the dry heat there. He realized that continuing

Courtesy: RACHEL LEE

Koenigsberger

in Egypt was not an option. And neither was going back to Germany. During this time, his uncle, the famous theoretical physicist Max Born was at IISc at the invitation of Sir CV Raman. Born was asked by Sir Mirza Ismail, the Dewan of Mysore, if he knew of any qualified architects who would be willing to work for Mysore State. And Born said, "Yeah, my nephew!" Koenigsberger was initially worried about the effect Bangalore might have on his health. But then he was told that Bangalore was a place where people in India came to be treated for tuberculosis because Bangalore's climate was so good. So he moved here. And his tuberculosis never came back.

Trial by Fire:

When Koenigsberger was hired, Ismail saw him as a successor to the then Government Architect Srinivasa Rao Lakshminarasappa, who was due to retire in a few months. The Dewan initially gave Koenigsberger a probationary one-year contract to work under Lakshminarasappa, who was against a European taking over his position. But there were no professionally qualified local architects available. Those first few months were nothing short of a nightmare for Koenigsberger. He was given a lot of tasks. All his draftsmen were taken away from him and he had to meet really, really hard deadlines. So he had to prove himself. And he did. He described his ordeal in a letter to his sister (reproduced in Lee's book).

"He was given a lot of tasks. All his draftsmen were taken away from him and he had to meet really, really hard deadlines. So he had to prove himself. And he did"

Buildings in Bangalore:

After Lakshminarasappa's retirement, Koenigsberger was appointed Government Architect of Mysore State, a position he held from 1939 to 1948. During this period, he was responsible for all the architecture and town planning projects undertaken by the Mysore administration. Among the buildings that he built in Bangalore include the Municipal Swimming Pool, the City Bus Terminus in Kalasipalayam, the Krishna Rao Pavilion in Basavanagudi, the "Tiffin Mantaps" (now demolished) at the entrance to the Government Boys High School in Malleswaram, the Bathing Ghat in Chickpet, the Victory Hall (now called Jawahar Bal Bhavan) in Cubbon Park, the Jayachamarajendra Institute of Indian Medicine and the Tuberculosis Sanatorium on the NIMHANS grounds. I'm sure there could be many more that we don't know about.

Scientific Architecture:

Koenigsberger came from the beginnings of the modernist school. He believed that architecture was a science, something that should be studied. These architects were interested in the orientation of buildings, the placement of space, etc. And they also had a big social conscience. Besides, he came from a very scientific background too. Max Born and other people in his family were scientists. And, he was quite rational and pragmatic. And when he came to India, he said, "Oh my God, look at this colonial architecture. We shouldn't be building like this. We should be looking at what has been built here for years—studying local building forms and spatial practices. How do we take what's already there and modernize it? And make it more efficient with the addition of new materials?" He suggested that we have a climate building research station. He did eventually build a small station for himself.

"Koenigsberger came from the beginnings of the modernist school. He believed that architecture was a science, something that should be studied"

Ostentatious Mysore State Architecture:

I think Mirza Ismail fancied himself as an architect and a town planner to some extent. He was into ostentatious features like domes and colonial clock towers. And it wasn't just Mirza Ismail. Many private clients had a similar approach. I think they just wanted to use such elements unquestioningly which was always against Koenigsberger's approach. He believed that you only have a dome if the dome makes sense. And they definitely had conflicts about that. I think Mirza Ismail was a bit disappointed that Koenigsberger's first buildings

were so austere and rational. He demanded a bit more pomp and fireworks.

Koenigsberger had to give in to such demands to some extent. In his portfolio, he wrote things like "government insisted on clock tower with dome". He didn't take any names, but his friend and well-known physicist, Homi Bhabha, adding his own comments in Koenigsberger's portfolio, wrote in his scrolling handwriting, "Mirza Ismail!"

Shared Vision with Tatas and Mysore State:
The Tatas were very committed to industrializing and modernizing India in the same way that Mysore State was. And I think that's why the Tatas had a strong connection with Mysore State. Koenigsberger came into contact with the Tatas through Homi Bhabha. They had very similar approaches. They were both committed to science and industrialization, modernization, progress. Koenigsberger worked with the Tatas on Jamshedpur, and on replanning a small area around the textile mill in Kurla in Bombay. And, of course, he built IISc as well.

"They had very similar approaches. They were both committed to science and industrialization, modernization, progress"

Buildings in IISc:
Aeronautical Engineering
I think the first building he built was Aeronautical Engineering. He started working on that in 1942. It was completed quickly and had the first closed circuit wind tunnel in India. And in that sense, it's also very interesting technically. I don't know how he managed to do the research to find out how to make such a thing. (Note: The Department of Aeronautical Engineering was renamed as the Department of Aerospace Engineering and has since shifted to a new building.)


Courtesy: APC
The old Aeronautical Engineering Building

Dining Hall and Auditorium


Courtesy: APC
The Dining Hall and Auditorium now serving as the Hostel Office

I think the dining hall was his second building on campus. What made it strange was its hybrid function. The new dining hall was supposed to replace all the other canteens that were on campus. And it was also to function as a lecture theatre, not just for lectures, but also for singing and other performances. To optimize the acoustics of the building, he worked with an acoustic engineer from IISc called NB Bhatt. Bhatt is credited in an article as the co-designer of the building. That's something Koenigsberger always did. He always credited the people he worked with. (Note: This building has since been modified and now serves as the Hostel Office besides a venue for events like exhibitions.)

Metallurgy
It had all the laboratories on the first floor with big cantilevered verandahs. It was really beautiful. The


Courtesy: APC
The Metallurgy building

laboratories had an open plan with a huge band of windows behind them which were all eventually made into individual offices. It's quite nice to see these buildings still function. Even if they have been changed around, it's great that they're still being used. (Note: The Department of Metallurgy has been renamed as the Department of Materials Engineering.)

Hydrogen Plant and its Discovery

Courtesy: APC

The Hydrogen Plant (with cylinders piled up in front of it) in the building that now houses Prakruthi Restaurant and other establishments

Koenigsberger was not particularly good at keeping an archive. He had loose black & white photographs, besides a few colour photographs in boxes. I had seen a couple of photographs that were yet to be identified. One was of an entrance tower to a building and another was a building with a particularly ugly façade. He also had a couple of CVs that he put together in 1960s. In one of them, he had listed a Hydrogen Plant at IISc. I asked people in IISc about it. They said, "Hydrogen Plant? What're you talking about?" I thought it had been demolished.

The first time I was at *Prakruthi* (the restaurant on campus), I ate a masala dosa. And then went inside the building. I thought to myself, "This is such an awful building. I'm so glad it wasn't built by Koenigsberger!" On another occasion, I was walking past the Tata Book House on my way to the Metallurgy (Materials Engineering) building, and it seemed to me that it looked like one of the unidentified photographs. And I walked around to the back, and I said to myself, "It's that awful façade!"

I realized that all belong together. This building had to be the Hydrogen Plant. When I went back, I had another one of the B&W photographs, which was of really bad quality. I felt that maybe I could see something in it. So I did a correction filter on Photoshop and you can see on the grass in front of the same building that there were hydrogen cylinders piled up in front.

(Note: At its peak, the plant produced 20,000 cubic feet of hydrogen gas per month to be shipped to Hindustan Aircraft—now Hindustan Aeronautics Ltd—where American World War II planes were serviced.)

Koenigsberger's Legacy:

It was very important for him that buildings were well planned. He wanted to get different people involved and use a collaborative approach. And architecturally, he was very interested in local forms and tried to understand the materials and how they worked with the climate, and how the spaces worked with the climate. He built buildings that were as cheap as possible, but with the highest quality possible which was a very German approach. He tried to do that here.

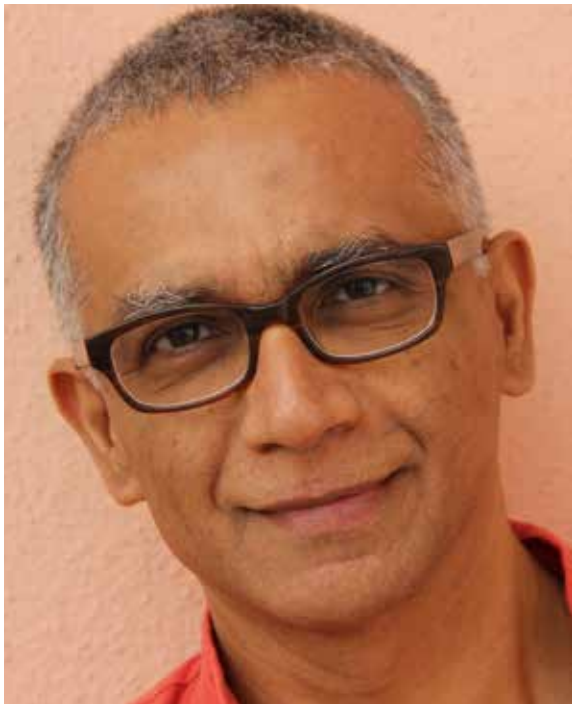
Keeping Koenigsberger's Legacy Alive in IISc:

One thing that would be worth doing is just to provide some information on these buildings and their history. People might be interested in that. And not just his buildings, but all the buildings in IISc. There are so many interesting structures here—the Main Building, for one, which was built by a Scottish firm in the early 1900s.

"One thing that would be worth doing is just to provide some information on these buildings and their history. People might be interested in that"

ANIL ANANTHASWAMY: TAKING SCIENCE TO SOCIETY

✍ **DEBALEENA BASU**

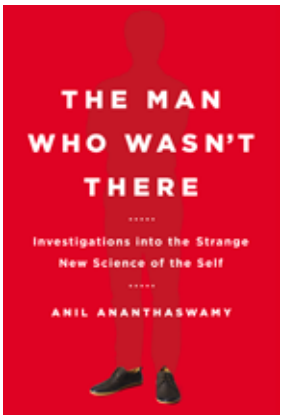


PRASAD VAIDYA

Anil Ananthaswamy, an acclaimed science writer, is a consultant for New Scientist*, a leading science magazine published from the United Kingdom. He is also a freelance feature editor for the* Proceedings of the National Academy of Science's Front Matter *and has also written for* National Geographic News*, and science magazines like* Discover *and* Matter. *His first book,* The Edge of Physics: A Journey to Earth's Extremes to Unlock the Secrets of the Universe *was chosen as the Book of the Year 2010 by* Physics World*, a magazine published by the Institute of Physics, UK. He was also awarded their inaugural Physics Journalism Prize in 2013 for his feature on the Square Kilometre Array.*

Ananthaswamy's second book, published by Penguin Random House, is the recently released The Man Who Wasn't There: Investigations into the Strange New Science of the Self. *In an event organized by IISc Press in September, he spoke about his new book which offers an insightful glimpse into how neuroscience is beginning to inform our understanding of our sense of self. During his visit, he also took some time off to talk to* CONNECT *about science writing, his journey as a science writer, tips to budding science writers and more.*

From Engineering to Science Writing



Courtesy: ANIL ANANTHASWAMY

Ananthaswamy's recently released book published by Penguin Random House

After his B.Tech from IIT Madras, Ananthaswamy did a Master's from the University of Washington, Seattle, and worked as a software engineer in Berkeley, California, before he realized that his true calling was science writing. Reflecting on why he jumped careers, he says, "It was not something that I had planned beforehand. I had started writing fiction even while working as a software professional, and it was probably a combination of disillusionment with the job, and my love for writing and science that eventually pushed me over to science journalism."

His transition into a science writer was made smoother by a science journalism course he took at the University of California Santa Cruz (UCSC). Though there are science writers without a formal degree in journalism, he says that specialized journalism training is important to learn the craft well and and jump-start one's career. He believes that training in journalism also provides a deeper

understanding of issues related to journalistic integrity and ethics.

As a science writer, Ananthaswamy has a wide array of interests (he focuses on physics, neuroscience and climate change). "Being a science journalist with an engineering background, I was not restricted in terms of which scientific domain to write on," he says, referring to the diverse subjects he has addressed as a science writer.

"Being a science journalist with an engineering background, I was not restricted in terms of which scientific domain to write on"

What Makes a Good Science Writer

Ananthaswamy believes that it is crucial for any aspiring science writer to learn the skill of good reporting in order to make a career as a science writer. "Before writing up a story, one needs material for it—collecting relevant information through reading, interviews and discussions is the first step. This is what reporting is all about; and one needs to do it well to lay the ground for a good story or a feature."

Ananthaswamy also emphasizes the importance of developing one's writing skills to become a successful science writer. He believes that though the creative facet is very hard to teach, one should be reading good material to improve one's writing. Citing his own experience, he says that reading popular science books has been a major source of motivation for him as a science writer. The books that he says have influenced him as a writer include *The Lives of a Cell: Notes of a Biology Watcher* by Lewis Thomas, *Phantoms in the Brain* by VS Ramachandran, *The First Three Minutes: A Modern View of the Origin of the Universe* by Steven Weinberg and the many books by Oliver Sacks.

A third skill, Ananthaswamy says, one should hone in order to write well, even in science, is to craft a good story. "The challenge for the writer is to keep the technical details intact, yet not to forget that ultimately, it has to be an engrossing story," he explains.

"The challenge for the writer is to keep the technical details intact, yet not to forget that ultimately, it has to be an engrossing story"

According to Ananthaswamy, a science writer has to both educate the readers as well as entertain them without sounding patronizing. His own writings demonstrate this skilful task of explaining science—often complex—to a layperson using an engaging narrative. For instance, his first book, *The Edge of Physics: A Journey to Earth's Extremes to Unlock the Secrets of the Universe*, combines complex ideas in cosmology and particle physics, narrated using impressive prose. But what makes it particularly engaging is that it is written in the form of a travelogue, detailing his visits to remote locations around the world—from abandoned iron mines in the American Midwest to the vast frigid expanses of Lake Baikal in Siberia—where pioneering research is throwing light on different aspects of cutting-edge physics.

Science Communication in India

While the collaboration between the scientists and the media is an established process in the West, in India, scientists—with a few notable exceptions—do not engage enough with the media and public. According to Ananthaswamy, the reason lies partly in the lack of trained science communicators, crucial for writing a good story with proper emphasis on scientific details. At the same time, he believes that unless scientists are willing to make time to explain the science in their research in layperson's terms and show some interest in engaging with journalists, the situation has little scope of improving.

Ananthaswamy also adds that scientists, not just journalists or professional writers, have written a lot of the good books on science. "I am sure that our scientists have amazing stories to tell, they just have to be more open about reaching out to the public

themselves or through science communicators and then more can share the beauty of how science works."

"I am sure that our scientists have amazing stories to tell, they just have to be more open about reaching out to the public themselves or through science communicators and then more can share the beauty of how science works"

Pointing out how underdeveloped the field of science communication is in India, Ananthaswamy says, "At this point, there does not exist a single popular science magazine of the stature of *New Scientist* in India." However, he thinks that though the field in India is still in its infancy, the scenario is improving. Many institutions like IISc and NCBS (National Centre for Biological Sciences) have realized the importance of communicating science to society and are making conscious efforts to improve the situation. For instance, a Science Media Center has been set up at IISc to facilitate communication between scientists and the media. To date, the Center has written over a hundred press releases, providing an overview of research being carried out at IISc.

Teaching Science Communication

Ananthaswamy himself has been contributing towards training of the next generation of science writers, both in the US and in India. He is a guest editor at the University of California Santa Cruz's (UCSC) Science Communication programme. And, here in India, he organizes a science writing workshop at NCBS every summer, one in which he also teaches.

Discussing how the workshop began, Ananthaswamy says, "The workshop took shape in 2011 when Sanjay Sane, a professor at NCBS, and I began talking about the need to set up a programme in India that could help train local science journalists." Since then, NCBS has been providing facilities as well as financial support for the workshop. Anathaswamy is happy to have NCBS on board as a partner because he believes that it recognises the importance of communicating science to the lay public. His main co-instructor over the last few years has been Peter Aldhous, formerly of *Nature* and *New Scientist*, and now at *BuzzFeed News*. Aldhous also teaches science journalism at UC Santa Cruz and UC Berkeley.

Each year the workshop receives applications from about 50 students, of which only 10 are chosen, a number Ananthaswamy is reluctant to change. "The number of students per workshop is hard to change. Ten seems to be the optimal number. The workshop is very intensive—students have to write a lot, and instructors do real-time editing and discussions of the writing. More students would slow down the process and we'd not be able to accomplish as much in two weeks," he explains.

"The workshop is very intensive—students have to write a lot, and instructors do real-time editing and discussions of the writing. More students would slow down the process and we'd not be able to accomplish as much in two weeks"

Ananthaswamy believes that though it's still early days, there are very encouraging signs that the workshop is succeeding in what it set out to do —to teach the basics of science journalism and inspire at least some of the students to take it up professionally. "Some indeed have and we are thrilled about that," he adds.

MANGALA SUNDER KRISHNAN: USING TECHNOLOGY IN HIGHER EDUCATION

✍ **MEGHA PRAKASH**

Courtesy: MANGALA SUNDER KRISHNAN

A theoretical spectroscopist, Mangala Sunder Krishnan is a professor at IIT Madras. He is also one of the national coordinators of the ***National Programme on Technology Enhanced Learning*** *(NPTEL), an initiative of the Ministry of Human Resources and Development (MHRD), Government of India. It is being jointly run by the various IITs and the Indian Institute of Science (IISc). Krishnan who was on a sabbatical at IISc during the second half of 2014 spoke to* CONNECT *about this novel programme which provides free online courses for students across the country and seeks to use technology to improve learning outcomes.*

Origin and Early Years of NPTEL:

With an objective to create learning material of fairly high quality and to make them available to colleges, NPTEL was started by Professor MS Ananth (former Director of IIT Madras). It was based on a concept paper written in 1999, but it formally took off in 2003. Initially, it was aimed at teachers because around then many colleges didn't have highly qualified teachers in sufficient numbers. Besides, the ratio of faculty members with PhDs to students was also low. So NPTEL sought to increase the number of teachers and to enhance their quality by training them through workshops with this content and encouraging them to use this.

By 2007, our target to produce full lecture content for about 250 courses with 40-45 lectures in each course was completed. But we also realized that the teacher training process was not necessarily the most optimal way of transferring content because the number of teachers was small. So we decided to put the course material including lectures online similar to what Massachusetts Institute of Technology (MIT) had been doing then. The difference was that we decided to publish the content under a systematic curriculum process. And from then on, many teachers from different institutions and colleges have been using the course content developed by NPTEL. I think about 1000 or more institutions have the entire repository of NPTEL lectures, and they, like every individual, use the lectures in the way they want.

"I think about 1000 or more institutions have the entire repository of NPTEL lectures, and they, like, every individual, use the lectures in the way they want"

Evolution of NPTEL:

We now have about 930 online courses. The developments in the second phase, started in 2009, are interesting because they not only augmented what was there in the first phase but added many more disciplines, including pure science. The focus in the first phase was on engineering courses. And now, we have physics, mathematics, chemistry, biology, biochemistry course content, as well as courses in the social sciences. These lectures are given by faculty members, mostly from the IITs and IISc. Contributing faculty members are either invited to participate or are encouraged to write proposals. In the next phase, we plan to include arts, commerce, humanities, social sciences, medicine, agriculture and many other areas by tapping into the expertise available in other institutions. NPTEL has been fully funded by MHRD which is encouraging people to be part of this growing team.

NPTEL and Other Online Courses:

There are three varieties of online courses. The first is an open courseware model in which the content is made available free on the web (like lectures from MIT, Stanford University, etc.). However, these universities have no systematic way of building the courses. In India, there is a need for quality contents of certain minimal quality to be recognized as baseline content.

The second is the model used by edx, Coursera, Udacity and many others; all are classified under what is called Massive Open Online Course (MOOC). And these are synchronous, in the sense that they are timed for a period of delivery; students enrol for that period follow a prescribed sequence and then graduate by submitting their papers or writing exams. However, there is no verification for what you submit—whether you have done it independently etc. The system assumes that you want to learn something and here's what you have to learn. If you cheat on the examination, you are cheating yourself. But in India when you are issuing certificates from higher educational institutions (because MOOC is supported by the MHRD), one has to have a method of verification.

The third kind is online educational material for a degree programme. For example, the British Open University, Arizona State University, Athabasca University, Malaysian Open University, Australian National Open University and others offer exclusive online programmes for a fee. And therefore, their course has been pedagogically structured for self-learning. IGNOU is the best example of this in India; unfortunately, IGNOU has not gone further to make their courses available online or to use technological tools.

Unlike these models, NPTEL is striving to create a curriculum without a gap in all the courses. It is funded by the government, it is free to copy and the copyright formula of NPTEL is same as that of the Wikipedia, something which no other university in the world has agreed so far to.

"Unlike these models, NPTEL is striving to create a curriculum without a gap in all the courses"

NPTEL Lectures on YouTube:

In 2006, MIT started a YouTube channel. Immediately after that, YouTube also offered commercial free unlimited bandwidth and unlimited file size to the University of California at Berkeley. At that time, one of the senior vice presidents of Google, Dr. Guha Ramanathan, an alumnus of IIT Madras, knew that NPTEL had created 5000 videos. He approached us to find out if NPTEL needed some help in hosting the content; NPTEL agreed. Though there were some difficulties with the Directors of the institutes involved putting up educational content on YouTube, they were convinced after they saw the MIT channel and other university channels which were coming up. YouTube offered us one channel which at that time was called *nptelhrd*. On that channel, about 6000 videos were uploaded from the first four-five years programme. Currently, the channel has 19000+ video hours uploaded and is the most viewed video channel in the world among other educational channels with more than 160 million views and over 460,000 subscribers. YouTube gave NPTEL a phenomenal popularity across the world.

But during the past four years, NPTEL has been streaming its own channel with the server at IIT Madras. Together, NPTEL has recorded 20,000 videos and has provided full subtitles and text of video for about 15000 hours so far. Subtitles in Indian languages are very much in the pipeline.

Courtesy: MANGALA SUNDER KRISHNAN

NPTEL recording studio

Operational Challenges in Rural India:

Given that we don't have the required bandwidth for individual users in rural areas, all lectures are copied onto hard disks and sent to colleges which approach NPTEL. The service is free but the institutions will provide the hard disks. Colleges are asked to sign a copyright agreement to ensure that the content is not commercialized and that it will be made available to the students for free. We also instruct the colleges to load the copied content onto the local college servers, thus enabling the students to copy them on their own storage devices. Even private educational service providers and all private industry can have them for their internal use by the same method.

NPTEL also creates DVD sets for individual courses that are distributed through agencies. These agents charge a service fee (Rs. 200 for each DVD, including postage and service provider fees) for copying the content. But if the students directly send requests to NPTEL, the DVDs are provided to them for free. Students can soon go to one of the NPTEL centres and get contents copied for their personal and academic use. To further popularize the programme, NPTEL conducts workshops across the country. Also the NPTEL website is user-friendly. In the 'Ask Me' section, students can ask questions on the subject that they are studying.

Way Forward:

NPTEL offers many short duration courses based on its contents through its online portal. In January, more than 20 titles are likely to be offered. Such courses are supported by faculty and student mentors, and participants learn through published lectures and discussion forums. They are encouraged to join for free but will pay only if they need a formal certificate for completion along with marks scored. NPTEL would like to go towards what's called the virtual university model in which the entry level will be judged by an entrance test and once students qualify, online programmes will be provided with some mentor help. If you want a certificate, you pay a fee. So it is not an open university model; it will be open courseware which is going to be certified. We believe that a certification process has to be there. Hopefully in the next 3-4 years, we will be able to launch a university or technical institution like that.

"NPTEL would like to go towards what's called the virtual university model"

To know more about NPTEL, go here: http://nptel.ac.in/ OR https://www.youtube.com/iit.

IISc signs collaborative pacts

The Indian Institute of Science (IISc) has taken steps to strengthen translational research

✍ **BHARTI DHARAPURAM**

October saw IISc signing MoUs with two industry partners as part of its efforts to encourage translational research. The first collaboration was sealed with the German technology giant Bosch on 28 October, and the papers were later exchanged in the presence of the President of India, Shri Pranab Mukherjee. The second MoU was signed two days later with Centre national de la recherche scientifique (CNRS)—the government research organization in France—and Thales group—a French defence technology company.

"In recent years, the industry has sponsored translational research centres [at IISc]," said the Director, Anurag Kumar. "While fundamental research in science and engineering remains IISc's core value, the translational aspect is expected to be strengthened," he added.

"While fundamental research in science and engineering remains IISc's core value, the translational aspect is expected to be strengthened,"

IISc had, in 2011, received a philanthropic grant from the Robert Bosch Foundation which enabled it to set up the Robert Bosch Centre for Cyber Physical Systems, which focuses on interdisciplinary research. The current MoU, spanning over the next five years, connects IISc with Bosch Engineering India, for work on projects that deliver health, water, transport and energy solutions relevant for India. On-going discussions will flesh out the details of these planned projects.

"The specific technologies will include sensors, wireless communications, distributed signal processing, data analytics, inference, and control, in the framework of the Internet of Things," said Anurag Kumar.

Courtesy: THALES INDIA

Thales Vice-President and Country Director Antoine Caput with IISc Director Anurag Kumar at the MoU signing

IISc also strengthened its research ties with France by partnering in a fellowship scheme which will allow PhD students here to work researchers in France, who will be matched based on shared research interests. These will be in the fields of advanced electronics systems, electromagnetism, antennas, meta-materials and nanotechnology, said Srini Kaveri, Director of CNRS in India. Initially, four PhD students registered with IISc will be selected for the fellowship. After completing their course work and clearing the comprehensive exam, they will have the opportunity to work with collaborators at French research labs, and also use the research facility at Thales, France.

This fellowship scheme being sponsored by the Thales group will provide students with a contingency fund to meet travel and living expenses at the institute abroad. The participating organizations are also discussing possibilities of students returning to visit Thales, France after obtaining their doctoral degree from IISc.

"Through this significant MoU, we look forward to contributing to the Indian government's mission of skilling and up-skilling people, and its focus on enhancing the R&D fields in India," said Antoine Caput, Vice President and Country Director, Thales India, at the MoU signing, according to a press release.

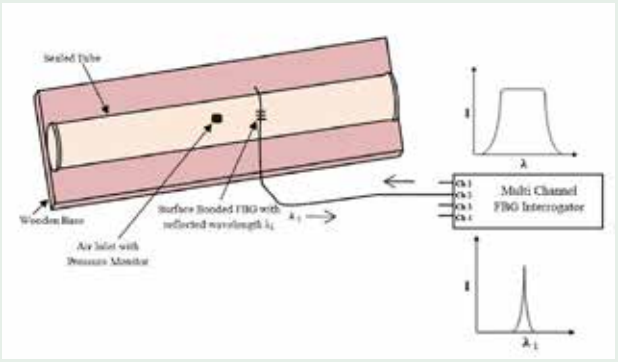
HOT OFF THE PRESS

Research highlights from the Indian Institute of Science (IISc)

✍ Compiled by **NITHYANAND RAO** from press releases written by the **SCIENCE MEDIA CENTER***

OPTICAL ENGINEERING

Optical fibre-based pressure sensors that can be operated remotely



Courtesy: S ASOKAN'S LAB

Precise measurement of pressure in pipes and channels are critical in oil, gas and chemical industries. But the sensors used to measure pressure often have to be mounted in inaccessible locations and may have to operate in corrosive environments. To circumvent this, a research group at the Department of Instrumentation and Applied Physics has developed a pressure sensor using a Fibre Bragg Grating (FBG) which can accurately determine the pressure inside a pipeline carrying a fluid, gas or chemical. Using optical fibres, FBG sensors reflect particular wavelengths of light and transmit others. The sensor can detect the expansion at the outer surface of the pipeline—where it is mounted—an indicator of the pressure inside.

Published in: Proc. SPIE 9524, International Conference on Optical and Photonic Engineering
Read more at: http://dx.doi. org/10.1117/12.2189663

NEUROBIOLOGY

How your hand and eye work with each other

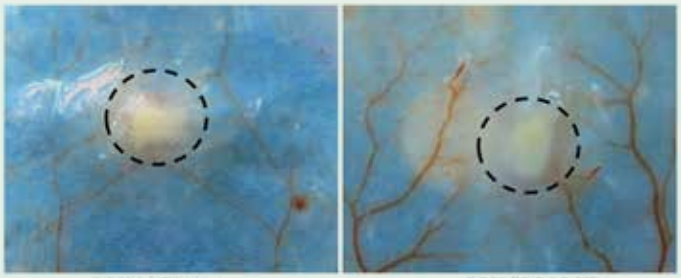
Though the motor systems controlling hands and eyes can function independently, humans and other primates show a sophisticated level of hand-eye coordination. There are three potential hypotheses to explain how this flexibility is achieved in the nervous system: (1) the eye and hand systems coordinate simply because of the common input; (2) they interact only when coordination is required; (3) they have a common command centre. Researchers at the Centre for Neuroscience, using a well-known model from physics known as the *diffusion model*, found support for the common command architecture, the most parsimonious of all models, which allows humans and primates to execute complex tasks. The researchers then validated this model through the electromyograph (EMG) results of human subjects while they performed certain tasks. Their conclusion was also supported by the demonstration of the presence of an inhibitory system in the common command centres, one that controls eye and hand movements simultaneously.

Published in: *Journal of Neurophysiology*
Read more at: http://dx.doi.org/10.1152/jn.00276.2015

*SCIENCE MEDIA CENTER is a joint initiative of IISc and Gubbi Labs

CANCER BIOLOGY

Potential new drug target for a deadly form of brain cancer



Courtesy: MAMATHA B NIJAGUNA

Glioblastoma (GBM) is a brain tumour that is unusually aggressive. Its aggressiveness is fuelled by angiogenesis—the formation of new blood vessels within them. A protein that is known to aid angiogenesis called VEGF has been the target of a drug, but this drug has failed, suggesting that there are molecules other than VEGF that are involved in the formation of new blood vessels. Now, a team including researchers at the Department of Microbiology and Cell Biology have discovered a new molecule, IGFBP1, that is also involved in this process. Its production is driven by the secretion of another protein called MCSF. The discovery of IGFBP1 thus paves the way for researchers to develop a targeted therapy for those suffering from GBM.

Published in: *Journal of Biological Chemistry*
Read more at: http://dx.doi.org/10.1074/jbc.M115.664037

ANIMAL BEHAVIOUR

Duets in the dusk: song and dance in a chirping insect

When a female katydid (bush cricket) is attracted to a male song, she moves toward him. Researchers at the Centre for Ecological Sciences and the Centre for Nano Science and Engineering have found a deviation from this typical call-response behaviour in a katydid species called *Onomarchusuninotatus* found in southwestern India and Malaysia. They discovered that during courtship, the male songs —produced at an unusually low frequency— prompt vibrational responses called 'tremulations' (bodily oscillations) in the females. The vibrations of the females are created when they shake their body while sitting on a tree branch with their feet touching the branch. The female vibrations alternate with the male chirps, maintaining perfect timing throughout the duration of the song, thus creating a song-vibration duet! The researchers also showed that the males could use these vibrational signals to locate females when the same song-vibration sequence is repeated.

Published in: *Journal of Experimental Biology*
Read more at: http://dx.doi.org/10.1242/jeb.122911

PHYSICS

New discovery may lead to faster memory chips

A quantum phenomenon, first proposed in 2012 by Tanmoy Das of the Department of Physics, has now been observed by his collaborators from Switzerland and Germany. The magnetic field generated by an electron orbiting the nucleus of an atom interacts with the one created by the electron's rotation around its own axis. This spin-orbit interaction results in the latter magnetic field getting aligned with the former. In a crystalline solid, each atom can have its own spin-orbit interaction, which often cannot be controlled externally. Das had proposed a "spin-orbit density wave", which propagates with, say, the forward moving wave having one definite spin, and the backward moving wave having the opposite spin.

PLANT-INSECT INTERACTION

The complex insect community within fig fruits

Courtesy: Renee Borges' Lab

A research group at the Centre for Ecological Sciences has studied how flowering patterns of fig trees affect the myriad relationships between a particular fig species and its coterie of fig wasps that reproduce inside the fruits. Only one of these fig wasps is a pollinator, while six are non-pollinating parasites—three gallers and three parasitoids. Gallers inject venom into fig flowers to form rounded structures called "galls" which provide food and shelter for their developing young. The other three are parasitoids, which drill into galls and lay eggs on young galler wasps—these parasitoids eat gallers from the inside out. This study showed that trees producing figs out of synchrony with each other attracted fewer parasitoids, and had more beneficial pollinators inhabiting their figs. Furthermore, the flowering/fruiting pattern affected fig wasp reproduction, which in turn again influenced the next cycle of flowering.

Published in: *Oecologia*
Read more at: http://dx.doi.org/10.1007/s00442-015-3372-9

This has now been observed using an ultra-thin lead wire on a patch of silicon. This phenomenon may help in retaining the electron's spin as it moves, which has hitherto been a challenge in the development of spintronic devices—ones which exploit not just the charge but the spin of the electron too, and can be faster than conventional electronic devices.

Published in: *Nature Communications*
Read more at: http://dx.doi.org/10.1038/ncomms9118

ROBOTICS

A mobile robot that does not slip

Autonomous mobile robots are suitable for varied activities—from household cleaning and delivering goods, to interplanetary exploration. But if one of its wheels slip, things can go awry. Researchers at the Department of Mechanical Engineering working with colleagues elsewhere have proposed a design to counter this problem. They have designed a robot that has one front wheel and two torus-shaped rear wheels connected to a platform through a suspension mechanism having four links. Two of the links are fixed and the other two are free to move at an angle. This enables lateral tilting of the wheel, thus preventing a slip. The wheels are coated with rubber to enhance friction. The team tested a prototype and also simulated its functioning—they observed a 50% reduction in slippage compared to previous models.

Published in: *Mechanism and Machine Theory*
Read more at: http://dx.doi.org/10.1016/j.mechmachtheory.2015.06.009

HELLO!

Meet new faculty who have joined the Indian Institute of Science (IISc)

Compiled by **MANU RAJAN** and **IPSITA HERLEKAR**

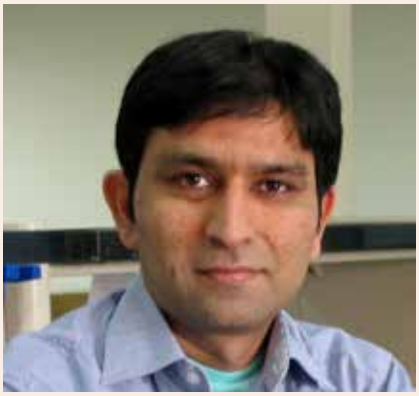
ARAVIND PENMATSA (Assistant Professor, Department of Molecular Biophysics), a native of Hyderabad, has a PhD in biophysics and structural biology from the Centre for Cellular and Molecular Biology, Hyderabad. His keen interest in neuroscience and pharmacology led him to pursue his postdoctoral research at Eric Gouaux's lab in the Oregon Health and Science University, USA, where he characterized the mechanisms of antidepressants and psychostimulants like cocaine and amphetamines. His current research interests lie in elucidating mechanisms and pharmacology of membrane embedded proteins.

TANMOY DAS (Assistant Professor, Department of Physics) hails from the state of West Bengal. He received his PhD form the Department of Physics at Northeastern University, Boston, USA and pursued his postdoctoral work at Los Alamos National Laboratory, also in the US. He also carried out a year-long appointment in the Graphene Research Center at the National University of Singapore before he joined IISc. His current work focuses on theoretical studies and numerical simulations in condensed matter physics.

GURUNATH GURRALA (Assistant Professor, Department of Electrical Engineering) has a PhD from the Indian Institute of Science and did his postdoctoral work at the Texas A&M University and the Oak Ridge National Lab, both in the USA. At IISc, he works on the development of parallel algorithms for faster than real-time simulation of large power systems which enables the prediction of blackouts and development of mitigation strategies in real-time before a catastrophic failure of the power grid happens.

Courtesy: KAUSIK MAJUMDAR

KAUSIK MAJUMDAR (Assistant Professor, Department of Electrical Communication Engineering) received his PhD from IISc. His research focus lies in the physics of novel material systems and their applications to optoelectronic and nanoelectronic devices—both from experimental as well as theoretical points of view. He is interested in 2D valleytronics, as well as in tunneling of electrons through ultra-thin ferroelectric and multi-ferroic materials, and their applications in novel memories.



CONNECT

SACHIN KOTAK (Assistant Professor, Department of Microbiology and Cell Biology) was born and raised in New Delhi. He received his PhD from the Goethe University-Frankfurt, Germany, where he worked in the area of seed-development in *Arabidopsis* and uncovered the essential role of a plant heat shock factor *HsfA9* during seed maturation. His interest in the process of asymmetric cell division in animal cells led him to work with Pierre Gönczy at EPFL, Switzerland. At IISc, his research focuses on unravelling the spatiotemporal dynamics of cell division in animal cells.

Courtesy: RAMRAY BHAT

RAMRAY BHAT (Assistant Professor, Department of Molecular Reproduction, Development and Genetics) grew up in Kolkata and has a background in Hindustani classical music and medicine. He received his PhD in cell biology and anatomy from the New York Medical College, Valhalla, USA, and completed his post-doctoral fellowship from Berkeley Labs, California, USA. His current research interests include understanding how sugars hold the balance between health and disease of our cells, tissues and organs.

HAPPY MEAL

✍ IPSITA HERLEKAR

A profile of the messes at the Indian Institute of Science (IISc) that seek to keep young researchers well-fed and also give them an opportunity to socialise with their colleagues

CONNECT

As the lunch hour approaches, the laid-back campus of IISc looks unusually busy as people, many chit-chatting in small groups, seek a well-deserved meal from among the many places to eat on campus. The students among them move towards a common destination where piping hot food awaits them —one of the four messes dedicated to serve their gastronomic needs.

Beginnings

The history of the messes in IISc dates back to 1911, when the first batch of students was enrolled in the Institute. Keeping the young minds of campus well-fed was a priority even back then. IISc's first Director Morris Travers believed that efficiency in work cannot be expected on a half-empty stomach. In one of the Institute's early reports, he wrote, "I thought it of the greatest importance that the students should be well fed, so that I might be able to get the maximum amount of work out of them."

Travers, an Englishman, had limited knowledge about Indian food, but was aware of the diversity of food habits prevailing in India. So among the first decisions he made after the Institute was established was to set up multiple messes, even though there were very few students back then. He also brought in cooks from different parts of the country to provide students with regional delicacies that they were accustomed to. "We had about 35 students, but as they came from all over India, I had to have six different messes and ultimately

seven, to accommodate a single Muslim student. Everyone seemed happy and contended," a retired Travers wrote in a letter in 1949 from his home in England to K Sreenivasan, then a professor at the Department of Electrical Engineering.

"I thought it of the greatest importance that the students should be well fed, so that I might be able to get the maximum amount of work out of them."

In the early years, the messes were attached to individual hostel, blocks. In 1944, however, these individual messes were abolished and a common dining hall was built for the entire hostel. But as the number of students increased, new blocks were added to the hostel and the kitchen and the mess facilities were again augmented. The hostel messes were provided with two common kitchens and dining halls, one for the vegetarians and the other for the non-vegetarians.

The ABCD of the four messes

Although the messes have evolved since they were first setup, even today they strive to offer food to suit the palates of students who come to IISc from different parts of the country.

KUMAR MP

Busy lunch hour at one of the messes

Now IISc has four messes: *A, B, C* and *D*, all located close to the hostel blocks. *A* mess serves south Indian vegetarian food, whereas *B* and *C* messes both serve a combination of vegetarian and non-vegetarian food cooked in north Indian and south Indian styles respectively. *D* mess, on the other hand, serves only north Indian vegetarian meals.

During mealtime, each of the four messes is geared up to feed about 500-600 students. To help feed that many hungry mouths, the kitchens are equipped with modern gadgets like electric powered coconut grater, potato peeler, rice steamer and dough (*atta*) kneader besides an efficient kitchen staff.

CONNECT

One of the temporary employees

In the kitchens, nearly 150 people clean, chop and stir, putting together delicious meals day after day. The kitchen staff also includes a few workers (above 60 years of age) belonging to a lower economic background who are employed for smaller temporary chores. "These older women are generally those who are no longer wanted by their families. To help them earn a small living, we seek their services like sifting rice, cleaning vegetables and other produce. In return, a small salary is paid to them and they are permitted to take leftover food," explains Arka Baksi, a PhD student and a former president of the mess committee.

By the students, for the students

All the messes are run by the students. But back in 2011, a new mess in partnership with a private entity was introduced on a trial basis. This initiative, however, was not successful. "Unimpressed by the quality of food and soaring prices, the students demanded that we go back to the student-run model," says Bheemanna, one of the mess supervisors.

CONNECT

Cooks at work

Under this model, a student mess committee is in charge of operations. It comprises a president, four vice-presidents and a few voluntary student members, (usually five to nine). This committee is responsible for a variety of tasks—checking products and produce supplied by vendors to ensure that quality is maintained weekly, allotting rations to the kitchen staff daily besides maintaining hygiene and cleanliness of the mess. It also needs to check and manage the stocks on a regular basis. In addition to this routine, members of the committee dedicate time every week to fix a menu keeping in mind both the culinary preferences of students and affordability of food. Another issue that the committee has to deal with is to ensure that the cost of food does not change over a period of time, even as the market prices fluctuate. So a budget is prepared well before the vendors are approached.

"The entire credit for running the mess efficiently and keeping up high hygiene standards goes to the student mess committee," says Ashok Raichur, Professor, Department of Materials and Engineering, who is the faculty-in-charge of the hostels and messes.

"The entire credit for running the mess efficiently and keeping up high hygiene standards goes to the student mess committee"

The current president of the mess committee, Saurav Islam, adds that in addition to their mess bills, students also bear the cost of services of the kitchen staff, cooking gas and any minor repairs that are required. The average cost turns out to be around

Rs. 100 per student for four meals which includes breakfast, lunch, evening snacks and dinner. In case a student is leaving town for two days or more, he/she has the option of signing out from their mess accounts for that period.

Though there are other eating avenues on campus that are more pocket-friendly, most students prefer eating in the messes—they find the food more appealing and hygenic. "It doesn't feel like I'm away from home. The food served in the mess is better compared to the food served in my previous hostel," says Arindam Sau, an undergraduate hailing from West Bengal. He adds that the food in his mess is fairly priced and the cuisine has enough variety to keep his Bengali palate satisfied.

"It doesn't feel like I'm away from home. The food served in the mess is better compared to the food served in my previous hostel"

The mess committee also ensures that it keeps in touch with students on a regular basis. It reaches out to them through a Facebook page where it posts notices, shares the menu and once in a while, seeks feedback from the students about the quality of food and service. Besides, students can also participate in a poll conducted each week to rate the items on that week's mess menu. The committee members also interact with the kitchen staff frequently, sometimes even encouraging them to try out new recipes and cooking techniques.

One other focus of the committee is to try to reduce wastage and improve efficiency in the kitchen. In spite of their best efforts, at times, some of the food needs to be discarded. If this happens, the discarded food is sold as pig feed to a local farm along with other organic waste, says Baksi.

The committee is also planning to use technology to help monitor the kitchen activities with the help of CCTV cameras which are expected to be installed soon. "Smooth running of the four messes is a collective responsibility of all members of the mess committee," says Islam, while adding that he would like to see more student volunteers who can help run the mess even more efficiently.

Social Hub

The messes have also become hubs for social interaction and cultural exchange, and even contribute to the overall growth of the students dining in them. Suhas Mahesh, an undergraduate student, is a member of the Sanskrit Association of IISc (Samskrita Sangha) whose members have always had the problem of finding the right time and place to meet. Mahesh reveals how the mess helped their cause. He says, "It so happens that all of us from the *Samskrita Sangha* are in the same mess. We all meet during lunch and if you hear Sanskrit chatter from a mess table, it means that we are actually having the meeting there! Otherwise we don't get to converse in Sanskrit."

"We all meet during lunch and if you hear Sanskrit chatter from a mess table, it means that we are actually having the meeting there!"

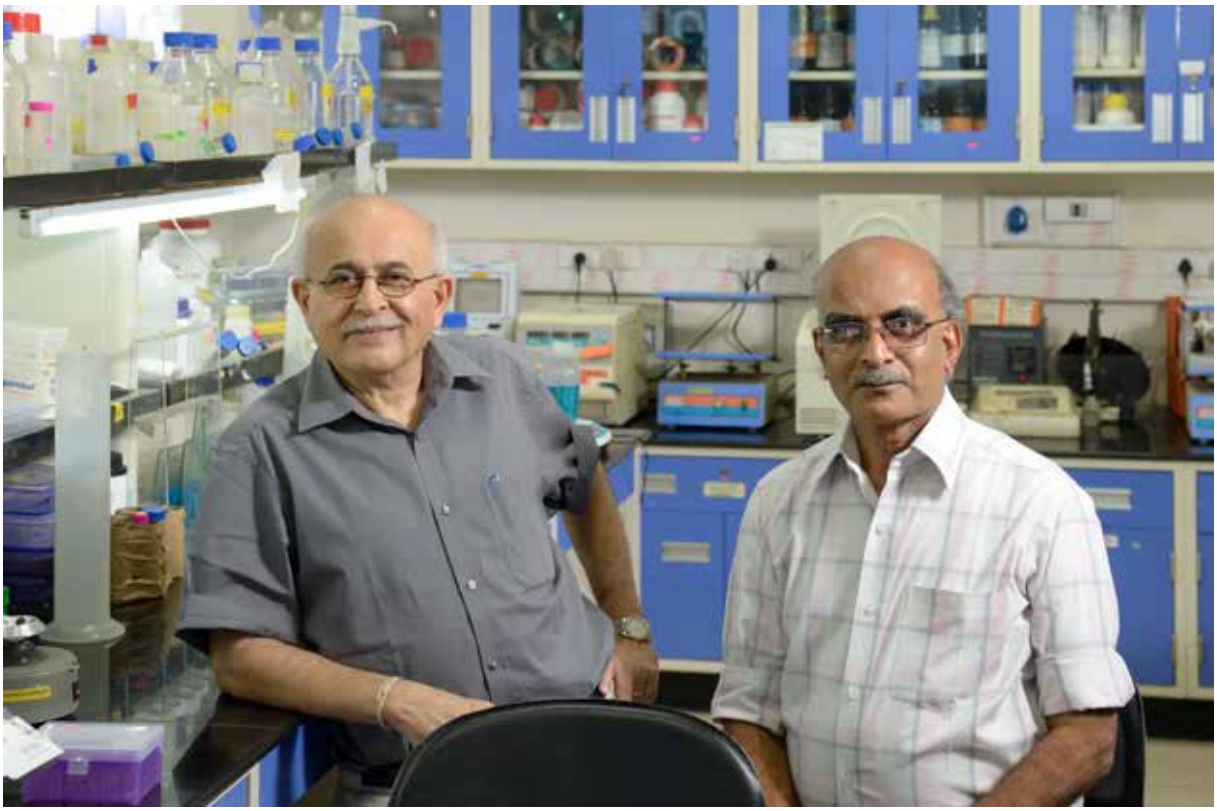
Another student, Raghunath Joshi who is pursuing his PhD, was a regular at one of the messes until he became a day scholar. "When I was in the mess, there was a table where a group of us would sit and argue about social and philosophical issues. Sometimes the discussion would get really deep. Because of these discussions, I had many ideas and read many books, and I would use this knowledge to argue better with them. It used to make me think a lot." Joshi adds wistfully, "Now I miss those days."

DISPATCHES FROM THE LAB

In this section, we shine the spotlight on researchers from the Indian Institute of Science (IISc) who are making a splash in their field of research

✍ **COMPILED AND EDITED BY THE CONNECT TEAM BASED ON INPUTS FROM THE FEATURED RESEARCHERS**

V NAGARAJA (PROFESSOR, MICROBIOLOGY AND CELL BIOLOGY) AND S RAMAKUMAR (PROFESSOR, DEPARTMENT OF PHYSICS)



MANOJ SUDHAKARAN

COMBATING TUBERCULOSIS

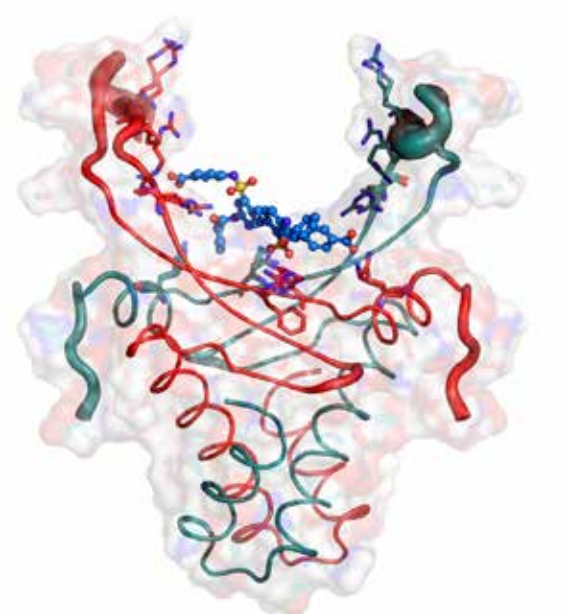
Mycobacterium tuberculosis is an ancient pathogen that causes the disease tuberculosis (TB), infecting millions of people every year; the disease has a very high rate of mortality and morbidity. The TB challenge has only grown with the emergence of drug-resistant strains of this bacterium. To combat the disease caused by these drug-resistant strains, researchers across the world are employing diverse strategies, including finding new drug molecules.

Nagaraja, a molecular biologist has been trying to understand the organism's key biological processes which are essential for its growth and survival. Now in collaboration with Ramakumar, a physicist, he is using an interdisciplinary approach to investigate how a TB-causing bacterium's DNA in

the chromosome is compacted, coiled or unwound by enzymes and DNA-binding proteins.

Now in collaboration with Ramakumar, a physicist, he is using an interdisciplinary approach to investigate how a TB-causing bacterium's DNA in the chromosome is compacted, coiled or unwound by enzymes and DNA-binding proteins

Nagaraja's and Ramakumar's labs have carried out structural and functional studies of one such DNA organizing protein *HU*, essential for the survival of the pathogen. They believe that knocking out this protein's function would kill the TB causing bacterium. So far the progress achieved by using this approach has been impressive—they have successfully cloned, expressed and purified the *HU* protein. This collaboration has also led to the deciphering of the 3D structure of this protein and the identification of small molecules that bind to the key pocket in the protein. In addition, they have shown that these molecules inhibit the protein, decompact the chromosome and affect the bacterial growth. This is the first time the proteins of this class have been targeted for inhibition from any organism.



Courtesy: V NAGARAJA

***HU* from *Mycobacterium tuberculosis* bound to Stilbene derivative inhibitor**

MANOJ SUDHAKARAN

Nagaraja and Ramakumar with their teams

KUSALA RAJENDRAN

(PROFESSOR, CENTRE FOR EARTH SCIENCES)

MANOJ SUDHAKARAN

EARTHQUAKE MECHANISMS, RECURRENCE AND HAZARD EVALUATION

The Himalaya—formed by the India-Eurasia collision about 40 million years ago—is the northern boundary of the Indian subcontinent, and Burma-Andaman arc is its eastern boundary. Both of these are active tectonic boundaries which have made parts of the Indian subcontinent exceptionally vulnerable to earthquakes and resultant hazards like tsunamis. Kusala Rajendran's research seeks to further our knowledge on how earthquakes are generated along the plate boundary systems and to develop source and recurrence models, leading to more effective earthquake and tsunami preparedness and hazard mitigation. Her investigations have led to several recent publications in leading international journals.

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Rajendran's ongoing projects, many of them in collaboration with CP Rajendran, a professor at the Jawaharlal Nehru Centre for Advanced Scientific Research, are helping develop a better database for earthquake hazard models for the central Himalaya region. Based on archaeological and historical data as well as geological proxies, she and her team have dated the last great earthquake in this region at around 700 years ago. Only a few months before the high-magnitude earthquake that hit Nepal, her seismo-tectonic models predicted a large strain build up and a renewal time of about 600 years, meaning that this segment of the Himalaya was due for the next big earthquake. Rajendran's research also suggests that the Nepal earthquake in 2015 ruptured only about 150 km length of the fault, leaving adjoining segments ready for future earthquakes.

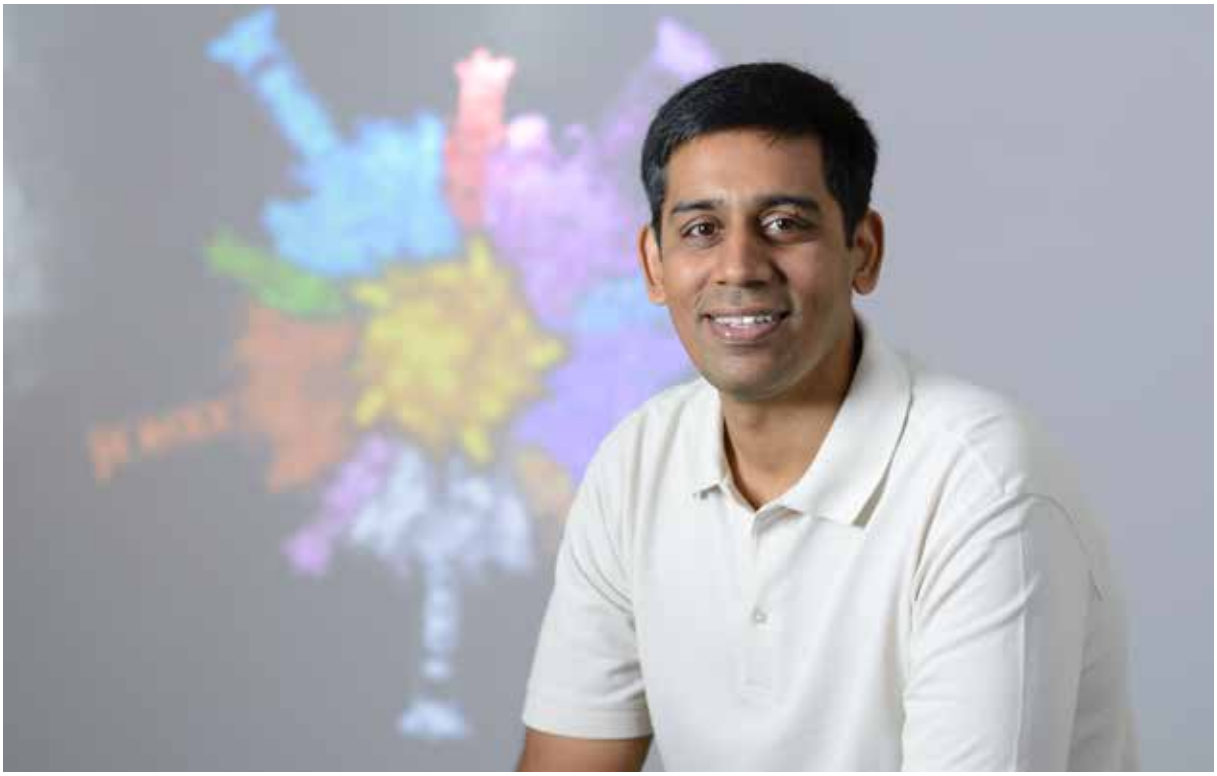
One of her research projects, funded by Indian National Centre for Ocean Information Services (INCOIS), aims to build earthquake source models for the Andaman-Sumatra plate boundary and the Indian Ocean earthquakes and also developing models for tsunami cycles. Studies by Rajendran's team along the Andaman and Nicobar Islands and the east coast of India suggest that tsunamis had occurred there in the past with an approximate interval of 500 years. These observations together with the numerical models for coastal inundation provide inputs for the Indian Tsunami Early Warning System at INCOIS.

Courtesy: KUSALA RAJENDRAN

At Sidhababa Cave, Nepal, during a field work with students and collaborator. The field work was to determine whether there was any damage within the cave due to ground shaking after the 2015 earthquake

VIJAY NATARAJAN

(ASSOCIATE PROFESSOR, DEPARTMENT OF COMPUTER SCIENCE AND AUTOMATION)



MANOJ SUDHAKARAN

VISUALIZING DATA

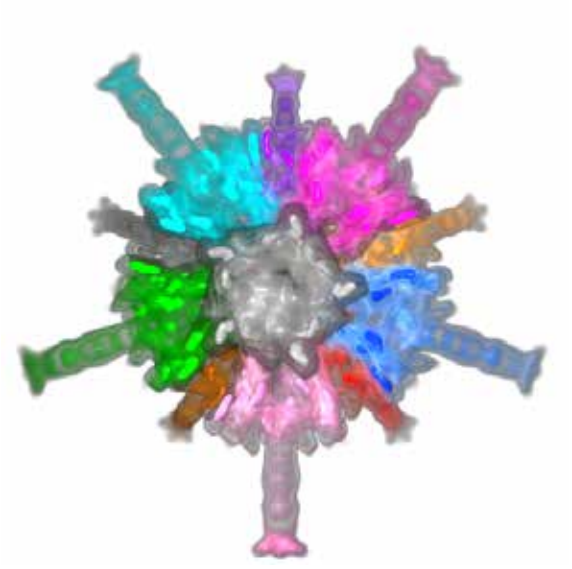
Scientific data—such as those arising from imaging devices and computational experiments in science and engineering disciplines—is increasingly becoming larger in size and richer in its features. A deeper understanding of such data plays a fundamental role in the discovery of knowledge. In their research, Natarajan and his team employ an approach called feature-directed data visualization where the data is first processed to obtain abstract representations, which in turn can be visualized for interactive exploration. They have demonstrated the effectiveness of such feature-directed and knowledge-assisted visualization methods to data from various disciplines like weather and climate science, molecular biology, and cosmology.

In their research, Natarajan and his team employ an approach called feature-directed data visualization where the data is first processed to obtain abstract representations, which in turn can be visualized for interactive exploration

One problem that has received Natarajan's special attention is the study of the role of symmetry in understanding the structure as well as the physical properties of both natural and man-made objects. His lab has modeled the problem of symmetry identification for the first time in a feature-aware manner, where the symmetric repeats are restricted

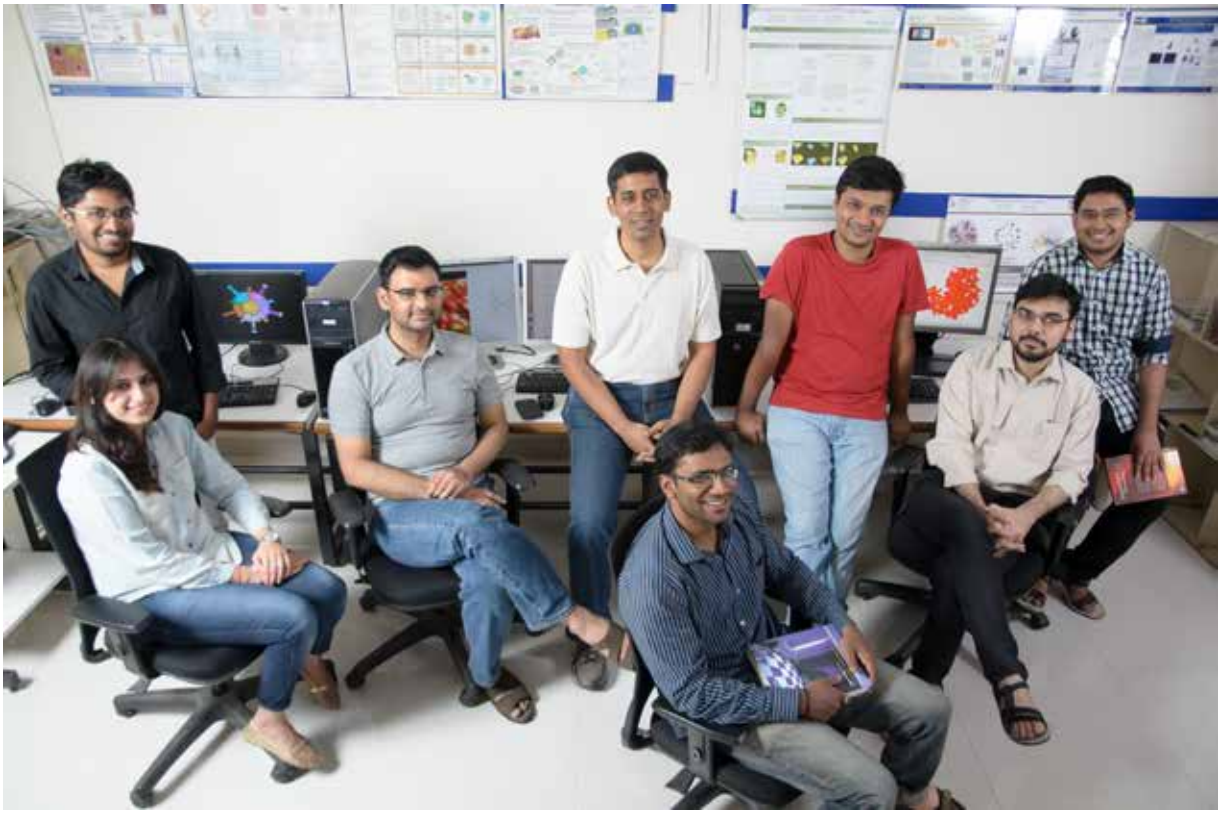
to features of interest in the data. They have also designed computationally efficient algorithms to identify symmetric regions within volumetric data that may arise from 3D imaging devices or from simulations. The automatic detection of symmetry is a computationally challenging problem because it necessitates a search over all possible regions within the volume and a search over all possible symmetries. Moreover, real life data sets never exhibit perfect symmetry. This introduces additional challenges in determining symmetry in an approximate sense as well as in handling noise and in identifying missing parts within symmetric regions in the data.

Natarajan and his team have shown that symmetry information helps enhance traditional visualization methods. They have also demonstrated applications to query-driven exploration of feature-rich data where displaying the entire data is neither efficient nor useful. They believe that their methods for symmetry detection will open new frontiers in analyzing structural similarity of scientific data.



Courtesy: VIJAY NATARAJAN

Visualization of the dodecahedral symmetric structure of the human adenovirus. The symmetric patterns were computed automatically from cryo-electron microscopy data and used to highlight interesting features in a visualization

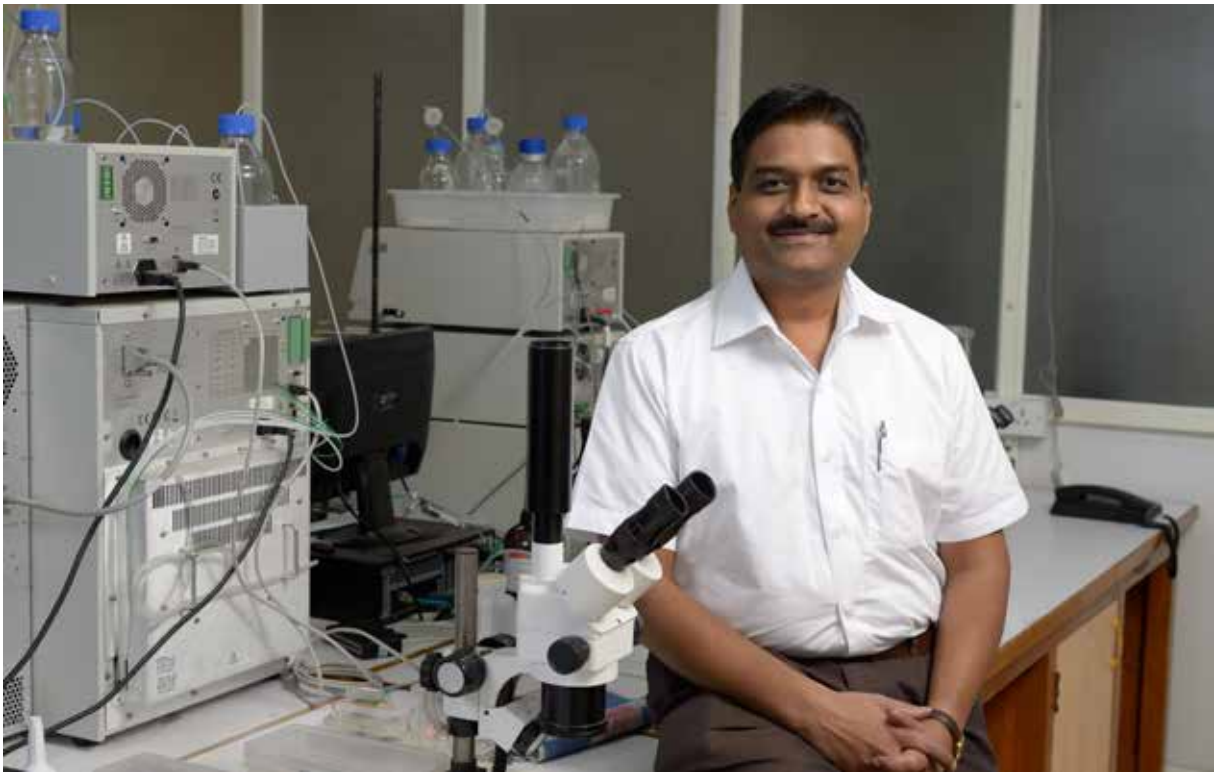


MANOJ SUDHAKARAN

Natarajan with his team

G MUGESH

(PROFESSOR, DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY)



MANOJ SUDHAKARAN

HELPING DEVELOP NEW DRUGS

G Mugesh's laboratory works on developing new therapeutic agents to battle diverse diseases like cancer, renal disease, and neurodegenerative disorders such as Alzheimer's and Parkinson's. These disorders are associated with reactive oxygen species (ROS)—chemically reactive molecules containing oxygen that are important in cell signaling—and oxidative stress. Oxidative stress is an imbalance between the production of free radicals (highly reactive and short-lived molecules) and the ability of the body to neutralize their harmful effects through antioxidants. Mugesh's group has developed compounds that efficiently mimic antioxidant enzymes and combat oxidative stress without affecting the cellular antioxidant systems. These include several biocompatible selenium compounds and nanomaterials, which exhibit remarkable antioxidant activity and protect human cells against ROS-mediated damage. New compounds are being evaluated to determine whether they can inhibit the aggregation of amyloid β-peptides, a biomarker of Alzheimer's disease, and whether they can prevent the inactivation of eNOS, an enzyme essential for a healthy cardiovascular system.

Mugesh's group has received worldwide attention for their seminal contributions in understanding the mechanism of thyroid hormone action.

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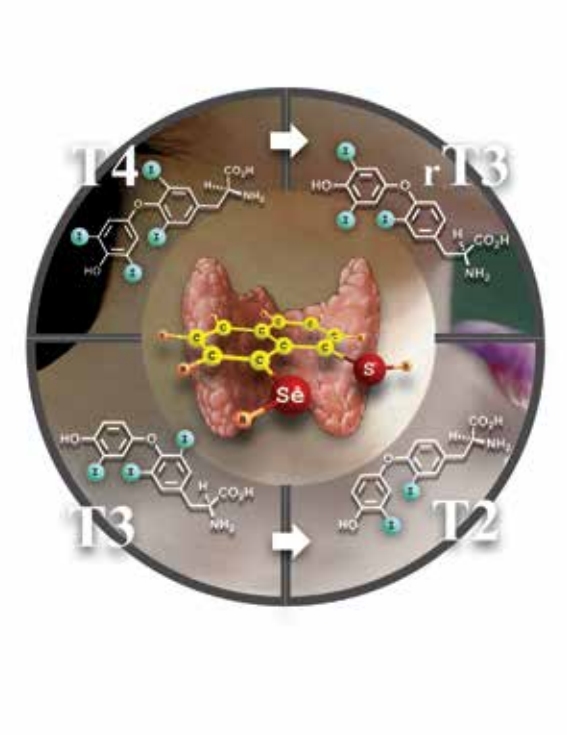
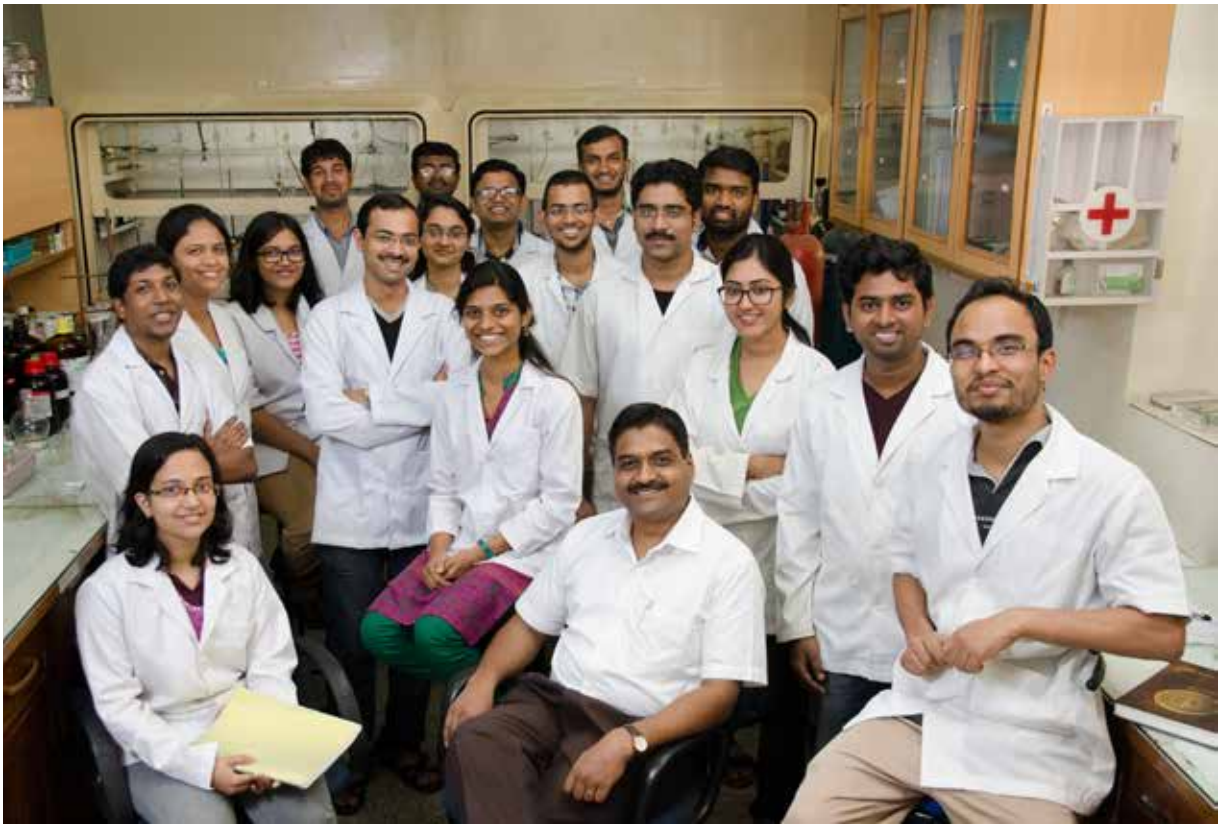
This understanding will help in designing and synthesizing novel compounds that can control thyroid levels through regioselective deiodination—the selective removal of an iodine atom from a molecule. As abnormal thyroid levels have adverse effects in different disease conditions, such as hypoxia, myocardial infarction, neuronal ischemia, tissue injury and cancer, the novel compounds developed in his laboratory are candidates for further drug discovery studies.



Courtesy: G MUGESH



MANOJ SUDHAKARAN

Mugesh with his team

CAMPUS CHRONICLES

In this section, we feature some of the events that were held on the campus of the Indian Institute of Science (IISc) recently

MONSOON SCHOOL ON URBAN FLOODS 2015

The second edition of the **Monsoon School on Urban Floods** was organized by the Department of Civil Engineering at IISc from 24–29 August, 2015.

Last year, the school began as an outreach activity as part of the research project entitled "Urban Flood Management in India: Technology Driven Solutions", sponsored by ITRA (Information Technology Research Academy) and the Ministry of Information and Technology, Government of India. Lack of trained manpower and the miniscule number of experts available in the country led PP Mujumdar, Professor, Civil Engineering, to take the initiative.

The key feature of the week-long school was its interactive nature. Participants were divided into small groups and were assigned problems related to urban flooding and water policies, among several others. The groups were encouraged to present their ideas for solving the assigned problem. This exercise was followed by a computer tutorial on how to use software to analyze problems of flooding in cities.

Apart from tutorials and group discussions, expert lectures on topics like urban meteorology, urban hydrology, radar and remote sensing analysis of rain events, big data analysis for urban processes, engineering practices and post-flood responses, were also held. A visit to the Karnataka State Disaster Management Centre (KSDMC) and the Hydraulics lab in IISc was also arranged. KSDMC is a government organization which monitors floods in the city and was one of the partners of this school.

"It was a good exposure for the participants to know what measures the government is taking to combat urban flooding," said Mujumdar. "It is good to see that MS Baroda University has now started working on urban floods after some of their faculty members attended the school last year. And enthused by both the content and structure of the programme, RK Dave, Head, Government Initiatives, ITRA has requested us to conduct the next edition in Nepal," he added.

Courtesy: SRIVANI ACHARYA

Participants during a live demonstration held as part of the school

Given the success of the programme, the only difficulty that the organizers had to deal with was accommodating the large number of participants. There were 47 participants this year, compared to last year's 30 which included a mix of government officials, young faculty members, researchers and people from the industry. "Selection of the candidates was tough as we got a large number of applications. We tried our best to have a fair representation of gender, geographical locations, and of different educational backgrounds," the organizers said.

✍ **MEGHA PRAKASH**

SMART ENERGY SYSTEMS

A mini symposium on **Smart Energy Systems** was organized by the Robert Bosch Centre for Cyber Physical Systems (RBCCPS) at IISc on 16 September, 2015.

The symposium sought to bring together researchers and students working in the field of energy systems and served as a platform for them to disseminate recent advancements in research and technology.

During the symposium, Shiv Kalyanaraman (Program Director, Special initiatives, IBM Research India) introduced the "nPlug", a device that could help reduce the imbalance in the power loads in urban India, alleviating the problem of power cuts to a large extent. "By identifying power load peaks the nPlug helps distribute the power load evenly," he said. He also spoke about Project UrJar, which envisages recycling discarded laptop batteries and using them to power small table lamps. This technology, he said, is being made available at low prices.

Courtesy: RBCCPS

Participants during the symposium

Rahul Tongia (Professor, Carnegie Mellon University) spoke about how smart grids, introduced in India in 2010, can help cut load shedding, detect power theft and also improve the service quality. Nagendra Rao (Department of Electrical Engineering, IISc) and Kumar PR (IISc) in their talks highlighted the challenges faced in integrating renewable energy sources with the grid system.

✍ **IPSITA HERLEKAR**

IWSDA'15

The **Seventh International Workshop on Signal Design and its Applications in Communications (IWSDA'15)** was held from 13–18 September, 2015 at IISc.

The biannual workshop was jointly organized by the Department of Electrical Communication Engineering (ECE) and the National Mathematics Initiative (NMI), and was co-sponsored by the Bengaluru Chapter of the Institute of Electrical and Electronics Engineers (IEEE). The workshop series originated in 2001 in Chengdu, China, and was held in India for the first time.

The weeklong workshop covered a wide range of topics such as signal design for CDMA, error-correcting codes, cryptography and big data analytics. There were also keynote and invited talks and poster sessions, broadly on low-correlation sequences and coding theory.

A special session was organized to celebrate the 60th birthday of P Vijay Kumar (Professor, ECE), a pioneer in the field of signal design. He has made seminal contributions to 3G Wideband Code Division Multiple Access (WCDMA), a technology that enhances the data transfer rate, which is ubiquitous in mobile telecommunication networks.

Courtesy: PUBLIC RELATIONS OFFICE

Participants at IWSDA'15

Speaking to CONNECT, T Srinivas, a professor at ECE, and one of the organizers of the conference, said, "The workshop provided a common discussion platform for pseudorandom sequence designers, coding theorists, cryptographers, communication practitioners and mathematicians."

✍ **SUDHI OBEROI**

HIGHER EDUCATION: WHAT'S THE WAY FORWARD?

A **Discussion Meeting on New Knowledge** was organized by the Centre for Contemporary Studies (CCS), IISc, on 3 October, 2015 to discuss the challenges facing the higher education system in India and the steps to overcome them.

One of the major challenges in India is bureaucratic interference, said Rudra Pratap (Chairman and Professor, Centre for Nano Science and Engineering, IISc). On the other hand, the education system in countries like Finland is successful because it lends greater autonomy to teachers at the university level, he added To help improve the state of institutes of higher education in India, Suri Venkatachalam (Connexions Life Science, Bangalore) suggested that increased funding was essential. However, S Sivaram (Director, National Chemical Laboratories, Pune) opined that government funding alone would not fuel innovation.

Improving Curriculum Content

Rajan Gurukkal (CCS) said that academics should map new knowledge which is interdisciplinary and regenerative in nature, and which helps us understand problems of national interest. Agreeing with Gurukkal, Harini Nagendra (Azim Premji University) added that new knowledge is complex, and that it changes rapidly. In order to integrate and contextualize such new knowledge, Venkatachalam and Anindita Bhadra (Assistant Professor, IISER Kolkata) stressed on the need for including liberal arts and humanities courses in science institutes.

In addition to upgrading the curricula, most speakers agreed on widening the scope for hands-on training in the learning process. Highlighting a Karnataka government initiative called "Catch them young", Maulishree Agrahari (Directorate of IT & BT, Bangalore) explained how it helped impoverished school children participate in science experiments designed to spark their interest.

Assessment

After curriculum design and teaching, assessment is the next step. NJ Rao (Former Chairperson, Department of Electronics Systems Engineering, IISc) said that evaluators tend to focus on a few specific keywords in the students' answer sheets, which assumes that what is not examinable is not worth teaching. HA Ranganath (Visiting Professor, Division of Biological Sciences, IISc) argued that the final grades given should be transferable between different universities and countries.

Industry Interaction

Addressing ways to enhance academia-industry interaction, S Sivaram invoked legislations in the USA and Germany that helped universities reap financial benefits by letting them hold—and then lease for a fee—the Intellectual Property Rights for inventions made by their researchers. In addition to interaction with the industry, Nagendra expressed the need to encourage academic interaction with the civil society as well, for overall growth of the students.

Based on the discussion, the organizers proposed to prepare a policy document and submit it to the Ministry of Human Resources Development.

Courtesy: CCS

Row-wise (L to R): S. Sivaram, Raghavendra Gadagkar, HA Ranganath, Maulishree Agrahari, Vijay Chandru, Suri Venkatachalam, Parameshwar Iyer, NJ Rao, Anindita Bhadra, Rajan Gurukkal, Harini Nagendra, Rudra Pratap, Uday Balakrishnan

✍ **RAGHUNATH JOSHI**

CONFERENCE ON NEURODEGENERATIVE DISEASES

The newly-founded Centre for Brain Research (CBR) at IISc organized its first international conference from 16–18 November, 2015, on **Neurodegenerative Diseases: Pathogenesis to Therapy**. Leading researchers from all over the world gathered to deliberate on the challenges and recent advances in diseases related to the ageing brain.

"Relentless ageing of the society and imperfect diagnosis is making Alzheimer's disease (AD) a world health epidemic," warned John C. Morris (Professor, Washington University at St. Louis) in his talk. He added that the AD brain is usually irreparably damaged by the onset of the behavioral symptoms, rendering clinical intervention futile. Other talks stressed the need for a more systematic, focused and collaborative effort to deepen our understanding of neurodegenerative diseases and mitigate their symptoms. Researchers also presented novel population-level epidemiology studies and computational approaches for early diagnosis apart from discussing the recent successes in the field. Many speakers also highlighted the need for research in detecting and treating another form of dementia seen in some people suffering from Parkinson's disease.

Deepak Nair and Balaji Jayaprakash (both assistant Professors from the Centre for Neuroscience) showcased the recently set up ultra-resolution microscopy and in-vivo live neuron cell imaging facilities at IISc. Vijayalakshmi Ravindranath (Chairperson, Centre for Neuroscience) also presented promising data that showed how traditional Indian herb extracts reduced Alzheimer's symptoms in animal models of the disease.

The conference concluded with a panel discussion on the importance of creating a "Dementia Network" —a common platform for caregivers, researchers and doctors. Chairing the panel, Stanley Fahn

Courtesy: PUBLIC RELATIONS OFFICE

Left to Right: Yves Joanette, Sudha Seshadri, Hirsch Etienne, Vijayalakshmi Ravindranath, Kris Gopalakrishnan, Ana Ines Ansaldo

(Columbia University) stressed on the importance of communication between all the members of this proposed network. Yves Joanette (Université de Montréal) added that it was important for academia and industry to collaborate. Y Narahari (Professor, Department of Computer Science and Automation, IISc) underscored the role of big data analytics and cloud based data-sharing among members. Echoing the views of the panel, Ravindranath, in her concluding remarks, indicated that CBR would create a web portal to connect people working in the field of dementia.

The Centre was founded earlier this year with a generous grant from the Pratiksha Trust, established by Kris Gopalakrishnan (co-founder of Infosys) and his wife, Sudha Gopalakrishnan. Explaining the motivation behind setting up the Centre, Kris Gopalakrishnan said, "In the next 10 years, the population above the age of 65 in India will go up dramatically and it is estimated that one out of every five individuals will suffer from brain-related disorders." Speaking to CONNECT, he also said that he would like to see IISc, and hence Bangalore, become the hub for brain research. "This conference is just one of the many more to come in future ," he added.

✍ **SUDHI OBEROI**

6TH EDITION OF THE STUDENTS' CONFERENCE ON CONSERVATION SCIENCE (SCCS)

Courtesy: SCCS

Jairam Ramesh, the former Union Minister for Environment and Forests

The sixth edition of **SCCS**, as in previous years, was held at IISc, from 8–11 September, 2015. It was organized by the Centre for Ecological Sciences (CES) at IISc, the National Centre for Biological Sciences (NCBS), the Ashoka Trust for Research in Ecology and the Environment (ATREE) along with the Madras Crocodile Bank Trust (MCBT) in Chennai and the Asian Nature Conservation Foundation (ANCF) in Mysore.

Around 500 participants from over 11 countries came together to share ideas and learn new skills during the event which included talks by experts, workshops, student presentations and posters. The focus of this year's conference was on conservation work being done in Asia and Africa.

The event started with a plenary talk by TR Shankar Raman of the Nature Conservation Foundation, who talked about his team's work on ecological restoration. This was followed by a session with Ben Mirin, a beat boxer and avid birder, who combined vocal percussions with bird calls to produce some splendid music. In his plenary talk on day two, James D Nichols, who has been a scientist with the US Fish and Wildlife Service for more than 40 years and a long-time collaborator on Indian conservation research projects, spoke about how to make science more useful for conservation.

The plenary on day three by Sudha Vasan (Delhi University) illustrated the extent of globalization across India using the example of villages in the Kullu district where agriculture has shifted from traditional food crops to cash crops. Uma Ramakrishnan (NCBS) spoke about how advancements in genetics have aided conservation during her plenary talk on the final day of SCCS.

Conference Format

The first day of the conference focused entirely on long workshops, which ran for six hours each. Other days included shorter workshops every afternoon, imparting a variety of skills required for conservation. There were "Who's Who in Conservation" sessions to introduce people to the work done by various research institutions and conservation organizations.

Every evening during the four-day event, public lectures were organized. Krushnamegh Kunte from NCBS spoke about retaining a sense of wonder for nature, and his passion for butterflies. Kanchi Kohli, a researcher and activist, detailed the conflicting aims of development and environmental management, and finally, Jairam Ramesh, former Union Minister of Environment and Forests, discussed climate change and Indian policies.

Students gave short presentations on a variety of topics, and from among them, the ones by Grace Nugi from Papua New Guinea, Rachakonda Sreekar from India and Rodrigue Castro Gbedomon from Benin were adjudged as the three best talks of the conference.

✍ **ANANYA JANA** and **SHAKILUR KABIR**

(With inputs from **Gubbi labs** and **Madhura Amdekar**)

LOOK WHO'S TALKING

Some of the important lectures delivered at the Indian Institute of Science (IISc) in the past few weeks

INSTITUTE COLLOQUIUM: ED JEMMIS

Courtesy: ED JEMMIS

"In 1968, during my undergraduate days, one of the classroom lectures on the relationship between benzene and graphite, and methane and diamond triggered curiosity in me if a similar connection existed for the element boron," recalled ED Jemmis, who gave the Institute Colloquium on 12 November 2015.

Jemmis is a professor in the Department of Inorganic and Physical Chemistry who studies structural chemistry of boron. In his talk, he gave an overview of his research in several areas and then concentrated on how boranes—compounds of boron and hydrogen—are related to elemental boron.

To understand this relationship, Jemmis proposed the 'mno' rules, which are electron counting rules to deduce the structure of polyhedral molecules. These rules help in understanding the structure of polyhedral boranes and their relationship with elemental boron. Jemmis explained how the 'mno' rules are used to understand the complicated structure of the beta-rhombohedral boron, the most thermodynamically stable allotrope of boron. He also described numerous experiments that support the theoretical explanation of this allotrope's structure which includes many extra occupancies and a vacancy, based on the 'mno' rules.

✍ **G NISHA MEENAKSHI**

INSTITUTE COLLOQUIUM: SUNDARRAJAN ASOKAN

Courtesy: S ASOKAN

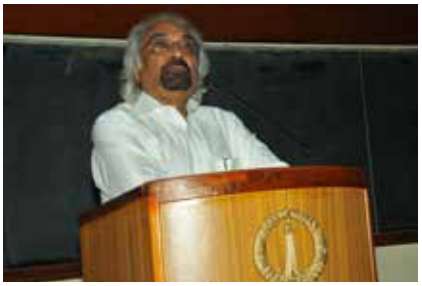
Sundarrajan Asokan, Chairperson of the Robert Bosch Center for Cyber-Physical Systems and a professor at the Department of Instrumentation and Applied Physics, has worked on Fibre Bragg Gratings (FBGs) for nearly a decade, and it was the subject of his Colloquium on October 28, 2015.

FBGs consist of a grating etched in an optical fibre—composed of a core with a sinusoidally varying refractive index—and a cladding. A wave travelling forwards in the fibre constructively interferes with one travelling backwards, arising from Fresnel reflection. This results in one sharp wavelength being reflected, determined solely by twice the product of the effective refractive index and the pitch of the grating. Minute changes in the pitch (due to mechanical strain, temperature or vibration) or the effective refractive index (arising from chemical or biological processes in the surrounding medium) would result in a shift in the reflected wavelength which can then be easily detected.

The main advantages of FBG sensors over the more conventional detectors lie in their insensitivity to electromagnetic interference, chemical inertness, high bandwidth and small size which permits a large array to be placed on the same fibre.

✍ **RHINE SAMAJDAR**

SAM PITRODA'S JOURNEY TO CONNECT INDIA



Courtesy: PUBLIC RELATIONS OFFICE

Sam Pitroda played a pivotal role in developing telecommunications technology relevant for Indian conditions. On 21 October, 2015, he gave a talk at IISc about this "Journey to Connect India", and more.

After graduation, Pitroda travelled to the US, and did a Master's in Electrical Engineering. He then, "by accident," got into a telephone company that worked on early designs of switching systems, went on to build a business in 1974, and sold it in 1979 for $50 million. During this period, while on a trip to India, he found he couldn't make a phone call from Delhi to his wife in Chicago. He resolved to set that right which is how he got involved with C-DOT (Center for Development of Telematics). "If I had known everything I know today about India, I'd have never tried it," he quipped.

Pitroda talked about his friendship with former Prime Minister Rajiv Gandhi, and his work on several national programmes where he used technology to address the problems of development, overcoming several obstacles placed in his path by vested interests, both national and international. A change of government led to corruption charges being filed against him, which ultimately fell flat. Later, he was involved with the National Knowledge Commission.

Towards the end of his talk, he imagined how education, health and governance would be transformed in the next few years due to the internet. "Change is inevitable," he said.

✍ **NITHYANAND RAO**

3RD CBR LECTURE ON NEUROMORPHIC ENGINEERING

Neuromorphic engineering is an emerging interdisciplinary field that involves designing sophisticated devices based on the complex neural circuits of the brain. André van Schaik, who made the first neuromorphic product in 1994, gave the third Centre for Brain Research (CBR) lecture "Neuromorphic Engineering: Why is it such a hot topic?" on 23 September, 2015 at the Indian Institute of Science (IISc). Schaik is a research professor of Bioelectronics and Neuroscience at the MARCS Institute for Brain, Behaviour and Development at Western Sydney University, Australia.

Courtesy: ANDRÉ VAN SCHAIK

Using principles of the nervous system for engineering applications helps achieve two main goals. First, computations occurring in actual biological circuits could be better understood by attempting to replicate them in hardware. Second, unique properties of biological circuits can help design and implement efficient engineering products. For example, Earsmart, an advanced voice processor chip, replicates principles of sound localisation and separation present in human hearing to suppress surrounding noise, thereby increasing clarity. This product is now being used by leading mobile phone manufactures.

Neuromorphic chips aim to circumvent the size limitations of traditional chips by mimicking the massive parallel computing power of the brain, Schaik said. He added that they would also consume lesser power and, mimicking biological neurons, the connections in these chips could adapt in response to stimuli.

✍ **DEBALEENA BASU**

EARLY TRANSLATIONAL RESEARCH AT IISc: THE ACETONE FACTORY

✍ SUDHI OBEROI

As a member of the Governing Council of the Indian Institute of Science (IISc) in its early years, Sir M Visvesaraya, the then Dewan of Mysore State, encouraged the Institute to not just explore new avenues of research, but also to use its research to help set up industries. One such enterprise was the Government Acetone Factory

Courtesy: WIKI COMMONS

Cordite filaments manufactured in 1964 in a .303 British Rifle cartridge

If you've had to deal with messy white boards, chances are that you have used acetone to wipe it clean. Acetone or propanone (C_3H_6O), a colourless, flammable organic compound, is used ubiquitously in academic research labs because of its ability to dissolve tough organic compounds such as oils, resins and plastics. It is also employed widely in the pharmaceutical industry for thinning and dissolving substances, and in the manufacture of varnishes, paints and polish removers. But acetone had a very different use about a hundred years ago, during World War I [1, 2].

World War I marked a tumultuous time in the world history and repercussions of this deadly war were felt even in India. Though India was far away from

the theatre of the war, it was under the British Raj, and the Government of India wanted to be prepared for an attack on its soil. It was, in particular, keen on ensuring availability of sufficient ammunition.

The British army, in those days, used cordite instead of gun powder. The manufacture of cordite, a smokeless, highly flammable explosive, required large quantities of acetone. Therefore, the British administration wanted to set up an acetone factory in India at the earliest. To help achieve this goal, they sought the help of a British scientist, Gilbert J Fowler [2, 3, 4].

Gilbert J Fowler

Fowler was an eminent environmental science and engineering specialist and the Director of the Frankland laboratories in England. He had pioneered the development of the activated sludge process to treat sewage. He was also among the first to advocate the recovery of nitrogen from waste materials for use in soil fertilization and healthy crop production. When he eventually moved to India, Fowler's efforts led to installation of activated sludge plants all over the country, including one at IISc.

Courtesy: APC

Gilbert J Fowler, Professor, Department of Applied Chemistry at IISc

In 1915, Fowler was offered a position in the Department of Applied Chemistry at IISc. At the behest of Harold Baily Dixon, a professor at the University of Manchester, he accepted the offer. It was also then that he was approached by the Government to help with manufacture of acetone in India [5]. When he arrived in India, Fowler, by virtue of his expertise on the subject, was appointed as the consulting chemist on a project to produce acetone from starch.

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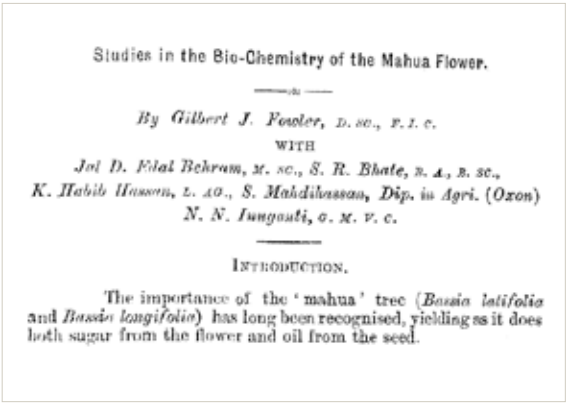
Convergence of Interests

As World War I was in full swing, the Government of India envisioned and drafted a factory for industrial scale production of acetone to manufacture cordite. This initiative complimented the efforts of IISc to help set up industries based on its research, greatly influenced by the "industrialize or perish" mantra of Sir M Visvesaraya [1].

Fowler's Method

To produce acetone, it was important for Fowler to choose the right method, one that was both inexpensive and efficient so that the research conducted in the lab could be scaled up for production in a factory. Prior to his research, acetone was being produced mainly by distillation of wood. Acetone produced by this method constituted



Studies in the Bio-Chemistry of the Mahua Flower.

By Gilbert J. Fowler, D. SC., F. I. C.

WITH

Jal D. Filat Behram, M. SC., S. R. Bhate, B. A., B. SC.,
K. Habib Hussen, L. AG., S. Mahdihassan, Dip. in Agri. (Oxon)
N. N. Jungauli, G. M. V. C.

INTRODUCTION.

The importance of the 'mahua' tree (*Bassia latifolia* and *Bassia longifolia*) has long been recognised, yielding as it does both sugar from the flower and oil from the seed.

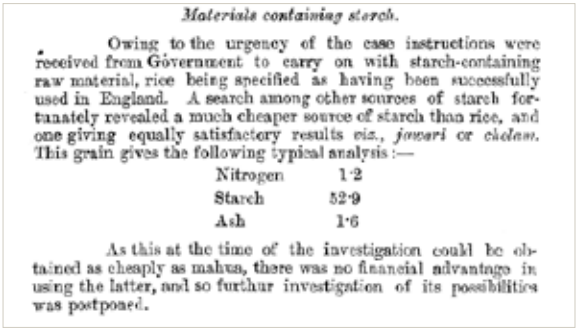
Courtesy: IISc PRESS

Fowler's paper detailing the properties of Mahua flowers [6]

50-55% of the mixture yielded after distillation. However, another method to produce acetone was just being developed, one that involved the fermentation of starch-rich substances such as rice, wheat, maize, etc. by the bacterium, *Clostridium acetobutylicum*. After this bacterium, also called the Weizmann Organism, was isolated from the surface of starch sources, it would degrade starch into organic solvents, which when further distilled would produce pure acetone. This process was favored by Fowler and the Government of India because it utilized cheaper sources of starch and the acetone obtained by this process was of higher quality.

In principle, this process was efficient and could be used to manufacture about a million gallons of acetone in two years [4].

But Fowler had to first find a cheap source of starch. He was introduced to the *Mahua* flower (*Bassia Latifolia*) which he then believed was the ideal candidate. *Mahua* flowers were already being used to produce large quantities of alcohol by fermenting the sugar contained in them in a factory in Hyderabad. So along with his team of two Indian research scholars, YG Wad and AG Gokhale, Fowler began working on experiments to produce acetone from *Mahua* flowers. However, after repeated attempts, they found that the flower contained little or no starch. They conducted further experiments to improve the fermentability of these flowers, but these efforts also proved to be unsuccessful [3, 4].



Materials containing starch.

Owing to the urgency of the case instructions were received from Government to carry on with starch-containing raw material, rice being specified as having been successfully used in England. A search among other sources of starch fortunately revealed a much cheaper source of starch than rice, and one giving equally satisfactory results *viz.*, *jowari* or *cholam*. This grain gives the following typical analysis :—

Nitrogen	1·2
Starch	52·9
Ash	1·6

As this at the time of the investigation could be obtained as cheaply as mahua, there was no financial advantage in using the latter, and so further investigation of its possibilities was postponed.

Courtesy: IISc PRESS

Fowler's paper demonstrating jawar as a source of starch [7]

Following the failure of fermentation experiments with *Mahua*, Fowler and his team started looking for alternate sources of starch. One of their options was to use rice, which was already being used in England for fermentation experiments. But Fowler's team was seeking a cheaper alternative. And fortunately for them, a cheaper source was found: *Jawari* or *Cholan* (*Sorghum vulgare*). *Jawari* yielded satisfactory results during trial fermentations, producing considerable amounts of acetone. This convinced Fowler and his team that it should be the raw material for large scale production of acetone [6, 7, 8].

Jawari yielded satisfactory results during trial fermentations, producing considerable amounts of acetone

Acetone Factory

With *Jawari* qualifying as a source of starch for the production of acetone, an experimental plant was set up in the Department of Applied Chemistry at IISc itself. A fermentation plant was imported from England. Besides a fermentation unit, it consisted of a distillation unit and an effluent purification unit. The plant was capable of producing 6 gallons of acetone in each fermentation cycle [4].

The plant set up in the Institute aimed to study the entire process thoroughly before scaling up for industrial application. IISc also hosted a temporary office of the Government Acetone Factory in Bungalow No. 9. The Government rented the bungalow from the Institute for a monthly rent of Rs. 120. They hired drawing staff, engineers and architects for the factory that would eventually be setup. These people were trained by the expertise available in the Department of Applied Chemistry. Fowler's students, Wad and Gokhale were appointed as assistant bacteriologist and assistant chemist respectively of this new enterprise [3, 4].

The team, now expanded, worked hard to perfect the fermentation and purification processes involved in the production of acetone, all along

CONNECT

Bungalow No. 9 which served as the office for the acetone factory that was to come up in Nasik

ensuring the sterility of the plant, until they were satisfied with the results. It was now time to set up the factory.

The Government decided to establish the factory in Nasik rather than in Bangalore. And so the Government Acetone Factory at Nasik was born using the research that was conducted under Fowler's guidance at IISc. It became fully operational soon and provided acetone for production of cordite for the British war effort. However, not long after, in 1918, World War I was coming to an end. Eventually, the demand for cordite went down, and the project was dropped and production of acetone stopped [2, 8].

Eventually, the demand for cordite went down, and the project was dropped and production of acetone stopped

Even though the factory did not remain functional after World War I, research on fermentation at the Institute continued. Scientists from IISc also offered technical help to the *Mahua* industry in Hyderabad where its flowers were being investigated as a source for industrial alcohol and motor fuel.

(The author acknowledges the help of Sowmithri Ranganathan for help in sourcing archival material for the article.)

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AND THE AWARD GOES TO...

Researchers from the Indian Institute of Science who were honoured with awards

✍ Compiled by **MANU RAJAN, IPSITA HERLEKAR** and **SUDHI OBEROI**

CONNECT

ROHINI M GODBOLE

Professor, Centre for High Energy Physics

Devi Award of the New Indian Express Group

Courtesy: CHANDAN SRIVASTAVA

CHANDAN SRIVASTAVA

Assistant Professor, Department of Materials Engineering

NASI Young Scientist Platinum Jubilee Award

MANOJ SUDHAKARAN

PRADIP DUTTA

Professor, Department of Mechanical Engineering

Distinguished Alumnus Award, IIT Kharagpur

MANOJ SUDHAKARAN

PARTHA TALUKDAR

Assistant Professor, Supercomputer Education and Research Centre

Accenture Open Innovation Grant Award

CONNECT

GOVARDHAN P REDDY

Assistant Professor, Solid State and Structural Chemistry Unit

Dr. Srinivasan Rajagopalan Award of the IISc Alumni Association

Courtesy: SANTANU MUKHERJEE

SANTANU MUKHERJEE

Assistant Professor, Department of Organic Chemistry

Dr Srinivasan Rajagopalan Award of the IISc Alumni Association

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RAGHAVENDRA GADAGKAR

Professor, Centre for Ecological Sciences

AV Raman Rao Technology Award by CSIR Indian Institute of Chemical Technology

CONNECT

S VASUDEVAN

Professor, Department of Inorganic and Physical Chemistry

JC Bose Award

Courtesy: S RAMAKRISHNAN

S RAMAKRISHNAN

Professor, Inorganic and Physical Chemistry

Distinguished Alumnus Award, IIT Bombay

CONNECT

GURUNATH GURRALA

Assistant Professor, Department of Electrical Engineering

Young Engineer Award of Indian National Academy of Engineering

MANOJ SUDHAKARAN

SATHEES C RAGHAVAN

Associate Professor, Department of Biochemistry

DAE SRC Outstanding Investigator Award for Biological Sciences

Courtesy: SURYASARTHI BOSE

SURYASARATHI BOSE

Assistant Professor, Department of Materials Engineering

Young Engineer Award by the Indian National Academy of Engineering

Courtesy: ANINDA J BHATTACHARYYA

ANINDA J BHATTACHARYYA

Associate Professor, Solid State and Structural Chemistry Unit

National Prize for Chemical Research by Chemical Research Society of India

Courtesy: SANJIV SAMBANDHAN

SANJIV SAMBANDAN AND HIS GROUP

Assistant Professor, Instrumentation and Applied Physics

Google Pitch Fest Award, Switzerland

CONNECT

GADADHAR MISRA

Professor, Department of Mathematics

Biju Pattnaik Award for Scientific Excellence by Government of Orissa

Courtesy: KP GOPINATHAN

KP GOPINATHAN

Professor, Department of Microbiology and Cell Biology

Kerala State Award for Lifelong Accomplishments in Science

Courtesy: MAYANK SHRIVASTAVA

MAYANK SHRIVASTAVA

Assistant Professor, Department of Electronic Systems Engineering

IEEE Electron Devices Society Early Career Award

Courtesy: U RAMAMURTY

UPADRASTA RAMAMURTY

Professor, Department of Materials Engineering

The World Academy of Sciences Award (Engineering)

Courtesy: ALUMNI ASSOCIATION

IISC ALUMNI AWARDS

The Alumni Association of IISc gave away its **Distinguished Alumnus Awards** for 2015. The recipients were **AS Kiran Kumar** (Chairman, Indian Space Research Organization), **KSR Charan Reddy** (Inspector General of Police, Special Investigation Team, Karnataka Lokayukta) and **Vedu Mitter** (Chief Executive, Changeman, Bengaluru)

Campus Critters

A rare sighting of the Indian Cobra

Main Building, Indian Institute of Science