CONNECT

WITH THE INDIAN INSTITUTE OF SCIENCE

Crystallography: Its history through its tools

Centre for Contemporary Studies: A case for humanities

George Smoot: Astrophysicist and Nobel laureate

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COVER PAGES

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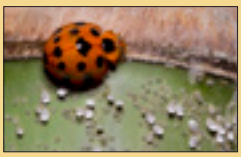
Front Inside Cover: IISc Campus (Photograph: Kumar MP)



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From the CONNECT Team

Greetings!

As we enter the new year, CONNECT has taken another step, a significant one, in its evolution. It will now appear in the form of a magazine rather than as a newsletter. The transformation comes with two other changes. One, it will have more reading and be broader in scope. Two, CONNECT will now be a quarterly instead of a bimonthly; this year will see four issues, of which this is the first.

In the last couple of issues, we have been running a multi-part series on the significant contributions by researchers from the Indian Institute of Science (IISc) to the field of crystallography. It seemed appropriate to feature this increasingly multidisciplinary area of research, not just because IISc has had many stalwarts in the field, but also because 2014 was proclaimed as the *International Year of Crystallography* by the United Nations. This issue sees the final article in that series. It tells the story of crystallography at IISc through the tools of its trade. While the Institute has always been blessed with skilled crystallographers, it has suffered, at least in the past, from a lack of resources. In a field that relies heavily on its instrumentation, not having access to the state-of-the-art has, unfortunately, resulted in our researchers not being able to remain at its forefront. They have, at times, even had to choose their questions based on the equipment at hand. This phase of crystallography, however, spawned some successful attempts at improvisation, thus, once again, revealing the famous *jugaad* instinct. Thankfully, the era of lack of resources is over. But crystallographers at IISc (and elsewhere in the country) still have one major complaint — they do not have a synchrotron, fast becoming a necessity to obtain high quality diffraction data.

We also have an interview with the well-known Kiwi crystallographer, Ted Baker, who visited IISc to give the first M Vijayan Lecture organized by the Alumni Association. Among other visitors to the campus was the Nobel laureate, George Smoot. He talks to CONNECT about his Nobel and other interests.

This issue also highlights an interesting experiment that IISc embarked upon in 2004 when it started the Centre for Contemporary Studies. Its Chair, Raghavendra Gadagkar, tells us what it does and why a centre that focuses on the humanities and social sciences is crucial to the Institute.

And we have plenty more. Please do write to us with your feedback. We always look forward to hearing from you.

Happy reading!

In This Issue...

CRYSTALLOGRAPHY AT THE INSTITUTE (PART III): THE MACHINERY

The third and final part of this series traces the history of crystallography at IISc through the tools of the trade

✍ MANEESH KUNTE

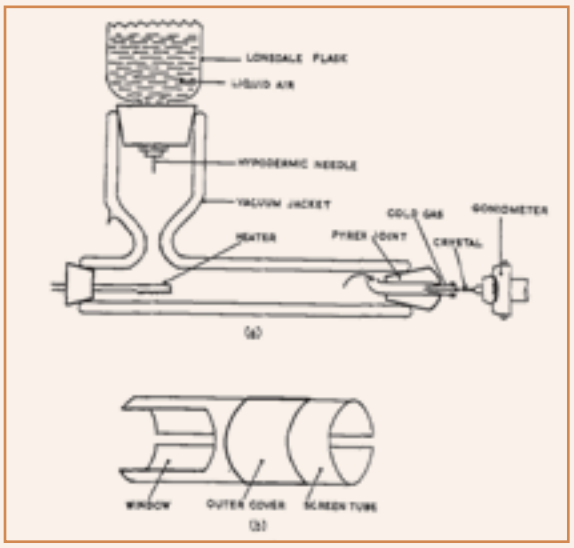
There are many ways of recounting the history of a science — through its protagonists, through the science itself, and sometimes through the tools of its trade.

Instruments used in crystallography calculate the structure of a crystal by analysing how it interacts with radiation beamed upon it. When X-rays or other electromagnetic waves are incident on a crystal, the atoms scatter the radiation in very specific patterns because of their unique and regular placement in the crystal lattice or framework. The incident radiation could be in the form of X-rays (as in X-ray crystallography) or electrons (as in Scanning Electron Microscopy) and is generated by an appropriate source. The scattered rays from the crystal are captured as spots, either on a photographic film as in the days of yore or on a specialized detector. The crystal structure can then be back-calculated from the pattern of scatter spots.

The history of crystallography at IISc when told through its instruments reveals an interesting story, but not an uncommon one in India. It is the story of researchers having to build their own versions of standard instruments readily available abroad, of having to hack them for added functionality, of having to reinvent the metaphorical wheel, and sadder still, of having to pick problems based on the tools they had.

Building Your Own

The late MA Viswamitra, a PhD student working with S Ramaseshan (the pioneer of crystallography at IISc and its former Director), built a low-temperature Weissenberg camera himself. The basic Weissenberg camera consisted of a cylinder along whose axis the crystal of interest was mounted. A slit along the length of the cylinder allowed X-rays to strike the crystal as the crystal rotated about the cylinder's (and also its own) axis. A photographic film lined the sides of the cylinder and recorded the scattered rays from the crystal. A modified version of the Weissenberg camera was built by Viswamitra. It contained a modular cooling circuit and could work with liquid air to cool the crystal. This was a major step forward; it made more accurate measurements thanks to the reduced thermal oscillations of atoms. Viswamitra went on to become a professor of physics himself at IISc on completing his PhD.



J. SCI. INSTRUM.

A sectional view of the low temperature Weissenberg camera from the original publication (*J. Sci. Instrum.*, 1962, Vol. 39)

Yet another well-known crystallographer from IISc, Hattikudur Manohar, retired Professor, Inorganic and Physical Chemistry (IPC), also built his own copy of a regular Weissenberg camera. He built it when he joined IPC after analyzing the design of a similar instrument in the Physics Department.

Exposing the crystal to X-rays and recording the scattered radiation is just one part of doing crystallography. It also involves the analysis of the captured spots to arrive at the crystal structure. Computation of structures at this point was still largely a manual task with researchers measuring distances and intensities on the exposed photographic films without any machine help.

Improvisation

In a lecture at the Indian Institute of Science Education and Research (IISER), Mohali, TN Guru Row, Professor, Solid State and Structural Chemistry Unit (SSCU), recalled how his group had to improvise to arrive at structures of crystals when he was a PhD student in the Department of Organic Chemistry at IISc. For instance, 3D models of crystals were built for visualization with bicycle spokes and coloured beads from bangle stores. The spokes marked the axes and the beads were the atoms. They were built one atom at a time. The improvisation worked remarkably well, but a large crystal such as Vitamin B_{12} would take up to 6 months to build. Once the models were ready, "we could just take a metre-scale and measure the bond lengths; we could measure the lengths, we could measure the angles, and we were never wrong," Row said.

Automation

The advent of computers in the 1970s saw a revolution in crystallography with a lot of these tasks becoming automated now. Manohar, on sabbatical in Switzerland in 1972, recalls being asked by Satish Dhawan, the then Director of the Institute, to visit the Enraf-Nonius facility at Delft in The Netherlands. Enraf-Nonius was building microcomputer-controlled diffractometers at the time and IISc was considering buying one. The first CAD-4 finally made its way to India in 1975 and was installed in the Central Instrumentation and Service Laboratory (CISL) which later became the Instrumentation Services Unit (ISU) and then the Department of Instrumentation and Applied Physics (IAP). Two more followed a few years later, one each in the Department of Physics and IPC. Computers were still very basic by today's standards — a computer with about 4KB RAM took up an entire room. Programmes were submitted through punch-cards and a 10-atom crystal took about a week to be solved as opposed to an hour or two on a desktop computer now.

VIVEK KUNTE

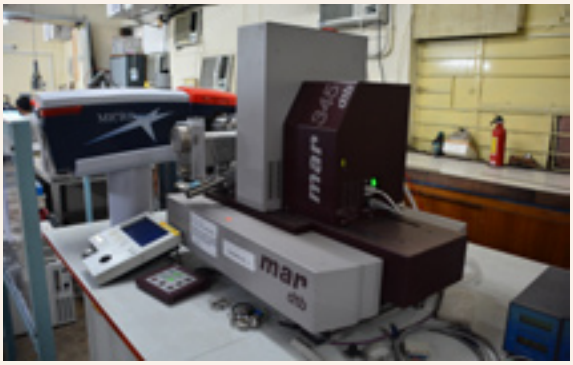
Enraf-Nonius CAD-4 Diffractometer at CISL, IISc (Original image ca. 1975)

Choosing Problems Based on Equipment

Macromolecular crystallography, however, posed other problems. The difficulty in growing a single crystal of large biological molecules and its low thermal stability meant that it could be exposed to X-rays for only a very short time. This required higher intensities and larger detectors, pushing equipment costs higher and making procurement harder. Researchers such as M Vijayan (Emeritus Professor, Molecular Biophysics Unit (MBU)) who were trained in large molecule crystallography were, therefore, forced to pick problems that fit their methods.

Increased Funding

But this situation began to change in the 1980s when DST (Department of Science and Technology) recognized the importance of X-ray crystallography



N VINAYAK

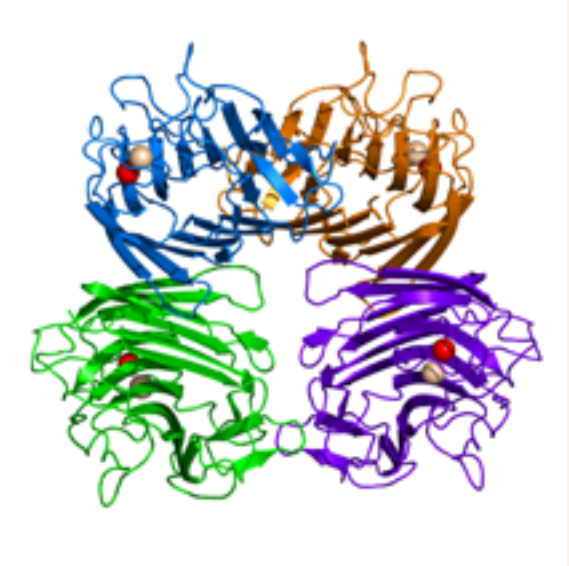
X-ray generator with Imaging plate detector at MBU, IISc

as a thrust area and increased funding. "[Now] there was a facility, and immediately, work on proteins and viruses was started at Bangalore and first structures of both viruses and proteins came in the 90s," says MRN Murthy (Professor, MBU and former Dean of Science) who started his career as a faculty member at IISc around that time.

Advances in Protein and Chemical Crystallography

It was also during this period that photographic films as sensors gave way to multi-wire area detectors and then to imaging plate detectors. Now diffraction spots could be recorded on a plate in two-dimensions, read off using a He-Ne laser, and then erased, similar to a rewritable CD. A detector of this kind allowed the researcher to capture the scattered rays even from a large molecule in one shot. This helped Vijayan to solve the structure of peanut lectin, a type of protein.

Chemical crystallography too saw technological shifts with newer techniques such as the Rietveld method gaining prominence. This method allowed the refinement of data from powder crystallography



MBU

Crystal structure of peanut lectin, the first to be determined at the X-ray facility in MBU using X-ray diffraction data

International Year of Crystallography 2014

During its sixty-sixth session in July 2012, the United Nations General Assembly (UNGA) proclaimed 2014 as the International Year of Crystallography (IYCr). Crystallography, the study of the structure of crystals and their formation, is today an indispensable tool in fields as diverse as materials science and biology. To popularize the science of crystallography and its many implications, and to provide an impetus to ongoing research in the field, UNESCO organized numerous activities around the world in 2014 in association with the International Union of Crystallography (IUCr). These activities included conferences, workshops, open labs and competitions for school children.

In India, the Indian Institute of Science (IISc) which has a long tradition in crystallography was involved in many outreach activities. The theme of IISc's annual calendar was crystallography and the significant achievements of crystallographers from the Institute. IISc was also involved in the release of a special postage stamp to commemorate IYCr on 30 January last year. The *Journal of the Indian Institute of Science*, published by IIScPress, brought out a special volume on crystallography. Educational material produced by IUCr to celebrate crystallography was translated into several regional Indian languages to reach out to school children.

KG HARIDASAN

Stamp release ceremony

Gautam Radhakrishna Desiraju is a Professor in the Solid State and Structural Chemistry Unit (SSCU), IISc, and the immediate past President of IUCr. He also heads the activities of IUCr in India. He spoke to CONNECT about some of the initiatives of IUCr in 2014, particularly in India.

G DESIRAJU / AN PRIYA

Q Why celebrate 'international years'?

'International years' help in creating awareness among students and the general public. It allows us to focus on communicating the worth of doing science to both the government and the public.

Q Can you tell us about some of the international initiatives undertaken by IUCr during 2014?

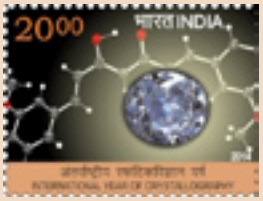
In countries like Japan and Italy, the Crystallography Societies and Associations got together with museums to analyze the pigments on paintings using X-ray methods. The idea was to interest people in the subject. And many countries also released postal stamps. Apart from such activities, theme-based summits were organized in Pakistan (chemical crystallography), Brazil (synchrotron), and South Africa. These summits were held to expose young students to the field and also give researchers and policy makers a common platform to meet and discuss challenges, new technologies etc. For example, in South Africa, a country rich in minerals, a workshop on technical diffraction was thought to be useful in letting people come and see the facility used to analyze minerals. Similarly, Brazil which boasts of a synchrotron organized a Latin American summit on biological crystallography. In addition to summits, open labs were organized in 15 different locations in association with IUCr, UNESCO, and with the support of several private companies. UNESCO helped students to travel to neighboring countries for intensive training programmes (for a week or two) on how to use crystallography machines or learn a bit of crystallography. Since awareness about crystallography in India is sufficiently high, an open lab was not hosted in India.

Q How did the idea of releasing a postal stamp at IISc come about?

The idea was proposed by P Balaram, the then Director of IISc, because the Institute has had some eminent crystallographers like GN Ramachandran, S Ramaseshan and many others. Based on his suggestion and encouragement, we decided to release the stamp on 30 January, 2014.

Q What does the stamp depict?

The stamp depicts a diamond, known for its hardness, and the structure of curcumin, a component which provides turmeric its medicinal property.



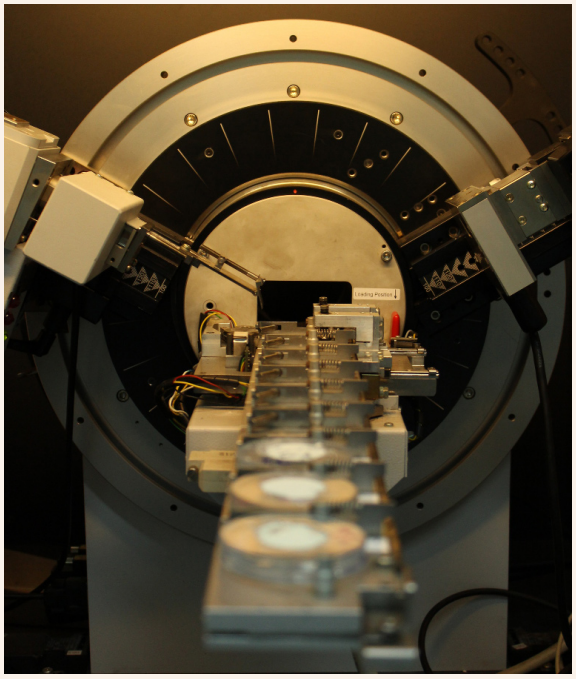
Read more about IYCr here: http://www.iycr2014.org/

✍ MEGHA PRAKASH

studies, wherein the single crystal is replaced by a powder of the material. Newer detectors of the Charge Coupled Device (CCD) type, which led to the Nobel Prize in Physics in 2009, also began to find application in crystallographic imaging in place of photographic film detectors and line detectors. Chemical crystallography in IISc received a big boost when Gautam Desiraju moved to SSCU as a professor in 2009 after a long stint at the University of Hyderabad. (Desiraju currently heads the activities of the International Union of Crystallography in India and has been its past President) [*See box*]. The chemical crystallography facility was started in 2000; it now boasts of a highly advanced setup with 3 additional single-crystal X-ray diffractometers, 2 powder X-ray diffractometers, and 1 small angle diffraction machine.

New Applications

The changing technology and advances in the science



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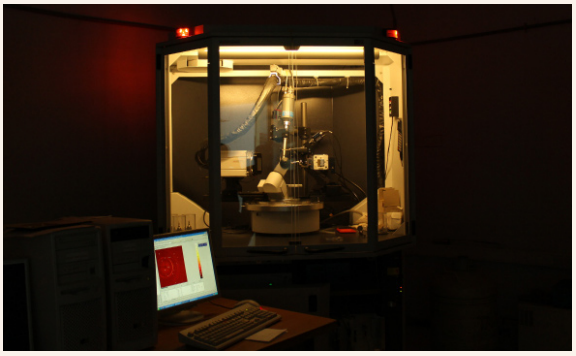
Bruker Powder Diffractometer

have also led to a change in the crystallographer's role. Structure determination is no longer the end-result; structural data of molecules is an invaluable input for further analysis in studies in fields as diverse as evolutionary biology and drug design. As S Ramakumar, Professor, Physics Department, says, "One can say that the 3D structure is a starting point for further elaboration and discussion." One such example is the work carried out recently by Ramakumar in collaboration with V Nagaraja, Professor, Microbiology and Cell Biology (MCBL). They analyzed the crystallographic structure of a protein from the tuberculosis-causing bacterium at the central facility set up by the Division of Chemical Sciences. This led to the identification of a molecule that can target and potentially inhibit the bacterium.

Need for a Synchrotron

Applications of interdisciplinary crystallography studies, as in the case of the search for a cure for tuberculosis, have highlighted the importance of having the latest and best facilities at hand. One such facility, sorely lacking in India, is a synchrotron. A synchrotron, a type of a particle accelerator, allows the generation of much higher energy X-rays with



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A single crystal diffractometer in action in the CCD facility in the Division of Chemical Sciences

consequently lower wavelengths, which in turn leads to finer-grained data. Higher energy sources also allow the user to carry out time-resolved crystallography with a series of snapshots being taken and pieced together to generate a sequence like a video. While DST has been forthcoming with funds for researchers to travel to synchrotron facilities abroad, the logistics involved in transporting crystals out of the country every time a structure is to be determined makes a strong case for having this facility in our own country. Crystallographers in the country have been expressing the need for a synchrotron for some time now.

Challenges

The other challenge has been in attracting newer talent into the field. As Vijayan puts it, "We need younger people to continue the tradition in chemical crystallography. Even physics-oriented crystallography is very weak. It is imperative to get new faculty," he says. There is also another worry. Most crystallographers in the country are experimentalists, which by itself is not a bad thing, but it seems to have cost India's pre-eminence in theoretical crystallography. As Murthy puts it, "Now most crystallographers are practical crystallographers who do experimental crystallography. That finesse in theory is kind of lost in the country."

The author would like to thank the following people for help with the article: H Manohar, retired Professor, IPC; M Vijayan, Emeritus Professor, MBU; MRN Murthy, Professor, MBU; TN Guru Row, Professor, SSCU; S Ramakumar, Professor, Dept. of Physics; Amar Hosamani, PhD student, SSCU.

GEORGE F SMOOT

George F Smoot, the well-known astrophysicist and cosmologist, was at the Indian Institute of Science (IISc) to deliver the **Nobel Prize Inspiration Initiative** lecture titled 'Modern cosmology: The Big Bang Theory' at the Faculty Hall on 3 November, 2014.

George Smoot is famous for his research on cosmic microwave background radiation (CMB), a relic of the Big Bang. In 2006, along with John C Mather, he won the Nobel Prize in Physics for "the discovery of the black body form and anisotropy of the cosmic microwave background radiation". He has worked closely on the Cosmic Background Explorer (COBE), a satellite dedicated to investigating CMB.

Smoot received his BS degree (dual degree in mathematics and physics) in 1966 and PhD in particle physics in 1970, both from the Massachusetts Institute of Technology. He has been serving as a professor of physics at the University of California, Berkeley and at the Lawrence Berkeley National Laboratory in California since 1970. Currently he is also with the

CONNECT

University of Sorbonne in France where he directs the Paris Centre for Cosmological Physics (PCCP). He has 9 US patents, over 500 scientific papers and is a member of the National Academy of Sciences, USA. He was recently elected as a member of the National Academy of Inventors, USA.

In 2009, George Smoot made a cameo appearance as himself in the famous American sitcom, *The Big Bang Theory*. He also won $1 million on the TV quiz show *Are You Smarter Than a 5th Grader?*

Smoot took time off during his visit for a brief conversation with CONNECT in which he shared his views on how life has changed after the Nobel, his visit to India, Indian science as well as his other interests.

Q How did you react when you were told that you won the Nobel?

It was three in the morning when I got a call, a call that broke to me the news. At first I thought it was a hoax until I walked into my living room and turned on my computer to check the Nobel Foundation website to be sure. But it wasn't there! (Laughs) I was a bit shocked. However, about fifteen minutes later, my name showed up on the Foundation's website. And the moment it did, I called the Laboratory University Press people and said, "You guys have to wake up because the press reporters are going to try and find you." And there it started. I was happy but at the same time I also had to deal with the onslaught of the press.

Q How is life after the Nobel?

I think of it as another job. Being a Nobel laureate in itself is a whole new job, a job with additional responsibilities other than teaching and doing research. People from all over the world start looking up to you; you get invited for talks and interviews. My inbox overflows with requests from people from different parts of the world inviting me to deliver talks, especially from India. For instance, since it was announced that I was coming to India, I have been getting at least four messages a day!

Q You have come to India a few times. How much has it changed?

My first visit to India was 30 years ago and I have

come a number of times since then. India has changed very noticeably over that time period. For example, there was no IT industry in Bangalore when I first came, but it eventually emerged as an IT destination. I see that in a bunch of countries that we call the developing countries, the changes have been incredible. I expect that India is entering that phase.

Q Do you see Indian science progressing?

India has been progressing well in terms of producing quality students. I had an Indian graduate student who worked with me and she was very good. I also worked with another Indian postdoc when I opened a center in Berkeley. He later got an opportunity at Michigan. In the last 10 years, India has produced good students with whom I have published papers. And having worked with a few of them, I can say that the basic undergraduate education in India provides a strong base for these students to go abroad and develop science ahead in their careers.

Q You are here as part of the Nobel Prize Inspiration Initiative to popularize science. How important is it to communicate science to society?

I think it is absolutely important for the general public in a modern society, especially in a democracy, to be informed about science… and to know the process of science, to know who is doing what. Science literacy and comfort with scientific questions are very important for us to function as a democracy. We have many decisions to make in the next twenty years: whether we need coal-based power plants and if yes, how many we need; whether we need GM crops or designer babies. These kinds of questions will come up.

Q You are a voracious reader. What was the last book that you read?

Earlier, I used to read 2-3 books a week, but now I read only a few every year. In the last two years, I haven't been able to read much, for the reason that life has become too busy. I get to read mainly when I visit my family for Christmas. So during my last vacation, I read three books — one was about society, second on future protection from technology, and the third was a straight fiction.

The Nobel Prize Inspiration Initiative

KG HARIDASAN

Mattias Fyrenius, CEO, Nobel Media AB speaking about the initiative at IISc

The Nobel Prize Inspiration Initiative is a global programme that seeks to bring Nobel laureates into closer contact with the scientific community, especially young scientists. During these interactions, the laureates share their inspirational stories and also insights into their own research. The events in India in October and November, 2014 were the largest outside Scandinavia so far. The programme included an exhibition as well as University lectures, a seminar and other events in Delhi, Bangalore, Mumbai and Pune.

Talking about the initiative, Mattias Fyrenius, CEO, Nobel Media AB, which develops and manages the Initiative's programmes, told CONNECT that the numerous activities they organize are aimed at inspiring people to take up science and research. He added that the idea behind running such activities is to provide a platform for young students and others to interact with the Nobel laureates directly, as well as to bring out the glamour of the Nobel. As part of these activities in India, apart from lectures by Nobel laureates, an exhibition titled 'The Nobel Prize: Ideas Changing the World' was also organized at the Nehru Memorial Museum & Library in New Delhi. According to Fyrenius, the response to these events has been wonderful.

Read more at: http://www.nobelmuseum.se/en/exhibitions/ideas-changing-the-world-sthlm

Q What kind of reading can stir young minds?

I always think it is important that people should have a broad education, understand civilizations and social ideas. It is not a good idea to restrict your reading to your field of interest. Reading outside your field makes one aware about civilizations and the context why it is going on.

I will recommend people to read something like a historical novella or biographies and a bit of fiction. I remember reading fiction when I was young. It used to stir my imagination on how the future might be. And of course, we all recommend biographies of Nobel laureates too! (Laughs)

✍ **MEGHA PRAKASH**

Ramakrishna (Ram) Ramaswamy

ICTS

Ramakrishna Ramaswamy, better known as Ram Ramaswamy, studies stochasticity and non linearities in dynamical systems. An active researcher, educator and administrator, he also blogs regularly about matters pertaining to higher education in India and his experiences at the University of Hyderabad, of which he was the Vice Chancellor until a few days ago. Earlier, Ramaswamy was at the Jawaharlal Nehru University (JNU), New Delhi, where he continues to be a Distinguished Professor. He delivered a talk titled 'Complexity and Simplicity in Biological Systems' organized by the International Centre for Theoretical Sciences (ICTS) at IISc on 21 November, 2014, after which he spoke to CONNECT.

Q You are a trained chemist but your current research interests lie in physics and biology. Can you tell us more about when and how this transformation happened?

Even when I was doing my PhD in chemistry [at Princeton], I was fond of physics and mathematics. It was around then (late 70's) that Chaos Theory picked up and I got interested in it. And when I was in Caltech, I actually got a chance to work in Chaos. Here I took a couple of math courses on Chaos. And later when I came back to TIFR for my postdoc, I started working in "physics". But then I moved to JNU [as a professor] which had an interdisciplinary department of physical sciences; it was there that I started to really concentrate on Chaos Theory and since then most of my work has been in this field.

Q You have been a Vice Chancellor, an active researcher, an administrator and a blogger. How do you manage all these roles without losing focus on your research?

The fact is if I am not able to do research, then nothing makes sense. Earlier I used to have a big group of students, but now due to paucity of time, I have restricted them to three or four. But I make sure that I meet them almost every day.

Q What can be done to promote interdisciplinary science in our schools and colleges?

I do not think we should change anything at the school level. I personally believe that at school things should be taught as separate boxes [subjects] which will help you build a strong foundation and a solid command over a subject. And then when you start doing independent research, you can work in interdisciplinary fields. You will also do much better because of your strong hold in one subject.

✍ **NIKUNJ GOEL**

TED BAKER

Edward Neill Baker

The renowned crystallographer, Edward Neill Baker or 'Ted' Baker, visited IISc to give the first M Vijayan Lecture titled 'Foundations of X-ray Crystallography and its Ability to Transform Biology and Chemistry' on 2 December, 2014 organized by the IISc Alumni Association.

After he completed his PhD in crystallography from the University of Auckland in 1967, his postdoctoral research took him to the University of Oxford, where he worked on the structure of insulin with the Nobel laureate, Dorothy Hodgkin. He then took up an academic position at Massey University back in New Zealand. Here he discovered the structure of the kiwifruit enzyme actinidin. In 1997, he moved back to the University of Auckland where he became a professor of structural biology and later the Director of the Maurice Wilkins Centre for Molecular Biodiscovery. Baker has also served as President of the International Union of Crystallography and is a Fellow of the Royal Society of New Zealand. In 2006, he was awarded the Rutherford Medal, the highest honor in New Zealand science. Baker, currently a Distinguished Professor at the University of Auckland, spoke to CONNECT about his life as a scientist and his interactions with Indian crystallographers. He also emphasized the need for a synchrotron in India.

Q What attracted you to crystallography?

I began in crystallography when I chose it as a research area for my MSc degree. I was attracted by the idea of actually seeing molecules through crystallography which seemed quite amazing to me. It is more satisfying than plotting a graph or recording gels or numbers in a table. Besides, crystallography combined chemistry, physics and mathematics, all the subjects I liked best. What also attracted me was that I really liked the professor who would be my supervisor. Also, the crystallography group was a very lively one.

"Seeing molecules through crystallography is more satisfying than plotting a graph or recording gels or numbers in a table"

Q You and many crystallographers of repute around the world have studied under or worked with Dorothy Hodgkin. What stood out about her?

I admired her scientific achievements enormously, of course. She had such a brilliant, incisive mind that she could look at an electron density map or a diffraction pattern and immediately see what was most important or novel or interesting. Her intuition was amazing. But what struck me equally was her warmth, her kindness and generosity of spirit; she was like one's favourite grandmother, and her first thought was always for people. She was quite simply a wonderful human being. When our first child was born, she made a place in the lab where the baby could be. It was a family sort of place.

Q Why is crystallography so multidisciplinary?

I think it is because crystallography basically reveals the structure of matter, no matter what kind of material it is. So crystallographic skills are

transferable to many fields. What it also does is allow a researcher to develop new and creative ideas. When you can actually see some complex molecule or material in all its detail and beauty, it can suggest entirely new ideas about how it works or how it might be used.

Q In your talk, you emphasized the importance of skills for crystallographers. What kind of skills do they typically need to succeed?

To succeed, you have to really want to succeed, so that if something goes wrong you are then determined to simply find a way around whatever the problem is. The most important skills are generic research skills — to understand data and data quality, and to work carefully and accurately. Later on, an ability to write clearly and simply becomes very important. I think that in the end it has been my ability to write well that has helped me most.

"To succeed, you have to really want to succeed, so that if something goes wrong you are then determined to simply find a way around whatever the problem is"

Q Do you have any advice to students about writing their papers?

Your research paper has to give a big picture. It has to tell a story. The first thing to think about is what the real message is from the piece of work you have done.

I always encourage the students to write the first draft of a paper early, but not all of them do that. It's a very good practice. When you start working on a project, you may not realize exactly why you are doing it, but when you start writing, you come to realize the real value of research and what you have achieved. When you are in the process of writing a paper, you may want to think of new experiments that would make the story stronger. That's why you should start writing early.

"Your research paper has to give a big picture. It has to tell a story"

Q What should students who are still finding their feet in research focus on? Should they be worried about publications and impact factors at this stage?

Publications are very important. After all, if you do not publish your work, nobody will actually know that you have done it. So, as you do research, you should always be thinking about publications — both small papers and larger papers. And what additional data you may need to be able to publish your work. But you should not get too worried if the results sometimes come slowly — that's the nature of research. And don't be too concerned about impact factors. The most important thing is for your work to be seen and read by others in the field. And then it will be cited. In these days of open access, it matters much less where something is published.

"Don't be too concerned about impact factors"

Q Can you tell us more about your association with M Vijayan (Emeritus Professor, Molecular Biophysics Unit, IISc, after whom the lecture is named) and other Indian crystallographers?

I met Vijayan when we were both working with Dorothy Hodgkin, and we have remained strong friends with him and his wife, Kalyani, ever since. Through Vijayan, we learnt a great deal about India. Dorothy was a great friend of India, knew all the Indian crystallographers and many other scientists, as well as political figures, and in a way we inherited these friendships. Since we got to know Vijayan, of course, we also got to know other Indian crystallographers through him.

TED BAKER

"I met Vijayan when we were both working with Dorothy Hodgkin, and we have remained strong friends with him and his wife, Kalyani, ever since"

Q Where do you think the field of crystallography is headed in the next few years?

I think that membrane protein crystallography is beginning to expand rapidly as methods for crystallization have taken big steps forward recently. The two other breakthrough areas are in the use of Free Electron Laser (FEL) technologies, and in cryo-electron microscopy (cyro-EM). FEL research will remain a highly specialised technology, I think, limited to a few synchrotrons. But cryo-EM has taken dramatic steps forward to much higher resolution. Combining high-resolution cryo-EM with crystallography will be a very powerful way of analyzing large biological assemblies.

Q You have visited India often. Tell us about your experience in India and at IISc.

My wife and I have been to India 6 or 7 times. We love India for its life, its colour, its foods, spices and smells, and its wonderful cultural heritage. Even the noise and apparent chaos are rather exhilarating. We love the conversations we get to have with so many people. And when we do stupid things, like leaving a purse in a shop or a camera in an autorickshaw, someone helps us.

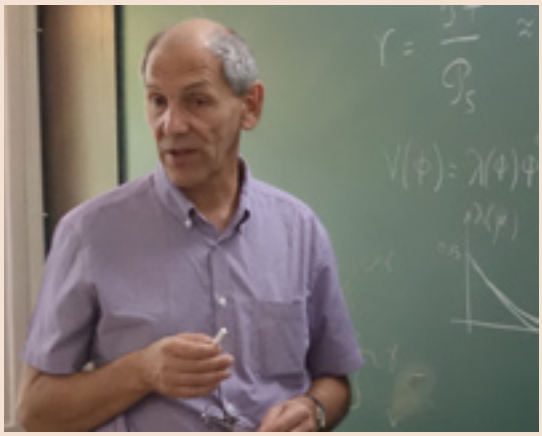
The quality of the work done at IISc is as good as anywhere in the world, and the students are wonderful. When we first started coming here, in the 1990s, problems with the power supply and other infrastructure were holding some research areas back, but those problems seem mostly to have been overcome now and the equipment available is great. *You do need a synchrotron, though!*

✍ **DISHA MOHAN**

VALERY RUBAKOV

Valery Rubakov is a theoretical cosmologist at the Institute of Nuclear Research, Russian Academy of Sciences and Moscow State University, Russia. He gave a public talk on 'The Universe Before The Hot Big Bang' at IISc on 24 November, 2014. It was part of a distinguished lecture series organized by the International Centre for Theoretical Sciences (ICTS).

In his research career, Rubakov has made fundamental contributions to cosmology, non-perturbative quantum field theory, baryon asymmetry in the universe and to theories of extra dimensions. He has won numerous awards and has been a member of the Russian Academy of Sciences since 1997.



ICTS

During his talk, Rubakov discussed what might have happened before the Big Bang. Evidence suggests that the Big Bang was preceded by yet another epoch with unusual properties.

✍ **DEOVRAT PRASAD**

THE CENTRE FOR CONTEMPORARY STUDIES

CONNECT

The Centre for Contemporary Studies (CCS) is a unique initiative in the human sciences at the Indian Institute of Science (IISc). It is chaired by Raghavendra Gadagkar, also a professor at the Centre for Ecological Sciences (CES). He spoke to CONNECT ***about the Centre's history, its activities and also how it contributes to an institute focused on the natural sciences and engineering***

✍ **KARTHIK RAMASWAMY**

THE BIRTH

About ten years ago, Raghavendra Gadagkar received a message from Goverdhan Mehta, the then Director of the Institute, who asked Gadagkar to meet him immediately. At that time, Gadagkar was away in Germany at the Institute for Advanced Study (where he has been a Permanent Fellow for the last fourteen years). He went to meet Mehta the day he arrived back in Bangalore. He recalls the conversation vividly. "Mehta told me, 'We have made a decision. There will be a Centre for Contemporary Studies. And you will be its Chairman.' He added, 'You have no choice.' In response, I told him that I did not want a choice. And that I will be very happy to take this up."

CCS was created when the erstwhile Centre for Theoretical Studies (CTS) was bifurcated into two separate centres — CCS and the Centre for High Energy Physics. CTS was meant to bring in social sciences and humanities into IISc, but its focus had shifted to research in high-energy physics. So the Institute's administration decided

BITASTA DAS

Raghavendra Gadagkar, Chairperson of CCS

on the bifurcation and a new centre dedicated to the study of humanities and social sciences was born, one that had an opportunity to revisit the original mandate of CTS.

"He [Goverdhan Mehta] added, 'You have no choice.' In response, I told him that I did not want a choice. And that I will be very happy to take this up"

NEW HOME IN AN OLD BUILDING

The building where CCS is housed has an old world warmth about it. It is after all one of the oldest buildings on campus. Sitting comfortably among trees of varying shades of green and a neatly trimmed lawn, the white building is adorned by a red Mangalore-tiled roof; its doors and window frames, made of mature hard wood, are painted chocolate brown. It maybe ageing, but it is ageing well.

A few years ago, this quaint building served as the office of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR). When JNCASR moved out of this building, there were not many takers for it, because it was not "modern" enough for them. "So I jumped at the chance and we occupied it," says Gadagkar, referring to how CCS moved into its new home from the Tata Institute of Fundamental Research building where it was then housed. The building has a long history, having once served as the IISc Gymkhana (Mahatma Gandhi is supposed to have come here when he visited IISc). It was also where the Centre's predecessor, CTS, was originally established.

"So I jumped at the chance and we occupied it"

HUMANITIES IN A SCIENCE INSTITUTE

When asked about the scope of the Centre, Gadagkar is quick to say, "The universe minus IISc." CCS prides itself on not having rigid boundaries. Its visitors come from many fields of human endeavor — social sciences, humanities, arts, literature, philosophy, music, law, films… the list is impressive. Gadagkar is convinced that such a centre is essential in an Institute dedicated to the natural sciences. He argues that scientists are so specialized in their disciplines that they have

CONNECT

lost the ability to comprehend what people in other fields do and how they do it. And that he believes is a great shame. He continues, "The other problem is that people look down upon what they do not understand." Gadagkar believes that by exposing faculty and students at the Institute to how researchers in other fields approach problems and generate knowledge, they can look at their own research problem in a different light. He thinks that the least this exposure would do is to make our criticisms of others' fields more informed and constructive. CCS, thus, provides an ideal platform for the Institute community to engage with scholars from disciplines outside the natural sciences.

"The other problem is that people look down upon what they do not understand"

FACULTY

The Centre has three Associate faculty — HN Chanakya (Chief Research Scientist, Centre for Sustainable Technologies), Rudra Pratap (Chair, Centre for Nano Science and Engineering) and S Ramakrishnan (Chair, Division of Chemical Sciences). Chanakya, who is interested in understanding sustainable development from different perspectives, also teaches an undergraduate humanities course on the subject.

The Centre, however, relies more on its Visiting faculty to create a rich multi-disciplinary learning environment. Scholars from many different fields of social sciences, arts and humanities come to the Centre for varying periods of time, ranging from a few days to a few months. They have complete freedom to choose what they want to work on. "CCS develops its character through its visitors," explains Gadagkar.


CONNECT


CeNSE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Associate Faculty at CCS (from left to right): HN Chanakya (Chief Research Scientist, Center for Sustainable Technologies), Rudra Pratap (Chair, Center for Nano Science and Engineering) and S Ramakrishnan (Chair, Division of Chemical Sciences)

The Centre also hosts lectures almost every week. They are open to not just the Institute community, but the public as well. In the first half of their lectures, speakers typically focus on educating the audience about their disciplines — what they do and how they do what they do. The second half is focused on their own contribution to their field. These talks have been so successful that they have spawned a semester-long course called "Production of Knowledge", open to anyone interested; some institutions even use it for credit.

"CCS develops its character through its visitors"

UNDERGRADUATE COURSES

CCS has another important responsibility — it runs the humanities courses for the undergraduate (UG) programme at IISc. UG students take courses offered by CCS in six out of their eight semesters, thus making the humanities an integral part of their curriculum. Most courses are taught by the Visiting faculty. The Centre also has an Instructor in Bitasta Das. She currently teaches a course about the diversity of folk arts in India. Besides teaching, Das plays a crucial role in the day-to-day coordination of the Centre's activities.

The course work for UG students at IISc in the humanities section comprises two sets of courses: *foundation* courses that are offered in the first three semesters, followed by *advanced* courses offered in the fourth, fifth and sixth semesters. The three *foundation* courses offered are: "Ways of Knowing", a course about how knowledge is produced in different disciplines; "Ways of Seeing", a course about how what we know is communicated

CURRENT VISITING FACULTY AT CCS

MOHAMMED ROSHAN

Uday Balakrishnan is a former member of the Indian Postal Service and has served as the Registrar of IISc. He teaches an *advanced* UG course in which students are introduced to the functioning of the Indian Government, both in theory and practice.

MAHESHWARI SATHEESH

Tejaswini Niranjana is a Senior Fellow at the Centre for the Study of Culture and Society, Bengaluru, besides being a Visiting Professor at the Tata Institute of Social Sciences (TISS), Mumbai. She has been actively involved with CCS since its inception and has helped design its curriculum.

CONNECT

Rajan Gurukkal, a former Vice Chancellor of MG University at Kottayam, is a social scientist, historian and writer. He also teaches in the "Production of Knowledge" course offered by the Centre.

CONNECT

A journalist with vast experience as a writer and an editor, **Amrita Shah** has also written a biography of Vikram Sarabhai. She has previously taught in the "Production of Knowledge" course and is currently teaching an *advanced* course on science journalism.

CONNECT

Also a Senior Fellow at the Centre for the Study of Culture and Society, **SV Srinivas** has been associated with the development of the *foundation* courses. With a background in English literature, Srinivas has been studying the link between popular culture and politics.

CONNECT

Srinivas Raghavendra is an economist at the National University of Ireland, Galway, Ireland. A macroeconomic theorist, Raghavendra is currently interested in how the modern financial sector impacts the macroeconomy.

in different disciplines; and "Ways of Doing", a course about how to bring scholarship in different disciplines to bear on the solution to real-life problems. The *advanced* courses provide the students with more freedom as they explore subjects as diverse as "Science Journalism", "Governance" and "Mapping India through its Folk Arts".

The goal of these courses, according to Gadagkar, is not to teach humanities as a set of disciplines, but to teach the social context in which science is done. Elaborating further, he says, "While there are universal facts that science reveals, the context too is important. Starting from the choice of the problem all the way to how exactly you proceed is hugely context-dependent which we cannot ignore. Therefore, instead of first learning science and then being told that it is context-dependent, we want our students to learn science in the social context in which it happens. In fact, I think science should never be taught outside this context."

UTKARSH VIJAY

A *Dollu Kunita* performance from Das' class

CONNECT

Bitasta Das is an Instructor and coordinates many of the Centre's activities

"Therefore, instead of first learning science and then being told that it is context-dependent, we want our students to learn science in the social context in which it happens"

Gadagkar also argues that understanding the context will motivate the students and make them better scientists. He cites the example of a course that was taught by the famous theatre personality Prakash Belawadi. In this course, students learnt about the theory of theatre and took part in a theatre workshop. The course ended with them performing a play for the Institute community as their final exam. Called "Photograph 51", it is the story of how the structure of DNA was discovered and Rosalind Franklin's contribution to this vital discovery. Through the play, the students tried to understand the sociology and the politics of science at the time of the discovery.

"For us, it is not science versus humanities; it is not science and humanities; it is science sitting on top of humanities"

"You can see how being part of this play would motivate the students to study what Watson and Crick achieved," says Gadagkar. "For us, it is not science versus humanities; it is not science and humanities; it is science sitting on top of humanities," he concludes.

■

HELLO!

Faculty who have joined us recently tell us about themselves

AMIT SINGH

AMIT SINGH (Assistant Professor, Department of Microbiology and Cell Biology)

Hailing from Agra, Amit Singh did his postgraduation in Biotechnology from IIT Roorkee. He received his PhD from the University of Delhi where he studied the mechanisms that the bacterium *Mycobacterium tuberculosis* uses to infect humans and cause tuberculosis. His postdoctoral work took him to University of Birmingham, Alabama, USA, where he studied the genetic mechanisms that underlie latency and reactivation of this bacterium. At IISc, Singh will continue to focus on *M. tuberculosis*, while also studying HIV; these two pathogens often work together to co-infect their human hosts.

Take Five with Amit

- **The best advice I ever received…** keep things simple.
- **I begin my day by…** reading the newspaper and sipping hot ginger tea.
- **If I'm not in my lab or at home, you are most likely to find me at…** the playground with my kids.
- **What I like most about Bengaluru is…** its weather.
- **My favourite sport is…** badminton

ARPITA PATRA

ARPITA PATRA (Assistant Professor, Department of Computer Science and Automation)

Arpita Patra grew up in West Bengal where she had her early education including her B.Tech. After her Masters at IIT Madras, she did her PhD from the same Institute; here, she studied cryptography, the mathematical science of secrets. Her postdoctoral research in cryptography and distributed computing took her to the University of Bristol (UK), ETH Zurich (Switzerland) and Aarhus University (Denmark). While she does not have a fixed agenda for her research at IISc, she has identified a number of topics in cryptography that will keep her engaged the next few years.

Take Five with Arpita

- **My favourite movie is…** 'The Apu Trilogy' by Satyajit Ray.
- **Success for me means…** nothing; I just do what I love and believe in.
- **If I weren't a researcher, I'd be…** a photographer or an archaeologist.
- **The most influential person in my life is…** my father.
- **If there is one thing I dislike, it is…** dirty and evil politics of India.

CONNECT

RAVI SUNDARESAN (Assistant Professor, Department of Microbiology and Cell Biology)

Ravi Sundaresan is originally from Tamil Nadu. After his postgraduation and PhD from the Indian Veterinary Research Institute (IVRI) at Bareilly in avian molecular genetics, he did his postdoctoral work at the University of Chicago. This research involved studying human heart failure using cell culture and animal models. He also explored therapeutic targets for heart failure using transgenic mice models. Sundaresan currently studies the basis of the development of heart failure in diabetes patients. He is trying to understand the role of two specific molecules in the pathogenesis of diabetic cardiomyopathy.

Take Five with Ravi

- **I love research because…** it gives me satisfaction.
- **The most important person in my life is…** my wife, who understands and always supports me.
- **My idea of a Sunday afternoon is…**the time for nice nap after a busy week.
- **My favourite actor is…** I do not have any, but I do have a favourite music director — AR Rahman.
- **I never leave home without…** my shoulder bag.

SUSHOBHAN AVASTHI

SUSHOBHAN AVASTHI (Assistant Professor, Centre for Nano Science and Engineering)

Sushobhan Avasthi grew up in Lucknow. He graduated in Electrical Engineering from IIT Kanpur and did postgraduation from Princeton University. For his PhD, which he also did at Princeton, Avasthi worked on organic/ silicon heterojunction solar cells. After this he continued working in the same field at the Princeton Institute of Science and Technology of Materials (PRISM). His current areas of research interests include the study of novel materials like perovskites, metal-oxides, metal-oxynitrides, and metal-oxide thin-film transistors for solar cell applications.

Take Five with Sushobhan

- **My favourite singer is…** Kishore Kumar
- **The one thing I dislike about research is…** traditionally it has been too narrow in its focus and there are not enough incentives to diversify and learn "other" things.
- **If I had to use an adjective to describe myself, it would be…** curious.
- **The best thing about the IISc campus is…** nature.
- **The street food I enjoy the most is…** pani puri.

IISc enters into collaboration with French defence firm Safran

SAFRAN INDIA PVT LTD

Alain Coutrot (Deputy Director, Safran) and Mary Mathew (Resource Executive, SID) after the signing of the agreement

The French defence major Safran announced a collaboration with the Society for Innovation and Development (SID), Indian Institute of Science (IISc) and the Foundation for Innovation and Technology Transfer (FITT), IIT Delhi, on 29 October, 2014. This collaboration aims to initiate research and development in the field of advanced avionics systems to develop the next generation aerospace technologies.

The agreements were inked in the presence of the French Ambassador to India, François Richier. At the signing, SID was represented by its Resource Executive, Mary Mathew, who is also a Professor at the Department of Management Studies at IISc. In a press release, Richier who welcomed the signing of these agreements, said, "In liaison with the French Embassy, Safran is developing collaborations with prestigious Indian institutions like IIT Delhi and IISc, Bengaluru, which is most promising for Indo-French cooperation." Stéphane Lauret, CEO, Safran India, said that these agreements reinforce Safran's commitment towards India's education sector. He also added that the strategy of Safran is in line with the vision of the Indian Government's "Make in India" campaign.

Safran is a leading international technology group with operations spread over three major areas: aerospace (propulsion and equipment), defence and security. It was formed in 2005 by the merger between SNECMA, which manufactures engines for aircrafts

SAFRAN INDIA PVT LTD

From left to right: Alain Coutrot (Deputy Director, Safran), Mary Mathew (Resource Executive, SID), François Richier (French Ambassador to India), Anil Wali (MD, Foundation for Innovation & Technology, IIT Delhi) and Stéphane Lauret (CEO, Safran India Private Ltd)

and rockets and also aerospace components, and the security company SAGEM. Safran, individually or in partnership with other firms, holds world or European leadership positions in its core markets.

The current agreement is in line with Safran's desire to expand its R&D activities outside France and to better leverage the global talent pool. While IISc will develop an advanced computing platform for use in next generation avionics, IIT Delhi will be involved in developing advanced pattern recognition algorithms to be applied to complex data sets in aerospace related applications.

According to Jayant Modak, Professor and Chief Executive of SID, what attracted Safran's interest in IISc was the work of SK Nandy, Professor, CAD Laboratory, Supercomputer Education and Research Centre (SERC). With the help of *Morphing Machines*, a startup specializing in semiconductors incubated at SID, Nandy has developed a powerful parallel processing technology called REDEFINE MPP. This architecture is ideally suited in avionics applications that often require real time solutions with quick response times. Modak told CONNECT that Safran saw great value in the work carried out by Nandy and *Morphing Machines*, eventually leading to this collaboration. The agreement between Safran and SID will pave the way for this technology to be used in Safran's avionics applications. Modak added that *Morphing Machines* will also play a crucial role in this collaboration.

The relationship between the Safran Group of companies and IISc may not be limited to just research and development of this technology, according to Mary Mathew. She said that it could also involve personnel from Safran pursuing a PhD via the external registration programme, as well as Safran hiring Undergraduate, Masters and PhD students from IISc to help them enhance their technological competencies.

ANKIT RUHI

IISc to spearhead new Science Gallery in Bengaluru

Bengaluru is set to host Asia's first Science Gallery and the Indian Institute of Science (IISc) is poised to play a key role in the development and functioning of this prestigious venture. After an initial feasibility study, an agreement to bring the Science Gallery to Bengaluru was signed by the Government of Karnataka and Science Gallery International based in Dublin, Ireland. It will be the third such gallery in the world; the first is in Dublin and the second is coming up in London, UK.

SCIENCE GALLERY INTERNATIONAL

Chris Horn (Chair, Science Gallery International) shaking hands with Mohan Das (Registrar, IISc) after the signing of the MoU as Srivatsa Krishna (IT, BT and S&T Secretary, Govt. of Karnataka) looks on. Standing (left to right): Michael John Gorman (Director, Science Gallery), Anurag Kumar (Director, IISc), SR Patil (Minister for IT, BT and S&T, Govt. of Karnataka) and Damien English (Minister, Govt. of Ireland)

The Science Gallery project, pioneered by Trinity College in Dublin, is a one-of-a-kind venture that aims to engage and inspire young minds with a unique blend of science and art. Besides the emphasis on design, the Science Gallery differs from the traditional museum in another sense; instead of a permanent collection that one tends to see in a science museum, the Science Gallery has year-round, interactive scientific exhibitions on constantly changing themes, often of topical interest. Science comes alive at these exhibitions which are complete with artistic scientific models, live experiments and interactions with scientists. The first Science Gallery, started in 2008 in Dublin,

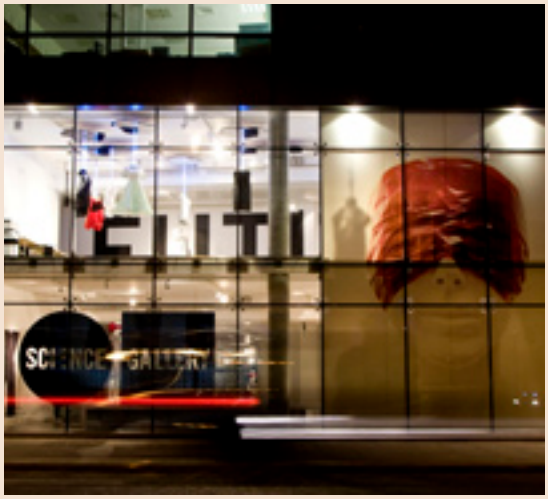
has held over 30 interactive exhibitions and has received over 1.8 million visitors, making it a truly successful science-outreach initiative.

The success of this innovative approach in taking science to the layperson has led to the launch of the Global Science Network, the international chapter of the Dublin Science Gallery. Founded with a start-up grant of € 1 million from Google, the network aims to develop eight Science Gallery nodes worldwide by 2020.

According to Louise O'Reilly, Network Development Manager for Science Gallery International, the Bengaluru Science Gallery will be developed on the model pioneered at Trinity College. It is expected to start functioning in 2018 and will welcome about 400,000 visitors annually. The search for an ideal location to house the Science Gallery in Bengaluru is still on.

The Government of Karnataka, being the principal sponsor and overseeing authority, will be financing a part of the estimated annual operating costs amounting to INR 80 million. The rest of the money will come from philanthropic and corporate funding.

Referring to IISc's role in conceptualizing and implementing the exhibitions, its Director, Anurag Kumar, in a press release said, "IISc will join prestigious international institutions such as Trinity College, Dublin and King's College, London in the creation of the Global Science Gallery Network to inspire future generations of innovators and to bring Indian research to a global stage." Speaking to CONNECT, Rahul Pandit, the Chair of the Division of Physical and Mathematical Sciences at IISc, said that the Institute's participation in this project is in keeping with its spirit of public outreach as seen during its Open Day initiative.



SCIENCE GALLERY INTERNATIONAL

The Science Gallery in Dublin, Ireland

IISc will be collaborating on the project with National Centre for Biological Sciences (NCBS) and the Srishti School of Art, Design and Technology. The proposed collaboration between the scientific institutions and an art school reflects the motto of the Science Gallery—a place where science and art collide.

SCIENCE GALLERY INTERNATIONAL

Anurag Kumar (Director, IISc) addressing the gathering during the MoU signing

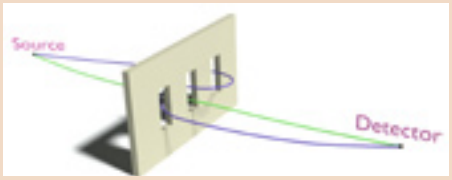
✍ **DEBALEENA BASU**

RESEARCH

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

PHYSICS

Travelling light



CHEP

In 1803, Thomas Young performed the famous two-split experiment which showed that light can also behave as a wave. It was a watershed moment in physics, because most people, including Newton, believed that light was a particle (not unlike a billiards ball). Young's experiment proved them wrong. Today, introductory physics textbooks use the experiment to introduce readers to quantum mechanics. However, a common assumption is that photons always take a straight path to go from point A to B, the so-called 'classical path', but this assumption may not be true in the strange world of quantum physics.

In order to understand whether photons can also take 'non-classical' paths as well, more than two hundred years after Young's celebrated experiment, researchers from the Center for High Energy Physics and Raman Research Institute have proposed a simple table-top experiment which uses three slits rather than two. Their calculations, based on Feynman's path integral formulation — a framework for dealing with all possible paths — show that photons do take both classical and non-classical paths from point A to B. The study was published in the journal *Physical Review Letters*.

Read more at: http://goo.gl/d0LkiF

MANAGEMENT STUDIES

What influences venture capitalist funding in India?

Venture Capitalist (VC) firms pump in money into startups that are often brimming with exciting ideas; the money helps entrepreneurs chase their dreams. MH Bala Subrahmanya's group at the Department of Management Studies investigated the factors which influence VC funding in India. The study, published in the *Proceedings of IEEE International Conference on Management of Innovation and Technology* (ICMIT), Singapore, shows that the performance of the Indian economy relative to that of other developed economies is a key factor in determining VC funding.

Read more at: http://goo.gl/OUmYol

SUSTAINABILITY

How much energy is consumed while producing building materials?

India uses more than 2 billion tonnes of construction material every year and this number is rising. The energy consumed to manufacture building materials alone is 20-25% of India's total energy consumption. A first step towards making our construction industry more sustainable is to quantify the amount of energy consumed. An assessment framework to calculate the total energy consumed during building material production has been developed by researchers from the Department of Civil Engineering and the Centre for Sustainable Technologies. It was published in the journal *Energy and Buildings*.

Read more at: http://goo.gl/bEKOKc

ENGINEERING

A new water repellant surface

A team of researchers from the Department of Mechanical Engineering has developed a novel water repellant surface with special structures on its surface to trap tiny pockets of air. These air pockets allow water to flow without coming in contact with the surface and thus flow without friction. The duration for which repellant properties are maintained can also be controlled, allowing for its diverse applications in self-cleaning surfaces, better printers, and efficient and cheaper blood testing. The study was reported in the journal *Colloids and Surfaces A: Physicochemical and Engineering Aspects*.

Read more at: http://goo.gl/XNDLbM

POLYMER SCIENCE

Materials for shielding microwave radiations

Two polymer based materials that can block electromagnetic radiations have been developed by a group of researchers from the Centre for Nano Science and Engineering, Department of Materials Engineering and the Department of Chemical Engineering. Shielding of electromagnetic radiations is required to isolate electrical devices from the 'outside world', and to isolate wires from the environment through which the cable runs. The study which appeared in the journal *ACS Applied Materials and Interfaces* is expected to allow for the design of flexible and lightweight electromagnetic interference shielding materials by careful selection of functional nanoparticles.

Read more at: http://goo.gl/Z3iAW3

ANIMAL BEHAVIOUR

Bats more likely to hunt female bush crickets

ROHINI BALAKRISHNAN

HARISH PRAKASH

The main predators of bush crickets (bush crickets and crickets belong to different families of insects) are bats. Bats hunt them down in the dark when these insects too are active. As evening falls, male bush crickets sing to woo females; the females remain silent, but move towards the songs they fancy. One would expect that bats go straight for the singing males. This assumption was tested by Rohini Balakrishnan's group at the Centre for Ecological Sciences. They published the results of their study in the *Proceedings of the Royal Society B*. They found that silent females were three times more likely to be preyed upon than singing males. It is not clear whether moving towards the singing males puts the females at greater risk of predation. Balakrishnan believes that in order to solve this mystery they would have to study bat predation more closely in different species of bush crickets and in more natural environments.

Read more at: http://goo.gl/awWsKN

BIOSENSORS

A sensor for detecting proteins associated with infection

The human body encounters several harmful agents like bacteria every day. These encounters can trigger inflammation in the body. When infected, the body produces a protein called the C-reactive protein (CRP) in higher than usual amounts, thus making its detection crucial for infection diagnosis.

Researchers from the Department of Physics, the Robert Bosch Centre for Cyber Physical Systems and the Department of Instrumentation & Applied Physics have come up with an alternative method for CRP detection using etched optical Fibre Bragg Gratings (eFBGs). These gratings are special optic fibers that can block out (or reflect) certain wavelengths of radiation. This method of detection is more sensitive and specific even in the presence of interfering agents commonly found in blood like urea, glucose and creatinine. The study was published in the journal *Biosensors and Bioelectronics.*

Read more at: http://goo.gl/sHr86N

MATERIALS

A shock absorber to protect your electronic devices

A shock absorber made from graphene which can protect your electronic devices like cell phones, tablets and laptops from physical damage has been designed by researchers from the Department of Instrumentation and Applied Physics. Graphene is a material made up of just a single layer of carbon atoms. In this study, published in the journal *RSC Advances,* graphene was made into a 3D network structure known as graphene foam and integrated with PDMS (polydimethyl siloxane) to obtain a reusable composite with a load bearing capacity six times higher than just graphene foam.

Read more at: http://goo.gl/4No2XK

CELL BIOLOGY

New insight into protein synthesis

Proteins, the building blocks of life, are synthesized by the process of translation. The protein sequence in this process is determined by the "message" carried by the messenger RNA (mRNA) when it binds with transfer RNA (tRNA), a binding facilitated by ribosomes. Ribosomes and tRNA identify each other because of an identity tag: three consecutive Guanine-Cytosine (GC) base pairs in the anticodon arm of tRNA.

Reporting in the *Proceedings of the National Academy of Sciences*, Umesh Varshney's group from the Department of Microbiology & Cell Biology have found that when a sequence on the mRNA called the Shine-Dalgarno sequence is longer than the usual 4–6 base pairs, it can bind to a tRNA without the characteristic 3GC base pairs. If the process of translation can be initiated without initiator tRNA, it could result in synthesis of novel proteins.

Read more at: http://goo.gl/CimdWO

SOFTWARE

VoW! A technology to warp voice

A team of researchers from the Department of Electrical Engineering has come up with a new technology that can ensure fine synchronization between lip movement and video. This can lead to superior voice dubbing in movies. Called 'Voice Warping' (VoW), the technology can do many other things as well — from helping you learn French to Carnatic music. It could also make radio and television advertisements less expensive.

Read more at: http://goo.gl/vCUWUZ

EVENTS

This section features many of the important events that took place recently in the Indian Institute of Science (IISc)

VIJYOSHI 2014

Vijyoshi 2014, the National Science Camp, was held from 8 to 10 November at IISc and from 10 to 12 November at the Science Auditorium, Kolkata. About 1100 students attended the camps. Of these, about 550 students who are from the northern part of the country were at the Kolkata event, while those from southern India attended the camp in Bengaluru.

Funded by the Department of Science and Technology (DST), Government of India, Vijyoshi is organized annually by the Kishore Vaigyanik Protsahan Yojana (KVPY), IISc, in collaboration with the INSPIRE (Innovation in Science Pursuit for Inspired Research) programme. The Indian Institute of Science Education and Research Kolkata was also involved in organizing this year's camp. KVPY, initiated by DST, is a National Fellowship programme in the basic sciences that seeks to identify and motivate exceptionally talented students to pursue a career in basic science research. The students attending this camp included KVPY fellows, students with INSPIRE fellowships and many other undergraduate students from universities all over India.

Until recently, IISc was the sole host of Vijyoshi with the exception of the year 2009 when the Jawaharlal Nehru University, Delhi, was a co-host. But given that the number of participants in Vijyoshi has been growing exponentially, the organizers decided that from 2014 onwards, the camp would be held in two different cities each year, with IISc as a permanent host.

Vijyoshi aims to provide a platform for interactions between keen young minds and pioneering researchers in various branches of science and mathematics. "The idea behind this camp is that these young students can interact with scientists doing interesting work all over the world," says

TEAM VIJYOSHI

The camp saw many hands-on student activities

Kaushal Verma, the Coordinator of Vijyoshi 2014 and member of the core committee organizing the event. Verma is also a professor in the Department of Mathematics at the Institute.

The camp, a three-day event, is organized each year either in November or December. This year's camp began with welcome speeches by PK Das (Convenor, Vijyoshi 2014, and Professor, Department of Inorganic and Physical Chemistry, IISc) and Anurag Kumar (Director, IISc). It was followed by an inaugural address by K VijayRaghavan, Secretary, DBT.

The camp included lectures by renowned scientists from India and abroad. Besides IISc, this year's speakers came from Stanford University, Purdue University, University of Michigan, Tata Institute of Fundamental Research (TIFR), National Center for Biological Sciences (NCBS) among others. Some of the many stimulating talks included "The Fascination of Science: Dreaming Allowed?" by the Nobel laureate J Georg Bednorz from IBM Research in Zurich, "Can we Organize Molecules to Form Materials We Need?" by MK Sanyal of the Saha Institute of Nuclear Physics (SINP), Kolkata, and "The Pleasure of Doing Science" by R V Hosur of TIFR, Mumbai. Besides the lectures, tutorial sessions were organized to ensure that students interacted closely with speakers. The camp also witnessed several hands-on scientific activities on a variety of topics in science. These were organized by PhD students from IISc.

TEAM VIJYOSHI

Students interacting with speakers was an integral part of the camp

The enthusiasm of the students impressed the speakers. Greg T Buzzard from Purdue University, speaking to CONNECT, said, "The students were very engaged. They asked great questions and were genuinely excited to be a part of the camp."

The camp also included a cultural programme followed by a special dinner for all students, speakers and invited guests.

✍ **TARU VERMA**

THE 2ND INTERNATIONAL CONFERENCE ON EMERGING ELECTRONICS

The 2nd International Conference on Emerging Electronics (ICEE 2014) was held from 3 to 6 December, 2014 at the JN Tata Auditorium. The event was hosted by the Centre for Nano Science and Engineering (CeNSE), IISc. The theme of ICEE 2014 was "From Materials to devices".

The four day event saw speakers from national and international institutes giving plenary talks, public lectures and invited talks. More than 200 students from around the country attended the conference. Diverse topics in the field of nano-electronics were covered; they included photovoltaics, flexible electronics, advanced logic and memory devices, nanobiosensors, photonics and plasmonics. The event was supported by governmental agencies as well as corporate sponsors.

Two public lectures were organized as part of the conference. Rao R. Tummala, an endowed Chair Professor and Founding Director of 3D Systems Research Center at the Georgia Tech University, spoke about system scaling for smart, wearable and wireless electronics as well as the unique opportunities for India in this field. The other public speaker was Stuart SP Parkin, an IBM Fellow and manager of the Magnetoelectronics group at the IBM Almaden Research Center in San Jose, California, and also the Director of the Max Planck Institute for Microstructure Physics in Germany. Parkin provided an overview of the cutting edge in technology for memory devices. He also discussed his latest research in 3D memory storage making use of nanowires and cognitive materials.

The conference also had many interesting plenary talks. Anurag Kumar, Director, IISc spoke about how cyber-physical systems can make our lives easier. Jeevak Parpia, Professor, Cornell University gave an overview of graphene resonators. Krishna Saraswat, Professor, Stanford University discussed quantum well heterostructures as substrates in electronics and photonics. Arnab Bhattacharya, Professor, Tata Institute of Fundamental Research, Mumbai, discussed the role of nitride-materials in the spectacular success of LED lighting. He also talked about his own research in the field. Arved C Huebler, a professor at the Institute for Print and Media Technology, Chemnitz University of Technology, provided an overview of printed electronics.

Numerous startups and companies were represented in the conference. Besides having their own stalls, they participated in a special session called 'Mind to Market'. There was also a panel discussion on 'Emergence of India as an Electronics Powerhouse' which had notable panelists like Ajay Kumar, Joint Secretary, Department of Electronics and Information Technology (DeitY), Government of India, Apparao Mallavarapu, founder and Managing

CeNSE

Anurag Kumar, Director, IISc

Director of Centum Electronics, a Bengaluru-based electronics major, Krishna Saraswat of Stanford University, Ganesh Subramanian, a venture technologist, and J Vasi of IIT Bombay.

Students from various institutes and colleges from all over the country showcased their research in the form of oral or poster presentations. They also got an opportunity to interact with experts in their field. Day-long tutorials were also held for students interested in nano electronics in topics ranging from photovoltaics to photonics.

SA Shivashankar, the Chair of the Organizing Committee and Professor, CeNSE, told CONNECT that besides showcasing research on novel materials in emerging electronics, the conference also served to highlight the work at CeNSE. Both the General Chairs of ICEE 2014, Rudra Pratap, Chair of CeNSE, and Anil Kottantharayil, a professor from IIT Bombay, were overjoyed by the response to the conference. Pratap said, "While very high quality is expected from plenary and invited talks, what was really heartening here was the quality of contributed papers. We have every reason to cheer about the future of electronics in this country."

✍ **DEBADRITA PARIA**

COSMAR 2014

The Department of Management studies at IISc organized the 14th Consortium of Students in Management Research (COSMAR) on 21 and 22 November, 2014. The conference was supported by the Robert Bosch Centre for Cyber Physical Systems, IISc, besides other corporate sponsors. It provided a platform for doctoral students in management from around the country to showcase their research as well as to interact with academicians and members of industry.

The presentations were made on topics as diverse as employer branding, labour management, service, energy, cleanliness in factories, the overseas rupee market and voluntary job switching. Sieglin de Pfaendler, Robert Bosch Centre, spoke on funding, patenting, and industrial collaboration. Vijay Chandru, the founder and Chairperson of Strand Life Sciences discussed the future of research based startups. The conference also included a workshop on technical writing by Karthik Ramaswamy, Visiting Scientist, IISc.

COSMAR

A panel discussion on doctoral students' hardships and solutions raised several important issues like societal outlook towards PhD students, the importance of choosing the right advisor and challenges in publishing their research. Mary Mathew, the Coordinator of COSMAR 2014 and Professor, Department of Management Studies, IISc, described the discussion as thought provoking.

A few select papers from COSMAR 2014 will be published in the *South Asian Journal of Management* (SAJM). Awards were also given to the authors of the best papers. The first, second and third prizes went to Chitra Dey (IIT Madras), Riddhi Panse (IIT Bombay), and Prakash Awasthi (IIM Bangalore) respectively.

✍ **SUBHAM MRIDHA**

ANCST WORKSHOP

The 3rd Asian Network on Climate Science and Technology (ANCST) workshop on 'Atmosphere-Ocean Interactions in the Indo-Pacific basin and their Impact on Asian Climate' was held on 23 and 24 November, 2014. It was conducted by the Centre for Atmospheric and Oceanic Sciences (CAOS) in collaboration with Divecha Centre for Climate Change (DCCC). Scientists from India, Japan, Malaysia, Sri Lanka, Vietnam, UK, and USA participated in the workshop.

KRUTHIKA SG / SHRAVANTH VASISHT

The aim of the workshop was to highlight the effects of ocean-atmosphere interactions on the climate of Asia. It also discussed the influence of global warming on ocean-atmosphere interactions and its subsequent effect on climate. GS Bhat, Professor, CAOS, and organizer of the workshop, told CONNECT that workshops like these would help gain greater insight into the region's climate and also contribute to making better monsoon predictions.

✍ **SUBHAM MRIDHA**

SCIENCE EDUCATION CONCLAVE

A conclave to discuss urgent reforms in science and engineering education in India was held in the Faculty Hall of IISc on 21 November, 2014. It was organized jointly by the International Centre for Theoretical Sciences (ICTS) of TIFR, Bangalore and the Observer Research Foundation (ORF), a Mumbai-based public policy think tank.

The conclave was chaired by TV Ramakrishnan, Indian Institute of Science and Benaras Hindu University. It was one in a series of conclaves being organized by ORF in partnership with IIT Guwahati, IISER Pune, Pune International Centre, Chandigarh Regional Innovation and Knowledge Cluster and Society for Promotion of Science and Technology in India.

The conclaves are part of an initiative guided by well-known scientist CNR Rao. It seeks to come up with a comprehensive set of reforms in science education in schools, colleges and universities in India. The proposed reforms are being arrived at in consultation with experts in science education as well as the general public. It is also gathering inputs on how these pressing reforms could be implemented.

ICTS

Spenta Wadia, Director, ICTS, addressing the gathering. Others in the picture are Leena Chandran-Wadia, TV Ramakrishnan and CNR Rao

The starting point of this initiative was a report by ORF titled ***'Whither Science Education in Indian Colleges? Urgent reforms to meet the challenges of a Knowledge Society'*** based on a survey of 30 of the most highly rated science colleges in Mumbai, Chennai, Delhi and Kolkata. The first conclave was held in Mumbai on 21 July, 2014 in the presence of CNR Rao and about 50 other participants.

Leena Chandran-Wadia, a Senior Fellow at ORF, told CONNECT that the outcome of the Mumbai conclave was a draft 'Manifesto for Action'

towards reforms in higher education. She said that this draft was discussed in Bangalore and in the other conclaves as well. Wadia added that the suggestions will be incorporated into a revised manifesto and, once approved by all, will be submitted to the Prime Minister with a request for action.

✍ MEGHA PRAKASH

INDIAN CONFERENCE ON COMPUTER VISION, GRAPHICS AND IMAGE PROCESSING

ICVGIP

AG Ramakrishnan (General Chair, ICVGIP 2014 and Professor, Department of Electrical Engineering, IISc) addressing the gathering

The 9th Indian Conference on Computer Vision, Graphics and Image Processing (ICVGIP) was held at the Faculty Hall of IISc during December 14 - 17, 2014. It was organized by AG Ramakrishnan, Professor, Department of Electrical Engineering, and General Chair of the conference, K Rajgopal, Professor, Department of Electrical Engineering, and Venkatesh Babu, Assistant Professor, Supercomputer Education and Research Centre, in association with the Indian Unit for Pattern Recognition and Artificial Intelligence (IUPRAI).

Inaugurating the conference, Y Narahari, Chairperson, Division of Electrical Sciences, and Professor, Computer Science and Automation (CSA) and M Narasimha Murthy, Dean of Engineering and Professor, CSA, spoke about the visionaries who laid the foundation of this research area in India. They also conveyed their appreciation for the quality of the conference.

A unique feature of the event was the live streaming of the proceedings and the virtual participation of academics from IIT Delhi and University of Illinois.

Started in 1998, this conference has grown both in terms of numbers and prestige. It attracts leading researchers in vision, image processing and graphics. In this edition, 33 oral papers and 57 posters were presented by authors from many Institutes like IITs, IIITs, NITs, ISI besides IISc.

The response to the conference was overwhelming; registration for the conference closed exactly one month before it actually began. More than 130 students came from outside Bangalore. What gladdened the organizers was that nearly half the participants and almost half of those who presented papers were women.

Plenary talks were given by Martial Hebert from Carnegie Mellon on geometric reasoning and data-driven techniques for image interpretation, Guido Gerig from University of Utah on spatiotemporal shape analysis of medical images and PJ Narayanan,

ICVGIP

Participants at the conference

Director, IIIT Hyderabad, on enhancing structure-from-motion. These are now available in the video archives of IISc.

Amit Roy Chaudhury (University of California, Riverside) gave a tutorial on Wide-Area Vision Networks. There were also three parallel workshops on Document Analysis and Recognition, Medical Image Processing and Applications. A doctoral symposium was another interesting feature of this conference; this was conducted to encourage PhD students from around the country to present their work as posters and interact with researchers in their field.

Awards were given to the best paper presented and best doctoral symposium poster. IUPRAI also instituted a best PhD thesis award this year, which was shared by Purshottam Kar (IIT Kanpur) and Himanshu S Bhatt (IIIT Delhi).

The Medical Image Processing and Applications workshop hosted eminent researchers in medical imaging including Anand Rangarajan (University of Florida), Guido Gerig (University of Utah) and Kaleem Siddiqui (McGill University). Phaneendra Yalavarthy (IISc) also presented his research. New ideas discussed included the reformulation of distance transform in terms of Schrodinger's equation, longitudinal analysis of spatiotemporal data and shape analysis of heart

ICVGIP

Anand Rangarajan from the University of Florida speaking at the Medical Image Processing and Applications workshop

wall myofibers and creation of a brain atlas for the Indian population. The workshop also featured talks from researchers from GE, Siemens and IMEC, besides other presentations. It ended with a panel discussion in which a number of important ideas were proposed for the nurturing of the medical imaging community in India. The workshop saw active participation from a large number of attendees and was received enthusiastically.

✍ **MEGHA PRAKASH**
(with input from AG Ramakrishnan)

EURASIA 2014

The Division of Chemical Sciences, IISc, hosted the 13th Eurasia Conference on Chemical Sciences from 14 to 18 December, 2014. This was the first time that the biennial international conference was held in India. It seeks to promote interactions among chemists in Asia and Europe; this edition also saw the participation of scientists from other continents.

The conference included an inaugural lecture, 8 plenary lectures, 47 lead lectures and 64 invited lectures. It was attended by 515 participants from 27 countries. "We had very enthusiastic

EURASIA 2014

CNR Rao, Linus Pauling Research Professor, JNCASR, making a point during the inaugural lecture

participation from across the country; nearly 250 participants, both faculty and students, from

across India attended the event," S Ramakrishnan, the Chair of the Organizing Committee and also the Chair of the Division of Chemical Sciences told CONNECT. Ten sessions, each dedicated to a distinct topic in the chemical sciences, were covered in the event. N Jayaraman, Convener of the conference and Professor, IISc, discussed the challenges of organizing an event of this magnitude. He said that the biggest among them was to bring in the best researchers from different fields to ensure that the event was truly representative of the diverse and important topics in chemistry. Ramakrishnan, elaborating on the challenges of arranging the logistics for the conference, said that the members of the organizing committee worked for almost a year to ensure the smooth conduct of the conference. "Small teams of my colleagues at the Division of Chemical Sciences took up the organization of 9 different sessions (the tenth was organized by our Japanese colleagues) and they did a fantastic job in putting together a very fine academic programme," he added.

CNR Rao, a leading solid state and structural chemist and Linus Pauling Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), delivered the inaugural lecture on inorganic graphene analogues. He argued that two-dimensional materials have attracted the attention of materials scientists because they are easier to synthesize and have inherent properties that make them superior to graphene in many ways. Rao also claimed that research on these inorganic analogues is already eclipsing the research on graphene and holds tremendous promise for the future.

A popular topic at the conference was the chemistry of energy systems. It saw delegates share their latest research on how batteries can be improved and how new materials can be incorporated into such systems. Other topics including self-assembled functional materials, nano-biomaterials, chemistry induced and

EURASIA 2014

S Ramakrishnan, Chair of the Organizing Committee and Chair of Division of Chemical Sciences, IISc, addressing the participants

probed by light, organometallic and coordination chemistry, organic and supramolecular chemistry, polymers and soft matter attracted a large number of speakers and participants.

A novel feature of this conference was a discussion on chemistry education in schools and colleges. S Kesavamurthy, Professor, IIT Kanpur, stressed the importance of moving away from merely fact-based learning in chemistry, so prevalent in our education. To help students understand important concepts in chemistry, he emphasized problem-based learning. He also highlighted some of the everyday problems we encounter that could be used in teaching chemistry.

In his concluding remarks, Nick Hadjiliadis, the well-known bio-inorganic chemist and member of the International Organizing Committee, praised the organization of the event. He also announced that the next conference in 2016 would be held next door in Karachi, Pakistan.

Jayaraman told CONNECT that the conference, which began in Bangkok, Thailand, in 1988, has come a long way and had secured a reputation among the global scientific community. Discussing why this conference is special, he said, "The series is unique as it brings the entire chemical sciences under one umbrella. A conference like this makes one realize the many different ways in which chemistry can be practiced."

✍ **ABHISHEK SHAHI** & **AMOGH KINIKAR**

CHEMISTRY AT THE INDIAN INSTITUTE OF SCIENCE: ONE HUNDRED YEARS OF BONDING

CONNECT

An exhibition, entitled 'Chemistry at the Indian Institute of Science: One hundred years of bonding', was organized by the Archives and Publications Cell (APC) from 14 to 31 December, 2014 at the Faculty Hall, IISc. The exhibition featured the evolution of chemistry at IISc.

The exhibition traced the birth and evolution of various departments that come under the Division of Chemical Sciences. General and Applied Chemistry (GAC), along with Electro-Technology, was the first department in the Institute. These were followed by the departments of Organic Chemistry and Biochemistry (now a part of the Division of Biological Sciences). These departments contributed significantly to the war effort as evidenced by entries in the Royalty Register of the Institute from the 1940s which was on display in the exhibition. It also featured some of the equipment from this era including chemical balances manufactured by Oertling & Co., Paul Bunge & Co., and the Coolidge X-ray tube apart from the photographic plates used by CV Raman in his research.

GAC became the Department of Inorganic and Physical Chemistry (IPC) in 1958. One of the major advances made by the department was in silicon wafer technology; a few polysilicon samples believed to be the largest in the country, produced by the late AR Vasudeva Murthy, former Professor, IPC, were also part of the exhibition.

The Solid State and Structural Chemistry Unit (SSCU) and the Materials Research Centre (MRC) were founded in the mid-to-late 1970s by CNR Rao, former Director, IISc, to further research in materials chemistry. The Nuclear Magnetic Resonance (NMR) Centre which deals with NMR Spectroscopy and biomolecular structure determination was also set up around the same time.

CONNECT

A chemical balance displayed at the exhibition

The curator of the exhibition, Sowmithri Ranganathan, a Consultant at APC, was however, disappointed with the lukewarm response. "The exhibition needs wider publicity since the Institute fraternity is not exposed to such events regularly," she told CONNECT. She is also concerned about how much information and equipment of historical value has been lost over the years. Ranganathan added, "The Institute fraternity should be proud of their achievements and more willing to share them."

✍ **MANEESH KUNTE**

THE MAIN BUILDING (PART III)

NITESH BHATIA

The third and final part in the series on the early history of the Main Building at IISc reveals the close link between its origin and the story of Morris Travers, the first Director of the Institute

✍ KARTHIK RAMASWAMY

The Main Building at the Indian Institute of Science (IISc) is a remarkable edifice; its origin is equally remarkable and is closely intertwined with the story of one of the most important men in the history of IISc — its first Director, Morris Travers.

Arrival in india

Travers, a chemist who worked on the discovery of noble gases with William Ramsay, arrived in Bangalore in late 1906. His first task as the Director was to construct a building to house the new departments, administrative offices, laboratories and the library. Travers, still young at 34 and lacking administrative experience, went about the task with great earnestness.

Cost Estimate

Based on the recommendation of the Tata brothers (Dorab and Ratan, sons of JN Tata and the executors of his will after his death in 1904), Travers got CF Stevens, an architect from Bombay, to prepare estimates and draft plans of the Main Building (and a few smaller buildings).

The proposed buildings were estimated to cost about INR 13 lakhs, well above what the Institute could then afford. The money that IISc had been promised for capital expenditure by the Mysore *Durbar* and the Government of India was INR 7.5 lakhs (it also expected to receive INR 2.5 lakhs for annual expenditure, mainly from the 'Bombay Properties' that JN Tata had endowed to IISc, and also from the Mysore *Durbar* and the Government of India).

Provisional Committee

Travers took Stevens' plans to the Provisional Committee on 23 March, 1908. The Committee, which preceded the governing Council, was responsible for taking administrative decisions. Besides Travers himself, it comprised SM Fraser as its Chairman (British Resident in Mysore), HJ Bhabha (Inspector General of Education, Mysore), VP Madhava Rao (Dewan of Mysore), BJ Padshah (representative of the Tatas), Alfred Hay (Professor, Electro-Technology) and Norman Rudolph (Professor, Applied Chemistry). Travers told the Committee that he proposed to make up the deficit of INR 5.5 lakhs from savings on the income during the period of development. Moreover, the Governments of Bombay and Madras had also promised financial assistance. The Committee

approved his plans and there was no opposition to Travers' handling of the finances.

Start of Construction

Travers then called for tenders for the construction of the foundation and the plinths of the Main Building. At the next meeting of the Provisional Committee on 23 April, 1908, a bid by TCW Skipp was accepted. Construction which started in May that year was personally supervised by Travers. He lived at West Bank on Avenue Road and rode his horse *Peter Pan* every morning to the construction site along with his stable assistant who rode a donkey.

Run-in with Padshah

Travers, during his time at the Institute, did not see eye to eye on several issues with the Tata brothers, including in the interpretation of JN Tata's will. Travers also had serious differences with Padshah, the Tata brothers' representative on the Committee and, eventually, the Council.Padshah was a brilliant scholar and educationist who had been handpicked by JN Tata to create the roadmap for the Institute when it was conceived. The first confrontation between Padshah and Travers occurred when the former wrote a letter to the Provisional Committee saying that the cost of construction should not exceed INR 6.5 lakhs (an amount suggested by the 1901 Mason and Clibborn Report instituted by the Government of India to study the proposed "University"). Padshah argued that the final decision on expenditure should be left to the yet-to-be-appointed governing Council. Though he had the support of HJ Bhabha on the Committee, he was outnumbered by Madhava Rao and Fraser who supported Travers' plans for construction.

Once the foundation and the plinths were completed in January, 1909, Travers asked TCW Skipp to begin the construction of the superstructures without seeking a meeting of the Provisional Committee, a decision that did not go down well with Padshah.

Governing Council

In May, 1909, the Government passed a vesting order for the creation of the Institute. Later that year, the

DAVID TRAVERS/CURRENT SCIENCE

Travers riding Peter Pan

governing Council was formed. Its composition was largely the same as the Provisional Committee, but the new Dewan of Mysore, Ananda Rao, took the place of his predecessor, Madhava Rao. However, three members from the Court of Visitors (also formed that year) were yet to be appointed.

In the second meeting of the newly-formed Council on 5 November, bids for construction were considered and once again Skipp's bid was accepted. Travers signed the contract for construction with Skipp based on more detailed plans submitted by the architect, Stevens.

Building Plan

According to Stevens' plans, the building, to be built in classical style using dressed granite stones, would face north into an open *maidan*. The inside walls would be made of wire-cut bricks. It would have an eastern and a western wing with a central tower for holding water tanks. The chemistry labs were to be in the eastern wing, while Electro-Technology was to occupy the western wing. The first floor would be taken up by the library. Besides the Main Building, Stevens' plan also included bungalows for the director, professors and the librarian, as well as students' quarters. The smaller buildings were to be built around the *maidan*.

Administrative Faux Pas

In March, 1910, Travers took another administrative misstep. Due to the delay in the appointment of new members to the Council, payments for construction were being made with the help of a Finance Committee that included Hay, the Dewan and Travers. But soon disagreements between the Dewan and Travers resulted in the former refusing to sign cheques for payments. Travers who did not want the work to suffer sought the help of friend Sydenham Clarke, the Bangalore Branch Manager of the Bank of Madras. Clarke helped Travers open a personal account in the bank and sanctioned a loan of INR 2 lakhs to pay the contractor until the Council's vacancies were filled. Travers' actions, once again, rubbed Padshah the wrong way.

Completed Governing Council

After Padshah's repeated insistence that the decisions of the Council were not legitimate until it was complete, the Patron of the Institute (the Viceroy of India) appointed three new members from the Court of Visitors to the Council; they included Alfred Chatterton (Director of Industries, Madras Presidency), AG Bourne (Director of Public Instruction, Madras Presidency) and GT Walker (Director General of Observatories, Government of India).

Departments and Students

Construction proceeded smoothly in 1911 until an exceptionally heavy monsoon caused a delay towards the end of the year. On 1 February, the long overdue Foundation Stone laying ceremony took place. General and Applied Chemistry started as a single department along with Electro-Technology; the Department of Organic Chemistry started a few months later. The Institute also opened its doors to its first students in July that year.

Changing Face of Governing Council

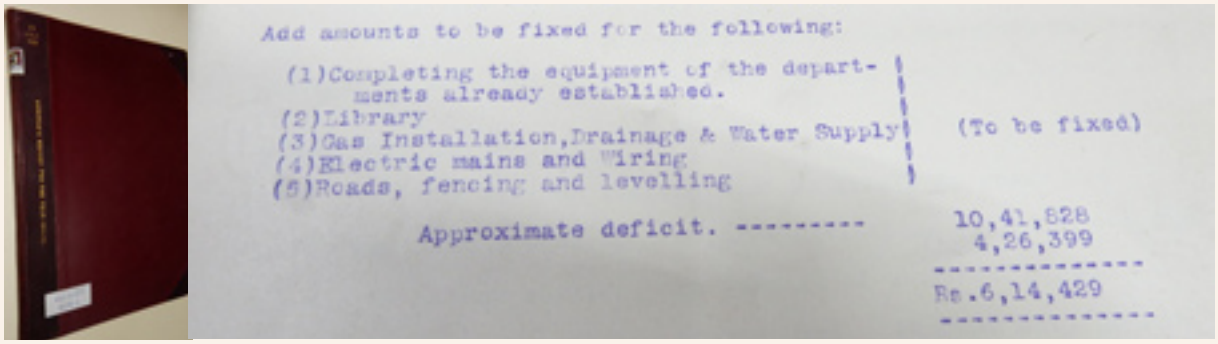
During this period, however, the Council's composition began to change. This did not work in favour of Travers. Many of its members — Chatterton, Bourne, Ananda Rao, JD Ghandy (who replaced Padshah as the Tata representative), Hugh Daly (the new British Resident to Mysore) as well as Bhabha, were not friendly towards Travers' style of functioning.

Vacation and Rebellion

In 1912, Travers took a long break from work; he left for England in March with his young family only to return in October. In his absence, the Chief Engineer, W Miller, was replaced by ER Subrayer. At a Council meeting on 27 August, the Auditor's Report of

ARCHIVES AND PUBLICATIONS CELL

The Main Building under construction


Add amounts to be fixed for the following:

(1)Completing the equipment of the depart-
ments already established.
(2)Library
(3)Gas Installation,Drainage & Water Supply (To be fixed)
(4)Electric mains and Wiring
(5)Roads, fencing and levelling

Approximate deficit. --------- 10,41,828
4,26,399

Rs.6,14,429

ARCHIVES AND PUBLICATIONS CELL

The Auditor's Report showing the deficit between assets and liabilities in the Institute's finances

1911-12 was placed before its members. It showed a "deficit" of a several lakh rupees. The members claimed that they were kept in the dark about the financial position of the Institute by Travers. They passed a resolution seeking an explanation from Travers on his return about what they perceived to be financial irregularities in the accounts. There were other developments — Travers' chief clerk and friend, Sundaram Iyer, was fired and the building contract with Skipp was cancelled.

On his arrival back in Bangalore, Travers realized that the hostility of the Council had turned into an open revolt against him. Travers was convinced that he had placed every financial liability before the Council. He wrote a detailed memorandum with his response which he circulated among Council members. But it had no effect on the situation. Things only took a turn for the worse when Skipp dragged the Institute to court demanding that his dues be paid along with interest. The grim situation demanded the intervention of the Viceroy. In March, 1913, he appointed a Committee of Enquiry to look into the affairs of the Institute, including the conduct of Travers.

Enquiry Committee

The Enquiry Committee held several hearings and met with a number of people including Travers. Travers believed that he had rebutted all the allegations against him successfully, including the "deficit" in the Auditor's Report. He also provided a detailed account of the history of the Institute and the ambiguity in the roles of the Director and the Council.

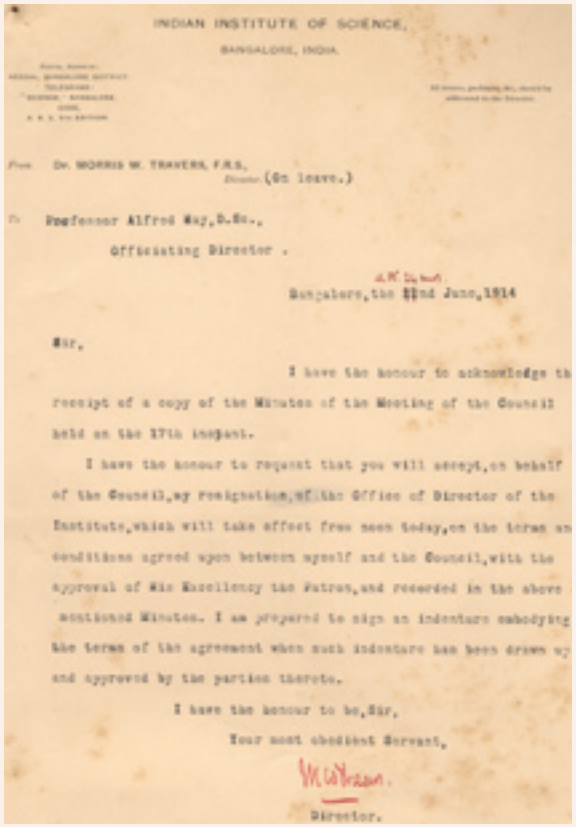
In the meanwhile, the Education Department of the Government of India acknowledged that the Council had made a mistake in cancelling the building contract with Skipp. Skipp was awarded damages of INR 1 lakh and a new contract was signed with him for the completion of the building. The Government also offered to give the Institute INR 4 lakhs to tide over the crisis.

In late 1913, the Committee of Enquiry finished its investigation and submitted its report to the Viceroy. In March of the following year, the Viceroy took a considered decision about Travers based on the report as well as the rebellious mood that prevailed among many Council members. The Viceroy said that though Travers' dismissal was not justified based on the findings, his continuation was "inimical" to the interest of the Institute. He, therefore, suggested that Travers resign, but added that the resignation should be secured by agreement.

Resignation

The Viceroy's decision led to negotiations between Travers and the Council about the terms of his resignation. It was finally decided that Travers would take a vacation leave until his 10-year term ended in December, 1916 following which he would start receiving his pension. Travers finally resigned in June and left Bangalore for England in September, 1914.

Before his departure, Travers had requested that the Council make the Enquiry Report public. But the Council refused to entertain his request because they did not think that anything "useful" would come out of this.



INDIAN INSTITUTE OF SCIENCE,
BANGALORE, INDIA.

From Dr. MORRIS W. TRAVERS, F.R.S.,
Director (On leave.)

To Professor Alfred Hay, D.Sc.,
Officiating Director.

Bangalore, the 22nd June, 1914

Sir,

I have the honour to acknowledge th
receipt of a copy of the Minutes of the Meeting of the Council
held on the 17th instant.

I have the honour to request that you will accept, on behalf
of the Council, my resignation of the Office of Director of the
Institute, which will take effect from noon today, on the terms an
conditions agreed upon between myself and the Council, with the
approval of His Excellency the Patron, and recorded in the above
mentioned Minutes. I am prepared to sign an indenture embodying
the terms of the agreement when such indenture has been drawn up
and approved by the parties thereto.

I have the honour to be, Sir,
Your most obedient Servant,

W. M. Travers.
Director.

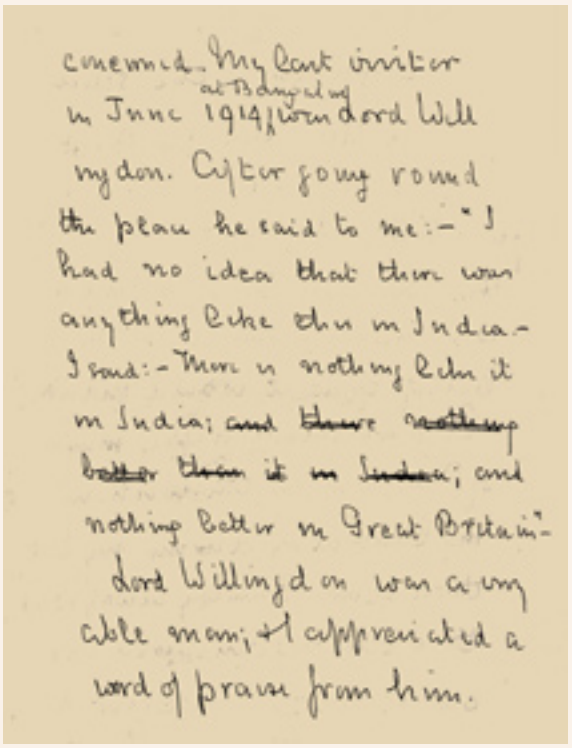
ARCHIVES AND PUBLICATIONS CELL

Travers' resignation letter

Travers' departure did not hasten the construction of the Main Building in any way; if anything, there were several delays. The tower to hold water was completed in 1917 and the building itself was mostly complete by 1919.

"Nothing Better"

Many years later during the Golden Jubilee celebrations of IISc in 1959, Travers wrote to the then Director, S Bhagavantam, expressing his inability to attend owing to poor health. In the same letter, Travers recounted the visit of the last guest entertained as Director of IISc. On 12 June, 1914, the Governor of Bombay (and the future Viceroy of India), Lord Willingdon, visited the Institute. Upon seeing the place, he admitted to Travers that he did not know that anything of this kind existed in India. To which Travers responded, "There is nothing like it in India; and nothing better in Great Britain."



concerned. My last visitor at Bangalore in June 1914 was Lord Willingdon. After going round the place he said to me:- "I had no idea that there was anything like this in India." I said:- "There is nothing like it in India; and ~~there is~~ nothing better in ~~London~~; and nothing better in Great Britain." Lord Willingdon was a very able man; & I appreciated a word of praise from him.

ARCHIVES AND PUBLICATIONS CELL

Extract from letter written by Travers to S Bhagavantam, former Director, IISc, in 1959 on the occasion of the Institute's Golden Jubilee celebrations

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The author thanks Sambavi AP for scanning some of the images used in the article

AWARDS

The following faculty from the Indian Institute of Science (IISc) were recently honoured in recognition of their research. CONNECT ***spoke to Kaushal Verma and Kavirayani R Prasad (both winners of the Shanti Swarup Bhatnagar Award), Jayant Haritsa (winner of the INFOSYS Science Foundation Award) and Dipankar Banerjee (winner of the DRDO Lifetime Achievement Award) to find out what these awards mean to them, their views on science and education, and interests outside academics***

CONNECT

Kaushal Verma

Kaushal Verma (Associate Professor, Department of Mathematics) received the **Shanti Swarup Bhatnagar Award** (2014) from the Council of Scientific and Industrial Research (CSIR). Verma, who grew up in Mumbai and Pune, is interested in complex variables and his research emphasis has been on holomorphic mappings and invariant metrics. He is also fond of reading history and poetry.

On being conferred the Shanti Swarup Bhatnagar Award…

First of all, I didn't believe it! Personally, I am very shy of all these things and I feel happy to be left alone in my room to do whatever I am doing. This is not to undermine the prestige of the award. But I think the best way is to accept it and say a big thank you.

On what can be done to get students interested in the subject...

I think it boils down to having good teachers at all levels in academia, right from primary level to 10+2, and equally inspiring teachers both at the undergraduate and graduate levels.

On what motivated him to choose a career in mathematics...

When I was still in class 9, I was least interested in the subject. But in class 10, I developed a keen interest, thanks to my teacher. And then, until class 12, I had two good teachers. I was lucky to have at least one good teacher to discuss my doubts with without feeling uncomfortable or being let down. And today, I like the subject so much that I can't think of my life without it.

On where his work finds uses...

Mathematicians like me pursue our work for its intrinsic beauty because the goal is to find structures where apparently none exists. But it is often used in understanding the mathematics involved in fluid mechanics and modelling.

CONNECT

Kavirayani Ramakrishna Prasad

Kavirayani Ramakrishna Prasad (Professor, Department of Organic Chemistry) was awarded the **Goyal Prize** (2012-13) and the **Shanti Swarup Bhatnagar Award** (2014) for his contributions to the synthesis of natural products and their analogues from readily available chiral pool compounds.

On what the award means to him...

Awards are nice. The work that we did for the past 10 years in IISc is what has been recognised. The Bhatnagar award is highly valued in Indian science, so getting it means something. But it also means more responsibility; the expectations have doubled, even tripled, not just internally in the organization, but also from the whole community — the community of organic chemistry.

Jayant Haritsa

Jayant Haritsa (Professor, Supercomputer Education & Research Centre and Department of Computer Science and Automation) received the **Infosys Science Foundation Award** (2014). He also won the **Best Software Demonstration Award** (2014) at the 40th International Conference on Very Large Databases held in China.

On being conferred the Infosys Science Foundation Award…

I was not at all expecting to be selected, and the news came as a big surprise. I am really pleased for this award because theoretical computer science has traditionally enjoyed a hallowed standing in India, and deservedly so, but research on computer systems, which is more applied in nature, has not received comparable exposure. Hopefully, the Infosys recognition will serve to stimulate greater academic activity in this field, and in the long run, build the foundation for the Indian software industry to develop products, and not be restricted to services alone.

On the importance of awards in science and why the INFOSYS award is special...

Awards can serve as a signalling mechanism by which the leading lights of the research community emphasize what they consider to be of principal value, and in that sense provide a moral compass to the prosecution of the scientific enterprise. And, for the recipients, it can serve to reinforce their commitment to these values. At the same time, one should be careful to not let the tail wag the dog — working solely with awards in mind can only be inimical to the progress of science.

A singular feature of the Infosys prize is that the jury is international in both composition and outlook. They focus primarily on the creativity and impact of technical contributions, placing less emphasis on the common quantitative indicators of scientific output, which tend to play an over-sized role in Indian academia.

On his own research....

I work on the design of database engines, which form the backbone of today's information-rich society, providing a congenial environment for handling data during its entire life cycle of generation, storage, maintenance and processing. In the early days of computing, their presence loomed large primarily in the enterprise sector, covering major financial, industrial and governmental domains such as e-commerce, transportation, manufacturing, banking, insurance, healthcare and utilities. Now, in recent times, their scope has expanded to personalized systems such as social networks, internet searches, and online courses. Looking into the future, we expect that with the advent of the so-called Big Data world, wherein data is the engine driving virtually all aspects of human endeavour; the role of database systems will soon assume ubiquitous proportions.

CONNECT

Dipankar Banerjee

Dipankar Banerjee (Professor, Department of Materials Engineering) received the **DRDO Lifetime Achievement Award** for the year 2013. He has participated in many critical defence programmes in his career in DRDO spanning 31 years.

On receiving the DRDO Lifetime Achievement Award...

I was associated with DRDO (Defence Research and Development Organization) for 31 years. It is the only organization that I had worked for after my PhD thesis at IISc and before coming here. I feel very honoured to be recognised in this manner by DRDO.

On his long association with DRDO...

The kind of satisfaction that you get when you see the technology that you were involved in being used in actual applications is hard to describe; for example, titanium alloys in our aircraft, castings in small jet fuel starters for the light combat aircraft or armour for the main battle tank or steel for India's first aircraft carrier. As Chief Controller for aeronautics programmes in DRDO, I had the opportunity to be involved in our major aeronautics activities ranging from the LCA to unmanned air vehicles, advanced early warning aircraft systems to cruise missile projects. Understanding the management of large systems programmes and learning how technology interfaces with systems design and development was a wonderful experience. It was exciting and deeply satisfying to work in an organization that offers so many opportunities.

On his work at IISc...

When I did my thesis from IISc and first joined DRDO, I worked with titanium alloys for aircraft applications and electron microscopy of materials. I continue to research in these areas in IISc. We have a group of 10-11 Masters and PhD students. I co-supervise them with colleagues, both within and outside the department. Our group looks at the science of a wide variety of engineering materials such as titanium alloys used in aircraft and gallium nitride alloys for semiconductor devices. The research covers the design and evolution of the structure of materials at various length scales and its relationship to their properties.

On what a career in science offers the student...

Every career has two aspects — professional satisfaction and monetary benefits. Doing science in academic institutions and R&D laboratories in the country is not monetarily as attractive as working in some other areas. But it is hard to convey the pleasures (and also pains) of a scientific career; the excitement of discoveries and opportunities to interact with peers and now students, and develop friendships across the world cannot be quantified in terms of money. I think I have been particularly blessed in having the opportunity to do science, technology, engineering to application, and technology and systems management across the span of my professional career. I could not have asked for more.

CONNECT

TG Sitharam

TG Sitharam (Professor, Department of Civil Engineering) received the **Gopal Ranjan Research Award** (2014) from IIT Roorkee. His expertise is in geotechnical engineering and is particularly interested in rock mechanics, earthquake engineering, micromechanics of granular materials, earth dams and tailing ponds, reinforced earth structures, instrumentation in geotechnical engineering, numerical methods in geo-mechanics and web based education.

CONNECT

Partha Pratim Talukdar

Partha Pratim Talukdar (Assistant Professor, Supercomputer Education & Research Centre) received a **Google Focused Research Award** (2014) to carry out research in the area of goal-directed ontology extension for Natural Language Understanding. His recent research has focused on graph-based learning algorithms for large-scale information extraction and data integration, temporal information processing, automatic knowledge harvesting from large data and neuro-semantics.

CONNECT

Neelesh B Mehta

Neelesh B Mehta (Associate Professor, Electrical and Communication Engineering) won the **NASI-Scopus Young Scientist Award** (2014). He works on the design, modelling, analysis, and optimization of current and next generation wireless communication systems.

Y NARAHARI

Y Narahari

Y Narahari (Professor, Computer Science and Automation & Divisional Chair, Electrical Sciences) received the **ACCS-CDAC Award** (2014) in recognition of his work in game theory and mechanism design. During the past decade, he has made important contributions to this emerging area which lies at the interface of computer science and economics, touching a variety of topics including design of electronic auctions and markets, and social network analysis.

CONNECT

Yalavarthy Phaneendra

Yalavarthy Phaneendra (Assistant Professor, Supercomputer Education & Research Centre) won the **NASI Young Scientist Platinum Jubilee Award** (2014). He works in the area of medical image computing, specifically in areas such as diffuse optical tomography, photoacoustic tomography, and neuroimaging.

AG RAMAKRISHNAN

AG Ramakrishnan

AG Ramakrishnan (Professor, Electrical Engineering) along with his student, Shiva Kumar HR, won the **Manthan Award** (2014) for e-inclusion and accessibility. Ramakrishnan has developed several technologies for Indian languages, such as optical character recognition, handwriting recognition, text-to-speech synthesis and Android based keyboard. His current research focuses on new knowledge-based features for speech that can lead to scalable technologies for multilingual speech recognition (utterances with words from more than one language) robust to noise and obviate the need for huge annotated databases for adapting the system to new languages. In addition, he has made contributions in prediction of foetal lung maturity, 3D compression of MRI, heart rate variability studies and camera-based document analysis and recognition.

✍ **MEGHA PRAKASH** & **MANU RAJAN**

Campus Critters

A ladybird picks on aphids feeding on a bamboo stem

Centre for Contemporary Studies