CONNECT

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AN INORDINATE FONDNESS FOR PLANTS

"An inordinate fondness for beetles" is what the great biologist JBS Haldane said when he was asked by a theologian as to what he could conclude about the nature of the Creator through his studies. Haldane was, of course, referring to the huge diversity of these insects and his own fascination for them.

I, on the other hand, developed an inordinate fondness for plants as a young man. I began to recognize the various species by observing them carefully and wanted to tell the world about plants as people in love tend to. So I became a teacher of botany at St. Joseph's College, Bangalore, after my PhD in plant sciences. This job allowed me to share my enthusiasm of plants with my students.

It was at Joseph's that I first met Father Cecil J Saldana, my senior colleague in the Botany Department. He recognized my love for plants and together we went on innumerable botanical explorations to study and collect plants from their native habitats. This phase of my life during the nineteen sixties and seventies added a new dimension to my relationship with plants – respect. I now respected them for their diversity, adaptations, their physiology and their complex interactions with other plants and animals.

As we collected more plants, we decided to start a herbarium to house our collections. It was called *Herbarium JCB* (Joseph's College Bangalore). Like all herbaria, it comprised a repository of our plant specimens that were dried, pressed and mounted on a sheet. Each of these sheets has information about the plants collected: when it was collected, where it was collected and the name of the species. Groups of species belonging to a genus were stacked together into a folder. Groups of genera belonging to a family were stacked together into a larger folder and so on. These folders were placed into pigeonholes in cabinets. This herbarium grew enormously under the leadership of Father Saldana.

Even though my fascination with plants remained undiminished, I went to Canada for my postdoctoral training in biochemistry and not botany. Studying plants, unfortunately, was and still is considered

A typical herbarium sheet

In this issue

From the Editorial Team

As you may have noticed, this issue of CONNECT is bigger and, we hope, better. In this issue, K Sankara Rao writes about his love for plants and about a unique online plant database developed by his team at the Centre for Ecological Sciences. Mary Mathew provides a primer on patenting one's research in the Institute. Hanudatta Atreya showcases research equipment at the NMR facility on campus. We also feature some events from the Institute over the past few days: an exhibition on the life and times of Sir CV Raman, a Golden Jubilee Lecture, the inauguration of a Hypersonic Wind Tunnel, the Open Day and Samanway, an event bringing together students and industry. Faculty who have joined us recently introduce themselves and Karthik Ramaswamy reflects on the history and significance of the Memorial to the founder of the Institute. And as always, Manu Rajan highlights researchers who have been honoured for their work and Natasha Mhatre and K Sankara Rao provide snapshots of flora and fauna on our campus.

Father Cecil Saldana (seated, ninth from left) and me (seated, sixth from right) at St. Joseph's College

old-fashioned. Studying plant taxonomy was frowned upon even more. But even while I was in Canada, my mind was never far away from the world of plants. I would go out on weekends with my camera and observe the kind of plants inhabiting these forests, their diversity, abundance and distribution. Living in the northern latitudes allowed me to compare plants in the temperate world with those in the tropics. This added to my awe of the tropics with their rich diversity and complex ecological relationships.

After my stint as a postdoc in Canada, I moved back to Bangalore and joined the Department of Biochemistry in the Indian Institute of Science (IISc). Interestingly, Father Saldana also moved to IISc as a Visiting Professor at the Centre for Ecological Sciences (CES) and the herbarium moved with him.

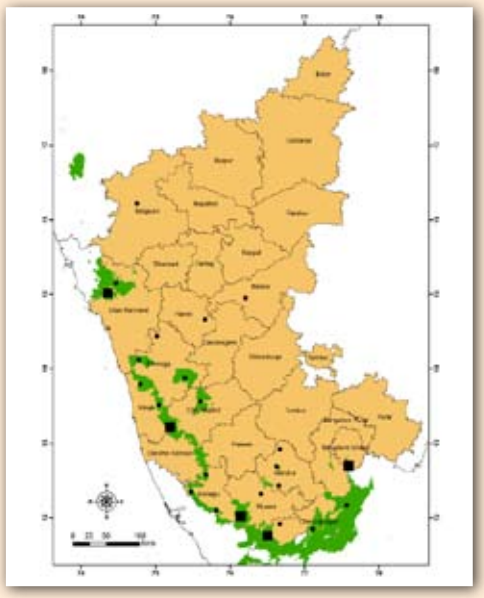
As a biochemist, I saw opportunities to continue to work with plants. I studied aspects of both their development and genetics. I also investigated the potential of genetically engineered commercial crops during this phase. But my first love remained studying the taxonomy and ecology of plants.

Father Saldana continued building on the herbarium until he retired. Sadly, Father Saldana is no longer with us, but he has left behind a rich legacy of plant research and of course, his herbarium collection. In 2006, Prof. R Sukumar, the then Chair of CES, asked me to take charge of the herbarium after I retired from the Biochemistry Department. I was delighted to get an opportunity to do what I enjoyed the most.

My group at CES

Besides maintaining the herbarium, I realized that there was a crying need to document the plant wealth of Karnataka and share it with others. The flora of Karnataka is one of the richest in the country and is distributed across many vegetation types including lowland coastal forests, mid-elevation wet evergreen forests, montane forests and grasslands. These vegetation types are spread over 38,000 sq. km. A large proportion of these plants are distributed in the Western Ghats, one of global hotspots of biodiversity.

The same year my team and I embarked on a journey to add to the herbarium collection and to use it to create an



The plant wealth of Karnataka

Biodiversity Heritage Sites
Kudremukh
Talacauvery

■ **National Parks**
Anshi – Dandeli
Kudremukh
Bannerghatta
Bandipur

● **Wildlife Sanctuaries**

online database of the plants of Karnataka. After years of hard work, this labour of love yielded fruit.

We have now created the first online herbarium to encompass the complete flora of any state in India. It is also the only online database for ferns from this geographic region. It holds information on 4710 flowering species and 290 non-flowering plants, besides ferns and allies.

***Homepage* of the online database**

The database features detailed descriptions of plant species known from Karnataka. Besides these descriptions, each species page has the citation of the 'Flora' in which it is described, nomenclature updates as per 'The Plant List' (http://www.theplantlist. org/), its phenology, distribution, threat status and comments on any special features of the taxon. The arrangement of angiosperms in the database is on the lines of that proposed by A. Cronquist (1968) in "The Evolution and Classification of Flowering Plants".

An example of a *Species* Page

The database has an *Advanced Search* option that allows you to explore its database using 20 different search criteria. It also has an *image gallery* that enables the user to browse species profiles with the help of digital photographs.

***Advanced Search* Page**

Though the biological diversity of the state is under great threat, we have little information about the conservation status of most plant species. We expect that this online database will serve as a stepping-stone for further research on the ecology of plants and as a platform to create awareness about Karnataka's rich floral heritage.

A plant from the *Image Gallery*

As we move forward, I am particularly keen that we include information about mosses and lichens, plant groups that are often neglected. I would also like the participation of botanists, both from IISc and elsewhere, to help our database evolve.

The database can be accessed at http://florakarnataka.ces.iisc.ernet.in

-- K Sankara Rao

NMR Research Centre

Nuclear magnetic resonance (NMR) spectroscopy provides information about the structure, function, dynamics, and chemical environment of molecules by exploiting the magnetic properties of atomic nuclei. Way back in 1977, a superconducting magnet-based high field NMR spectrometer was installed in the Indian Institute of Science (IISc). The installation of this spectrometer, the first of its kind in India, marked the birth of the NMR Research Centre. Today, it has grown to become a nodal centre for research in the area of magnetic resonance in the country and has retained its leadership in research and development as well as in the area of spectral service.

The Centre has six NMR spectrometers under one roof, a unique national distinction (a seventh NMR spectrometer operating at a ^{1}H resonance frequency of 400 MHz for solids is being acquired). The spectrometers cover a range of frequencies from 400 MHz to 800 MHz and have different capabilities. Research interests of the faculty at the Centre cover a range of topics. They include:

- Theoretical and experimental aspects of NMR Spectroscopy
- Development of multi-dimensional techniques and applications to liquids, solids and mesophases
- Application of NMR techniques to biological systems such as peptides, proteins and model membranes to study their structure, dynamics and interactions at atomic resolution
- High resolution solid state NMR techniques and applications
- NMR imaging and NMR quantum computing
- Metabolomics and Nanoscience

The Centre also caters to a very large number of users in the country from academic and research institutes and also from industry. At any given time, there are about 300 researchers using the facility. Besides this service, the Centre provides consultancy to various users both formally and informally. More details can be obtained from the following websites: http://sif.iisc.ernet.in or http://nrc.iisc.ernet.in

AV 400

- Operating ^{1}H frequency: 400 MHz (9.4 Tesla)
- Used for high throughput analysis of regular organic compounds
- 24 position sample changer
- Equipped with:
  - Broad Band Inverse Probe (BBI)
  - Broad Band Fluorine Observation Probe (BBFO)
- Operating temperature: - 60^{0} C to 100^{0} C
- Provides capabilities for carrying out routine ^{1}H and ^{13}C based 1D and 2D NMR experiments in the solution state

DRX 500

- Operating ^{1}H Frequency: 500 MHz (11.7 Tesla)
- Equipped with:
  - Triple Resonance Probe (TXI) (1H, 13C, 15N)
  - Triple Resonance Broadband Probe (TBI) (1H, 13C, X)
  - Broad Band Inverse Probe (BBI)
  - Quad Nucleus Probe (QNP)
- Operating temperature : - 60^{0} C to 100^{0} C
- Provides capabilities for carrying out routine ^{1}H and ^{13}C based 1D and 2D NMR experiments in the solution state

AV 500 (S)

- Wide bore NMR spectrometer for analysis in solid state
- Operating ^{1}H frequency: 500MHz (11.7 Tesla)
- Equipped with double and triple resonance magic angle spinning probes of variable rotor diameters:
  - 1.3 mm (Spinning speeds up to 60 kHz)
  - 2.5 m (Spinning speeds up to 35 kHz)
  - 3.2 mm (Spinning speeds up to 25 kHz)
  - 4 mm (Spinning speeds up to 18 kHz)
  - 7 mm (Spinning speeds up to 6 kHz)
- Temperature range : - 30^{0} C to 200^{0} C
- Provides capabilities for carrying out ^{1}H, ^{13}C and ^{15}N based 1D, 2D and 3D NMR experiments in the solid state

AV 500 (L)

- Operating ^{1}H frequency: 500 MHz (11.7 Tesla)
- Equipped with :
  - Quattro Resonance Inverse Probe (QXI)
  - Triple Resonance Inverse Probe (TXI)
  - Broad Band Inverse Probe (BBI)
- Equipped with High Resolution Magic Angle Spinning (HRMAS)
- Temperature range: - 60^{0} C to 100^{0} C
- Provides capabilities for carrying out ^{1}H, ^{13}C and ^{15}N based 1D, 2D and 3D NMR experiments in the solution state

AV 700

- Operating ^{1}H frequency: 700 MHz (16.4 Tesla)
- Equipped with:
  - Cryoprobe - TCI
  - Triple Resonance Inverse Probe (TXI) (room temperature)
- Temperature range: 0^{0} C to 50^{0} C
- Four RF channels
- Provides capabilities for carrying out ^{1}H, ^{13}C and ^{15}N based 1D, 2D, 3D and 4D NMR experiments
- Useful for protein/peptide structure determination and metabolomics studies in the solution state

AV 800

- Operating ^{1}H frequency: 800 MHz (18.7 Tesla)
- Equipped with:
  - Cryoprobe - TCI
  - Triple Resonance Inverse Probe (TXI) (room temperature)
- Temperature range: 0^{0} C to 50^{0} C
- Four RF channels and dual receivers
- Provides capabilities for carrying out ^{1}H, ^{13}C and ^{15}N based 1D, 2D, 3D and 4D NMR experiments in the solution state
- Useful for protein/peptide structure determination and metabolomics studies

-- Hanudatta S Atreya

Events on Campus

Open Day The Indian Institute of Science opened its gates to thousands of visitors on 1 March, 2014 on the occasion of its Open Day. The Institute warmly welcomed science enthusiasts, school children and the public to have a peek into the world of science and the research facilities at the Institute. The event included exhibitions, experiments and hands-on learning activities put together by individual labs from the over forty departments in the Institute.







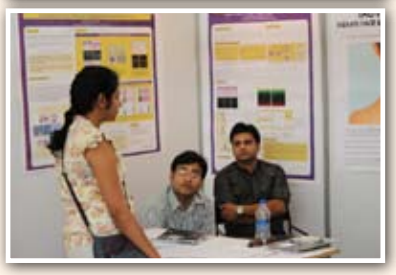


A Hypersonic Wind Tunnel, the second largest in the country, was inaugurated at the Aerospace Engineering Department on 8 April, 2014 by Prof. Roddam Narasimha, the renowned aerospace scientist and former Director of the National Aerospace Laboratories (NAL). The inauguration was also attended by heads of several aerospace laboratories in the country. The 0.5 m Wind Tunnel is a new addition to the high speed wind tunnel complex. This complex already has a 0.3 m hypersonic wind tunnel and two other supersonic tunnels for basic and applied research in the area of high speed aerodynamics. This facility was funded by grants from the Aeronautics Research and Development Board and developed in just 2 years at a cost of Rs. 6 crores.




-- B Vasudevan

Samanway The Students' Council of the Indian Institute of Science (IISc) organized Samanway (Part I) on 12 April, 2014 in the Biological Sciences building. The goal of this annual event is to provide a platform for students to interact with the industry about research opportunities in niche areas of R&D. Part I focused on the pure sciences. Twelve companies, including Shell, ITC, BEL, L'Oreal, and Gubbi Labs and about 250 students participated in the event.



The morning session included a panel discussion titled 'Resurrection: Scientific temper in India'. Prof. S Umapathy, Prof. TN Guru Row, and Dr. SP Arun were the participants from IISc and Dr. Venkat Krishnan (ITC), Dr. K. Nagarajan (HIKAL), Dr. Deependra Moitra, and Dr. Anna Tudos (Shell) represented the industry.

The afternoon session saw many talks from people in the industry about career opportunities and challenges in their companies. They also encouraged students to pursue other careers like science journalism and even exhorted them to consider becoming entrepreneurs. Gubbi labs, a company founded by the alumni of IISc, worked with the Students' Council to bring out a newsletter on the occasion. The newsletter highlights the research carried out in IISc in the past year.

-- Prapanch Nair

Golden Jubilee Lecture Subra Suresh, the President of Carnegie Mellon University, USA, gave a Golden Jubilee Lecture titled 'Study of Human Diseases at the Intersections of Engineering, Science and Medicine' at the Faculty Hall in the Indian Institute of Science on 12 March, 2014.

Suresh, who has also served as the Director of the National Science Foundation, USA, continues to have an active research programme in spite of his role as a science administrator.

Using his background in engineering, Suresh studies structural changes in red blood cells (RBCs) in patients suffering from malaria, sickle cell anaemia and cancers like leukaemia. In his talk, he argued that it was now possible to use advances in nano-engineering to better understand the biomechanical changes caused by disease at the cellular level.

Suresh showed, using a video, how healthy RBCs change their shape from discs to bullets as they shoot across thin capillaries. Infected cells, on the other hand, lose their flexibility and become stiff, thus getting trapped at the mouth of capillaries. They are, therefore, unable to perform the vital function of gas exchange.

Suresh also claimed that it was now possible to diagnose diseases of the blood based on the shape, size and stickiness of RBCs.

-- Megha Prakash

CV Raman: Celebrating the Life of a Rare Gem

An exhibition titled 'CV Raman: Celebrating the Life of a Rare Gem' was organized by the Archives and Publications Cell (APC) of the Indian Institute of Science (IISc). It gave a fascinating peek into the life of one of the most important men in the history of not just IISc, but also Indian physics.

The exhibition coincided with the one-hundred-and-twenty-fifth birth year of Raman (he was born on 7 November, 1888). It was inaugurated on 26 February, 2014 at the Reception Hall of the Main Building by Dominique Radhakrishnan, Raman's daughter-in-law, two days before the National Science Day. National Science Day is celebrated on February 28 every year to mark discovery of the Raman Effect. The exhibition ended on April 30.

Besides rare photographs from APC as well as from the archives of the Raman Research Institute, the exhibition included a sixteen minute documentary written and produced by APC about the life and times of the remarkable physicist and institution builder.

A few representative photographs of Raman from the exhibition

In Calcutta (1907)

With his spectrometer

With Pandit Nehru and the Maharaja of Mysore, JC Wadiyar

Felicitation in Chennai after being knighted (1929)

With Prof. S Bhagavantam

At the Indian Science Congress in Bangalore (1936)

Admiring his Nobel Certificate

With Gandhi on his visit to IISc

Interacting with children

-- Sowmithri Ranganathan

HELLO!

In this section, faculty who have recently joined the Indian Institute of Science (IISc) introduce themselves and their work

Tushar Kanti Chakraborty

(Organic Chemistry)

After nearly 26 years in the CSIR system, with the last five as the Director of the Central Drug Research Institute, Lucknow, I find my transition to the Indian Institute of Science as a professor in the Organic Chemistry Department most refreshing. I have a sense of freedom in my research that was largely missing in the midst of routine administrative drudgery. The morning chill (even now in summer!) and walking the tree-lined avenues in the campus soothe my body and soul fatigued over the years by the extremes of the north!

I consider organic chemistry a form of art in science. Organic chemists, like sculptors, create molecules bit by bit; they feel excited as their creations start taking beautiful three dimensional shapes, get mesmerized watching them in motion, and applaud when they perform in real space, sometimes far beyond their own expectations.

We chemists try to understand the mysteries of nature at molecular, atomic and subatomic levels. Use of natural products or synthetic small molecules as probes to unravel the yet unknown facets of biological processes, disease progression, ultimately to conquer them, assumes great significance today with the advances in spectroscopy, imaging, modeling, computation, systems biology and other related areas.

Our group is interested in the broad areas of organic synthesis, encompassing the total synthesis of natural products, peptides and peptidomimetics based on multifunctional building blocks called sugar amino acids (SAAs) that we have developed in our lab. We also study their structures and properties. Presently we are working on cationic antimicrobial peptides, cyclic as well as linear, that are showing effective and very selective activities against *Mycobacterium tuberculosis* (MTB). Our SAA-based anticancer molecules target microtubule dynamics, c-MYC and other gene promoters that are over-expressed in many cancer cells, VIP receptors, HDAC and others.

In the synthesis of natural products, we have over the years synthesized wide-ranging molecules like glycopeptide antibiotics of the vancomycin/teicoplanin family; immunosuppressants like FK506, rapamycin, stevastelins, antascomicin; anticancer molecules like amphidinolides, epothilones, crocacins, clavosolide, rhizopodin, etc. In many of our syntheses, we use a radical mediated method, developed in our laboratory, to construct chiral 1,3-diols by opening epoxy alcohols using Ti(III) reagent as a key step. The method has since been extended to construct 5- and 6-membered carbo-, oxa- and aza-cyclic compounds and synthesis of natural products having such rings.

Soumya Das

(Mathematics)

I joined IISc as an Assistant Professor in the Department of Mathematics in July last year, before which I was an Inspire Faculty for a few months here.

I did my PhD from the Harish-Chandra Research Institute, Allahabad and spent two years as a postdoc at the Tata Institute of Fundamental Research, Mumbai. I work primarily in the field of Number Theory, especially on topics related to "modular forms". Modular forms are objects that are central to Number Theory and many other areas of mathematics. They are also extensively used in theoretical physics (for instance, string theory).

In simple terms, they are analytic functions on the complex upper half plane and have many symmetries coming from certain groups. They are periodic and can be expanded into a nice Fourier series. The Fourier coefficients often encode many interesting arithmetic and analytic data. For example, the solution to counting the number of ways of writing a positive integer as a sum of 'n' squares comes from a Fourier coefficient of a certain modular form!

Besides doing math, I enjoy playing table tennis, travel and watch movies. I find IISc a great place to work in: the campus is very beautiful and the work ethic in the Institute is tremendous. And Bangalore stands out for its pleasant weather.

Naren Ramanan

(Centre for Neuroscience)

I graduated with a PhD in molecular microbiology from the Institute of Molecular and Cell Biology, National University of Singapore. I then joined the laboratory of Prof. David Ginty as a postdoctoral research fellow in the Department of Neuroscience at Johns Hopkins University School of Medicine in Baltimore, MD, USA. After completing my postdoctoral training, I started my independent lab in 2006 as an Assistant Professor of Neurobiology in the Department of Anatomy and Neurobiology, Washington University School of Medicine in St. Louis, MO, USA. In July 2013, I moved my laboratory to the Centre for Neuroscience, Indian Institute of Science.

My lab is interested in several longstanding questions in developmental neuroscience: (1) What are the molecular mechanisms regulating axonal growth during development and how can these mechanisms be activated to promote axonal regeneration after injury? (2) What are the mechanisms regulating neural stem cells to astrocyte differentiation in the brain and how do these mechanisms go awry resulting in gliomas, the major tumours in the brain? and (3) How do synapse-to-nucleus signalling and activity-dependent transcription of immediate early genes sculpt neuronal connectivity during development and in adulthood? How are these signalling and downstream transcriptional pathways affected in neurological and neurodegenerative disorders? My lab uses a combination of mouse genetics, molecular, biochemical and cell biological approaches to address these questions.

Whenever the luxury of free time is allowed by my children, I like to read and listen to music.

Campus Critters

Two male rat snakes involved in a ritualized combat to settle a territorial dispute

Photograph: Natasha Mhatre (Reprinted with permission from *IIScPress)*

Patenting in the Indian Institute of Science

Publishing is an integral part of research. Researchers – faculty, postdoctoral fellows, students and staff – publish their research findings in the form of theses, books and journal and conference papers. However, patenting one's work, apart from merely publishing, may offer the researcher certain additional advantages.

Besides providing protection, patenting increases the potential of taking one's research to a wider scientific community and also directly to society via the markets. But the decision of whether to patent one's research findings or not is not a trivial one.

The decision about patenting one's research should be dictated by the patentability of the research. Patentability depends on:

- the novelty of one's work (to the world)
- its non-obviousness (not easily understood by a person skilled in the scientific area)
- its utility (to the market and hence, society)
- whether or not it has a technical effect (it performs an action, like charging a battery)

It is important to keep in mind that publishing and patenting are not either-or options. They are both possible, but a patent must be filed first before the paper, thesis or book is published and put into the public domain.

The Indian Institute of Science (IISc) set up the Intellectual Property Cell (IP Cell) in 2004 to help researchers in the Institute with issues relating to intellectual property. One of the main services that the IP Cell offers is to help researchers better understand the process of patenting their research.

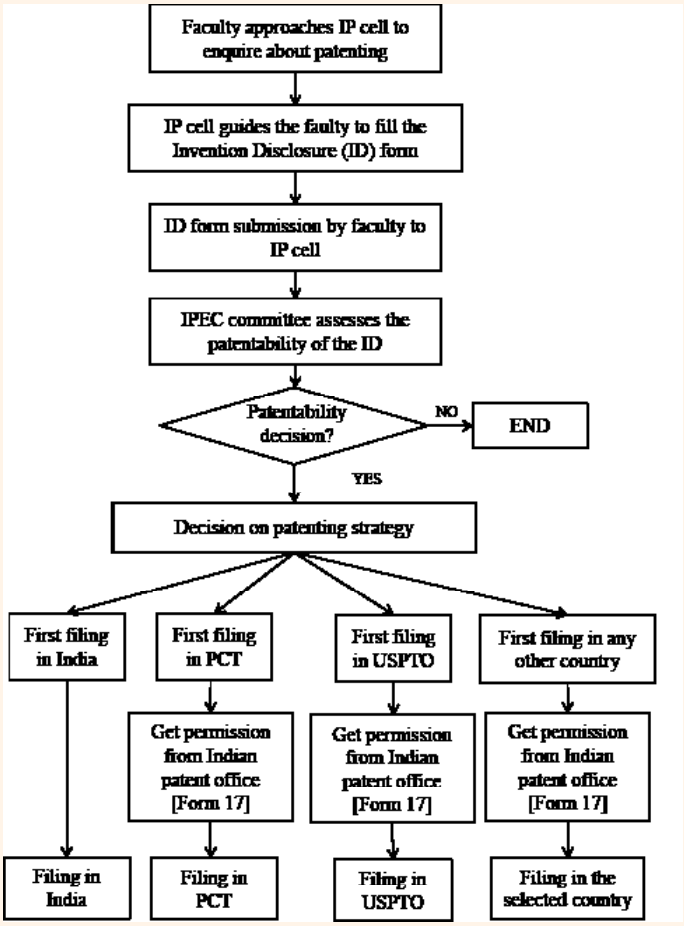
The IP Cell follows the Intellectual Property Policy and Guidelines document of IISc. The document is currently updated as of 2014. A committee called the Intellectual Property Management Committee appointed by the Director of the Institute oversees the management of the IP Cell. The IP Cell is geared to file patents for faculty, postdoctoral fellows, staff and students of IISc, and it does this with the help of a number of patent attorneys associated with the IP Cell.

The flow chart (see next page) summarizes the patenting process followed by the IP Cell. It begins with filling up an Invention Disclosure Form (IDF) that must be emailed to the IP Cell. An IP evaluation committee assesses whether or not to go ahead with the patenting process based on the information provided. It also makes a decision on which country to file the patent in.

If an affirmative decision is made by the committee and it is decided that the patent will be filed in India, it is done at the Indian Patent Office in Chennai. As seen in the chart, the patent may also be filed in foreign countries if there is a foreign market for the know-how in the patent and if it is patentable there. This stage is followed by a discussion between the inventor and a patent attorney who together write the patent application document. This application is then submitted to the relevant Patent Office by the patent attorney. A patent examiner assesses the patent at the Patent Office. There may be queries to the inventor from the patent examiner in the Patent Office. At this stage, there may also be opposition from those in similar R&D fields (either from academia or the industry) to the patent. If these challenges are overcome, the patent examiner studies the patent further and then decides whether to award the patent or reject it. The entire process may take anywhere between 2 to 4 years on an average. Queries and opposition delay the process.

But even during this period of examination, the patent can be marketed in its current *patent pending* state. This allows the researcher to take the invention to society via the markets. The term market here refers

to various specialists in industry who work on the know-how to convert it from laboratory scale to industrial scale know-how increasing its applicability and value. This conversion involves translation and commercialization of the patent. Finally the know-how is sold in product form to end users in the market, namely members of society. For many researchers, being able to take their research to society may be the most satisfying aspect of the process because it provides a direct feedback of the usefulness of their research. However, some may find commercializing the patent a challenge. The ones that choose not to take their patents to market may believe that their patent may not be useful to society. Another reason, and not an uncommon one, to not pursue the commercial strategy of a patent is because the researcher may not know how to find a buyer or user.



The patenting process followed by the IP Cell
(Credit: Pratheeba Subramanium)

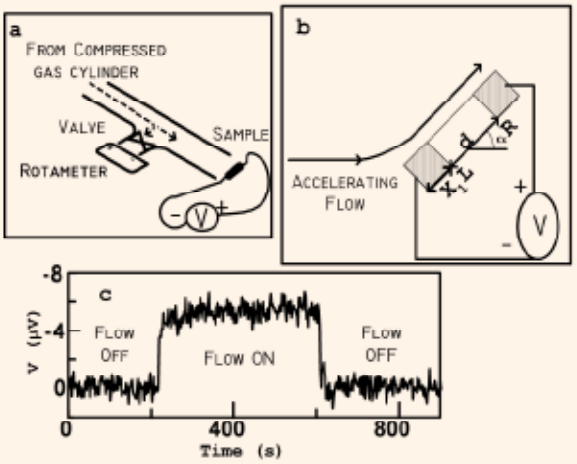
For those who may not have the time, are not willing to wade through the market, or are ignorant about the marketplace, the option of using *translators* is an attractive one. Translators are entrepreneurs and patent marketers who take the risk of translating the patent into marketable know-how by jumping over the many hurdles involved, manufacturability being one of them.

IISc is fortunate to be sitting on a mountain of scientific wealth useful for society. With about 472 patent applications since 1994, the Institute has an impressive geographic spread of its patent applications. This spread indicates that science and technology outputs from the research work of faculty, postdoctoral fellows, staff and students have relevance in various geographic markets across the globe. The Institute's patent filings cover India (259), USA (93), Europe (24) and 14 different countries (31) including Australia, Brazil, Canada, China, Indonesia, Japan, South Korea, Mexico, New Zealand, South Africa, Sri Lanka, Switzerland, Thailand, and Vietnam. Some of these patents are waiting to be commercialized. In the box (see next page) is highlighted a case study of a patent from the Institute.

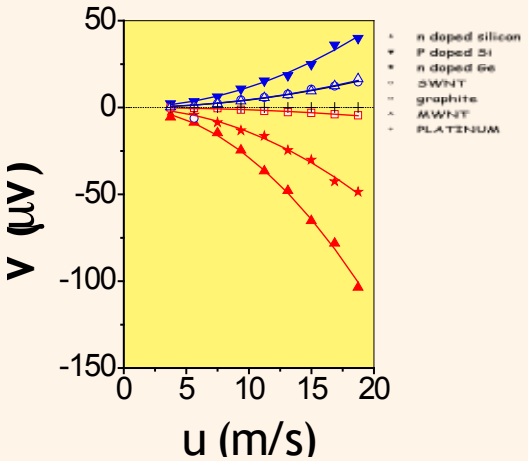
The IP Cell in IISc is situated in the building that also houses the Society for Innovation and Development (SID). Please contact us (Email: ipoff@admin.iisc.ernet.in; Phone: (080) 22932037 / (080) 22932038) for more information about the patenting process as well as how a patent can be commercialized, thus taking it directly to the people. You can also visit us at www.ipcell.iisc.ernet.in

Patent no. US 7302845 B2, March 2003. *Method for measurement of gas flow velocity, method for energy conversion using gas flow over solid material, and device therefore.*

A patent of IISc in the area of voltage generation by the flow of gases over semiconductors and carbon nanotubes (CNT) was awarded in the Indian and US patent offices. The invention (know-how) behind the patent determined flow velocities when gas is passed over selected solid materials (doped semiconductors) or carbon nanotubes. The material kept at an incline to the gas flow results in a pressure gradient along the flow direction (using the *Bernoulli Principle*), resulting in a temperature gradient *(gas law)*. This leads to voltage generation across the sample due to the *Seebeck Effect*. This laboratory based flow sensor giving tens of micro-volts, could be made even more sensitive if the electric output could be amplified. The figures show the sequence of events that constitute the technical effect in the patent as well as the empirical results. The possibility of power generation using this technology without any moving part still needs to be explored. The patent received much media publicity. It, along with other inventions of Ajay Sood and his student Shankar Ghosh, was featured in the May 3 (2003) edition of *The New York Times*. Pallava Bagla, the then Science Correspondent of *The Indian Express* termed it as the "Sood Effect". The patent was licensed exclusively to a start-up called Trident Metrology Inc., in Oregon, USA. The start-up grew very well, but was shaken by the economic down turn in the USA around that time. This triggered off a request for early encashment by its venture capital investors. Insights drawn from this commercialization project indicate that laboratory scale experiments may require risk-taking translators to realize commercial possibility of IISc's laboratory based inventions.



Various stages in the know-how



Empirical results from the tests

Figures sourced from: AK Sood and S Ghosh, *Phys. Rev. Lett.* 93, 86601(2004)

-- Mary Mathew

From the Archives: Memorial to the Founder

The Memorial to Jamsetji Nusserwanji Tata, the founder and benefactor of the Indian Institute of Science (IISc), is an impressive monument. A flight of steps, representing the steps of learning, leads to a stage on which rests a central pedestal. In front of the stage is a bronze rail with the lamp of learning at its centre; the lamp is flanked on either side by dolphins symbolising Tata's travels. On the pedestal, rests a shaft; the shaft has a tablet which sings praises of Tata. It is a reminder to future generations of his foresight, patriotism and magnanimity. The sides of the shaft are supported by handsome statues of two Greek women, one signifying *Knowledge* and the other, *Abundance*. To its left and right are reliefs that contain Gods and Goddesses from Greek mythology. The relief of the left has *Jove*, with his thunderbolts to typify electricity and *Vulcan* with his anvil, ready for steel. In the other, *Minerva* holds a distaff covered with flax and *Caliope*, representing research. From the central shaft rises a towering JN Tata, as he looks fondly at the replica of the Institute that he holds in his left hand. The Memorial, guarded on either side by two tall New Caledonian pines, faces the Main Building.

The statue of JN Tata, the heart of the Memorial and so symbolic of IISc, was made by the British sculptor, Gilbert William Bayes. It, along with other parts of the monument, was shipped to India all the way from England. The total cost of making and shipping the monument as well as constructing the balustrade and the forecourt was Rs. 79,500. It was unveiled on 10 March, 1922 by the Maharaja of Mysore, Narasimharaja Wadiyar. The Maharaja spoke on the occasion, as did Dorabji Tata, son of JN Tata, and Alfred Hay, the Director of the Institute.

The unveiling ceremony of the statue on 10 March, 1922. Standing at the foot of the statue from left to right: Alfred Hay (Director, IISc), Maharaja of Mysore, Yuvaraja of Mysore, WP Barton (Resident), Sir Dorabji Tata (Son of Founder JN Tata)

The bronze statue of JN Tata with a replica of the Institute in his hand

Knowledge and *Abundance* on either side of the central shaft

The Memorial tablet at the feet of JN Tata

The bronze rail with the lamp of learning at its centre with dolphins on either side

The relief on the left containing *Jove* and *Vulcan*

The relief on the right containing *Minerva* and *Caliope*

-- Karthik Ramaswamy

Awards and Honours

The following faculty were recently honoured for their research contributions

HK Firodia Award for Excellence in Science and Technology

DD Sarma *(Solid State and Structural Chemistry Unit)* has worked extensively on the physics and chemistry of materials with special emphasis on nanomaterials. He has made significant contributions in the fields of electron spectroscopy and materials synthesis. He has increased our understanding of their electronic, magnetic, dielectric and optical properties by combining a variety of experimental techniques with theoretical investigations. His publications are based on experimental and theoretical studies covering broad areas of Solid State Chemistry, Spectroscopy, Condensed Matter Physics, Materials Science, and Nanoscience. He has been awarded various national and international patents for his innovations.

Indian Science Congress Award for Outstanding Contributions to Science and RD Birla Award for Excellence in Physics by Indian Physics Association

AK Sood *(Physics)* is a pioneer in the fields of both soft and quantum condensed matter physics. A new phenomenon discovered by him shows that the flow of liquids on single walled carbon nanotubes induces voltage and current in the sample along the direction of flow. He has used light scattering to provide clear answers to some fundamental questions in quantum condensed matter physics. In soft matter, his investigations include shear-induced novel crystallization, shear thickening at very low volume fraction, ultra-sensitive immunoassay using electric field driven colloids and collective motion of self propelled active granular particles, mimicking the collective behavior of locusts which show disorder to order phase transition as their number density is increased.

Prof. SK Pradhan Endowment Lecture Award

Govindasamy Mugesh *(Inorganic and Physical Chemistry)* demonstrates the potential of bioinorganic chemistry to biomedical applications. His group is working on the design and synthesis of novel molecules as potential therapeutic agents based on the inhibition of metalloproteins along with several synthetic compounds having antithyroid and antioxidant activities. His contribution in the area of thyroid hormone metabolism has attracted significant national and international attention.

NRDC Meritorious Societal Invention Award

Subba Reddy B *(High Voltage Lab / Electrical Engineering)* has a wide range of research interests including pollution flashover studies on high voltage transmission insulators, development of newer types of conductors, studies on surge arresters and renewable energy systems. He has developed a novel field control element for high voltage ceramic disc insulators which addresses the issue of power interruptions caused by pollution induced outages/blackouts. Reddy has also won an award for outstanding service to the Indian insulator industry from Aditya Birla Insulators.

-- Manu Rajan

Campus Flora

Floss-silk tree (*Ceiba speciosa*) flowering in front of the Central Office Building

Photograph: K Sankara Rao (Reprinted with permission from *IIScPress*)

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