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Patrika

September 2009

Newsletter of the Indian Academy of Sciences

Platinum Jubilee 1934-2009

2009 Platinum Jubilee Meeting – I

D Balasubramanian

Lalji Singh

The annual meetings of the Academy are generally held at various cities other than Bangalore. Two exceptions are the Golden Jubilee meeting (which was to have been held at Bangalore in November 1984, but was postponed to early 1985 on account of the tragic passing of Smt. Indira Gandhi) and the Diamond Jubilee Meeting in 1994. Similarly the series of mid-year meetings initiated in 1990 have been held at Bangalore each year, except for one occasion when it took place in Mysore. This year 2009, being the Platinum Jubilee Year of the Academy, three meetings by way of celebration have been organized: The usual Mid-Year Meeting was at Hyderabad, July 2–4; the Annual Meeting at Bangalore, November 12–14; and one more at Mumbai during December 3–5, as part of the Homi Bhabha centenary celebrations. These three meetings are designated as Platinum Jubilee Meetings I, II, and III.

The first meeting in July 2009 at Hyderabad was co-hosted by the Indian Institute of Chemical Technology and the Centre for Cellular

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Forthcoming Events – 2009

Refresher Courses

1. Experimental physics XVII Carmel College, Goa	:	26 October – 9 November 2009
2. Experimental physics XVIII University of Calicut	:	23 November – 8 December 2009
3. Theoretical physics, Bishop Moore College, Mavelikara	:	7 – 19 December 2009
4. Biotechnology and modern molecular biology techniques Manipal University, Manipal	:	11 – 23 January 2010
5. Experimental physics XIX Karnatak University	:	7 – 23 January 2010
6. Experimental physics XX Manipal University, Manipal	:	24 May – 9 June 2010
7. Frontiers in atmospheric sciences, IITM, Pune	:	14 – 25 June 2010

Lecture Workshops

1. Biotechnology in modern medicine PES College, Bangalore	:	23 – 24 October 2009
2. Nano-materials and technology in chemistry and green chemistry Sikkim Manipal Institute of Technology, Sikkim	:	23 – 25 October 2009
3. Evolution Aurora College, Hyderabad	:	20 – 21 November 2009
4. Planet G Jai Hind College, Mumbai	:	24 – 25 November 2009
5. Contemporary issues in biology University of Mysore	:	3 – 4 December 2009
6. Recent advances in spectroscopy: Theory, instrumentation and applications Lady Doak College, Madurai	:	18 – 19 January 2010
7. Structure, function and design of biomolecules Bharathiar University, Coimbatore	:	28 – 29 January 2010
8. Diffraction University of Mysore	:	26 – 28 February 2010

and Molecular Biology. The attendance by Fellows, Associates and invited teachers was encouraging. Many of the lectures were extremely informative, some things that remain in one's memory are recalled below.

In his welcome address, Academy President D Balasubramanian dwelt on the scale and various efforts to mitigate the problems of impaired vision, both worldwide and in India. The eye being an isolated organ of the body, its diseases are in a sense easy to treat. Even gene-based methods are in principle available, as injected genes do not migrate to other parts of the body. There are about 40 million blind in the world (8 million of them in India). Of them 47% or 18 million suffer from cataract which is easy to handle; while 12% are glaucoma or increased ocular pressure cases. There are 15,000 ophthalmologists in India, and an important target is to reduce the incidence of eye diseases by a factor of two by 2020. The L V Prasad Eye Institute in Hyderabad has over the years built up a very carefully thought out rural eye care model, now operating throughout Andhra Pradesh. This is a pyramidal scheme, with small-sized rural care centres tackling simpler problems locally, while more complicated cases are referred to successively more sophisticated centres. Such a model has been shown to work very well, and should be copied by other states in the country.

Lalji Singh's special lecture on 'Genetic diversity in Indian populations and its implications in health and disease' was remarkably illuminating in many ways. Research by his group attempts to shed new light on the history of the human race. Anatomically modern humans arose in Africa about 160,000 years ago. Periods of drought some 135,000 years to 70,000 years ago in and around present-day Malawi led to a major exodus from Africa to other parts of the globe some 65,000 to 70,000 years ago. One of these streams took the Southern route passing through India and then onwards to the Andamans and Australia. (In comparison, the populations of the Nicobar islands came much more recently, about 12,000 to 18,000 years back, from China and the Malay peninsula). The genetic diversity of the Indian population far exceeds that of Europe as well as China, being made up of about 4600 culturally and anthropologically distinct groups. There are 'social' limits to gene flow. As a consequence, genetic analyses of disease patterns can yield information on history of migration. As a rule, Indians are more prone to heart-related diseases than any other group anywhere. A particular single-gene defect leads to heart failure with no prior warning by about 50; two such defects limit life span to 2 to 5 years. More generally, many diseases we face are 'our own', and western drugs are not suited to our population. All in all, so much learnt so far, so much left to learn!

The Symposium on 'Darwin and evolution' was remarkable for the range of topics covered. Conceived, organized and introduced by Vidyanand Nanjundiah, it had presentations on planetary scale events, origins and development of south Asian languages, genetic perspectives on the peopling of India (we are identified by our molecules!), cultural evolution as seen in Indian temples over the centuries, and the impact of Darwinism on the study of history. All of these led to animated discussions, and the symposium as a whole was a most appropriate celebration of the Darwin bicentennial year.

Narender Luther

The first Public Lecture by Narender Luther on the 'History and heritage of twin cities' – Hyderabad and Secunderabad – was a beautifully illustrated presentation covering four centuries of their existence. It recalled to mind the lecture on Delhi at the November 2008 meeting of the Academy. Many images had an arresting quality – the strange shapes of rocks in the region (some of them being destroyed as the cities expand), the 14th century Golconda fort of the Kakatiyas, the oldest and largest tree of the country within the fort, among others. Other 'treasures' of the cities and region that caught one's attention are the story of Bhagmati, the Kohinoor diamond found in 1656, the period photographs by Raja Deen Dayal, the work of Ronald Ross in 1897, and the Salar Jung museum which is the largest single-person art collection in the world. The quality of the lecture did justice to the quality of the available material.

Surendra Prasad

The meeting included a special lecture by Surendra Prasad on VDSL technology and a second Public Lecture by W Selvamurthy entitled life sciences in services of soldiers. Prasad's talk was on the challenging task of providing high speed bandwidths to 'ever hungrier' users of new technologies – the Very High Speed Digital Subscriber Line (or the VDSL). Twenty four newly elected Fellows and Associates presented their research work. The three-day programme concluded with a brief symposium on 'Ethnoarchaeology: rock art in peninsular India'.

PLATINUM JUBILEE MEETING – II BANGALORE

12 – 14 November 2009

Programme

12 November 2009 (Thursday)

0930 – 1145 **Inaugural Session**

Welcome by the President and Introduction of Fellows

Release of Special Platinum Jubilee Publications:
(1) *Current Trends in Science*
(2) *Directory of Fellows*

Messages by former Academy Presidents; Royal Society, Third World Academy of Sciences, German Academy, Pakistan Academy, Bangladesh Academy and others

Presidential address by D Balasubramanian
Stem cell biology and an example of its use in vision science

Platinum Jubilee special lecture by C N R Rao
Emerging India as a great centre of science

1230 – 1330 **Lectures by Fellows/Associates**

1230 – 1250 Hemalatha Balaram, JNCASR, Bangalore
Metabolism in the malarial parasite *Plasmodium falciparum*

1250 – 1310 R Srianand, IUCAA, Pune
Cold gas at high redshifts

1310 – 1330 D D Dhavale, University of Pune, Pune
Iminosugars as glycosidase inhibitors and immunomodulatory agents

1300 – 1430 Lunch break

1430 – 1700 **Symposium I – Climate change: An Indian perspective**
(Convener: J Srinivasan)

1430 – 1500 J Srinivasan, IISc, Bangalore
Climate change: Science, technology and policy

1500 – 1530 Pramod Aggarwal, IARI, New Delhi
Climate change and Indian agriculture

1530 – 1600 Tea break

1600 – 1630 Mala Rao, Indian Institute of Public Health, Hyderabad
The health impacts of climate change in India

1630 – 1700 Navroz Dubash, JNU, New Delhi
What should be India's strategy in the climate negotiations?

1700 – 1730 Tea break

1730 – 1830 **Public Lecture I**
Nandan Nilekani, Chairman, Unique Identification Authority of India, New Delhi
Unique identification project

1900 – 2015 Cultural Programme

13 November 2009 (Friday)

0900 – 1200 Symposium II – Navigation and communication – what we can learn from insects?
(Convener: R Gadagkar)

0900 – 0910 R Gadagkar, IISc, Bangalore
Introduction

0910 – 0935 Rudiger Wehner, University of Zurich, Zurich
A neuroethologist's look into the cockpit of an insect navigator

0935 – 1000 Rohini Balakrishnan, IISc, Bangalore
Acoustic communication in crickets: From biophysics to behavioural ecology

1000 – 1025 Sanjay Sane, NCBS, Bangalore
The aerodynamics of flapping flight

1025 – 1100 Tea break

1100 – 1125 Debashish Chowdhury, IIT, Kanpur
Ant traffic: Marching soldiers or disciplined drivers?

1125 – 1150 R Gadagkar, IISc, Bangalore
Communication of social status in a primitively eusocial wasp

1150 – 1200 Discussion

1200 – 1240 Special Lecture
M R S Rao, JNCASR, Bangalore
Genomic and system approaches to understand the biology of cellular differentiation and disease

1240 – 1400 Lunch break

1400 – 1600 Symposium III – Raman spectroscopy
(Convener: S Umapathy)

1400 – 1430 Hiro–o Hamaguchi, University of Tokyo, Japan
Raman spectroscopic view of life

1430 – 1500 Volker Deckert, Friedrich–Schiller–Universität, Jena, Germany
Raman spectroscopy beyond the diffraction limit

1500 – 1530 A W Parker, Rutherford Appleton Laboratory, UK
Seeing below surfaces: Developments in Raman spectroscopy for chemical and medical analysis

1530 – 1600 Juergen Popp, Friedrich–Schiller–Universitat, Jena, Germany
Raman spectroscopy: A unique tool for life science research

1600 – 1630 Tea break

1630 – 1710 **Lectures by Fellows/Associates**

1630 – 1650 V Ramgopal Rao, IIT, Mumbai
Polymer-based sensor systems for healthcare and homeland security applications

1710 –1745 Tea break

1745 – 1845 **Business Meeting of Fellows**

1900 – 2000 Public Lecture II
Sir Mark Tully, Former Chief of Bureau, BBC, New Delhi
The need for balance in an unbalanced world

14 November 2009 (Saturday)

0900 – 1020 **Lectures by Fellows/Associates**

0900 – 0920 Joydev Chattopadhyay, ISI, Kolkata
Prey–predator functional response: Current research and paradigm shift

0920 – 0940 Jaya S Tyagi, AIIMS, New Delhi
Unravelling secrets of a sleeping microbe: The curious case of the TB pathogen

0940 – 1000 S Kesavan, IMSc, Chennai
Homogenization and optimal control

1000 – 1020 Arun K Nandi, IACS, Kolkata
Multifunctional poly-(vinylidene fluoride) using supramolecular interactions

1020 – 1050 Tea break

1050 – 1230 **Lectures by Fellows/Associates**

1050 – 1110 T Kavitha, IISc, Bangalore
Efficient graph algorithms

1110 – 1130 Anil Grover, University of Delhi South Campus, New Delhi
Molecular components involved in mounting response to high temperature stress in rice

1130 – 1150 Chetan E Chitnis, ICGEB, New Delhi
Rational design of a malaria vaccine

1150 – 1210 S Sampath, IISc, Bangalore
Interfacial electrochemistry using functionalized surfaces

1210 – 1230 Vikram Tripathi, TIFR, Mumbai
NMR as a probe for strongly correlated electron behaviour in mesoscopic devices

ASSOCIATES – 2009

Ananth, Sudarshan
Indian Institute of Science Education and Research, Pune
Theoretical particle physics; quantum field theory

Banerjee, Rahul
National Chemical Laboratory, Pune
Crystal engineering; metal organic framework; hydrogen bonding

Bhavesh, Neel Sarovar
International Centre for Genetic Engineering & Biotechnology, New Delhi
Structural biology; NMR spectroscopy

Biswas, K
Ramakrishna Mission Vivekananda University, Belur Math, Howrah
Holomorphic dynamics; complex analysis; Riemann surfaces

Chauhan, Santosh
All India Institute of Medical Sciences, New Delhi
Molecular biology; microbiology; biochemistry

Dabeer, Onkar Jayant
Tata Institute of Fundamental Research, Mumbai
Wireless communications; estimation theory; information theory

Dewangan, Pawan
National Institute of Oceanography, Goa
Seismic wave propagation in anisotropic medium; exploration of gas hydrates; physical properties of shallow marine sediment

Ghosh, Suhrit
Indian Association for the Cultivation of Science, Kolkata
Polymer chemistry; supramolecular chemistry; surfactant aggregates

Gogate, Parag R
Institute of Chemical Technology, Mumbai
Cavitational reactors; waste water treatment; process intensification

Hum Chand
Aryabhatta Research Institute of Observational Sciences, Nainital
Cosmological variation of fundamental constant; active galactic nuclei; central engine; quasar absorption lines

Mahapatra, Santanu
Indian Institute of Science, Bangalore
Compact modelling; nanoelectronics; VLSI

Maji, Pradipta
Indian Statistical Institute, Kolkata
Pattern recognition; soft computing and machine learning; bioinformatics

Malik, Sudip
Indian Association for the Cultivation of Science, Kolkata
Electroluminescent polymers; clays; conducting polymers; small molecular gels

Mandal, Sumantra
Indira Gandhi Centre for Atomic Research, Kalpakkam
Thermo-mechanical processing; grain boundary engineering; materials modelling

Manjunath, Krishnapur
Indian Institute of Science, Bangalore
Probability theory

Mukhopadhyay, Samrat
Indian Institute of Science Education and Research, Mohali
Protein folding and misfolding; single molecule biophysics; biological fluorescence spectroscopy

Nagendran, Selvarajan
Indian Institute of Technology, New Delhi
Inorganic chemistry; main group organo - metallic chemistry; polymer chemistry

Patil, Satish A
Indian Institute of Science, Bangalore
Polymer chemistry

Pradeep Singh, N D
Indian Institute of Technology, Kharagpur
Functional group photolithography and its application; design and synthesis of new PRPGs; solid state photochemistry

Roy, Debdas
National Institute of Foundry and Forge Technology, Ranchi
Nanomaterials, composite materials; biomaterials

Saha, Binoy Krishna
Pondicherry University, Pondicherry
Crystal engineering

Saxena, Manoj
Deen Dayal Upadhyaya College, New Delhi
Microelectronics; semiconductor device modelling; nanoscale device simulation

Singh, Sanjay
Indian Institute of Science Education and Research, Mohali
Inorganic chemistry; organometallic chemistry; materials chemistry

Sunil Chandran, L
Indian Institute of Science, Bangalore
Graph theory; theoretical computer science; graph algorithms

Thilagar, Pakkirisamy
Indian Institute of Science, Bangalore
Polymer chemistry: nanomaterials: electronic materials and catalysis; main group organometallics

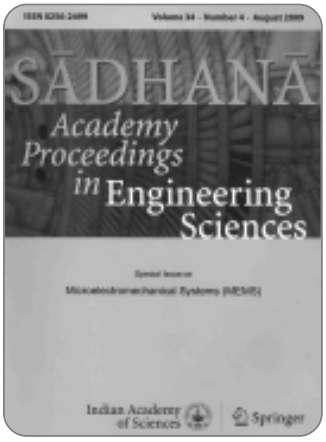
Venugopal, Santhanam
Indian Institute of Science, Bangalore
Nanoparticle engineering; nanoscale product design; energy conversion

Viswanath, Sankaran
Indian Institute of Science, Bangalore
Infinite dimensional Lie algebras; Coxeter groups

SPECIAL ISSUES OF JOURNALS

Microelectromechanical systems

Guest Editors: Rudra Pratap and K N Bhat
Sadhana, Vol. 34, No. 4, August 2009, pp. 529–688



As a field, micro electromechanical systems (MEMS) has matured over the last two decades with several scientific journals dedicated to it. These journals have brought out the interdisciplinary nature of research that the field demands. In the beginning, most papers were process-centric where realization of a MEMS device or structure using conventional CMOS processes or their variants was the centre of excitement. Slowly, it gave way to development of new materials, new processes, finer structures and new devices. Once the fabrication processes got established and commercial MEMS foundries came into existence, the focus shifted to MEMS design and system development. After the launch of a few commercially successful MEMS devices, the research focus shifted to exploration of vast areas of applications. Application areas have started creating their own segments of MEMS research and its has now become common to see international conferences dedicate sessions to bio-MEMS, optical MEMS, inertial MEMS, RF MEMS, and the like. As more researchers join the fray, the overlapping research areas benefit both from intense vertical investigations and cross-fertilization of ideas and methods from neighbouring areas. The intensity of research has grown facilities to carry out sophisticated tests and fabrication have mushroomed and the desire to make myriad MEMS sensors and actuators has intensified. Still, at the current rate of development there is plenty of room at the bottom.

In India, MEMS research has paralleled the developments elsewhere over the last two decades, lagging behind only marginally due to infrastructural constraints. Some national initiatives, notably, the National Programme on Smart Systems (NPMASS),

have provided tremendous impetus to MEMS research. Starting from hardly two small MEMS research groups in the country in the early nineties to tens of research groups in universities and national laboratories today, and establishment of MEMS foundries like Semiconductor Laboratories, Chandigarh, Central Electronics Engineering Research Institute, Pilani, and Bharat Electronics Limited, Bangalore, MEMS research in India has started flourishing. The number of papers presented by Indian researchers in national and international conferences in this area has increased ty two orders of magnitude. These are truly exciting developments.

In 2007, the International Union of Materials Research Societies (IUMRS) organized the Tenth International Conference on Advanced Materials (ICAM 2007) in Bangalore. This conference included a theme symposium on MEMS that spanned three days with paper presentations covering various aspects of MEMS technology. Of the papers presented at the symposium, fifteen were selected after due process of reviewing. These fifteen papers attempt to present a cross-section of MEMS research spanning work on novel MEMS materials, process technologies, devices, applications, design and simulation, fabrication and testing, and even system integration.

Current trends in physics

Guest Editors: Mustansir Barma and D D Sarma
Pramana, Vol. 73, No.1, July 2009, pp. 1–214

In 1974, the Russian physicist Vitaly Ginzburg wrote a book entitled *Key problems of physics and astrophysics* in which he presented a selection of important and challenging problems along with speculations on what the future holds. The selection had a broad range, was highly personalized, and was aimed at the general scientist, for whom it made very interesting reading.

Thirty odd years later as part of the Platinum Jubilee Year of the Academy, the Academy decided to commission articles from fellow physicists, which would constitute part of a special volume '*Current trends in science*' being brought out on this occasion. The five articles included in this volume are briefly explained here. Although necessarily different in scope and style from Ginzburg's book, there are some similarities: the choice of topics is subjective and the contributions convey important and challenging problems – both solved and unsolved – to the interested scientist.

Sunil Mukhi and Probir Roy trace developments in theoretical high energy physics, which they call the 'cutting edge of the human scientific endeavour', from the Standard Model and its inadequacies, to string theory. G Baskaran focusses on variations on the theme of resonating valence bond (RVB) behaviour to explain both high-temperature superconductivity and anomalous behaviour in the normal phase in a variety of correlated systems. G Ravindra Kumar sheds light on light and its interaction with matter. Technical breakthroughs such as chirping allow ultra-high fields to be created in pulses, resulting in completely new behaviour when they interact with hot, dense matter. R Pandit, P Perlekar and S Sankar Ray focus on turbulence, 'the last great unsolved problem of classical physics'. An overview of the statistical description of fluid turbulence is presented, including 2-d turbulence, the passive scalar problem and the effect of polymer additives. R Nityananda deals with gravitational dynamics on the galactic scale. Gravity leads to counter-intuitive effects, and normal statistical mechanical notions do not apply. Issues addressed include the Antonov instability, and the multiplicity of possible stable solutions in collisionless stellar systems.

Non-hermitian hamiltonians in quantum physics

Guest Editors: Sudhir R Jain and Zafar Ahmed
Pramana, Vol. 73, Nos 2/3, August/September 2009, pp. 215–626

The thirteenth conference in the series, 'Non-hermitian hamilt- onians in quantum physics', was held at BARC and TIFR, Mumbai in January 2009. It was also the first Homi Bhabha Centenary Conference for 2009. About 160 participants attended the conference which consisted of 4 review talks, 3 keynote talks, 20 plenary talks, 26 specialized talks, and 13 poster presentations.

About ten years ago, a possible generalization of quantum mechanics, which incorporates non-hermitian hamiltonians was proposed by Bender and Boettcher. This led to a large flurry of research on PT-symmetric quantum mechanics and quantum field theory. The physical systems that violate parity and time-reversal symmetry belong to this class – they include two-dimensional statistical mechanics, certain models in quantum chromodynamics, nuclei with PT-symmetric shapes, and so on. Broadly, the themes addressed during the conference were: PT-symmetry and pseudo-hermiticity, open quantum systems, non-equilibrium statistical mechanics, random matrix and field-theoretic models, and quantum computation.

The two special issues of *Pramana* contain the original results announced at the conference, in addition to two mini-reviews from pedagogical talks presented a day before the conference started.

REFRESHER COURSES

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

1. Motivational bridge course in physics

Gogate–Joglekar College, Ratnagiri
23 March 2009 – 11 April 2009

No. of participants: About 67 students and teachers from Gogate–Joglekar College, Ratnagiri and nearby colleges.

Course Director: S Ananthakrishnan (Pune University).

Course Co-ordinators: G V Kelkar (President, IAPT, Maharashtra), S A Deo, K V Sukhatankar (Gogate – Joglekar College, Ratnagiri), A W Joshi, Anjali Kshirsagar (Pune University).

Resource Persons: J V Narlikar and Mangala Narlikar (IUCCA, Pune), R Nityananda (NCRA, Pune), Arvind Kumar and Shirish Pathore (Homi Bhabha Centre, Mumbai), S H Patel (IIT, Mumbai), Suresh Chandra (SRTM University, Nanded), M V Jakale (Shivaji University, Kolhapur), Atul Mody (Vivekananda College, Mumbai), A D Gangal (University of Pune), Mahesh Shetti (Wilson College, Mumbai).

Local Speakers: Rajashree Thakur, A W Joshi, Anjali Khirsagar, Satish Nayak, K V Sukhthankar, B D Sutar, S S Sahasrabudhe.

The state of higher education in science, particularly in physics and mathematics at the undergraduates level is of concern and addressed in many fora. The IAPT (Maharashtra and Goa regions) initiated a summer school in Thane for undergraduates in physics to excite and motivate them. Based on the positive feedback received, the present programme entitled 'Motivational bridge course in mathematical method and laboratory experiment course in mathematical method and laboratory experiment and practices' was proposed. This was essentially meant for first and second year BSc students in small cities and towns in rural areas of Maharashtra and Goa region. The first of these was thus organized at Ratnagiri in Maharashtra.

The objectives of the course were:

(a) understand the intricacies of mathematics
(b) understand the relationship between physics and mathematics;
(c) be able to translate physics into mathematics and vice versa;
(d) understand and appreciate physics better

(e) appreciate better and clean laboratory practices;
(f) plan and design an experiment;
(g) think of simple, innovative, open-ended experiments;
(h) become good graduates;
(i) to remove fear of physics and math among students;
(j) face competitive exams of different kinds;
(k) face interviews.

The academic programme included the following topics: symmetries in physics; complex algebra; calculus; thermodynamics and kinetic theory; matrix algebra; probability and statistics; ordinary differential equations; orthogonal co-ordinate systems; vector algebra; vector calculus; calculations in special relativity.

2. Experimental physics – XIV

Alagappa University, Karaikudi
7 – 22 May 2009

No. of participants: About 30 students and teachers from Alagappa University and nearby colleges.

Course Director: R Srinivasan (Bangalore).

Course Co-ordinator: C Sanjeeviraja (Alagappa University).

Resource Persons: R Srinivasan (Bangalore), S M Sadique (Goa), KRS Priolkar, Efrem D'Sa (Goa University), S B Gudennavar (Christ University).

3. Animal and plant tissue culture

Rajiv Gandhi Institute of IT & Biotechnology, Pune
11 – 23 May 2009

No. of participants: 21 teachers.

Course Director: Sudha Gangal (Rajiv Gandhi Institute of IT & Biotechnology, Pune).

Course Co-ordinator: Alpana Moghe (Rajiv Gandhi Institute of IT & Biotechnology, Pune).

Resource Persons: Prabhakar Ranjekar, Sudha Gangal, Alpana Moghe, Snehil Jaiswal, Prachi (Rajiv Gandhi Institute of IT & Biotechnology, Pune).

Rajiv Gandhi Institute is a young institute, teaching ATC at UG as well as PG level and has a fairly good laboratory set-up. Considering the need to spread technology to needy colleges in the country, it was decided to organize the Refresher Course.

The programme generally consisted of a lecture in the morning followed by practicals. The participants were divided into 2 batches of 10 each. While one batch did the sterile work in the hoods, the other did the non-sterile work according to a prescribed schedule with small variations depending on the availability of cell culture.

Topics of lectures: Overview of ATC; hybridoma technique for development of monoclonal antibodies; physicochemical properties of media such as pH, temperature, gaseous phase requirements of cells; maintenance of cell culture; cryopreservation; cytotoxicity; upscaling; characterization of cells grown in culture; cytogenetic abnormalities shown by cells; importance of mutagenesis assays using tissue culture systems; stem cell biology; how viruses can be grown in simple explant cultures without sophisticated equipment; development of a culture system to observe growth of chick embryo; use of tissue culture systems for studies to replace animals; use of cell culture from a variety of wild animals.

The practical sessions were devoted to the following: Feeding of cell cultures; preparation of synthetic medium used in ATC and its sterilization by filtration; subculturing of cells and counting of viable cells; staining of cells with giemsa; primary cultures of chick embryo fibroblasts; sterility test medium; virus titration assay; chromosome preparations; growth curve analysis; cytotoxicity assays; tracheal organ culture; shell-less chick embryo cultures; practical demonstration for

separation of human peripheral blood lymphocytes on Fico-Hypaque gradient, collection of lymphocytes from the gradient and culturing.

Visits were arranged to the Serum Institute, which is involved in production of vaccines for many viral diseases, as well as to the Interactive Research School for Health Affairs (IRSHA). A one-day excursion within Pune was also organized. The participants were also given two books: 1. *Principles and practice of animal tissue culture*, Universities Press, Hyderabad. 2. *In vitro cultivation of animal cells*, Elsevier.

4. Experimental physics – XV

Mangalore University, Mangalore
1 – 16 June 2009

No. of participants: 33 teachers from various colleges in Mangalore.

Course Director: R Srinivasan (Bangalore).

Course Co-ordinator: Manjunatha Pattabi, Mangalore University.

Resource Persons: R Srinivasan (Bangalore), KRS Priolkar, S M Saddique (Goa University), Efrem D'Sa (Carmel College, Goa), Gnana Prakash (Mysore University).

As has been the practice with the Experimental Physics Refresher Courses organized of late, this course was restricted to participants from colleges affiliated to Mangalore University where physics is taught at the undergraduate level. Twentynine colleges were represented at the Course. R Srinivasan, the Course Director, outlined the spirit of the course and explained how many of the experiments carried out at the undergraduate and postgraduate levels with outdated equipment can be performed with better precision, better accuracy and less difficulty. Lectures were followed by laboratory experiments using kits developed for the Academy at the initiative of R Srinivasan. These kits were gifted by the Academy to the Mangalore University for conducting this course.

5. Experimental chemistry

University of Hyderabad, Hyderabad
15 – 29 June 2009

No. of participants: 20 University/College teachers from across India.

Course Director: Anunay Samanta (University of Hyderabad, Hyderabad).

Resource Persons: K C Kumara Swamy, P Raghavaiah, D Basaviah, R Nagarajan, L Guruprasad, S Pal, P K Panda, D B Ramachary, R Sridhar, M Durga Prasad, S Mahapatra, K Muralidharan, T Jana, V Baskar, M J Swamy, T P Radhakrishnan, A Nangia, M V Rajasekharan (University of Hyderabad).

This course was formulated with a view to strengthen the experimental chemistry programmes at the undergraduate and postgraduate levels in the country. The course involved experiments covering all major branches of chemistry. Preparation, purification and characterization of organic compounds; preparation of *cis*- and *trans-bis* (glycinato) copper (II) and *tris* (thiourea) copper (I) complex; exploitation of computers for understanding chemical problems; synthesis of polystyrene by emulsion polymerization. The experiments were designed such that the chemicals and minor equipment used in the course were inexpensive and amenable for easy implementation at the college/university level. The course comprised 13 laboratory experiments; 13 lectures and 1 demonstration experiment. The laboratory experiment can be broadly categorized as follows: 3 in organic chemistry, 4 in inorganic chemistry, 3 in physical chemistry, 2 in

materials chemistry and 1 in computational chemistry. Each day started with a lecture by a resource person giving a brief outline of his research activities followed by detailed instructions for the laboratory experiment scheduled for the day. Each participant was provided a laboratory experiment scheduled for the day. They were also provided a laboratory coat, a pair of safety goggles and a book on experimental chemistry (*General chemistry experiments* by Anil J Elias, Universities Press, 2002).

LECTURE WORKSHOPS

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

1. Evolutionary biology: 150 years after Darwin

Abasaheb Garware College, Pune
12 – 14 February 2009

Convener: Milind G Watve, Abasaheb Garware College, Pune.

Co-ordinator: Maithili Jog, Abasaheb Garware College, Pune.

Speakers: Madhav Gadgil (Agharkar Research Institute, Pune), V Nanjundiah, S Mahadevan (Indian Institute of Science, Bangalore), Amitabh Joshi (JNCASR, Bangalore), Anil Gore (Pune), Neelesh Dhanukar, R Umashankar, K N Ganeshaiah (University of Agricultural Sciences, Bangalore), T R Rao, M G Watve (Abasaheb Garware College, Pune), Suthirth Dey (IISER, Pune), Partha Majumdar (ISI, Kolkata), K S Nagaraja.

Participants: About 107 students/teachers from institutions in and around Pune.

Topics covered: Major transitions in evolution; evolution and chance; evolution as an experimental science; experimental design to study evolution; evolutionary game theory; parent offspring conflict in plants; evolution of insect plant mutualism; evolutionary psychology; on the interface of ecology and evolution; origin of genetic variation; drawing evolutionary inferences from DNA sequences; evolutionary medicine; evolution of languages.

2. Frontiers in chemistry

National College, Tiruchirappalli
13 – 14 March 2009

Convener: M Palaniandavar, Bharathidasan University, Tiruchirappalli.

Co-ordinator: M Murali, National College, Tiruchirappalli.

Speakers: M Periasamy (University of Hyderabad, Hyderabad), P K Das, S Natarajan, B R Jagirdar (IISc, Bangalore), P R Athappan, R Ramaraj (Madurai Kamaraj University, Madurai), M S Balakrishna, K P Kaliappan (IIT, Bombay), V Subramanian (Central Leather Research Institute, Chennai), P Ramamurthy (University of Madras, Chennai).

Participants: About 210 students from various colleges in Tiruchirappalli.

Topics covered : Methods and materials of organic synthesis; femtochemistry; our dwindling fossil fuels; DNA targetted metal complexes; new manifestations of inorganic co-ordination chemistry; designing and fine tuning of phosphorus-based ligands; organic synthesis; self-assembly and structural motifs in molecular clusters; nanostructured metal particles embedded in assembly systems; fluorescence spectroscopy and its applications.

3. Nanoscience and technology

Yenepoya University, Mangalore
23 – 24 March 2009

Convener: K J Rao, IISc, Bangalore.

Co-ordinator: Syed Akheel Ahmed, Yenepoya University, Mangalore.

Speakers: S B Krupanidhi, KBR Varma, S Sampath, K K Nanda, Satish Patil (IISc, Bangalore)

Participants: About 260 students/teachers from various colleges in Mangalore.

Topics covered: Nanomaterials for disease fighting; quantum dots and device applications; multifunctionalities of glass nanocrystals; nanomaterials in electrochemistry; organic nanomaterials for energy devices; applications of nanostructural materials.

4. Frontiers in chemistry

HKRH College, Uthamapalayam
27 – 28 March 2009

Convener: M Palaniandavar, Bharathidasan University, Tiruchirappalli.

Co-ordinator: S A Noor Mohamed, HKRH College, Uthamapalayam.

Speakers: C Srinivasan, R Ramaraj, S Rajagopal, K Pitchumani (Madurai Kamaraj University, Madurai); S Natarajan (IISc, Bangalore); P T Manoharan, P Selvam, (IIT Chennai); R Murugavel, K P Kaliappan (IIT Mumbai) M Palaniandavar, a Elangovan (Bharathidasan University, Tiruchirapalli).

Participants: About 251 students/teachers from various institutions in and around Madurai.

Topics covered: The fascinating nanoforms of carbon; from co-ordination chemistry to materials chemistry; nanoscience and nanotechnology; photoprocesses;

introduction to supramolecular chemistry; nanomaterials in confined environment; Lewis octet; organic synthesis; from a simple organic molecule to a drug.

5. Advances in chemical sciences

Mangalore University, Mangalagangothri
4 – 5 April 2009

Convener: K L Sebastian, IISc, Bangalore.

Co-ordinator: J Ishwara Bhat, Mangalore University, Mangalagangothri.

Speakers: K L Sebastian, S Sampath (Indian Institute of Science, Bangalore), K G George Thomas, C H Suresh (NIIST, Thiruvananthapuram).

Participants: About 111 students/teachers from various colleges/institutions in Mangalore.

Topics covered: Strange and (beautiful) world of quantum mechanics; molecular devices and motors; atom/molecule-up synthesis of nanostructures; electrochemical energy systems and electrochemical biosensors; introduction to nanomaterials; surface plasmon resonance in metal nanoparticle; application

of computational chemistry; theoretical revisiting of (S)-proline catalysed intermolecular Aldol reaction.

6. The fundamental concepts of mobile communication

Gauhati University, Guwahati
6 April and 18 May 2009

Convener: Abhijit Mitra, IIT, Guwahati.

Speaker: Abhijit Mitra, IIT, Guwahati.

Participants: 150 students from the ECE Department of Guwahati University.

Topics covered: Introductory concepts of mobile communication.

7. Recent advances in spectroscopy: theory, instrumentation and applications

Karnatak University, Dharwad
17 – 18 April 2009

Convener : E Arunan, IISc, Bangalore.

Co-ordinator: Jagdish Tonannavar, Karnatak University, Dharwad.

Speakers: E Arunan, S Umapathy (IISc, Bangalore); Sanjay Wategaonkar (TIFR, Mumbai), B P Singh,Tapan Kundu (IIT, Mumbai).

Participants: 118 students/teachers from the university and colleges in Dharwad.

Topics covered: Why atoms/molecules absorb radiation?; atomic physics & diatomic molecules: basic spectroscopic instrumentation and experimental set-up; femtosecond photophysics; optical and molecular probe for sensors; molecular beam microwave spectroscopy; laser spectroscopy; spectroscopy of molecules and clusters.

8. Frontier lectures in bio-organic chemistry

Bangalore University, Bangalore
28 – 29 May 2009

Convener: S Chandrasekaran, IISc, Bangalore.

Co-ordinator: V V Sureshbabu, Bangalore University, Bangalore.

Speakers: P Balaram, Santanu Bhattacharya, R Varadarajan, S Chandrasekaran, S Vijaya (IISc, Bangalore), K N Ganesh (IISER, Pune), Nitish Mahapatra, S Baskaran (IITM, Chennai).

Participants : Over 200 students/teachers from Bangalore University and colleges.

Topics covered : Probing of enzyme mechanism; DNA binding ligand design; design of protein-based molecular switches and immunogens; 4-aminoproline-based collagen mimetics; synthetic studies of peptides; physiological anti-hypertensive peptides; development of new synthetic methods; molecular and biochemical studies of flaviviral replication.

9. Plant genetic resources: mapping utilization and conservation

VIT University, Vellore
23 – 25 July 2009

Convener: R Uma Shaanker, University of Agricultural Sciences, Bangalore.

Co-ordinator: R Siva, VIT University.

Speakers: S Natesh (Dept. of Biotechnology, New Delhi), K N Ganeshaiah, Uma Shaanker (University of Agricultural Sciences, Bangalore), K V Krishnamurthy (Bharathidasan University, Trichy), Vasudevan (Forestry College, Sirsi), G N Hariharan (MSSRF, Chennai), R Siva (VIT University, Vellore), P Nagarajan (TNAU, Coimbatore), G Ravikanth (ATREE, Bangalore), Amit Agarwal (Natural Remedies Pvt. Ltd. Bangalore).

Participants: Around 175 students/teachers from institutions in Vellore.

Topics covered: Plant genetic resources of India; mapping life; indigenous knowledge system and IPR; estimating plant diversity; prospecting plant genetic resources; prospecting endophytic fungi and other lesser known taxa; molecular makers and its applications; molecular mapping of WBPH resistance gene in rice with; conservation of forest genetic resources in the Western ghats; plant genetic resources and industry.

10. Applications of nonlinear dynamics in engineering and technology

PSG College of Technology, Tiruchirappalli
30 July – 1 August 2009

Convener: M Lakshmanan, Bharathidasan University, Tiruchirappalli.

Co-ordinator: R Amuda, PSG College of Technology, Tiruchirappalli.

Speakers: M Lakshmanan (Bharathidasan University, Tiruchirappalli), K Ganesan (VIT University, Vellore), Rama Mohan (CMMACS, Bangalore), G Ananthakrishna (IISc, Bangalore), Sudeshna Sinha (IMSc, Chennai), K Murali (Anna University, Chennai), R Shankaranarayanan (National Institute of Technology, Tiruchirapalli), Arul Lakshminarayanan (IIT, Chennai).

Participants : 150 participants from various institutions in and around Coimbatore.

Topics covered : Introduction to nonlinear dynamics; applications of transforms; brain machine interface; dynamics and rheology of periodically modelling forced suspensions; modelling the realistic nonlinear systems; computing with chaos; chaos in electrical circuits; quantum computing; chaos: from pendulum to nucleus.

11. Biocatalysis for industry, medicine and environment

Sri Sathya Sai University, Prashanthi Nilayam
11 – 13 August 2009

Convener: V Chandrasekhar, IIT, Kanpur

Co-ordinator: C Janardhana, Sri Sathya Sai University, Prashanthi Nilayam

Speakers: Mukesh Doble (IIT, Chennai), T K Chandrashekar (NISER, Bhubaneswar), Somanath Mitra (New Jersey Institute of Technology, Newark, NJ), Dinesh Jagadeeshan (alumnus of Sri Sathya Sai University, Prashanthi Nilayam), Praveen Vadlani (Kansas State University), V Lakshminarayanan (RRI, Bangalore), Govind Rao, R Sai Sathish (CAST, University of Maryland, Baltimore).

Participants: Around 151 participants

Topics covered: Metathesis – a key reaction; receptors for cation and anions; enzymatic degradation of poly carbonates; dispersible nanometal carbon nanotube – hybrids with potential application in homogeneous catalysis; methanation of carbonates; biofuels and platform chemicals from agricultural resources: biocatalysis and microbial fermentation; electrochemistry for the study of bio-materials and electrocatalysis for energy generation; real time bio-process sensors; high-resolution surface plasmon coupled resonant filter: a low cost analytical tool with applications in bio-catalysis; medicine and environment; catalysis by molecules and nanoparticles; tissue-engineering; discovery of a novel lipid lowering drug; kinetics of hydrolysis of palm oil by lipase; expanded porphyrins: third order NLO materials; new methods for development of bioactive lignans based on natural products; biosynthesis of silver nanoparticles.

12. Advancements in chemistry

Scott Christian College, Nagarcoil
21 – 22 August 2009

Convener: R Ramaraj, Madurai Kamaraj University, Madurai

Co-ordinator: Chitra Thomas, Scott Christian College, Nagarcoil

Speakers: Suresh Das, K R Gopidas (NIIST, Thiruvananthapuram), M Palaniandavar (Bharathidasan University, Tiruchirappalli), S Rajagopal, K Pitchumani (Madurai Kamaraj University, Madurai), S Natarajan (IISc, Bangalore), C Retna Raj (IIT, Kharagpur).

Participants: 206 students/teachers in and around Nagarcoil.

Topics covered : Structure–function relationship in metallobiomolecules; cyclodextrins are reaction nanovessels and smart sensors; co-ordination chemistry and ligand reaction in the synthesis of new functional inorganic compounds; photoresponsive materials for imaging and energy harvesting applications; reaction of aromatic amines with Cu (II) in acetonitrile; lanthanide beta-diketonate complexes as emitting materials in organic light emitting diodes; carbon nanostructures.

13. Integrated approach towards understanding Darwinism

NMKRV College for Women, Bangalore
4 – 5 September 2009

Convener: K N Ganeshaiah UAS, Bangalore

Co-ordinator: B S Nirmala Shankar, NMKRV College for Women, Bangalore

Speakers: M G Narasimhan (NIAS, Bangalore), V Nanjundiah, Dipankar Nandi (IISc, Bangalore), K N Ganeshiah (University of Agricultural Sciences, Bangalore), Shobini Rao (NIMHANS, Bangalore), Suhel Quader (NCBS, Bangalore).

Participants : 270 students/teachers from various colleges in Bangalore.

Topics covered : Charles Darwin – a complete biologist; evolution of love and hate in plants and animals; immune system: an evolutionary perspective; evolution of human mind; evolution of evolutionary biology.

14. Statistics in ecology and environmental studies

BYK (Sinnar) College of Commerce, Nashik
5 – 6 September 2009

Convener: A P Gore, Pune

Co-ordinator: M B Kulkarni, BYK (Sinnar) College of Commerce, Nashik

Speakers: Anil Gore, Sharad D Gore, S A Paranjpe, Rajendra L Deopurkar Praveen Saptarshi (university of Pune), Shyam Ashtekar (yeshwantrao Chavan University), Madhav Gadgil (Agharkar Research Institute, Pune), Madhav Kulkarni, S N Kulkarni (B Y K College, Nashik), Leena Pathak (HPT Arts and RYK Science College, Nashik), Milind Watve (IISER, Pune),

Participants: Around 174 students and teachers in and around Nashik.

Topics covered: Why statistics?; status of public health in rural and urban India; involving people in monitoring and managing India's environment; gender bias and incidence of malaria; biofertilizers – ecofriendly bacteria; environmental laws; microbial diversity: the unexplored world; environmental sampling; principal component analysis in biology; mathematics for biologists; the bridge on the river 'why'.

15. Frontiers in astronomy and characterization of new materials

CBKB Science College, Akkalkot
10 – 12 September 2009

Conveners: P C Agrawal, (TIFR, Mumbai) and Sulabha K Kulkarni, (IISER, Pune).

Co-ordinator: K V Zipare, CBKB College, Akkalkot

Speakers: P C Agrawal, D Narasimha (TIFR, Mumbai); G S Shahane (Dayanand College, Solapur); Sulabha K Kulkarni (IISER, Pune); Sudha Bhoraskar, V P Godbole (University of Pune)

Participants: 205 students and faculty from colleges in Akkalkot, Solapur and Gulbarga

Topics covered: An inventory of Universe; solar activity; non-magnetic materials for ferro-fluid application; constituents and condition of stars; X-ray astronomy view of Universe; nanophase materials and nanotechnology; properties of materials; history of the Universe.

PLATINUM JUBILEE PROGRAMMES

Patrika 49 reported on some of the Platinum Jubilee programmes up to March 2009. The following is a list of events from April to September 2009.

1. Michael Balter (Contributing Correspondent, Science Adjunct Professor of Journalism, Boston University)

What made humans modern? A look at human evolution through the eyes of a science journalist

(a) 4 April 2009
India International Centre, New Delhi

(b) 6 April 2009
Indian Institute of Chemical Technology, Hyderabad

(c) 7 April 2009
B M Birla Science Centre, Hyderabad

(d) 8 April 2009
IITM, Chennai

Summary: Humans are capable of incredible creativity. We make art, music, and literature, and our everyday language is colourful and innovative. As one researcher put it, we are the 'symbolic species.' What are the roots of this symbolism, and why and how did we evolve these abilities? We cannot find the answer by simply looking for the earliest works of art, such as cave paintings, because we cannot be sure that even earlier examples of symbolic behaviour have been lost over time; and since language does not fossilize, we cannot know how long ago our ability to talk to each other evolved. Instead we must look for 'proxy' indications in the archaeological record, such as the ability to make sophisticated tools and the use of coloured pigments. This search leads us to hominid species that predate *Homo sapiens*, and raises important questions about how and why such abilities helped us to survive over the ages.

2. Marc Fontecave: (College de France, Paris) Raman Professor, Indian Academy of Sciences

Hydrogen: water, sun and catalysts

22 April 2009
Indian Institute of Science, Bangalore

Summary: One of the grand challenges of twenty-first century chemistry is to convert abundant energy-poor molecules to energy-rich molecules using sunlight as the energy source. Hydrogen from water is such a solar fuel. However its production and use currently depend on noble metals such as platinum which is expensive and not abundant enough. Viable renewable energy systems will require new catalysts made from earth-abundant materials, cheap and robust. The lecture described bioinspired strategy, aiming at reproducing hydrogenase active sites, which leads to remarkable cobalt-based and nickel-based (photo) catalysts for hydrogen production.

3. Madhav Gadgil: (Agharkar Research Institute, Pune)
Major transitions in evolution

5 June 2009
Manipur University, Imphal

Summary: Life, a manifestation of replicating entities with heredity and variation, has flourished on planet earth over the last 3.8 billion years. It has expanded and diversified, occupying an ever greater range of habitats and utilizing newer and newer forms of resources. This has involved the evolution of ever more complex organisms, animal societies and biotic communities. This progressive elaboration of complex forms has been accomplished through a diversification of simpler entities, their aggregation and incorporation into higher level entities. This has entailed ever more sophisticated cooperative interactions, supported by a variety of group cementing forces: genetic similarity, central control, and synergy. Since every replicating entity has a tendency of producing more copies of itself, this results in a variety of conflicts at many levels, leading to manifestations such as the proliferation of junk DNA, parent–offspring conflict, and suppression of one human language by another.

4. Richard J Roberts: Nobel Laureate, New England Biolabs, Beverly, USA

Genomics of restriction and modification

19 June 2009
Indian Institute of Science, Bangalore

5. Michael Witzel: (Wales Professor of Sanskrit, Department of Sanskrit and Indian Studies, Harvard University, Cambridge, USA)

(a) Origin and development of language in south Asia: Phylogeny vs epigenetics

9 July 2009
Jawaharlal Nehru University, New Delhi

Summary: This presentation began with a brief overview of opinions about the origin of human language and the controversial question of Neanderthal speech. Quickly moving from the language of the 'African eve' to the specific ones of the subcontinent, a brief overview was given of the prehistoric and current south Asian language families as well as their development over the past c. 5000 years. The equivalents of phylogeny and epigenetics in linguistics were then dealt with, that is, the successful (Darwinian style) phylogenetic reconstruction of language families (as 'trees'), which is interfered by the separate wave-like spread of certain features across linguistic boundaries, even across language families. A combination of both features lead to the emergence of the current south Asian linguistic area (sprachbund). This development made the structure of Indo-Aryan, Dravidian or Mund similar to each other but it could not eliminate most of their individual characteristics.

(b) The languages and cultures revealed by the Rig Veda: immigration, localization and convergence

10 July 2009
India International Centre, New Delhi

Summary: The outdated 19th century theory of an 'Aryan invasion' dominated political discussion for the past twenty or thirty years. The scholarly facts tell a different story. The linguistic data clearly indicate the derivation of Rigvedic Sanskrit from Indo-Iranian and Indo-European (and not an ultimate Indian origin). The same applies to the poetics, ritual, mythology and most of the religion of the Rig Veda. However, the 'lower,' more popular levels of myth and religion are clearly local, as are many words related to village life, agriculture and entertainment. Such words have a non-Indo-European structure and go back neither to Dravidian nor Munda but mostly to a prefixing language, similar to Austro-Asiatic, that must have been spoken in the northern Indus plains and in Haryana but that was not recorded in Indus documents of any substantial length. Interaction between the mainly pastoral Indo-Aryans and the local population of the Greater Panjab, remnants of the Harappan civilization, resulted in a certain amount of convergence visible in linguistic categories, leading to the 'south Asian linguistic area.' These changes involve languages from the Pamirs to Sri Lanka but they could not erase the inherent nature of the languages involved. Similar convergent features can be seen in the development of Vedic myth and ritual. While most of the deities and rituals are of Indo-Iranian (or even Indo-European age), a number of possible slight adjustments to local pre-Vedic, that is, post-Indus, religion and ritual may be discerned. The emerging scenario is supported by some features of post-Indus (late Harappan) archaeology, notably in Gandhara, and by some aspects of human genetics, especially the newly discussed autosomal data. Recent discoveries of a large Harappan graveyard in Haryana may shed further light on the matter.

7. B G Verghese: (Visiting Professor, Centre for Policy Research Delhi)

Managing India's diversities

11 August 2009
Central Food Technological Research Institute, Mysore

Summary: India is the most diverse country in the world and the most stratified over time and space. The social dynamics of the country is bringing ever newer elements, hitherto submerged and oppressed, into the 'mainstream'. This mistakenly suggests growing fragmentation and negative identity politics. In fact, this upwelling from below is converting 'Bharat' into 'India' and has vastly strengthened the roots of democracy. How we manage this delicate and difficult transition will determine the future.

8. Ramaswamy R Iyer: (Research Professor, Centre for Policy Research, New Delhi)

Water policy and science

11 August 2009
Raman Research Institute, Bangalore

Summary: Before we consider what kind of scientific grounding good water policy needs, we must first have a proper understanding of the complexities of water, and be clear about what we mean by the term 'science'. The lecture began by trying to bring clarity to these matters and deconstruct some current formulations. It then proceeded to identify certain water policy questions which would benefit from scientific knowledge.

9. Max Bennett: (Director, BMRI, Head Neurobiology Research Centre, University of Sydney, Australia)

Glial cell purinergic synapses in chronic pain, spreading cortical depression and the BOLD effect in non-invasive brain imaging

12 August 2009
Raman Research Institute, Bangalore

Summary: Chronic neuropathic pain is associated with a spreading inflammatory wave in the spinal cord from the site of initial synaptic transmission of the pain stimulus in the cord, thus recruiting wide areas of neuronal activity not implicated in the initial event.

Migraine pain is preceded by a wave of spreading depression of cortical neural activity, which extends from one end of the cortex to the other. Much information about the sites in the brain that function in order for one to experience pain is obtained through non-invasive brain imaging, which is thought to provide a measure of local neuronal activity through propagation of a wave that engages and modulates local blood oxygen level development (BOLD). It is shown that the waves in these different phenomena can be quantitatively accounted for by the transmission of calcium waves between glial cells, placing this mechanism at the centre of our interests in detecting the cellular signs of pain and its amelioration.

10. T N Narasimhan: (Department of Materials Science and Engineering, University of California at Berkeley)

Water: Emerging challenge for India's brightest

25 August 2009
Indian Institute of Technology, Chennai

Summary: India's water resources are finite, and there are good reasons to believe that India may already be at the threshold of over-utilizing its available resources. India does not have a coherent national water policy, and water use is unregulated, even as industrial and urban development proceed at a feverish pitch. Without bringing order and discipline into water management, India's economic expectations will be seriously jeopardized. Sustainable management of India's water resources requires knowledge of delicately interlinked earth systems, complicated by human attitudes and aspirations. Wise management of India's water resources offers enormous technical and human challenges. For civilized human survival on a finite, interconnected earth, technology must adapt to the nature of earth systems. Such an adaptation will have a chance of success only if India's brightest takes the earth as seriously as it takes physical and biological sciences. The talk provided a glimpse into the scientific and human dimensions of India's water resources situation.

11. Meera Kosambi: (Former Professor & Director Research Centre for Women's Studies, SNDT Women's University, Mumbai)

Dr Anandibai Joshee: The achievement and iconization of India's first woman doctor

15 September 2009
Centre for Cellular and Molecular Biology

Summary: Anandibai Joshee graduated from the Woman's Medical College of Pennsylvania in the USA in March 1886 to become India's first woman doctor.

Unfortunately she died the following year in India at the age of barely 22. But she has been iconized in various 'at times contradictory' ways in two biographies (one American and one Marathi) and a biographical novel (Marathi, later translated into English) This lecture contextualized Anandibai within India's social reform movement, analysed her biographies, and also explored her feminism and nationalism.

WOMEN IN SCIENCE

The Council of the Indian Academy of Sciences had, in January 2003, constituted a committee to address issues concerning women scientists. This led to the formation of a Panel 'Women in Science' (WiS), in January 2005, to study the current status of women scientists as well as the problems faced by them, in the Indian context, and to recommend suitable remedial measures.

The Panel, currently chaired by Rohini M Godbole, has the following members:

- Vineeta Bal (National Institute of Immunology, New Delhi)
- R J Hans-Gill (Panjab University, Chandigarh)
- Raghavendra Gadagkar (IISc, Bangalore)
- Vidyanand Nanjundiah (IISc, Bangalore)
- Ramakrishna Ramaswamy (JNU, New Delhi)
- Pratima Sinha (Bose Institute, Kolkata)

Some of the major initiatives so far undertaken by the Panel include:

Role model programme

This programme helps women students to interact with working scientists and help them in their career, both academic and social, by conducting a series of national seminars under the broad programme 'Women in science: A career in science'. In these seminars women scientists talk about their work, usually followed by a panel discussion on issues of women in science. The panel includes speakers as well as invitees who have given a serious thought to the subject. The seminars also provide information on career options for women in the field of science, which will hopefully inspire and motivate young women to take up a career in science. The seminars organized so far by the WiS Panel are listed below:

(a) Venue: Cochin University of Science and Technology, Cochin
5 April 2008

(b) Venue: St. Xavier's College, Ahmedabad
13 September 2008

(c) Venue: Sanatana Dharma College, Alappuzha
29 November 2008

(d) Venue: IIT, Madras
20 December 2008

Discussion session: Women in science

The 74th Annual Meeting of the Academy held at IIT Delhi included a discussion session on Women in Science on 1 November 2008. The members who participated were Vineeta Bal, Raghavendra Gadagkar, Saman Habib, Indira Nath and Sujatha Ramdorai. There was a lively discussion between the panel and the audience and many relevant points were made. Issues such as gender bias, under-representation and promotion of women in science were discussed at length. The summary of these discussions will form the basis of a possible position paper on the subject.

'Lilavati's daughters: The women scientists of India'

This publication of the Academy, coedited by Ramakrishna Ramaswamy and Rohini Godbole, was released by the President of the Academy, D Balasubramanian, during the Annual Meeting of the Academy on 31 October 2008. It is a collection of (auto)biographical essays of about 100 women scientists from India. Covering a range of disciplines, these women scientists talk of what brought them to science, what kept their interests alive, and what helped them achieve some measure of distinction in their careers. What makes a successful career in science possible? Many answers to this question can be found in these essays. The book is directed towards the reading public. A young student with research ambitions will find this an important collection where she or he can learn first-hand of women who functioned and achieved their goals in the Indian social and academic environment. Others will also find the essays to be of value and interest for what they say, and, as is often the case for what they do not say…

Reviews and feedback about *Lilavati's daughters*

Since its release, the book has been getting positive feedback from readers with several interesting reviews in journals such as *Nature* (Vol. 460, 27 August 2009, p.1082) and *Chemical & Engineering News* and reviews in newspapers and magazines such as *The Hindu*, *The Indian Express*, *Deccan Herald* and *The Mint*. The volume has already been translated and published into other Indian languages such as in *Loksatta* (Marathi), *Sandarbh* and *Srote* (Hindi). Translation into other languages is in progress and efforts will be made to make the book reach as many people as possible.

The Department of Science & Technology, New Delhi is also helping in promoting the book by releasing funds for distributing 1000 copies of the book in India and abroad.

Study of 'leaky pipeline'

A survey entitled 'Trained scientific woman power: How much are we losing and why?' aims at identifying women who have a PhD in pure and applied sciences, engineering and medicine but have chosen, for various reasons, careers that do not make use of their academic qualification. The survey also includes men and women who are practising science at different levels, with a view to understanding factors responsible for the loss of women scientists in our country (leaky pipeline). Separate databases with over 2000 women scientists and 400 men scientists have been created and questionnaires sent to them. The unique feature of this survey is the participation by both natural and social scientists in its formulation. With the data collection part of the survey completed, the analysis of the data is in progress and a report of the study is expected by the end of this year.

The Academy particularly seeks the assistance of its Fellowship in furthering the role model programme by conducting more seminars in the country. Suggestions from Fellows for further programmes to be instituted under the activities of the Panel are also welcome.

POST-SCHOOL SCIENCE TEACHING PROGRAMMES

This Academy, along with INSA (New Delhi) and NASI (Allahabad), has been jointly coordinating and supporting several programmes relating to science education in the country. These are under the overall supervision of the combined Science Education Panel which has members representing the three Academies. In 2006, the three Academies had jointly submitted a proposal to the Planning Commission for investments in higher education in science during the XI Plan and modalities for utilization of the resources. The Panel has also been taking up important issues relating to science education at UG/PG and research levels in our universities and colleges. It has held discussions with groups of teachers at various meetings of the Academy

on improvements in the existing situation as well as possible new initiatives. On 24 May 2008, a one-day meeting jointly supported by the three Academies was held at Bangalore to discuss specifically the concept of a 4-year BS programme for the country. Several heads of institutions, concerned individuals and many Fellows in Bangalore participated in the meeting.

Based on inputs received, a Position Paper was drafted by a group which included N Mukunda, S C Lakhotia, R C Budhani, B M Deb, V Balaji, N Sathyamurthy and S Umapathy. The draft was discussed by Councils of the three Academies. A final document entitled 'Restructuring post-school science teaching programmes' incorporating the comments received was jointly released. This was sent to heads of several Government science agencies, Vice-Chancellors, Science Advisory Committees and Councils of the country, the Prime Minister, Deputy Chairman of the Planning Commission, and Central Ministers for HRD and S&T.

An executive summary of the document appears in Annexure-1. Two major components of the document are: improvements in the present curricula and patterns of teaching sciences at UG and PG levels, the introduction initially in selected institutions of a new 4-year BS Programme after the 12th Standard. The Academies hope that this will give an opportunity to considerably improve the quality, content and integrity of teaching the fundamentals of the sciences to our most talented students, preparing them in a much better way than presently for careers in research as well as teaching.

A special brainstorming session to present this document and have extensive discussions on it was held at INSA, New Delhi on 12 January 2009 attended by a large number of heads/representatives of agencies, institutions, including UGC, AICTE, MHRD, DST, ICMR, Office of the Principal Scientific Adviser to Prime Minister, and Fellows of the Academies. Based on the discussions at this meeting, the Science Academies have made several recommendations for implement-ation. These are summarized in Annexure-2.

BUILDING – ADDITIONAL OFFICE SPACE

The Academy offices were functioning from two floors in two different buildings (total floor area 700 sq.m) housing over 55 members of permanent and temporary staff. Considerable expansion of the present activities as well as new ones in recent times has severely constricted the working space for staff. To ease the situation, it was decided in 2007 to construct an additional second floor over the existing old building of the Academy. The construction was started in late 2007 and the new floor was completed and taken over in March 2009. An additional office space of 633 sq.m thus became available. This floor now houses the publication staff of *Current Science* and some of the Academy journals besides two meeting rooms. An annexe was also added to house the despatch section, computer servers, UPS/electrical units, a seminar room, an archives room, and a staff lounge. The total cost of construction including the interiors amounted to Rs 133.50 lakhs.

OBITUARIES

Tanjore Ramachandra Anantharaman (elected 1964), was born on 25 November 1927 in Tanjore, Tamil Nadu to Appaswami Ramachandra Iyer and Saradambal. He

obtained the BSc (Hons) degree in chemistry of Madras University in 1947 and a BE in metallurgy in 1950 from the Indian Institute of Science (IISc) in 1950. The MSc degree in metallurgical chemistry followed in 1951 by doing research at the Madras University in 1951. Following his outstanding educational career wherein he secured the first rank in all public examinations, he was awarded the coveted Rhodes Scholarship in 1951 for doctorate research in physical metallurgy at the Oxford University in England. He joined the Trinity College in Oxford and qualified for the DPhil (Oxon) in 1954.

Anantharaman's professional career began in 1949 with a summer assignment as Nuffield Vacation Scholar at the Steel Plants of Newcastle and Port Kembla in Australia. Following his stay at Oxford, he got a post-doctoral research fellowship at the Max-Planck-Institute fuer Metallforschung in Stuttgart, Germany during 1954–56 and then became an Assistant Professor of Metallurgy at IISc during 1956–62. In 1962, he joined the Banaras Hindu University, Varanasi as a Professor of Metallurgy, a position which he held for over 25 years before his formal retirement in 1987 as the seniormost Professor in BHU. During his stay at BHU

he served the University in various capacities: Head, Department of Metallurgy (1962–77), Dean of Faculty of Engineering and Technology (1971–72), UGC National Fellow (1972–73), Director, Centre for Yoga (1975–78), Rector (1977–78), Programme Co-ordinator of CAS in Metallurgy (1979–87), Jawaharlal Nehru Fellow (1979–81), Director of Institute of Technology (1981–86) and Member of Executive Council (1982–85). After his retirement from BHU, he joined the Thapar Corporate R&D Centre as its Director from 1989–92.

Anantharaman's research accomplishments encompass a broad spectrum of topics in physical metallurgy. However, his most creative efforts have centred round pioneering contributions on rapidly solidified alloys and metallic glasses. Along with his gifted students, he innovated new techniques for rapid solidification and discovered a variety of metastable phases. He directed major national projects on microstructural characterization, metallic glasses and rapidly solidified iron alloys.

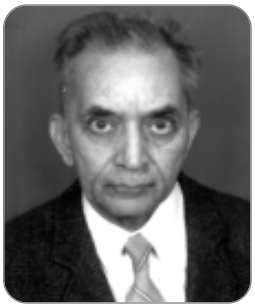
Anantharaman's most significant professional contribution has been the building up of postgraduate teaching and doctoral research programmes in the field of metallurgy at BHU. Under his leadership, the Metallurgical Engineering Department steadily grew in stature from 1962, received the UGC special assistance in 1972 and finally recognized by UGC as a Centre of Advanced Study in Metallurgy in 1979. Another dimension of his personality relates to Spirituality and Religion, particularly to the Vedic and Yogic traditions of India going back to over 4000 years and wrote books on the *Bhagavad Gita, Erkenntnis durch Meditation* (in German), and *Ancient Yoga and modern science*.

Anantharaman has to his credit over 200 technical and research publications, has edited a monograph on '*Metallic glasses'* and co-edited *Proceedings of Three International Conferences* (Metal sciences: The emerging frontiers, 1978; Light metals science and technology, 1985; and Advanced techniques for materials characterization, 1989). His co-authored books were *Rapidly solidified metals: A technological overview* (1987) and, as part of his later involvement in studies related to India's scientific and technological heritage, wrote a monograph entitled *The rustless wonder: A study of the iron pillar at Delhi* (1996).

Anantharaman received several awards and recognitions: National Metallurgists Day Award of Union Ministry of Steel and Mines (1964); Shanti Swarup Bhatnagar of CSIR for Engineering Sciences (1967); FICCI Award in Science and Technology (1972); Homi J Bhabha Award by UGC for Applied Sciences (1974), Vasvik Award in Materials Science (1978); INSA Bhatnagar Medal (1982), IISc Distinguished Alumnus Award (1982); Tata Gold Metal of IIM (1983); INSA Materials Science Prize (1987); IIM Platinum Medal (1996); ISCA GP Chatterjee Memorial Award (1997). He was elected a Fellow of INSA (1972), the Institute of Metallurgists, London (1968), Indian National Academy of Engineering (1987) and the American Society of Materials (1990).

Anantharaman passed away on 18 June 2009 in USA leaving behind his wife Priyamvada, two sons Thomas and Martin, and a daughter Karuna.

Bhupendra Nath Bhargava (elected 1974) passed away on 3 August 2009 at his residence in Delhi. He was born on 25 December 1919 at Sadabad in UP and had his schooling at Rajputana. He did his BSc from Agra University in 1941, and MSc from Allahabad University in 1943. He also had an MS from Ohio State University in 1947. Before starting his academic career he worked for two years at the Engineering Department of All India Radio in New Delhi (1943–45). He then



joined the services of the India Meteorological Department at the Astrophysical Observatory in Kodaikanal as a Meteorologist looking after the Magnetic Observatory and the Ionospheric recording station from 1949–60 and then as Assistant Director (1960–65). He took over as the Director of Colaba and Alibag Observatories, Mumbai in 1966 and continued there till his retirement in 1979. In 1971, these observatories were reconstituted as an autonomous research institute, the Indian Institute of Geomagnetism (IIG), and he became the first Director of the Institute.

At Kodaikanal, Bhargava was actively engaged in research dealing with magnetosphere and ionosphere and took keen interest in generating quality ionograms and magnetograms that can provide reliable and uninterrupted data. The archives of Kodaikanal ionograms are still considered one of the rich treasures as it provides useful data pertaining to the equatorial regions of the world.

When he came to Colaba, research activity was somewhat sporadic. He streamlined the process by

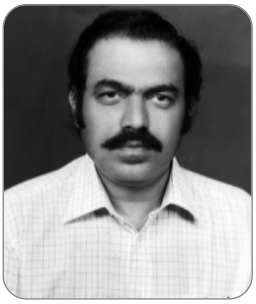
identifying young enthusiastic band of officers, provided them with enough material and topics for research and ensured that high quality scientific publications continued to emanate from them. The autonomy granted to the Institute enabled Bhargava to give new direction to the Institute by forming distinct groups each charged with separate responsibilities: observatory and data analysis, solid earth geophysics, upper atmospheric research and instrumentation. Lateral induction was implemented at different levels to ensure that efficiency and proficiency did not suffer. Thus, from a largely data gathering centre, IIG became a premier centre of excellence for geomagnetic research in the country. Scientific research activities were organized into data analysis, experimental and field work, theoretical studies, design and fabrication of instruments, and their maintenance.

Bhargava was instrumental in getting recognition to IIG as a postgraduate research centre under the Bombay University and several young researchers were able to obtain their PhD degree. His tenure as Director also saw a grand expansion of the magnetic observatory network in the country. From only three field stations (Alibag, Annamalainagar, Trivandrum) additional stations at Ujjain, Jaipur, Shillong and Gulmarg were started by the time he superannuated providing continuous and invaluable magnetic data for researchers worldwide.

Bhargava also gave considerable importance to international collaboration and cooperative scientific research was significantly enhanced with USSR, Australia, USA and other countries. IIG was recognized as one of the significant contributors to the success of the MAGSAT (the first magnetic satellite mission launched by NASA). Solid earth geomagnetism, with emphasis on field work, was firmly established with geomagnetic deep sounding across the country. Theoretical studies into aspects of instabilities in the ionosphere and magnetosphere, the phenomena of geomagnetic pulsations and substorms, etc. were carried out. High quality magnetic data from a network of Indian stations was analysed to bring out several significant features of the low latitude geomagnetic field. Bhargava's own contribution to the understanding of quasiperiodic oscillations in the geomagnetic field was globally recognized. His team also extensively looked into the interaction between the solar wind and geomagnetic changes.

Bhargava is survived by his wife, Pushpa, a son and a daughter.

Maroli Krishnayya Chandrashekaran (elected 1983) passed away after a brief illness on 2 July 2009. He was born in the Salem Town of the then Madras State on 4 January 1937. After his matriculation in 1953, he studied first at St. Aloysius' College in Mangalore and then at the Presidency College in Madras from where he got his BSc in 1958 and MSc securing a first-class-first-rank in 1960. He also completed his PhD in 1964 from Madras University.



Between 1964 and 1975 MKC (as he was known) worked at the University of Tübingen (as German Academic Exchange Scholar 1964–65, Alexander von Humboldt Scholar 65–67, DFG Research Associate 70–75 and the University of California, Berkeley (Miller Invitation Fellow 1968–70). He was also a regular visitor to the University of Munich between 1981 and 1996. Returning to India, he joined the Madurai Kamaraj University as a Reader (1975–80), later becoming Professor (in 1980) and Head, Department of Animal Behaviour and Physiology (from 1985 to 1996). From 1994 to 1996 he was a Senior Professor and coordinator of the School of Biological Sciences. At the University he was also involved in policy-making roles as a member of the Syndicate (1994–96), Chairman of the Syndicate Committee and as acting Vice-Chancellor in 1996.

In 1996 he moved over to Bangalore to set up the Animal Behaviour unit in the newly established Jawaharlal Nehru Centre for Advanced Scientific Research and chaired the unit from 1996–97. In 1997 he became the Astra Zeneca Research Professor of Life Sciences and headed the renamed unit (Evolutionary and Organismal Biology Unit) as its Chairman.

Early in his research career, MKC got interested in biological clocks, especially the one involved in maintaining the day-night (circadian) timing system that regulates adult emergence (eclosion) in the fruit fly *Drosophila pseudoobscura*. Starting with studies on the effect of light, temperature, spectral composition of light, 'dawn' and 'dusk', he became involved in more conceptual studies on phase response curves, transients, coupled oscillators and the much-sought singularity predicted by dynamical models. At Madurai he switched over to studies on rhythms in

bats, mice and humans. Most of his landmark studies on ecological and socio-biological significance of circadian clocks were performed in the eighties. He and his students showed that bats can communicate information about local time to each other, and that the mother mouse can regulate the activity/rest behaviour of her pups. MKC was always fond of neurobiology and with his collaborators in Germany and his students in Madurai he set up a facility to record electrical activities from the bat brain.

The circadian rhythm work carried out in Madurai made his group known internationally. It involved in roughly equal parts the study of phenomena associated with rhythmicity in insectivorous bats, field mice and humans. With Marimuthu and Subbaraj, he reported that social cues from conspecifics could synchronize the light activity rhythm in *Hipposideros speoris*. The group generated the first dark-pulse phase response curve in chronobiology, on the tomb bat *Taphozous melanopogon;* it was the mirror image of the light pulse phase response curve for the same animal. *H. speoris* was shown to be capable of responding to the dimmest intensity (5% of starlight) and shortest duration (0.0625 msec) of light found to entrain or phase-shift a circadian rhythm. With Viswanathan, he discovered that the circadian clock of the newborn pups in the field mouse *Mus booduga* was entrained by an unusual, but in hindsight perfectly understandable, social cue, namely the presence and absence of its mother. There was also an endogenous component to the pup's rhythm and the entrainment worked only within limits. With Vijay Kumar Sharma he found that light-induced phase shifts in *Mus booduga* were sensitive to the spectral composition of the light used.

Investigations on human circadian rhythms could begin only after the arduous process involved in the construction of an 'isolation bunker' was gone through. The findings were striking. Confirming an older observation of Aschoff's, the subjective estimation of short intervals of time was positively correlated with the period of wakefulness – almost as if the body knew at the time of waking when it would go to sleep that night. The female menstrual cycle was not coupled to the cycle of sleep and wakefulness. Similarly, the rhythms of body temperature and sleep-wakefulness could get desynchronized. Curiously, and contrary to common belief, the length of sleep did not depend on the duration of wakefulness that preceded it. Occasionally a 32-hour period of wakefulness preceded 16 hours of sleep, adding up to a circabidian (approximately two-day) rhythm of 48 hours. An interesting consequence was that the interval between meals got enormously lengthened.

At Bangalore despite many administrative responsibilities he managed to contribute to significant experimental findings. The eclosion rhythm in *D. melanogaster* persisted after as many as 600 generations in an aperiodic environment, hinting that a lapse from rhythmicity – or something with which it was tightly correlated – was strongly disfavoured. Observations on the rhythm of oviposition pointed to the presence of at least three different circadian oscillators underlying locomotor activity, eclosion and oviposition, respectively.

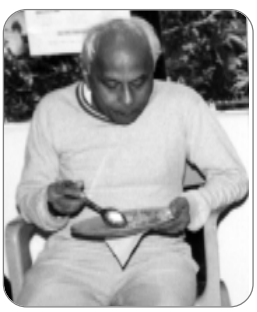
MKC published over 140 papers in international journals on the physiology and behavioural expressions of circadian rhythms in an intertidal crab, plants, fruit flies, two species of Californian grasshoppers, three species of insectivorous bats, the palm squirrel, the field mouse and human subjects. He authored books on biological rhythms (1985 and 1987) and animal behaviour (1987). A scientific monograph summarizing his researches was published as a JNCASR monograph in 2003.

MKC was the recipient of numerous awards and honours. The S S Bhatnagar Prize (1979), the J C Bose Prize (1989), Aschoff's Rule Prize (1991), UGC National Fellowship, UGC National Lectureship and DST–SERC National Lectureship were among these.

MKC served on the Council of the Academy from 1992 to 1997 and edited two of the Academy's journals: *Journal of Biosciences* (1991–97) and *Resonance: Journal of Science Education* (2003–05).

MKC is survived by his wife Shashikala and two daughters, Sujata and Sonali.

Swami Dayal Nigam (elected 1975) was born in Agra on 7 May 1924 and had his early education in Agra College. He completed his doctorate in Agra University under the supervision of S N Ray in the area of mathematical fluid dynamics. He worked in Agra College for some time before moving to the Indian Institute of Technology, Kharagpur as a faculty in the Department of Naval Architecture.



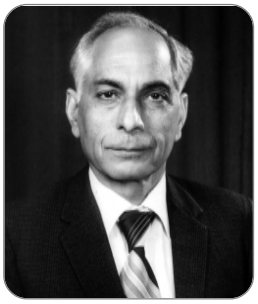
In 1964 Nigam moved to the Indian Institute of Technology

(IIT) Madras as Professor and Head of the Department of Mathematics. He was instrumental in establishing a strong group of both pure and applied mathematicians at Madras. Though a hard core applied mathematician working in fluid mechanics, he encouraged research in diverse areas of analysis and applications.

Nigam has numerous publications in international journals. A noteworthy contribution is a paper titled, 'Note on the boundary layer on a rotating sphere' (*Z. Angew. Math. Physik,* 5, 1954, 151–155) when he extended Howarth's treatment of the problem of boundary layer on a rotating sphere and established the existence of radial inflow from the pole to a latitude of $\theta = 54^0\ 45'$ and outflow between this latitude and the equator. His results confirmed Howarth's conjectures better than the approximate solution provided by Howarth himself. This paper attracted the attention of eminent scholars and opened fresh avenues of research in this area. This paper received wide citation during the period 1955–70. He retired from IIT Madras in 1984 but continued to help students and research scholars.

Nigam had a mild stroke in late 2008 and succumbed to cardiac arrest on 3 May 2009 leaving behind his wife, Savitri Nigam, and a son, Rakesh Nigam.

Ajit Ram Verma (elected 1974) was born on 20 September 1921 at Dalmau near Lucknow. After early education at several places including Allahabad and Meerut he passed his BSc (1940) and MSc (1942, gold medallist) from the Allahabad University. Even though



he was a topper in MSc (Physics) he opted to pursue a career in research rather than going for administrative services. After a short period as Research Scholar at Allahabad, he was appointed Lecturer in Physics at the University of Delhi in 1947. During 1950–55, he worked at the University of London and made well-known contributions on the observation and study of unimolecular growth spirals on the surfaces of silicon carbide crystals. He was awarded PhD in 1952 and DSc in 1969, both from the University of London. After serving as Reader in Physics for four years (1955–59) at the University of Delhi, he moved to BHU, Varanasi as Professor and Head of Department of Physics in 1959. In 1965, he was appointed Director of National Physical Laboratory (NPL), New Delhi which he served till 1982. Thereafter, for three years, he served as Visiting Professor at IIT Delhi and as Jawaharlal Nehru Fellow. He then worked as CSIR Emeritus Scientist and INSA Senior Scientist at NPL.

Verma established three very active schools of research in crystallography, one each at the University of Delhi, BHU (Varanasi) and NPL (New Delhi). In 1951, using phase contrast microscopy, he provided the first unequivocal experimental evidence in support of screw dislocation theory of crystal growth of millimetric sizes. He used phase contrast microscopy to study the crystal surfaces of SiC and photographed these 'nearly invisible' molecular growth spirals. Using multiple-beam interferometric technique, these molecular growth spirals were shown to be growth hills. The step height for 6H, SiC crystal was measured to be 15±1Å, which still stands in scientific literature. The lattice c-parameter for type 6H SiC as measured by X-rays is 15.079 Å, which shows that the measured step-height is equal to the relevant unit cell dimension. Hence, these spirals were shown to be unimolecular growth spirals originating from screw dislocations. Further, the shapes of these spirals were shown to be completely in accordance with theory. This work showed the power of phase contrast microscopy and Zernicke, who had developed this technique nearly twenty years before these studies, was awarded the Nobel Prize in Physics in 1953.

The correlation of step heights of growth spirals with the dimensions of X-ray unit cell had helped in explaining the phenomenon of polytypism by the screw dislocation theory propounded by F C Frank. Verma also made valuable contributions in the pioneering work on direct measurement of metric thicknesses of Blodgett–Langmuir molecular films. At NPL, in collaboration with Krishan Lal, several original contributions were made in the field of crystal growth and study of lattice imperfections.

At NPL Verma's efforts from 1964–82 were focussed on bringing the Indian National Standards of Physical Measurement to an international level. Also, in place of artifact standards, work on quantum standards was undertaken. He laid the foundation for several new areas such as quantum metrology, materials science including work on electronic materials like silicon and advanced materials like carbon fibres, high pressure

and high temperature synthesis of materials, phosphorous and piezoelectric materials, and consolidation of advanced materials characterization activities. Under his leadership, NPL made a strong impact at the national and international level. With Krishan Lal he also worked on crystal growth and lattice imperfections.

Verma authored several books on crystal growth and dislocations, polymorphism and polytypism in crystals and crystallography for solid state physics. He published more than 100 research papers in journals and contributed numerous invited papers and book chapters.

Verma received several honours and awards. Some of these are: British Council Scholar (University of London) 1950–52; ICI Fellowship (University of London) 1952–55; Shanti Swarup Bhatnagar Prize in Physics 1964, Padma Bhushan 1982; and Atma Ram Puraskar in Hindi by Kendriya Sansthan Agra in 1984. He was elected a Fellow of the National Academy of Sciences, Allahabad and a member of the Board of Editors of Solid State Communication, and the International Committee on Weights and Measures (1966–82).

Verma passed away on 4 March 2009 leaving behind his wife Sadhana, a son and two daughters.

Annexure 1: Document on post-school science teaching programmes

EXECUTIVE SUMMARY

The enormous potential for India to become a leading knowledge power in the coming years can be realized only if our younger generation has opportunities for all-round good education and training, especially in science and technology. Unfortunately, however, the present state of higher education in the country is rather poor. In order to make it more relevant to the changing needs of society and thus to propel India to a position of leading knowledge power, we need massive investments as well as well-planned radical changes in our higher education system. The Science Academies had, earlier in 2006, submitted a detailed proposal to the Planning Commission for investments in higher education in Science during the XI Plan period and modalities for utilization of the resources. The three Science Academies of the country are now proposing changes that are needed in our college and university education in Sciences to meet the emerging challenges.

The major drawbacks of our current post-school science education are: (1) compartmentalized teaching/ learning of a few sub-disciplines of science, (2) time and energy wasted in sequential admissions to BSc, MSc and PhD programmes, (3) repetition of topics at BSc and MSc levels, (4) poor laboratory facilities and consequent poor training of students in experimental methods, (5) little exposure to research methodologies, (6) limited options for movement between science and technology streams.

Keeping these in view, it is suggested that a new 4-year B S programme should be introduced, at select institutions to begin with, which the +2 pass students can join. Subsequently, the interested and competent BS qualified students can directly join a dual degree MSc, PhD programme. If they wish to leave in between, they can do so with an MSc degree alone. Those qualifying the 4-year BS or the ongoing BTech can move from basic science to technology and vice versa for further education, leading to MSc/MTech and/or PhD.

Considering the diversity of students' needs, their interests and capabilities on the one hand, and the varied infrastructure and competence available in the large number of teaching institutions in the country on the other, it is suggested that the existing 3-year BSc, 2-year MSc and the integrated MSc or integrated PhD programmes may also continue for the time being.

The +2 qualified students would thus have any of the following options for higher studies in science and technology.

1) 4-year B S followed by PhD in basic sciences, with a provision for early exit with MSc degree or dual degrees after completion.
2) 4-year BTech followed by PhD in basic sciences.
3) 4-year BS followed by MTech/PhD in professional (Technology) field.
4) 3-year BSc followed by 2-year MSc and then PhD or 3-year BSc followed by integrated MSc PhD.
5) 3-year BSc followed by 2-year BTech.
6) 5-year integrated MSc followed by PhD.
7) Vocational courses.

It is essential that all the existing BSc and MSc as well as the proposed 4-year BS programmes follow the semester pattern with credit-based courses. The BSc or BS curricula must provide a broad-based learning rather than segregating 'Bio-' and 'Math-' groups very early. In addition, opportunities must be available for students to take at least 15% of credits through courses in other science disciplines and in social science/arts, etc. All science courses must have good 'hands-on' laboratory training. The teaching programmes should also include courses in research methodology and communication skills.

There is a strong need for substantial improvement in the quality and quantity of teachers at college as well as university levels. Massive efforts for continuing training of teachers to keep them abreast of developments in science are required. A strong experimentally-oriented science education system would require massive investments for developing the necessary infrastructure in universities and colleges across the country.

Annexure 2: Recommendations on the post-school science teaching programmes

A special 'Brain Storming Session' to present this document and have extensive discussions on it was held at INSA, New Delhi on 12 January 2009 attended by a large number of heads/representatives of agencies and institutions, including UGC, AICTE, MHRD, DST, ICMR, Office of the Principal Scientific Adviser to Prime Minister and Fellows of the Academies. Based on the discussions at the brain-storming meeting, the Science Academies recommended the following for implementation.

1. The following multiple options should be available to students who have completed +2 level and wish to continue in Science stream:
   - I) 3-year BSc 2-year MSc, PhD (existing)
   - II) 5-year Integrated MSc programme, followed by PhD (existing)
   - III) 3-year BSc followed by integrated or dual-degree MSc–PhD programme (existing)
   - IV) A 4-year BS (Honours) programme followed by PhD programme, without the need for a Master's degree (new, details given later)
   - V) Vocational courses to facilitate self-employment.
2. Learning of science (and all other disciplines) in all the above models must be pyramidal and not a vertical high-rise. The curriculum must provide a broad-based training of different disciplines of scientific enquiry with specialization introduced as the student advances in training.
3. All courses should be semester-credit based.
4. The 1st two semesters of the 6 semester (3 years) BSc should provide for learning of all major science disciplines by all students with the next four providing core training in 2–3 disciplines; the last 2 semesters may provide for honours in one or two disciplines.
5. All semesters at BSc and MSc should provide 15–20% credits through courses in disciplines (in and outside science faculty) other than their major/honours subjects, including communication skills.
6. Courses in highly specialized subjects like biotechnology, bioinformatics, computer applications, nanotechnology,nanobiotech-nology, etc. should not be allowed at school and undergraduate levels.
7. All core courses must provide for 30–40% credits through laboratory/field work; several of the lab exercises must be based on open-ended experiments.
8. Students at MSc level must undertake a dissertation and prepare a research project proposal.
9. After completion of the 6 semester BSc, provision be made for a 2-year BTech/BE programme.
10. A new 4-year BS Honours programme may be introduced following which the graduates can join PhD programme.

I) The BS (Hons) programme would be credit based semester system available to those passing out of the +2 level in science stream.

II) The first 4 semesters will cover all major science streams as core courses. Students will opt for a major/honours subject in the last four semesters. Each semester would have 15–20% credits for elective courses in other fields, including communication, etc. The last semester should provide research experience.

III) On successful completion of the 4 year course, they would be eligible for seeking admission to PhD programme, since it is expected that the 4-year period would prepare them better than the conventional 3-year BSc + 2-year MSc courses and any deficit in a specific area can be made up through courses during PhD.

IV) The first two semesters of PhD programme will have credit-based lectures as well as laboratory courses. Those not desiring to continue with PhD may exit after successful completion of the course work with MSc degree.

V) The 4-year BS (Hons) programme should be introduced only where a good research base is available.

11. Mobility within basic sciences and between basic and professional courses should be facilitated, including for PhD.

12. A system for regulated transfer of credits from one major to another major within the institute and also between institutions may be evolved.

13. Vocational courses for those who complete +2 or 3-year BSc, or 2-year BTech after 3-year BSc should be strengthened so that those not interested in an academic career can take up self-employment or join appropriate industry.

14. Laboratory training courses should be initiated to provide for increasing need for laboratory technicians in educational/research institutions and in industry.

15. All science teaching colleges and universities must have adequate laboratory facilities – this must be rigorously monitored and audited.

16. Simple and exciting experiments, doable with minimal and inexpensive facilities, need to be designed and popularized.

17. The existing faculty must have opportunities for continuous training in new concepts/techniques.

18. Adequately trained and motivated new teachers should be regularly appointed on existing vacancies.

19. The Science Academies may assist the implementing agencies in preparing broad frameworks of syllabi at various levels.

We are particularly grateful to Prof. S D Thorat, Chairman, University Grants Commission, for having attended the meeting and for responding very encouragingly and supportively to our suggestions. The attached condensed report on proceedings of the brain-storming session also includes full text of Prof. Thorat's observations.

We are aware that the Science Academies are not major implementers or executors of policies and programmes, and can only aspire to act as catalysts and beacons that try to guide. We of course treat these roles with utmost seriousness. We assure all concerned implementing bodies and agencies that if they take up some or all of our recommendations for follow-up actions, the Fellowships of our Academies will be happy and willing to assist in any ways that are needed.

S/d by Presidents:

IASc, D Balasubramanian
INSA, M Vijayan
NASI, Asis Datta

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