No. 44 Patrika September 2006

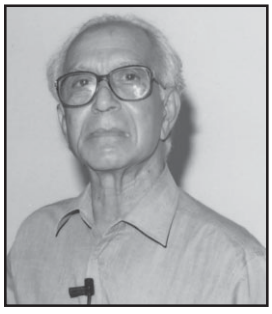
Newsletter of the Indian Academy of Sciences

2006 Mid-Year Meeting

The 17th Mid-Year Meeting of the Academy was held on July 14 and 15, 2006 at the Indian Institute of Science, Bangalore. There was good attendance, with 156 Fellows (80 from Bangalore), 4 Associates, and 48 Teacher invitees (12 from Bangalore) participating.

The opening Special Lecture by J N Goswami, titled "Origin of the solar system: A cosmic accident?" had obvious appeal to a general audience. Goswami described many experiments on fossil records of short-lived nuclides as time markers performed by himself and his associates. Their results have led to a rather surprising conclusion: the time span over which gravitational collapse of a cold dense molecular cloud led to formation of the solar system seems to have been much shorter than was earlier believed. This has led to the possibility that the formation process was caused by an external trigger, possibly the death of a massive star in the cloud neighbourhood, resulting in a supernova.

The second Special Lecture of the meeting was by K VijayRaghavan on "The development of locomotive ability". Key questions one asks are: how does the ability to move emerge during animal development, and how are networks of connections formed that permit complex movements and behaviour practically immediately after birth? VijayRaghavan pointed out that our understanding of the emergence of the ability to move is rather poor, though the ways in which patterns of gene expression regulate this development is demonstrable.



The public lecture on "What do mathematicians do, and how?" by M S Narasimhan to a packed hall was fascinating. The speaker was able to convey many key ideas even to nonmathematicians in the audience extremely effectively by his manner of presentation — the roles of abstraction, generalization and intuition in the structure of mathematics and in discovery; the degree to which help is obtained from the way

Inside...

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Forthcoming Events–2006/07

72nd Annual Meeting

Devi Ahilya Vishwavidyalaya, Indore
(see programme on p. 2)

Refresher Courses

Advanced topics in chemistry
Lady Doak College, Madurai
(7–20 November 2006)

Experimental chemistry
University of Hyderabad
(27 November–10 December 2006)

Tensors and their applications in engineering sciences
Indian Institute of Science, Bangalore
(11–23 December 2006)

Topics in mathematics and physics
Ramakrishna Mission Vidyamandira,
Belur Math, Dt. Howrah
(14–26 May 2007)

Lecture Workshops

Molecular endocrinology
Sree Narayana College, Kannur
(26–27 October 2006)

Modern biology
St. Pious College, Hyderabad
(27–28 October 2006)

Frontier lectures in biology
Jnana Bharathi Campus,
Bangalore University
(October/November 2006)

Modern biology
Aurora Degree College, Hyderabad
(17–18 November 2006)

Frontier lectures in physics
Jnana Bharathi Campus,
Bangalore University
(February/March 2007)

Nature works; and the importance of proof in building up a dependable basis of knowledge. He organized different areas of mathematics according to their basic inspirational sources: shapes to geometry, operations to algebra, and the study of change leading to calculus. And he contrasted the styles of problem solvers on the one hand, and theory builders on the other. It was a feast of ideas for the intelligent mind.

Apart from the above, there were a dozen lectures by recently elected Fellows and Associates.

For the Teacher invitees, a full day programme of lectures on "Biology Today" was organized under the leadership of V Nanjundiah, on the day prior to the Academy meeting. There were eight presentations in all, on several areas of modern biological research, which were informative to all teachers including those from subjects other than the Life Sciences. A record of these presentations has been prepared on CD's and distributed to all the teachers who were present.

72ND ANNUAL MEETING, INDORE SCIENTIFIC PROGRAMME

Venue: Devi Ahilya Vishwavidyalaya

10 November 2006 (Friday)

0930–1100 Inauguration and Presidential address by **TV Ramakrishnan,** Banaras Hindu University, Varanasi
Strong correlations, local constraints, and gauge theories for electrons in solids

1130–1300 **Lectures by Fellows/Associates**

1130 **TN Guru Row,** Indian Institute of Science, Bangalore
Intermolecular interactions in crystals: new directions

1200 **Chitra Mandal,** Indian Institute of Chemical Biology, Kolkata
9-Oacetylated sialic acids: the way sugar speaks for the survival of cancer cells in childhood leukaemia

1230 **Sanjay Puri**, Jawaharlal Nehru University, New Delhi
Kinetics of phase separation and wetting at surfaces

1430–1730 **Symposium**

The state of Indian science: problems, prospects and indicators (*Convener:* **R Gadagkar**)

1430 **R Gadagkar**, Indian Institute of Science, Bangalore
Introduction

1440 **Aparna Basu**, Fellow, GNR Genome Informatics Knowledge Centre, New Delhi
Scientometrics and science indicators: uses and pitfalls

1510 **MS Valiathan**, Manipal Academy of Higher Education, Manipal
Indian medical research today

1600 **P Rama Rao**, IARC for Powder Metallurgy & New Materials (ARCI), Hyderabad
The status of India's higher technical education: What is the way forward?

1630 **Tejaswini Niranjana**, Centre for the Study of Culture and Society, Bangalore
Narratives of decline? Social sciences-humanities education in India

1700 **T Ramasami**, Secretary, Department of Science and Technology, New Delhi
Some planned interventions in rejuvenating Indian science

1730 **R Gadagkar**, Indian Institute of Science, Bangalore
General discussion and concluding remarks

1800–1900 **S Ramaseshan Memorial Public Lecture, MGK Menon**, President, Indian Statistical Institute, New Delhi
The changing face of science

1930–2030 **Business Meeting of Fellows**
11 November 2006 (Saturday)

0930–1030 **Special lecture**

Kankan Bhattacharyya, Indian Association for the Cultivation of Science, Kolkata
Study of organized and biological assemblies using an ultrafast laser

1100–1330 **Symposium**

Genetically modified crops (*Convener*: **Deepak Pental**)

1100 **Deepak Pental,** University of Delhi, Delhi
Breeding of mustard through conventional and molecular methods

1130 **Rakesh Tuli,** National Botanical Research Institute, Lucknow
Designing promoters for regulated gene expression in transgenic plants

1200 **Anil Grover,** University of Delhi South Campus, New Delhi
Production of abiotic stress tolerant transgenic crops achievements and failures

1230 **Raju Barwale,** Mahyco, Jalna
Impact of use of genetically modified crops on agricultural production and farmers income: case of bollgard cotton

1300 **KR Kranthi,** Central Institute of Cotton Research, Nagpur
Bt and the beast

1430–1730 **Lectures by Fellows/Associates**

1430 **S Ramakrishnan**, Indian Institute of Science, Bangalore
Molecular engineering of polymeric systems

1500 **CS Rajan**, TIFR, Mumbai
On spectrum and arithmetic

1530 **Sandip P Trivedi**, TIFR, Mumbai
Whispers from the big bang and the emerging landscape of string theory

1630 **Kalyanmoy Deb**, Indian Institute of Technology, Kanpur
Computational optimization: scope and status in practical problem-solving

1700 **BK Thelma**, University of Delhi, Delhi
Complex diseases in humans — genome analysis and beyond

1800–1900 **Public lecture**

Andre Beteille, Indian Council of Social Science Research, New Delhi
Universities at the cross-roads
12 November 2006 (Sunday)

0900–1000 **Special lecture**

R Gadagkar, Indian Institute of Science, Bangalore
The functional organization of an insect society

1030–1230 **Lectures by Fellows/Associates**

1030 **Charusita Chakravarty**, Indian Institute of Technology, New Delhi
Mobility and order in liquids

1100 **Shankar Ghosh**, Tata Institute of Fundamental Research, Mumbai
Motion of a sphere in an oscillatory boundary layer: an optical tweezer-based study

1130 **GS Bhat**, Indian Institute of Science, Bangalore
Breathing tropics

1200 **Nibir Mandal**, Jadavpur University, Kolkata
Tectonics of an orogen

IASC–INSA JOINT 11TH PLAN RECOMMENDATIONS TO PLANNING COMMISSION

Over the three-month period June–July–August 2006, in a unique cooperative effort involving the Academy and INSA, New Delhi, a comprehensive set of detailed recommendations has been generated and presented to the Planning Commission for consideration in formulating the 11th Five Year Plan. Titled "Higher education in science and research and development: the challenges and the road ahead," it addresses several major issues confronting the science education and research scene in the country including: upgradation of existing universities and colleges, creation of new institutions, movement between S&T streams and industry, new scholarships at various levels, programmes for teachers, better opportunities for women in science, and improvements in the competitive grant system for research projects. The document is posted on the Academy website under **Higher education in science.**

ACADEMY JOURNALS — CO-PUBLICATION WITH SPRINGER

In recent months, several leading international STM publishers — Elsevier, Nature, Springer, Institute of Physics Publishing — have approached the Academy with proposals for copublishing some or all of its journals. On 12 August 2006 a full-day meeting was arranged where the first three groups mentioned above made detailed presentations. These were preceded by preparations and correspondence over several months. Separate meetings with IOPP had been held in August 2005 and March 2006. After evaluation and discussions involving office bearers, Publication Committee members, and all Chief Editors and many Associate Editors, an agreement is being entered into with Springer on copublication of the Academy's ten journals (i.e. all except *Current Science*). The Indian (domestic) editions will be handled totally by the Academy, while the International editions will be dealt with jointly. In particular, the Academy server will provide full free open access to all journals (and archives) worldwide, while Springerlink will host the international editions. Access to the international edition to all users in developing countries will be provided at substantially subsidized rates. Subscription rates for individuals and institutions outside India will be determined by consultation. All Editorial Boards and editorial decisions on acceptance of submissions, special issues etc. will remain in the hands of the Academy.

It is hoped that as a result of this arrangement — to begin with for a three-year period — the visibility of our journals worldwide will increase, gradually improve their impact factors, and in the course of time lead to more submissions of good quality papers both from within India and from elsewhere.

SPECIAL ISSUES OF JOURNALS

Proc. DAE–BRNS solid state physics symposium

Guest Editors: J V Yakhmi, V K Aswal and K G Bhushan

Pramana, Vol. 67, No. 1, July 2006, pp. 1–226

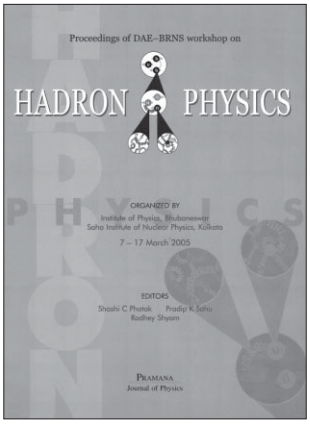
The 50th annual Solid State Physics Symposium sponsored by the Board of Research in Nuclear Sciences (Department of Atomic Energy) was organized during December 2005 at the Bhabha Atomic Research Centre and the Tata Institute of Fundamental Research, Mumbai. Several senior scientists, who had given their best to the growth of condensed matter research in the country attended the symposium. In all, about 800 delegates and participants attended.

Over 750 contributed papers were received from various research institutes and universities across the country. The symposium comprised of 30 invited talks covering different areas of condensed matter physics of which 20 are included in this special issue of *Pramana*.

Proc. DAE–BRNS workshop on hadron physics

Guest Editors: Shashi C Phatak, Pradip K Sahu and Radhe Shyam

Pramana, Vol. 66, Nos. 4/5, April/May 2006, pp. 621–960



The fundamental constituents of matter are thought to be quarks and leptons, which interact by exchange of gauge bosons. The hadrons (baryons and mesons) are colour-neutral objects made of quarks interacting *via* strong interaction mediated by gluons. There is, however, still no clear understanding of the internal structure of the hadrons and their properties. Various probes such as photons, electrons, muons and hadronic particles have been employed to explore the properties of hadrons. Recent discoveries of pentaquarks have opened up new avenues for theoretical and experimental studies in this area. New experimental facilities have come up in recent years, which will help in providing fresh insights into the nature of the strong interactions. The theory of quantum chromodynamics, which is accepted as the theory of quarks and gluons, can be tested more rigorously by careful measurements using these facilities.

The DAE–BRNS Workshop on hadron physics held at Puri in Orissa in March 2005 was aimed at providing a platform for physicists working in the area of strong interaction at GeV energies. The deliberations are expected to result in further collaborations among theorists and experimentalists working in this area. The Workshop dealt with different aspects such as medium

modification of hadron properties, hadronic structure and excitations and the underlying theoretical models. India does not have any accelerator facility at present for carrying out these studies. The 2.5 GeV electron synchrotron at CAT, Indore when operational, has the potential for exploring the field of intermediate energy hadron physics. The Workshop covered the experimental and theoretical scenarios in the frontier area of hadron physics. The proceedings of theWorkshop published in two numbers of *Pramana* contained texts of invited talks including reviews by expert theoreticians and experimentalists and shorter presentations by other Workshop participants.

Statistical techniques in electrical and computer engineering

Guest Editor: P S Sastry

Sadhana, Vol. 31, No. 2, April 2006, pp. 81–198

Stochastic models and statistical inference from them have been popular methodologies in a variety of engineering disciplines, notably in electrical and computer engineering. Recent years have seen explosive growth in this area, driven by technological imperatives. These now go well beyond their traditional domain of queuing models and signal processing to novel methodologies deriving from a variety of areas such as random graphs, stochastic differential equations, classification and regression etc. These find applications ranging from artificial intelligence and manufacturing to bioinformatics.

The present issue collects together some of the material presented at two discussion meetings held under the auspices of the Indian Academy of Sciences, and/or related material provided by some of the speakers. The meetings were on 'Monte Carlo methods and related techniques' in Coorg during November 2004, and on 'Machine learning' in Bangalore during September 2005. It covers a broad spectrum of statistical methodologies currently having impact on electrical and computer engineering. While not exhaustive, it is fairly representative of where things are headed. This special issue consists of six papers.

PUBLIC LECTURES

Physics of crystal surfaces and nanofriction near the melting point

E Tosatti

(International Centre for Theoretical Physics, Trieste)
17 July 2006, Indian Institute of Science, Bangalore

In the first part the speaker reviewed the physical behaviour of crystal surfaces, and to some extent of nanostructures, at high temperatures near the melting point of the corresponding bulk solid. Surface melting (wetting of the solid by its own melt) and non-melting was introduced, and discussed mostly from a theoretical viewpoint. The diverse high temperature surface behaviour of different classes of materials was briefly discussed, and demonstrated with the help of molecular dynamics simulation results. Materials will encompass van der Waals solids, valence semiconductors, metals, and ionic crystals. Solid liquid interfaces, and some properties of liquid surfaces, especially in alkali halides, may also be expanded upon, depending on time.

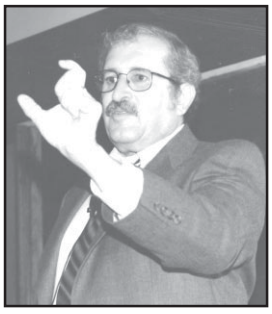
In the second part the speaker briefly described a recent research line on friction and nanofriction of hard tips on nonmelting crystal surfaces near their melting point. Using NaCl (100) as a test case, the speaker used molecular dynamics simulations of sliding nanofriction to exemplify the heavy plowing, wear-dominated regime, and the light grazing, phononic friction regime. Plowing friction exhibits a strong frictional drop near the melting point, the tip "skating" as it were over the hot solid. At the opposite extreme, the grazing, wear-free friction of a flat-ended tip exhibits a surge of friction near the melting point, where the surface is still solid, but not too far from a vibrational instability. This frictional rise can be seen as an analog of the celebrated "peak effect" found close to Hc2 in the mixed state critical current of type II superconductors.

Dark Matter: what is it? where is it? can we make it in the lab?

Michael E Peskin

(Stanford Linear Accelerator Center, California, USA)
7 September 2006, Indian Institute of Science, Bangalore

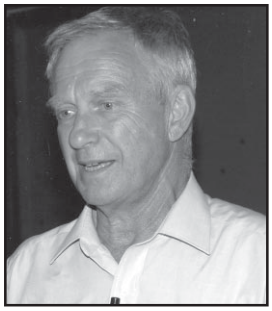
Eighty percent of the matter in the universe is "dark matter", a neutral, diffuse, and weakly-interacting material made of an unknown elementary particle. In this lecture, the speaker discussed the evidence for the existence of dark matter and methods for observing dark matter particles in the galaxy. The speaker then discussed the possibility of producing dark matter in the laboratory at high-energy particle accelerators.



Physics in the world around us

Edouard Brezin
(Laboratoire de Physique Theorique de l'Ecole Normale Suprieure, Paris Cedex, France)

15 September 2006, Indian Institute of Science, Bangalore



We are all aware that many present technologies grew out of our understanding of matter: information technologies, medical imaging, nuclear energy, CD's and DVD's are just examples present in everybody's mind. Other examples are less obvious: for instance the GPS requires atomic clocks and it wouldn't work without Einstein's general relativity. In this talk the speaker reviewed briefly some of the principles underlying these technologies. It was stressed that in most cases they emerged as side consequences of pure knowledge-driven curiosity.

DISCUSSION MEETINGS

Flow control and diagnostics

Orange County, Coorg
19–22 February 2006

Co-ordinator: R Narasimha

Flow diagnostics and control have always been of great importance in technology, but in recent decades they have become particularly active areas of research. This great surge of current interest can be traced to two reasons. The first is the potential for control of turbulent flows revealed by the discovery of coherent structures in what generally had been considered motion with complete disorder. The second is that great advances have recently been made in the technology of sensors, actuators, computers and related systems, making it attractive to consider small active control systems with a performance surpassing those that had earlier been available. Progress in MEMS and in nanotechnologies is unveiling ever newer possibilities.

An Academy Discussion Meeting to consider these advances seemed appropriate. There were 27 participants including from USA and UK. The four-day programme contained 22 presentations in sessions that dealt with flow control, flow diagnostics and flow instability.

REFRESHER COURSES

Excitements in computational physical and bio-sciences

International Institute of Information Technology, Hyderabad

June 12–17, 2006

No. of participants: 34

Course Co-ordinator: Nita Parekh (IIIT, Hyderabad)

Resource persons: R Gadagkar (IISc, Bangalore); Ramesh Hariharan (CTO, Bangalore); VK Gaur (IIA, Bangalore); Amitabh Joshi (JNCASR, Bangalore); Rahul Siddharthan (IMSc, Chennai); R Ramaswamy (JNU, Delhi); AK Mallik (IIT, Kanpur); Indira Ghosh and SR Gadre (University of Pune); B Jayaram (IIT, New Delhi); Prasad Bharatam (NIPER, SAS Nagar); D Balasubramanian (LV Prasad Eye Inst, Hyderabad); HA Nagarajaram and Shekhar C Mande (CDFD, Hyderabad); R Srinivasan (TCS, Hyderabad) and Somdatta Sinha (CCMB, Hyderabad).

The participants represented institutions from Ahmedabad, Banasthali, Bangalore, Chandigarh, Chennai, Chidambaram, Cochin, Hyderabad, Kolhapur, Kolkata, New Delhi, Noida, Panvel, Pune, Rajkot, Sikkim, Vellore.

Topics covered: Deciphering honey bee dance language, properties of simple sequences, nonlinear dynamics, data driven biology, bioinformatics and computational biology, theoretical and computational quantum chemistry, gene to drug, pharmacoinformatics and drug designing, structural bioinformatics, global carbon cycle, evolutionary genetics and overview of modelling biological systems.

LECTURE WORKSHOPS

QuarkNet workshop

Indian Institute of Science, Bangalore
10–11 March 2006

Course Director: Rohini Godbole

Participants: 23 lecturers from various schools and colleges in Bangalore

A two-day Workshop for school and college teachers, in and around Bangalore was held on March 10 and 11, 2006, at the Digital Information Services Centre (DISC) in IISc, Bangalore. The Workshop coincided with two days of International Linear Collider Workshop (LCWS06) from March 9–13, 2006. The QuarkNet team from the Fermi National Accelerator Laboratory (FAL) along with S C Tonwar and B S Acharya from TIFR and Raghava Varma from IIT, Mumbai conducted the Workshop.

Our education system places lot of emphasis on acquisition of knowledge and memorizing facts. These are, no doubt, necessary skills but what is more important is to produce students with a high degree of analytical abilities. It is here that our education system is found wanting. Students are encouraged to cram a lot of information in their courses and are not provided enough learning experience to evaluate and analyse the data collected.

QuarkNet is a teacher professional development programme funded by the National Science Foundation and the US Department of Energy. School teachers work on particle physics experiments and join a cadre of scientists and teachers working to introduce some aspects of their research into their classrooms, bringing them to the frontiers of 21st century research in particle physics. The QuarkNet centres are connected to high-energy physics experiments operating at CERN in Switzerland, at Fermilab in Illinois, at SLAC in California and others. In the framework of this programme physicists mentor work and collaborate with high school teachers spread across the globe. QuarkNet resource persons travel around the world and show the teachers and students how to build a simple cosmic ray detector, which consists of a plastic scintillator, a common piece of equipment in any nuclear or particle physics laboratory. Along with the detector is attached a global positioning system and a data acquisition card which can be hooked on to any personal computer. On the occasion of the International Linear Collider Workshop the QuarkNet team comprising of Marge Bardeen and Robert S Peterson came with some scintillator pieces, photomultiplier tube, GPS receivers, data acquisition card and other relevant material from FAL. They conducted the Workshop attended by physics teachers in and around Bangalore. The teachers were first introduced to the subject of cosmic rays and how to detect them. They were then involved in the process of assembling detector using a plastic scintillator, a light guide etc and then hooking up the data acquisition card and the GPS receiver to a PC. The GPS system gives the data a time stamp. All the data the detector collects then resides on the QuarkNet portal **(http://quarknet.fnal.gov/e-lab)** at FAL. The students/teachers are given username and passwords, using which they would be able to use the whole set-up to collect data and upload it to the QuarkNet portal. One can, in turn, have access to the data collected by other schools/students across the globe who are also participating in the experiment. They will be able to further participate in analysing these data, in the process learning the basics of data analysis. In all 23 teachers from various schools and colleges (22 from local schools and colleges and one from Pune) participated in this exercise. Rohini Godbole described the purpose of the Workshop. Marge Bardeen introduced the concept of QuarkNet and its aim to teachers.

These were followed by an inspiring lecture by S C Tonwar on what cosmic rays are, how they are detected, what questions about our universe they have helped to answer and so on. This was followed by an equally informative lecture by B S Acharya on detector technology, how they are built, and what we measure using them.

The teachers were then asked to explore the QuarkNet URL at FAL. This was a learning experience for all participants. They were allowed access to some of the data collected elsewhere and see some of the posters prepared. Many of them were creatively thought out problems. This provided inkling into the nature of work that could be carried out using the detectors. Later, in the evening the teachers were divided into four groups: one to assemble the detectors, the other three to choose one set of data to be analysed. The next day the detector group started fabricating the detector while the other groups tried to converge on what analysis they should do. The groups engaged in data analysis presented what they were going to look for while the detector group started assembling the detector. Even while assembling, a whole range of physics was discussed at length. In the afternoon, it was a moment of joy for the assembly team to see their detector detecting cosmic rays. The participants were finally given a short time to present what they learnt from their efforts. Judging by the response of the participants, the meet was a big success.

The entire hardware kit used in the Workshop was gifted to the participants for follow up action by the QuarkNet team from USA. The detector is now set up at the Jawaharlal Nehru Planetarium, Bangalore.

Bioinorganic chemistry

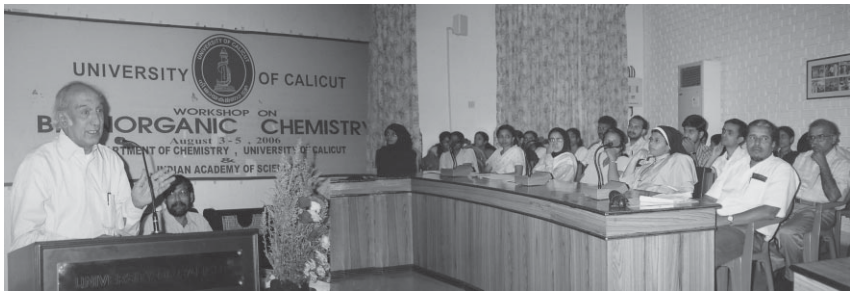
University of Calicut, Calicut
3–5 August 2006

Course Director: T K Chandrashekar

Co-ordinator: K Krishnan Kutty

Participants: 120 students and faculty from universities and colleges in Calicut

Speakers: V Krishnan (JNCASR, Bangalore); TK Chandrashekar, A Srinivasan and VG Anand (all of RRL, Thiruvananthapuram); R Ramaraj (MKU, Madurai); M Palaniandavar (Bharathidasan University, Tiruchirappalli) and K Padmakumar (Govt. College, Chittoor).



Topics covered: Importance of bioinorganic chemistry; occurrence of inorganic elements in biological systems, active sites of metal binding biomolecules and preferences, the role of alkali and alkaline earth metals in biological processes, biological oxygen transport, haemoglobin and myoglobin, copper proteins and their biological functions, role of zinc in biological systems, cytochromes, cyochrome vs. vitamin B12, photosynthesis, nitrogen fixation, electron transport in biological system, metals in medicine and therapy.

OBITUARIES

Manoj Kanti Banerjee (elected 1977) the noted nuclear physicist, died in Maryland, USA on 18 February 2006. He was born on 25 May 1931. After his schooling, he passed B.Sc from Patna University in 1949, M.Sc from Calcutta University in 1951 and obtained Ph.D in 1956 working at the Saha Institute of Nuclear Physics (SINP). He joined the Saha Institute of Nuclear Physics (SINP), Calcutta as a lecturer (1952–57), became a reader (1957–60) and a professor (1960–66). Between this period, he also worked at the Princeton University as a research associate from 1955 to 1957, and as a Weizmann Fellow at the Weizmann Institute of Physics from 1962–63. In 1966 he went to the University of Maryland as a Visiting Professor for 2 years, after which he was appointed a full professor of physics at the University. He remained at Maryland for the next 40 years.

Banerjee had a distinguished career in nuclear physics. He shot to fame early in his career when he developed the direct interaction theory of inelastic scattering in collaboration with Carl Levinson. Acknowledged as 'the most complete treatment of direct interaction', this work incorporated the initial-state and final-state interactions, and allowed for the direct interaction to take place anywhere inside the nuclear volume, leading to a remarkable agreement with experimental data (carbon data, to be specific) over a wide range of energy.

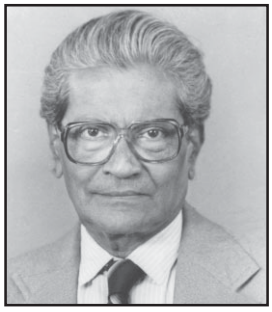
Among his contributions to the theory of nuclear structure, a noteworthy piece of work is the calculation of energy spectra of (2s, 1d) shell nuclei done in collaboration with Levinson and Meshkov. The theory used the SU(3) classification of shell-model states and was mainly focused on the ^{24}Mg nucleus. His interest in nuclear structure continued as he mentored a string of students, including L Satpathy and Harishchandra. Some of their studies related to application of the Hartree–Fock–Bogoliubov method to structure calculations. He also made interesting observations on the shapes and symmetries of light nuclei in collaboration with Levinson and Stephenson.

Banerjee was actively interested in the physics of nuclear matter. The first ever attempt at adapting the many-body theory to the calculation of the *t*-matrix for *finite* nuclei was due to Banerjee and Binayak Datta Roy. Banerjee returned to the physics of nuclear matter much later in his career. In collaboration with Tjon, he studied the pion-nucleon parameters in nuclear matter contributing valuable insight regarding their density dependence. A significant result obtained by Banerjee is that the derivative-coupled one-pion exchange potential in nuclear matter is seriously damped in relativistic calculations contrary to what would be expected in a non-relativistic treatment.

During the sixties, Banerjee's area of interest expanded to include hadron physics and from the seventies he vigorously devoted himself to the study of low energy pion-nucleon physics. Research in hadron physics of that era was boosted by the success of quark model on the one hand and the development of quantum chromodynamics as the gauge theory of strong interaction on the other, However, direct application of QCD to low energy hadron physics proved to be extremely difficult and the necessity of constructing QCD-inspired models as effective low energy theory was felt. In this background, Banerjee collaborated at various stages with Birse, Broniowski, Cohen and others

to develop and study such models particularly in the case of baryons. Inspired by considerations of chiral symmetry, linear sigma model and the Skyrme model, Banerjee along with his colleagues investigated the colour-dielectric model, the chiral quark-meson model and the chiral soliton model of nucleon and delta, which were reasonably successful in describing the static properties of the baryons. More importantly, they joined several other workers in the field to establish the importance of the role played by the mesons in the effective theory of strong interaction at low energy. Banerjee's contributions in the pion-nucleon physics include study of pion-nucleus optical potential and charge dependence of the πNN coupling constant. Apart from doing some research in the role of instantons in chiral confining models, he investigated the baryon mass splitting and the photoproduction of neutral pions in chiral perturbation theory which is considered to be the proper effective field theory of strong interaction.

Banerjee received many honours: the Weizmann Fellowship (1962), the Fellowship of the American Physical Society and the Humboldt Research Award (1966) in recognition of his contributions to science. He will be remembered not only as a devoted scientist but also as a remarkable teacher and a great source of inspiration for a whole generation of physicists. His wife Uma passed away sometime ago and he is survived by Sanjoy, his son.



Mrinal Kumar Dasgupta (elected 1990), the doyen of research in radio astronomy in India and the codiscoverer of double radio galaxy, Cygnus A, breathed his last at his Salt Lake residence, Kolkata on 28 November 2005.

Dasgupta was born on 1 September 1923 in Barishal district of the then undivided Bengal (later East Pakistan and now Bangladesh). He was the third son of Sukumar and Tarubala Dasgupta. His father was a school teacher, who inspired many students. He had his primary education in Barishal, but in later years he was a student of the famous St. Gregory School in Dacca. When he was in class IX he had the opportunity to listen to a popular talk on radio communication by Sisir Kumar Mitra which left a deep impression on his mind. His destiny finally brought him in close contact with his idol.

After passing matriculation and intermediate examinations, Dasgupta studied B.Sc with honours in physics and then topped M.Sc in physics in 1947, both at Dacca University. He studied under the legendary Satyendra Nath Bose, and many other illustrious teachers. Unfortunately, the period 1940–47 was turbulent due to the freedom movement and communal riots and it caused frequent interruptions to his academic life. Following the country's partition the family decided to cross the border and settle in Calcutta, where he joined as a research assistant in the newly created Institute of Radio Physics and Electronics (INRAPHEL) at the University of Calcutta with Sisir Kumar Gupta and was involved in preparing the second edition of Gupta's famous treatise "The Upper Atmosphere". He also started experiments on active nitrogen with a view to verifying a theory proposed by Mitra about the origin of active nitrogen in the upper atmosphere and finally succeeded in observing the glow. In 1948 Dasgupta was awarded an overseas fellowship to work with P M S Blackett, Nobel Laureate, at the University of Manchester and later at the Jodrell Bank with Sir Bernard Lovall.

The subject of radio astronomy was at the formative stage during the 1950s. R Hanbury Brown in 1950 conceived a radio interferometer, called the intensity interferometer. He asked his two research students, Roger Jennison and Dasgupta to design and fabricate a long baseline postdetection correlator radio interferometer since radio astronomical observations until then were beset with poor angular resolutions of radio telescopes and the limited sensitivity of receiving systems. This new concept solved that problem. The basic idea was to compare the fluctuations in the intensity of the source rather than its voltage, enabling long baselines. For this purpose two independent receivers were built at a frequency of 125 MHz with a bandwidth of 200 kHz. After a square law detector, the signals were filtered with a 2 kHz filter and multiplied and their cross-correlation was measured as a function of baseline between the antennas. This was tried on two of the strongest radio sources known, namely, Cygnus A and Cassiopeia. They found that as the baseline was increased up to 20 km, two large maxima in signal amplitude appeared in the case of Cygnus A, whereas a single maximum appeared for Cassiopeia, thus indicating that Cygnus A was not a simple source. The separation of the two 'radio lobes' was about 1' 28". This was how the classical double radio source structure of radio galaxies was discovered, a discovery of great importance in radio astronomy, leading ultimately to the idea of relativistic jets of plasma in two opposite directions emanating from the nucleus (which is now conjectured as a large accreting object or a black hole).

Dasgupta was awarded a Ph.D of Manchester University in 1954, after which he returned to India to rejoin INRAPHEL as a lecturer. In addition to his normal teaching duties, he started developing a research school with a few students. During the early 1960s UGC was planning to establish Centres of Advanced Study in selected University departments and in recognition of the pioneering contribution of Sisir Kumar Mitra,

INRAPHEL was included in the list. Dasgupta was promoted as reader and in 1967 became a professor in charge of the thrust area in space physics. He guided a number of Ph.D students, who later held key positions in USA, Brazil, West Indies, Canada, besides India. Dasgupta made significant research contributions in the field of atmospherics, solar-terrestrial physics, solar microwave and X-ray emission, etc. Some of the significant contributions made by him are listed below: (a) the sudden enhancement of the integrated field intensity of atmospherics subsequent to nuclear bomb explosions of megaton range; (b) the gradual enhancement of the integrated field intensity of atmospherics prior to the incidence of Nor'westers; (c) the solar cycle dependence of the incidence of sporadic $E(E_s)$ — a global picture; (d) the variability of solar microwave radiations; (e) the effect of a total solar eclipse on microwave line-of-sight propagation and also on ionospheric total electron content; (f) the effect of earth's orbital eccentricity on incident solar flux at 10.7 cm; (g) studies on solar radio burst in relation to other solar optical features; (h) spectral studies on different types of solar microwave emission — basic component, slowly varying and burst components.

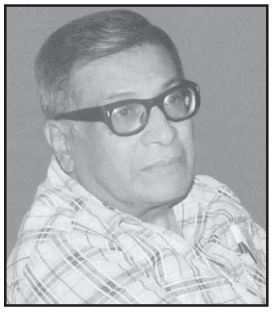
Dasgupta became the Head of the Department of Radio Physics and Electronics and the Director of the Centre of Advanced Study Programme in 1976, the posts he held till 1980. He was a member of the senate of the University of Calcutta and served in the Governing bodies of several educational/research institutions and state-owned electronic enterprises.

Dasgupta formally retired from the University in 1988 but continued to work for three more years (1988–91) as INSA Senior Scientist in the same Institute. In collaboration with A K Sen, he successfully conducted a research project on "Microwave rain attenuation from radiometric measurements at 12 GHz and 22.235 GHz". The investigations included radiometric signature of layer clouds; attenuation in clear air and during rain over Calcutta using dual frequency radiometer; rain attenuation characteristics at these wavelengths for the earth-space path, and the measurement of water vapour content and cloud cover using scanning radiometry at 22.235 GHz.

The radiometric data obtained in clear weather, during rain and at the time of overhead cloud formation were analysed, from which communication parameters and attenuation could be derived. The results show that the monthly variation of parameters clearly follow the monthly variation of water vapour density and was found to be maximum in the month of August. Further the diurnal and seasonal variation of water vapour density over Calcutta has also been obtained. It has been revealed from these analyses that the water vapour scale height around 2–3 km is in conformity with other observations. Water vapour profiles for different months were also drawn. The peak rain attenuation plotted against peak rain rate and by regression analysis showed that the relationship is linear. It was observed that the rain attenuation persisted for about 2–5 hr even after the rain stops presumably due to the presence of large ambient humidity and slow wind activity.

In 1991, Dasgupta initiated a diploma course in astronomy and planetarium science — the first of its kind in India — at the MP Birla Institute of Fundamental Research in Kolkata in 1992. Dasgupta was elected a Fellow of the Indian National Science Academy (1974). He presided over the Engineering Section at the 68th Science Congress at Banaras in 1981.

Dasgupta is survived by his wife Dipali and a son.



Basantidulal Nagchaudhuri (elected 1974) passed away in Kolkata in the early hours of 25 June 2006. With his passing a distinguished career in nuclear physics and science administration came to an end. He will be remembered for his invaluable role in the postindependence development of science and technology in our country.

Nagchaudhuri was born into a well-to-do family in Banaras on 6 September 1917. His father, the late U C Nag Chaudhuri, was a Professor at Banaras Hindu University (BHU). At the age of 13 he appeared for the matriculation examination topping the merit list. He was also a first class first in B.Sc from BHU in 1935. After taking his M.Sc in physics in 1937 from Allahabad University where he had Meghnad Saha as a teacher, he proceeded to USA for his pre-doctoral work with EO Lawrence at the University of California, Berkeley, from where he obtained his Ph.D in physics in 1940. About this time Saha appointed him as the Cyclotron Officer to help him procure from USA parts for his dreamchild, cyclotron, a machine first of its kind in the country to be built in Kolkata after the 38-inch-model at Berkeley.

On his return Nagchaudhuri joined the University of Calcutta initially as a lecturer in physics (1942–46) to become the Sur reader in nuclear physics (1946–53) and finally the Palit Chair in physics (1953–59) just vacated by Saha. By 1949 the Institute of Nuclear Physics had evolved out of the Palit Laboratory for teaching and cultivating nuclear physics with Saha as Director. After his untimely demise in 1956, Nagchaudhuri steered the Institute (renamed in 1958 as the Saha Institute of Nuclear Physics, SINP) to its objective, first as officiating (1956–59) and then as full Director (1959–67). It took much of doing in those days of teething troubles. He held this office until October 1967 when he

was called away to the Planning Commission. In October 1972, however, he accepted an Honorary Professorship of the Institute for two years. Between 1941 and 1960 and again, between 1960 and 1961, he held a couple of short-term visiting positions at the Universities of Illinois (Urbana) and California (Berkeley). He was appointed the Lincoln Lecturer in USA during 1966–67. Meanwhile, Nagchaudhuri was elected to the Fellowship of the Indian National Science Academy in 1964. He was awarded *Padma Vibhushan* in 1975. At SINP, which was also the seat of the Sur Reader for some time, Nagchaudhuri's interest lay in the fields of nuclear isomerism, artificial radioactivity, Cerenkov phenomena and low temperature plasma. He also carried out biophysical research using radioisotopes as tracer elements and had about 57 papers in national and international journals.

As a student in Banaras and Allahabad, Nagchaudhuri had been actively involved in politics (1931–37) even at the cost of serving small terms in jail. Saha turned his inborn leadership to science and technology which in later years caught the fancy of the Government of India and he was assigned to different decision-making positions. Thus, apart from membership of Planning Commission (1967–70), he served as Chairman of the Cabinet Committee of Science and Technology (1969–72), Scientific Adviser to the Ministry of Defence and the Director-General of DRDO (1972–74). In a span of few years he could put defence research in the international orbit and initiate the transformation of science and technology research and education for the welfare of the society. He was one of the first few to realize the urgency of developing qualified human resource in the country and was a natural choice for the vice-chancellorship of the Jawaharlal Nehru University, New Delhi (1974–78). During his time the University became one of the best centres for the production of high quality manpower in the country. He was also the Chairman of Science and Technology Manpower Committee, Government of India (1979–81). One of the pioneer scientists of our country bringing environment from textbook to practice, Nagchaudhuri made several important observations as the Chairman of a National Committee on Environmental and Planning Co-ordination, Government of India (1975–77). His message on the environment reached the United Nations where he was drafted and retained as a member of Senior Scientific Advisory Committee in its environment programme (UNEP) during 1976–82. He put equal emphasis on the development of science and technology, quality of environment and people's welfare in other countries as well, and worked there in various capacities. He was a Visiting Professor at the University of Science and Technology, Kumasi, Ghana during 1978–79 and a Member of the Board of Trustees (1978–81) and Chairman (1976–82) of the Programme Committee of the International Foundation of Science, Stockholm. He also served as a Member of the Scientific Council of the International Centre for Theoretical Physics, Trieste, Italy (1976–84) and a Member and Chairman of the International Advisory Panel, East-West Centre, Honolulu, Hawai. He chaired the Extra-Mural Research Committee of CSIR, the Board of Research in Nuclear Sciences of DAE (1975–77) and the Research Advisory Council of NPL (1980–82). For some time he was a member of the University of Calcutta Senate and Syndicate as also of the Syndicate of the Manipur University, Imphal.

Nagchaudhuri wrote on various scientific and social issues. His semipopular scientific articles like low-energy nuclear physics, electrodynamics of Cerenkov radiation, radioisotopic tracer in biological experiments are as lucid as enlightening. His other articles like impact of science and technology on international relations and the monographs like *Science and Society* (Ankur Publishers, Delhi), *Technology and Society* (Institute of Advanced Study, Simla), *Environmental Management in Developing Society* (Interprint, Delhi) and *Law and Environment* (with S Bhatt) etc. prove the expanse of his expertise. This, and the spectrum of positions he held show that his science was very different — it was to transcend the confines of a laboratory.

As a human being, Nagchaudhuri combined the grace of English aristocracy with the genre of a true teacher. Behind the outfit of a hard-core administrator — there lurked a simple man leading plain living and high thinking. He is survived by his wife Dipali, a noted exponent in classical Hindustani vocal, and his son Dipankar.

Lalit Kumar Pandit (elected 1976), the wellknown theoretical particle physicist passed away following a cardiac arrest on 23 May 2006, while visiting his elder son in Boston, USA. This is a discernible loss to India's theoretical physics community which considered him as one of its valued members.

Born into a Himachali Pandit family on 28 June 1932, Pandit was the fifth of the nine children of Pt. Chandu Lal and Kalavati Sharma. The young Pandit attended the Harcourt Butler Senior Secondary School, which functioned from both Shimla and Delhi for six months each, and stood first in the 1948 secondary board examination as well as in the all-India entrance scholarship examination conducted by Delhi University. The latter result led to a fully funded scholarship which enabled this member of a family of humble means to enrol at the elite St. Stephen's College of Delhi for the B.Sc Physics Honours. He graduated in 1951, again topping the list and securing a further full scholarship of two years to complete his M.Sc in 1953 from the same

university. Thus for five years he received his training in physics under the tutelage of India's stalwart physics professors of the time such as D S Kothari and R C Majumdar. He then spent a year working as a research fellow under Majumdar. In 1954 he won a Government of India full educational scholarship to go to Switzerland for his doctoral studies at the University of Zurich.

At Zurich, Pandit chose to conduct research in the newly developing area of high energy particle physics. He was guided in this by the distinguished quantum theorist Walter Heitler (author of the book *Quantum theory of radiation*), working under a group headed by Wolfgang Pauli. The latter impressed the young doctoral student so much as to leave in him a lifelong sense of reverence for the great physicist. Pandit's 1957 Ph.D thesis comprised a number of both static and dynamical calculations in the pseudoscalar meson theory. While the static ones computed the anomalous magnetic moments of nucleons, the dynamical ones addressed the electron-proton scattering process at high energies. These calculations represented some of the first instances of the utilization of the covariant integration method (applied with a cut-off) pioneered by Suraj Gupta. Also, while at Zurich, Pandit wrote a review on the properties of linear vector spaces with indefinite metric. This subject was very timely in the wake of the use of such spaces in the covariant handling of the gauge-fixing problem in quantum electrodynamics. A major emphasis in the article was on the general lack of reality of the eigenvalues of a hermitian matrix and the consequent non-orthogonality of the corresponding eigenvectors in such spaces. All categories of this behaviour were in fact systematically studied in this paper.

Returning to India in 1958, Pandit accepted Homi Bhabha's invitation to join the Tata Institute of Fundamental Research where he stayed till his retirement in 1992. During his first few years at TIFR, he worked on the properties of *K*-mesons in collaboration with S N Biswas, proposing different methods for determining their relative parity with respect to other baryons. He did spend some time in 1960 as a post-doctoral visitor to the Istituto di Fisica at Padova, Italy, collaborating with Nicola Dallaporta to explore the internal symmetry properties of baryons. These were studied in relation not only to baryonic mass differences but also to the interactions of the baryons with π- and *K*-mesons.

The three years from 1963 to 1966 were spent on a visiting assignment at the University of Rochester where his initial work concerned various mathematical properties of the newly proposed internal symmetry group SU(3). This was done in collaboration with N Mukunda who was then at Rochester. Together they developed computational techniques utilizing irreducible tensors of the said group. Methods were found for determining the direct product of two general irreducible representations of SU(3) and for the computation of some of the associated Clebsch–Gordon coefficients. In essence, a spinor calculus for SU(3) was developed. Pandit later did some important work with the famed Rochester particle theory group led by Robert Marshak. The most notable result, obtained together with Vishnu Mathur and Susumu Okubo, was a soft pion theorem (also derived at the same time and independently by Curtis Callan and Samuel Treiman of Princeton University) on the weak three-body semileptonic decays of the strange and charged pseudoscalar mesons $K^{\pm}$. This theorem utilized both Richard Feynman's partial conservation of the axial vector current hypothesis as well as the SU(3) $\otimes$ SU(3) algebra of hadronic weak and elctromagnetic currents, proposed by Murray Gell-Mann. The result was hailed as a major breakthrough since neither perturbative field-theoretic nor S-matrix methods, developed earlier, could be applied successfully to such a low energy weak process involving strongly interacting particles. A new idea then came from Pandit and Riazuddin with a certain amount of prescience. They proposed the existence of a unitary transformation (rather akin to the famous one due to Foldy and Wouthuysen) between two sets of quark fields that are now known as current and constituent quarks. This was a precursor to what later came to be known as the "Melosh transformation". Other interesting studies emerged from collaborations, of which Pandit was a member, pertaining to hyperon magnetic moments and to the mass difference between the short- and long-lived neutral kaons — calculated by current-algebra techniques. Because of all this success, he was invited to talk about applications of the algebra of currents at the Coral Gables conference of 1966. Given the fame he had acquired at that time, Pandit could have easily accepted a job offer in US and stayed on. But a strong sense of patriotism and a commitment to build up a good school of researchers at TIFR made him return to his homeland.

Back at TIFR after 1966, Pandit along with his younger colleagues started detailed studies of a variety of mesonic decays based on underlying symmetry principles such as the algebra of currents and asymptotic SU(3) as well as chiral SU(3) $\otimes$ SU(3). These led to several very interesting results. For instance, the decay widths of the vector meson ϕ as well as of the nonstrange and strange axial vector mesons A_1 and K_A respectively were computed, using the spectral function sum-rules proposed by Steven Weinberg. Another set of investigations led to a reasonably complete description of the four-body semileptonic decay of the *K*-meson as well as detailed studies of nonleptonic weak decays. The mid-sixties witnessed a real flowering of his creative talents with several papers published in the prestigeous *Physical Review Letters* and an invited review article (coauthored by Vishnu Mathur) in *Advances in Particle*

Physics (eds Rodney Cool and Robert Marshak). Quite a few of the results, with the derivation of which Pandit was involved, became benchmarks for the subsequently formulated theory of strong, weak and electromagnetic particle interactions, viz, the Standard Model, to agree with. That agreement necessitated the development of chiral perturbation theoretic techniques within the later established framework of quantum chromodynamics and the electroweak theory. One can say therefore that these results paved the way for the development of those techniques. Pandit's lectures on the subject in the 1967 Dalhousie summer school, which came out as one of the famous yellow reports of TIFR, convey to the reader the sense of excitement in the field at that time. It was largely on the strength of the above studies that Pandit was elected a Fellow of the Indian Academy of Sciences in 1976. Thereafter, his interests shifted to the algebra of bilinear quark operators on the light-cone. Again, his clear, informative and pedagogical lectures on the subject in the Dalhousie summer school of 1973 were much appreciated by all those who attended them.

Through the nineteen seventies and eighties, he and his colleagues continued their studies on newly emergent phenomena in particle physics, from the J/ψ to neutral currents and heavier families, by using symmetry groups suchm as SU(4) and $U(3)_W$. When the new revolution in high energy physics moved the focus of particle dynamics away from global symmetries into gauge symmetries and their characteristic features, such as screening and confinement, he kept track of all those developments enthusiastically. He participated in the 1982 international high energy physics conference in Paris where the Standard Model was given a canonical status. On his return, he gave a great colloquium on the meeting in which he said that, as an interested outsider, he could talk about "vintage physics deliberations observed from a vantage point".

Pandit was a wonderfully warm person and always radiated bonhomie as well as goodwill. He was a spirited teacher who infected his students with his boundless enthusiasm communicated through the frequent waving of his arms. On the other hand, he was an extremely nice individual, being gentle, considerate as well as kind and helpful — especially to younger colleagues. He would go out of his way to persuade TIFR authorities to help new academic entrants into the Institute in mundane but essential matters such as housing of which there was then an acute shortage. Whatever he felt to be worthwhile was pushed with elan and verve by him. He would never lose his composure in any discussion, however controversial, and his wide smile was always a source of reassurance to his colleagues and students alike. His vibrant presence in summer schools, that TIFR regularly organized over the course of two decades, was a stimulus to the students. The long walks that one had with him at the venues of such schools like Dalhousie, Mahabaleshwar and Panchgani are memorable for the wise words and insightful advice which came from him.

After his retirement from TIFR, he moved to Delhi and lived in his family house in Green Park. He was seen from time to time in various particle physics meetings in Delhi. He participated with gusto in the theoretical physics symposium SUJAYATA, held at TIFR, in 1996 to celebrate the golden jubilee of the Institute. In the later part of his life his energy did turn inward, making him meditative and spiritual. But his enthusiasm and love for life and his cheerful demeanour remained intact. At a meeting held at IIT, Delhi, to consider steps to attract motivated and good students to science, Pandit was heard saying "Show them that you enjoy doing science and they will come automatically". He had a serious heart attack about eight years ago, but did rebound to active life after that. The second heart attack proved fatal. He was supposed to speak in the next academic semester to students of IIT, Delhi on the history of quantum mechanics and his personal interactions with quite a few Nobel laureates in that area. Unfortunately, things turned out otherwise. Pandit leaves behind his wife Neeraja, two sons and a daughter.

Barry Ramachandra Rao (elected 1974) an eminent space scientist and a teacher who inspired generations of physics students at Andhra University, passed away on 24 September 2005 at his residence in Visakhapatnam.

Ramachandra Rao had a humble beginning, born on 21 November 1922 into a fisherman family in Yalamanchili, a remote village in the Visakhapatnam district of Andhra Pradesh. He had his schooling and intermediate education in Visakhapatnam. That he was an immensely talented student was known quite early, but his extraordinary gift came to be realized only after he joined the B.Sc (Hons) physics course at Andhra University. S Bhagavantham, greatly impressed by the talented young Rao, had taken special interest in him and provided him financial support. Rao secured first rank in B.Sc (Hons), not just of physics but all disciplines combined, and was awarded the Sripathi Medal in 1944. Even in M.Sc he stood first and was awarded the Metcalf Medal in 1945. That was the beginning of a brilliant research career.

Ramachandra Rao joined Andhra University in 1945 for his D.Sc under the supervision of S Bhagavantham. He was supported through a laboratory demonstratorship and later by a CSIR senior research fellowship. His

doctoral work was on diffraction of light by high frequency ultrasonic waves for which he was awarded D.Sc in 1949. He continued this line of work which led to the discovery that in the high frequency region the diffraction pattern follows the Bragg's law. He and his students developed new techniques for high precision measurement of ultrasonic velocities in liquids and solids. This pioneering research in ultrasonics led to a series of seven papers, six of them in *Nature*.

In 1951, he was awarded a Commonwealth Senior Research Fellowship to work at CSIRO, Australia with D F Martyn, who was then involved in formulating the ionospheric dynamo theory, now regarded as one of the most outstanding contributions in ionospheric physics. Martyn invited Rao to join him to work on this theory, but it would involve commitment to stay longer at CSIRO than what Rao intended. His primary objective was to work on experimental techniques that would help him start a school of experimental space physics at Andhra University. On return from Australia, he and his doctoral students started building an ionospheric research laboratory that over the years became one of the most advanced space science centres of international repute. There was tremendous diversity in the type of instruments that were designed and developed, taking the laboratory to the forefront of radio and space research in the country in a short time.

The first multi-frequency HF pulse radar in spaced-receiver configuration was developed by Rao's group and a comprehensive study was made of ionospheric plasma drifts over a low latitude. The group was also the first to adopt advanced correlation techniques to derive the scale size and anisotropy characteristics of the irregularities along with their turbulent and steady drift velocities. These were the first measurements based on which the low latitude upper atmospheric winds were derived. The winds so derived formed the reference against which the early theoretical models developed by the MIT group in USA were tested. Rao's group also made extensive measurements on radio wave absorption and polarization and the specialized instruments needed to perform these were built. The measurements were successfully interpreted in terms of the magneto-ionic theory of Appleton–Hartree.

One of the most interesting phenomena of the ionospheric *F* region plasma is the generation of a wide spectrum of irregularities immediately following sunset. The spread-*F* is the generic term by which these irregularities are commonly referred to, since they cause the spreading of the reflected signal recorded by a sweep frequency ionospheric sounder (Ionosonde). Some of the basic features of these irregularities, including the background plasma state conducive for their occurrence, were first reported by Rao and his group. These early observations greatly helped in understanding the plasma instability processes causing spread-*F*. This class of irregularities, as it turned out, came to be regarded as an important aspect of space weather with direct relevance to the GPS-based navigation and satellite communication applications. These observations, covering a wide range of geophysical conditions, still offer a valuable insight into the mechanism of spread-*F*.

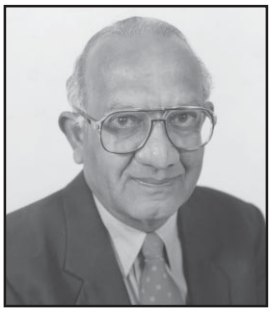
The early HF radars employed for ionospheric sounding were all based on amplitude detection of the ionospherically reflected radar signal. The signal phase measurement along with the amplitude provides a more sensitive method of studying ionospheric plasma dynamics. The first HF phase path sounder was designed and developed by the Andhra group and was used for extensive studies on low latitude gravity waves and plasma drifts. This group was also the first to design and develop two other major atmospheric sounding systems, a meteor radar and a sodar. The meteor radar offers a unique technique for wind and temperature measurements in the lower thermosphere ($\sim$90–100 km), using radar backscatter from meteor-induced ionisation trails. Meteor radar observations were also used to understand the formation of sporadic ionisation layers in the E region. The sodar was successfully operated to study boundary layer processes, including pollution dispersal. The current day HF Doppler radar, Doppler meteor radar and Doppler sodar systems are but a logical evolution of those early systems developed at Andhra.

The Andhra group was also among the first to undertake the important area of satellite radio beacon studies of total electron content (TEC) and scintillations. The radio beacon studies now assume great significance under the newly emerged discipline of 'Space weather — science and applications'. Other original contributions of the Andhra group include theoretical and modelling studies of low latitude ionosphere and the application of advanced magneto-ionic theory of Sen-Weyller for accurate interpretation of the radio wave absorption measurements. In recognition of its excellence in space research, UGC elevated the space science laboratory as an Advanced Centre for Space Research. Rao received the Shanti Swarup Bhatnagar Award in 1965 and was elected to all the three national academies. He also served as the President of the National Academy of Sciences, Allahabad during 1981–82 and President of the Indian Science Congress during 1982–83. He was conferred D.Sc (Ch.c) by the Andhra University in 1970.

In 1976 Rao was appointed the UGC Vice-Chairman and served in this capacity for two terms (1976–82). During this period, he introduced some important reforms in the university system including the semester system with internal assessment, major changes in the structure

and course content at the master's degree level, closer linkages between academic institutions and national laboratories, establishment of centres of excellence in science, university service and instrumentation centres (USICs) and state-of-the-art computer facilities at some major universities.

Rao was elected a member of the Rajya Sabha for a term (1982–88) and also had the distinction of serving as Chairman of the National Fisheries Advisory Board, Chairman of the Educational Consultants of India Limited and member of governing bodies of several R&D organizations, apart from serving on the top academic bodies of several universities. For all his accomplishments, he remained a very simple and unassuming person. He leaves behind his wife Susheela Devi.



Amulya Kumar N Reddy (elected 1974) was born on 21 October 1930 into a well-known family of Bangalore. After his schooling, he joined the Central College in Bangalore to do his B.Sc (Hons) in chemistry in 1951 and M.Sc in physical chemistry in 1954. He then went to London to do his Ph.D in applied physical chemistry from the Imperial College in 1958. His academic carrier started as a lecturer in chemistry (1951–58) at the Central College in Bangalore which was then affiliated to the University of Mysore. In 1958 he joined the Central Electrochemical Research Institute in Karaikudi as a senior scientific officer (1958–61). Between 1961 and 1966 he had a stint at the University of Pennsylvania as a senior research associate at the John Harrison Laboratory of Chemistry. Returning to India, he joined the Indian Institute of Science as an assistant professor (1966–70) and became a full professor in 1970 at the Department of Inorganic and Physical Chemistry.

During his active years of research in India on electrochemistry, Reddy's seminal contributions centred around the structure and growth of electrodeposits, electrodeposition, corrosion, ellipsometric studies of anodic films, thin layer electrochemistry, ion-exchange membranes, and nerve conduction. He particularly looked at electrodeposits, preferred orientations and techniques of observations, especially *in situ* optical techniques for the study of anodic films. His popular magnum opus "Modern electrochemistry" (in two volumes) with J O M Bockris, reflects faithfully his commitments to the subject, his holistic approach to science (and life) and passion for lucid exposition of complex ideas. In his own words about the book: "the ecstasy consisted of my discovering the electrochemistry for myself, being excited about what I learnt and communicating a fresh account of the learning".

The ground realities of doing research in an inter-disciplinary area like electrochemistry in the midst of scarce funding of the early seventies, compounded by a highly competitive international scenario and a growing alienation with the then existing philosophy and approach of S&T in the country were some of the factors that weaned Reddy away from the traditional confines of electrochemistry (and science, in general). This also launched him as a valiant player in a much wider and more meaningful (in his view) field of S&T choices in social development.

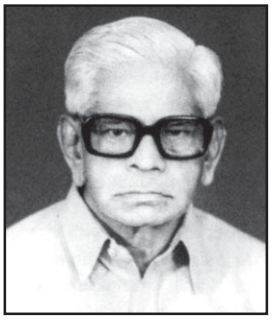
He played a pioneering and major role in attracting the attention, and re-orienting the work, of advanced institutions of education, science and technology in India, and concerned workers/agencies abroad, to important, but mundane, topics such as rural energy consumption patterns and technologies, biogas technology, urban consumption of firewood, etc. He developed the development-focussed, end-use-oriented, service-directed (DEFENDUS) approach to environmentally concerned energy analysis and planning in a developing country context (at a time when such an approach had been largely ignored despite its overwhelming importance). He authored/co-authored widely-quoted papers on the importance of biogas technology, rural energy, non-conventional energy sources for rural areas, urban consumption of firewood, the DEFENDUS approach to environmentally concerned energy analysis and planning. He directed or carried out research which have led to innovations in biogas technology; the first insights into rural energy consumption patterns revealing the central role of biomass fuels such as firewood — the quantities involved, who collects them, and the effort involved — and the requirements of cooking energy; discovering the unexpectedly large role of firewood in the energy consumption patterns of a modern metropolis like Bangalore; and formulating a DEFENDUS approach to an environmentally benign alternative electricity scenario for Karnataka state in India. He conceived of an extension centre for the Indian Institute of Science to be located in rural setting to provide a mechanism for understanding rural problems from the perspective of rural people; and established such an extension centre in Ungra village, Kunigal Taluk, Tumkur District, Karnataka State, South India — the extension centre has been operating since 1977. Following a survey of the energy consumption pattern in Pura village in 1977, he designed and constructed (in collaboration with P Rajabapaiah) a community biogas plant that is now supplying electrical illumination and piped water to the 90 houses in Pura, and developed a management system (in collaboration with P Rajabapaiah and H I Somasekhar) to operate and maintain the Pura Rural Energy and Water Supply Utility (REWSU) and handle its revenues and expenditures — this management system has been transferred to the Pura Grama Vikas Sabha which has been successfully running the REWSU since 1989. He,

encouraged by the replication of the Pura REWSU in a few neighbouring villages, developed an implementation package and proposal for the replication of the Pura-type system in a 100 villages. He conceived and established in 1991 the International Energy Initiative — a developing-country-led, developing-country-located international NGO devoted to the promotion of efficient production and use of energy for sustainable development through the activities of information, training, analysis, advocacy and action.

Reddy was responsible for designing, founding and building two innovative institutional mechanisms that have now become models for generating and disseminating technologies relevant to developmental problems: ASTRA (the Centre for the Application of Science and Technology of the Indian Institute of Science and its Extension Centre at Ungra Village) devoted primarily to the generation of rural technologies (he was its convener till 1983) and KSCST (the Karnataka State Council for Science and Technology) to catalyse the re-orientation of institutional efforts in Karnataka and to disseminate the new technologies (he was its secretary from 1975).

He authored and co-authored several volumes on energy and science & technology. These includes "Science, technology and the environment — A reappraisal" (UNEP, 1978), "The technological transformation of rural India" (Intermediate Technology, 1994), "Energy for a sustainable world" (Wiley-Eastern, 1988), and "Renewable energy: sources for fuels and electricity" (Island Press, 1992). He also edited an Academy published volume in *Sadhana* (Proc. in Engg. Sci.) on "Rural Technology" in 1980.

Amulya Reddy passed away in Bangalore on 7 May 2006 leaving behind his wife Vimala and three daughters.



Ramakrishnan Subrahmanyan (elected 1956), an eminent phycologist and an expert on marine phytoplankton, breathed his last on 5 March 2006, after a prolonged illness. He was born on 31 January 1919 at Pazhanayur in Trichur in Kerala. He had a brilliant academic career in school and college and took his B.Sc degree in Botany from the Madras Christian College in 1939 with a I class I rank. He was awarded a research scholarship by the University of Madras to work under the guidance of M O P Iyengar at the University Botany Laboratory (now Centre of Advanced Study in Botany) and obtained the M.Sc degree in 1943. His work on the cytology and life history of diatoms was acclaimed as path breaking. One notable contribution was his discovery of an autonomous sexual reproduction leading to auxospore formation in *Cyclotella meneghiniana*. Another was with reference to sex differentiation in *Navicula halophila*. He continued his work at the University Botany Laboratory until 1945 when he was selected for a scholarship to study abroad by the Government of India. He proceeded to the United Kingdom and joined the University of Liverpool where he worked under J McLean Thompson and Margery Knight. His investigations on the brown seaweed *Pelvetia canaliculata* involved his working partly at the Marine Biological Station, Port Erin, Isle of Man. He took his Ph.D degree from the University of Liverpool in 1948. He travelled widely in UK and Europe meeting and discussing with eminent phycologists of the time like F E Fritsch, Feldmann and Boergesen.

Returning from UK in 1948, he was appointed as a scientist at the Central Marine Fisheries Research Institute working at its centres in Cochin, Calicut and Madras. During this period he built up his reputation as an expert on marine phytoplankton on which he published a number of papers and wrote two volumes on the Dinophyceae of Indian Seas which form reference works of great importance.

For three years from 1961 to 1964 his services were lent to the Central Rice Research Institute at Cuttack to organize work on the use of nitrogen-fixing blue green algae in nitrogen deficient paddy field soils. In his characteristic thoroughness, he went about processing blue green algae to be used in rice cultivation and showed tangible results. He was a pioneer in this field. Later he returned to the Central Marine Fisheries Research Institute at Cochin where he served as the head of the Marine Biology and Oceanography Division until 1971 when he opted for voluntary retirement from service to concentrate on his other interests.

Subrahmanyan was a pioneer in phytoplankton studies of the Indian seas and was the first to draw attention to the high fertility of the Arabian sea adjoining the west coast of India. He elucidated many problems of fishery interest. He published more than fifty papers covering a wide field in marine fisheries studies and has authored two volumes on the Dinophyceae of the Indian shores. These, as well as his paper, a systematic account of the marine plankton diatoms of the Madras coast published in the Proceedings of the Indian Academy of Sciences, 1946, are still standard references for workers on the marine phytoplankton of the Indian seas.

He established two new genera, Hornellia with *H. marina* as the type species and *Protoeuglena* with *P. noctilucae* as the type and gave an account of their life history. *Hornellia* caused mortality among marine organisms of the coast of Malabar. Both *Hornellia* and *Protoeuglena* caused a green discolouration of the sea. Besides these two new genera, Subrahmanyan also described a new species of *Ruttnera R Pringsheimi* (Chrysophyceae).

He is survived by his wife Parvathi, a son and four daughters.