

tributed significantly to the preparation of some 550 interactive exhibits. He has lectured at universities in Europe and North and South America, organized research colloquia and has been a member of several editorial committees for publication of science books aimed at the lay reader, four of which have been authored by him. Since 1982, Valdes has been in charge of a major programme in Mexico, viz., *Domingos en la Ciencia* and was the first President of the *Sociedad Mexicana para la Divulgación de la Ciencia y la Técnica*, the society set-up to popularize science in Mexico.

Vinay Kamble, National Council for Science and Technology Communication, New Delhi.

IUCAA dedicated

At 7 p.m. on 28 December 1992, Subrahmanyam Chandrasekhar ('Chandra' to three generations of scientists) pressed a button. For a few moments there was a tense silence; then the gathering of around 500 broke out into an applause as there appeared on the large TV screen the bob of the Foucault Pendulum which began its slow but steady oscillations. It was a symbolic act wishing IUCAA success along its eightfold way.

Before Chandra delivered his Dedication Address (printed by IUCAA and available on request) on 'The Series Paintings of Claude Monet and the Landscape of General Relativity' the audience were treated to a brief *Son-et-Lumiere*. The walls and windows of the Central Quadrangle of the Devayani Complex lit up in a dramatic fashion highlighting the architectural beauty of the buildings. This was followed by a Sanskrit invocation from the terrace sung melodiously by two young girls. The verses from the *Yajurveda* called *Śivasankalpa Mana* extolled the power of the mind and thus marked a fitting call for an institution embarking on intellectual pursuits of an ambitious nature.

There were four silent spectators watching all this from the history of science, all of whom, appropriately had something to do with what the Foucault

Pendulum was trying to convey, that we on the spinning Earth are located in a non-inertial frame of reference. First Aryabhata told us, back in the 5th century, that the stars have a fixed frame of reference and that they appear to move from east to west because we see them from a spinning earth. Then came Galileo telling us the same in no uncertain terms about the Earth: 'E pur si muove'; followed by Isaac Newton who talked about the inertial forces that appear to drive the plane of oscillation of the Foucault Pendulum! Finally, there was Albert Einstein who had also worried about the concept of inertia and the inertial forces when formulating his theory of general relativity. As these majestic statues slowly lit up in the ambient darkness they seemed to enjoin the speaker, 'Speak on: we are listening'.

And Chandra spoke on in his precise and inimitable fashion ... about a marvellous cross cultural comparison that ranged from the haystacks and poplars of Claude Monet on the one hand to the general relativistic field equations describing spinning black holes and colliding waves on the other. At the highest level of creativity, the distinction between art and science disappears: the artists and the scientists are motivated by the same pursuit of excellence. Just as the impressionist paintings can portray a series of different ideas from the same basic entity so can the same set of equations in relativity describe widely different physical scenarios ... provided masterminds are at work behind both.

This broad sweep of ideas set the right tone for IUCAA's own broad spectrum of academic programmes, ranging from frontier research in Astronomy and Astrophysics, through pedagogical activities at various levels and the provision of world class research facilities to the public-oriented science popularization. Dedicating this Inter-University Centre for Astronomy and Astrophysics, the second IUC to be created by the University Grants Commission, its Chairman Ram Reddy expressed the hope that scientists from universities and colleges would make ample use of all that IUCAA has to offer.

The Dedication Ceremony was followed by a 2-Day Dedication Seminar on 29, 30 December and also the Foundation Day Lecture. The seminar was pitched at the research level and had

speakers from all corners of the world. Beginning with Chandra's talks on Newton's *Principia*, its relevance to the student of today, the seminar had Richard Bond (Canadian Institute for Theoretical Astrophysics, Toronto) reviewing the latest evidence of ripples in the microwave radiation background and its implication for structure-formation theories, Donald Lynden-Bell (Institute of Astronomy, University of Cambridge) talking on the attempts to obtain solutions of Einstein's equations for a rotating disc, Russell Cannon (Anglo-Australian Observatory, Australia) discussing observations of globular clusters and their age determinations, William C. Saslaw (University of Virginia, Charlottesville) on local and global interactions of galaxies and Sergei Shandarin (University of Kentucky and formerly from the USSR) highlighting the quasi linear regime of gravitational instability and its possible role in the observed large scale structure in the universe. The speakers from within the country included Govind Swarup (from the NCRA) on experimental astronomy in India, Ramnath Cowsik (from the IIA) on his gravitational experiments on the validity of equivalence principle and the limits on the magnitude of the so-called fifth force and Krishna Abhyankar on the history of Indian astronomy. The final talk at the seminar was a review of the A&A activities at IUCAA, presented by its Director.

In his Foundation Day Lecture, Yash Pal made a strong plea for parallelization and networking of information within the country stressing the use of the latest technology for quick spread and a wider sharing of knowledge. His own wide experience of the SITE experiment, the People's Science Move-



Chandrasekhar giving his dedication address

ments, the university sector and the IUCs, the potentials of space technology, etc. formed the nucleus of this highly personal talk which was deeply moving in places, especially where the speaker stressed the social impact of what technology can do.

The non-scientific but immensely enjoyable highlight of the Dedication Ceremony was the vocal musical concert in the North Indian classical style by Smt. Gangubai Hangal ably supported by her daughter Krishnabai.

The Dome at IUCAA has holes showing the bright star distribution as on 8 p.m. on 29 December 1988 the day that Yash Pal in his role as the UGC Chairman had unveiled the foundation stone of the Centre. Today some 15,000 square metres of excellent architecture stands on that empty site reflecting the vision of the architect Charles Correa. In his narration of the brief history of IUCAA at the Dedication Ceremony, the Director highlighted the goodwill of several friends and agencies, the dedica-

tion of those who worked here and, of course, several fortunate circumstances that made this achievement possible. The delightful buildings and the up-to-date facilities they house pose a stiff challenge to the IUCAA users: to produce high quality science that will match them in its excellence.

Jayant V. Narlikar, Inter-University Centre for Astronomy and Astrophysics, Pune.

RESEARCH NEWS

Conducting polymers — Newer avenues of application

S. Ramakrishnan

Polymers, by virtue of their light weight and greater ease of fabrication, have replaced and are continuing to replace metals in several areas of applications. Polymers have traditionally been considered good electrical insulators and a variety of their applications have been based upon this insulating property. However, for more than a decade now, researchers have shown that certain class of polymers which are conjugated (extended π -conjugation along the polymer backbone), exhibit semiconducting behaviour and can be doped (oxidized or reduced to create charge carriers) to give materials with conductivity as high as 10^5 S/cm (compare copper $\sigma_{\text{Cu}} = 10^6$ S/cm). Due to the presence of this extended conjugation along the polymer backbone, the chains are rigid and possess strong interchain interactions resulting in insoluble, and infusible materials, which are difficult to process. More recently, however, it was demonstrated that when lateral substituents were introduced, even conjugated polymers can be made soluble (hence processable) without significant loss in their conductivity. One other problem that plagued this field from its inception, is the inherent instability of these polymers (especially in the doped form) to ambient conditions. Today conducting polymers that are stable even in the

doped form have been prepared. This greater stability and enhanced processability of the new generation of conducting polymers has caused a resurgence of interest in this area. The realization that conducting polymers cannot compete with metals in traditional areas of application (due to their much lower conductivity) has caused researchers to concentrate on other areas of application that exploit the presence of extended conjugation in these polymers. Table 1 shows the structures and characteristics of some of the more important conducting polymers.

Polyacetylene, in view of possessing the simplest molecular framework, has attracted the most attention, especially of physicists, with an emphasis on understanding the mechanism of conduction. However, its insolubility, infusibility and poor environmental stability have rendered it rather unattractive for technological applications. The technologically relevant front runners belong to four families: polyaniline (PAn), polypyrroles (PPy), polythiophenes (PT) and polyphenylene vinylenes (PPV). While polyaniline may be considered as soluble in the neutral form, all other polymers are insoluble. However, laterally substituted derivatives of the later three classes are soluble in pristine form and are solution processable. PAn,

PPy and PT can be prepared either by chemical or electrochemical oxidation, the latter approach being often preferred as they result in polymeric films deposited on the anode surface, which can be removed to give free-standing films. The electrochemical method, in addition, may also be well suited for fabrication of microelectronic devices in which polymer films are directly deposited onto metal contacts. Although chemical oxidation yields powders, the reaction when done in the presence of surfactants in some cases, permits the preparation of emulsions, that upon drying form coherent films. In the case of the substituted derivatives, however, the chemical method is often preferred, as the resulting polymers are soluble, and hence can be purified and solution processed.

PPV has also attracted a lot of attention in recent years, due to the availability of a synthetic route that gives water soluble polyelectrolyte precursors which upon heating (about 200°C) under vacuum gives the wholly conjugated polymer (Scheme 1).

By virtue of this soluble precursor



Scheme 1.