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IUCAA Auditorium named after Subrahmanyan Chandrasekhar

On February 6, 1996, after addressing the school students on *Why is it dark at night?* in the jampacked IUCAA Auditorium, **Hermann Bondi** stepped out and unveiled the name of the auditorium: **Subrahmanyan Chandrasekhar**.

It was a simple ceremony that gave effect to the decision of IUCAA's Governing Body to name this magnificient auditorium after a distinguished scientist who began his brilliant career in India and continued for over six and a half decades to scale new heights with his manifold contributions to theoretical astrophysics. Chandra, as he was commonly referred to by the young and the old, was an Honorary Fellow of IUCAA and had delivered the Dedication Lecture when its buildings were dedicated on December 28, 1992. The Auditorium itself was completed and has been in use since August 14, 1993.

Several of IUCAA's buildings are named after Indian astronomers of the distant past: Aryabhata, Varahamihira, Brahmagupta and Bhaskara. The roads by its campus are named after modern astronomers Meghnad Saha and Vainu Bappu. To this astronomical setting is now added the Subrahmanyan Chandrasekhar Auditorium.

The Subrahmanyan Chandrasekhar Auditorium

National Science Day

The National Science Day, on February 28, 1996, was celebrated by IUCAA, with a participation of about 500 school students and teachers. *The programme included science test, essay competition, drawing competition, astro-dramas, video show on eclipse and science quiz.* Sixty schools from Pune city participated. The title of the essay competition was **Difficulties Encountered in Learning Science**. Essays were written in Marathi and English, and some of the essays were eye openers to the science curriculum makers. In *Marathi essay competition*, the *first* and the *second* prizes were awarded to **Madhura Dilip Sane** of H.H.C.P. High School and **Vrishali Suresh Kshirsagar** of Abhinav Vidyalaya. In *English essay competition*, the corresponding prizes were awarded to **Khushboo Shingare** of Vidya Bhavan High School and **Anita Sathe** of M.E.S. Bal Shikshan Mandir. There were some consolation prizes also. *(See box below for extracts from the first prize-winning essays in Marathi and English.)*

Theme of the *Drawing competition* was **Any Scientific Exhibit at IUCAA**. Some of the drawings were really excellent and the *first three prizes* were given to **Anuja Limaye** of P.E.S. Girls' High School, **Vinayak Nagpal** of Loyola High School and **Tejaswini Palande** of H.H.C.P. High School. There was one consolation prize also.

The Astro-dramas **The Lost Planet** and **Twinkle, Twinkle Little Star...** were enacted by the Standard V and IX students of Muktangan English School and Junior College. The students were assisted by the teachers and the performance was appreciated by one and all, and the theme was apt to the present day situation. A *Video film on the October 24, 1995, solar eclipse* was also shown.

The programme ended with the much awaited *Science Quiz*, in which 8 teams of 4 students each was selected and participated. The *first*, the *second* and the *third* prizes were attained by the teams from *St. Vincent's High School and Junior College*, *Loyola High School and Junior College*, and *Muktangan English School and Junior College*, respectively. The celebrations concluded with the Director giving away the rolling trophy, cup and a plaque to the winning teams.

Student participants of the Astro-drama, 'The Lost Planet', and teachers with the Director, IUCAA

"Today, we study not for knowledge but to score in the exams. So we hear words like : "Oh! Newton? He is optional..., Aristotle is worth four marks." Are Newton and Aristotle to be measured by such yardsticks? But that is how our examination oriented system has made us."

Ms. Madhura Dilip Sane
H.H.C.P. High School

"It cannot be said that science is not at all difficult. It is difficult, as science is a vast subject and needs a lot of study. But some students develop a fear of science thinking it to be very difficult to grasp. But this fear is developed only if the student does not try to understand it with interest. This interest has to be developed in students and not forced on the students."

Ms. Khushboo Shingare
Vidya Bhavan High School

Hubble's Law

As described in the previous article (Parsecstone 13), the extragalactic nature of faint nebulae was becoming clear thanks to the distance measurements by Edwin Hubble. Hubble was able to demonstrate that these nebulae were galaxies in their own right, containing hundreds of billions of stars like our Milky Way.

The key feature of Hubble's measurements was the variable stars called Cepheids. They have this class-name because the first such star was discovered in 1784 by John Goodricke and was known as Delta-Cephei. The luminosity of these stars fluctuates with time with regular periodicity. Moreover, there is a strong correlation between the fluctuation period of a Cepheid and its mean luminosity. In 1912, Henrietta Leavitt discovered that there is a fairly tight linear relation between the logarithm of luminosity and the logarithm of period.

Thus if we identify a variable star in a distant galaxy to be a Cepheid and measure the period of its luminosity, then by the period luminosity relation we know its absolute luminosity. If we also measure its apparent luminosity, then by the inverse square law of illumination we know its distance. It was in this way that Hubble was able to estimate the distances of several nearby galaxies.

Side by side with this development, between 1912 and 1925, V.M. Slipher discovered a novel feature of these galaxies. The spectra of these galaxies showed absorption lines that were generally redshifted. That is, these lines were seen at longer wavelengths than their standard laboratory values. If one interprets this shift as a Doppler shift, then the implication is that the source of light is moving away from us as observers. The Doppler shift formula tells us that the fractional increase in wavelength multiplied by the speed of light is the speed of radial recession.

When Hubble and his junior colleague Milton Humason combined the redshift observations with their distance measurements, a clear signal emerged. The farther the source galaxy the larger was its radial velocity of recession. In 1929, Hubble was able to express the result as a linear relation:

$$V = H . D,$$

where V is the velocity of recession and D the distance of the galaxy. H is a constant, known as Hubble's constant. The value, Hubble got for this constant was 530 km/second/megaparsec. We will return to this measurement in a later parsecstone.

Hubble's law as above came to be known, showed for the first time that the large scale universe may not be static but is a dynamic entity. How to model a dynamic universe was therefore a challenging problem for theorists and was to lead them to the foundations of the subject of cosmology.

Hermann Bondi at IUCAA

Sir Hermann and Lady Bondi paid a brief visit to IUCAA in February 1996 during their trip of India. This was the second occasion when Hermann Bondi was at IUCAA, the last being in IUCAA's primordial days back in early 1990. Apart from his address to the school students (see front page), he gave a seminar on *Foundations of the theory of gravitation* as well as a public lecture on *Energy in the world.* All talks were admired for their lucidity and humour, each having a clear message. The Bondis also paid a visit to the GMRT site.

We now look forward to their next visit.

Estimating Mass of Jupiter

Mass of the heavenly bodies can be estimated by an application of Newton's laws of motion and of gravitation attraction, if the circumstances are favourable. Thus, an estimate of the solar mass can be made because of the circumstance that the planets are orbiting around it. Similarly, the mass of Jupiter can be estimated by making use of the circumstance that several easily visible satellites are orbiting around it.

As per the Newton's laws we can find that for a body of negligible mass orbiting in a circular orbit around a body of mass M the following proportionality holds

$$r^3 \propto Mp^2$$

where r is the radius of the orbit, and p is the period of the orbit. This relation can be used to relate the parameters of the Jupiter system (Jupiter and its satellites) to the parameters of the solar system (Sun and the planets). Thus, comparing the orbit of the Earth around the Sun and the orbit of a Jupiter's satellite around Jupiter, we can write the following equation as a working approximation:

$$M_J / M_S = (r_s / r_e)^3 (p_e / p_s)^2$$

where p_e is the Earth's orbital period (365.25 days), r_e is the radius of Earth's orbit (1 AU), p_s is the satellite's orbital period, r_s is the radius of the satellite's orbit, M_S the mass of the Sun, and M_J is the mass of Jupiter. If one can measure "r_s" and "p_s", then the mass of Jupiter can be found in the units of solar mass (M_S).

Measuring r_s and p_s

Jupiter has four fairly bright satellites (which were discovered by Galileo and are called Galilean satellites) and any one of these can be picked for the observations through a small telescope; the innermost satellite, Io, has a period (p_s) of about 2 days. These satellites move in nearly circular orbits, and our line of sight nearly passes through their orbital planes. Therefore, if a measurement is made of the maximum apparent separation of the satellite from Jupiter, the radius of the orbit (r_s) can be estimated. During the observations the angular separation of the satellite from Jupiter can be visually estimated in units of the angular size of Jupiter. If the maximum angular separation of the satellite from Jupiter's rim is X times the angular diameter of Jupiter,

$$r_s = (X \times 2+1) \times 9.5 \times 10^{-4} \text{ AU},$$

where 9.5×10^{-4} AU is the radius of Jupiter.

The radius r_s can also be measured by measuring the time taken by the satellite to move across the disk of Jupiter (this should be done while the satellite is crossing in front of Jupiter, else the shadow of Jupiter might render the satellite invisible before it moves behind the planet). If this time of crossing is "t_c", one can write,

$$r_s = 9.5 \times 10^{-4} / \sin [(t_s / p_s) . \pi] \text{ AU}.$$

The period p_s can be measured by noting the times of two consecutive crossings of an edge of Jupiter by the satellite - the satellite should be moving in the same direction during each of the two crossings, i.e. either towards Jupiter or away from it. If the period p_s is counted in days, one can write,

$$M_J / M_S = (X \times 2+1)^3 \times (9.5)^3 \times 10^{-12} \times (365.25 / p_s)^2.$$

Seminars

held during January - March 1996

2.1.96 Ranjeet S. Tate on *Time-of-arrival in quantum mechanics*; 10.1.96 Avinash Khare on *Super symmetric quantum mechanics*, 22.1.96 Frank Verheest on *Waves in dusty space plasmas*; 23.1.96 Manoj Samal on *Applications of Cerenkov process in astroparticle physics*; 25.1.96 Anton Z. Capri on *Time and vacuum and the Weyl anomaly*; 31.1.96 Christian Vanderriest on *Integral field spectroscopy of quasars and galaxies with MOS-ARGUS at CFHT*; 6.2.96 Hermann Bondi on *The foundations of the theory of gravitation*; 12.2.96 Prasenjit Saha on *Reconstructing the galactic bulge or How (not?) to compare N-body simulations with discrete kinematic data*; 20.2.96 M. Parthasarathy on *Post-AGB stars : Chemical composition and evolution*; 8.3.96 L. Van Waerbeke on *The auto correlation function of the extragalactic background light : A new tool to analyse the gravitational lensing effects*; and 28.3.96 Martin Rivas on *The space-time structure of classical relativistic spinning particles*..

Colloquia

held at IUCAA...

8.1.96 Avinash Khare on *Quantum and statistical mechanics of anyons*; 29.1.96 B.B. Chaudhuri on *How the computer can read an Indian language book*; 5.2.96 A.A. Rangwala on *Optical solitons : Genesis and applications*; 19.2.96 Roberto Gallino on *Aims and difficulties in the galactic chemical evolution of the s-elements*; 1.3.96 Adriaan Blaauw on *History of the International Astronomical Union (IAU)* and 18.3.96 V.R. Venugopal on *Hickson's compact groups of galaxies - Facts and fallacies.*

Welcome...

to **Ali Nayeri**, who has joined as a Research Scholar

and... farewell

to **B.S. Sathyaprakash**, who has joined the Department of Physics and Astronomy, University of Wales, College of Cardiff, U.K. and

to **Devendra K. Ojha**, who has joined the Institut d'Astrophysique de Paris, France.

Visitors

January - March 1996

J. Perry, A. Robinson, C. Clarke, B. Murphy, D. Schaerer, S.N. Borah, A. Khare, P. Khare, I. Wanders, A. Baleisis, S. Lamb, Ranjeet S. Tate, A. Desai, M.S. Valiathan, Pramod Kumar, M.A. Ittyachen, S.S. Jha, C.V. Vishveshwara, N.C. Mathur, C.K. Shah, S.G. Tagare, P.S. Rajput, A. Karnik, Y.D. Mayya, N. Chakravarty, A. Baker, M. Sohnius, S. Rajagopal, D. Lal, G. Singh, H. Jamal, K. Baliyan, G. Shashikiran, Vinod Menon, G.D. Pimpale, P.S. Wamane, M.K. Samal, F. Verheest, A.Z. Capri, M.N. Anandaram, B.B. Chaudhuri, S. Banerji, H.L. Douroah, G. Ambika, V.C. Kuriakose, C. Venugopal, P.S. Naik, N.R. Shetty, M.L. Kurtadikar, C. Vanderriest, M.N. Satish, L.N. Gawande, A.A. Rangwala, S.S. De, H. Bondi, P. Saha, V.R. Venugopal, R. Gallino, V.V. Awati, K.S.V.S. Narasimhan, N.V. Madhusudana, T Nagarajan, M. Parthasarathy, G.K. Mehta, R. Banerjee, O.N. Srivastava, Deepak Kumar, S. Isobe, A. Bhanumathi, S.D. Verma, S. Sattler, N. Barthakur, A.K. Sharma, L. Van Waerbeke, A. Blaauw, K.D. Abhyankar, S.M. Alladin, M. Rivas, G.K. Johri.

Visitors

Expected

April : P.S. Naik, Gulbarga University; L.M. Saha, Zakir Husain College; M.K. Das, SriVenkateswara College; H.P. Singh, SriVenkateswara College; B.A. Kagali, Bangalore University; K. Boruah, Gauhati University; G. Ambika, Maharaja's College; V.M. Nandakumaran, CUSAT; M.N. Anandaram, Bangalore University; G. Yellaiah, Kakatiya University.

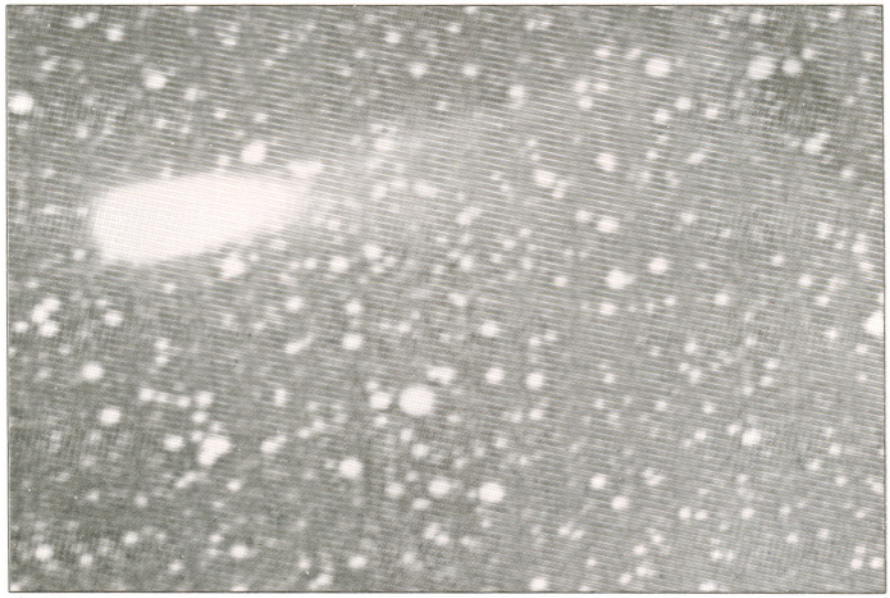
May: B.K. Datta, ICSC-World Laboratory; A. Banerjee, Jadavpur University; S.R. Prabhakaran Nayar, Kerala University; S. Banerji, Burdwan University; D.B. Vaidya, Gujarat College; P. Vivekananda Rao, Osmania University; S.D. Verma, Gujarat University; U. Narain, Meerut College; D.K. Chakraborty, Ravishankar University; K.S. Sastry, Osmania University; R. Ramakrishna Reddy, Sri Krishnadevaraya University; L.K. Patel, Gujarat University; Suresh Chandra, IGNOU; P.C. Vinodkumar, Sardar Patel University.

June : B. Lokanadham, Osmania University; P. Khare, Utkal University; D.P. Datta, NERIST; T. Singh, Banaras Hindu University; P. Das Gupta, Delhi University.

Workshop on Instrumentation for Small Telescopes and Astronomy Programmes at University Level

A Workshop on Instrumentation for Small Telescopes and Astronomy Programmes at University Level was held from February 26 to March 1, 1996 at the K.V. Parekh Science College (Bhavnagar University), Mahuva, Gujarat. The workshop was jointly organized by IUCAA, Department of Physics, Bhavnagar University and Mahuva Education Trust. P.C. Vaidya inaugurated the workshop and B.K. Parekh, Chairman, Mahuva Education Trust delivered the presidential address. There were lectures by S.N. Tandon and Ranjan Gupta (IUCAA), T. Chandrasekhar, J.N. Desai, N.M. Ashok (Physical Research Laboratory), R.V. Mehta, S.P. Bhatnagar (Bhavnagar University), Ashok Ambastha (Udaipur Solar Observatory) and D.B. Vaidya (Gujarat College). There were also experiment and demonstration sessions by V. Ramamurthy (Bhavnagar University) and Ranjan Gupta (IUCAA), and sky-watching sessions. Night sky observation at the residential rural school at Kalsar, where the students and teachers were involved, also formed a part of the workshop. About 40 participants including M.Sc. students, and college and university teachers attended the workshop. A science quiz was organized by C.S. Narayanamurthy (Bhavnagar University) on the National Science Day. R.V. Mehta, D.B. Vaidya and Ranjan Gupta were the coordinators of the workshop.

Participants of the Workshop on Instrumentation for Small Telescopes and Astronomy Programmes at University Level



Comet Hyakutake imaged, using a CCD camera atop the Giravali mountain near Arvi, Narayangaon. The comet was observed on March 19, 1996, by Arvind Paranjpye and Vinod Menon, both from IUCAA and Sanjay Bhatnagar from National Centre for Radio Astrophysics (NCRA).

Visits Abroad

J.S. Bagla attended the Moriond Conference on Dark matter in the universe, held at Les Arcs, France in January 1996. He gave a talk on *Observational constraints on cosmological parameters*. He also visited Institut de'Astrophysique in Paris, Observatories in Strasbourg, Toulouse and Edinburgh, Max Planck Institute of Astronomy in Garching, Queen Mary and Westfield College in London, and Institute of Astronomy in Cambridge. In each of these places he gave talk(s) on some aspects of his research work.

Ranjan Gupta visited the Physics and Astronomy Division, University of California, Los Angeles; University of North Carolina, Chapel Hill; Kitt Peak National Observatory (KPNO), Tucson; CfA, Harvard and Buffalo University, Buffalo (all in USA); IUE-VILSPA, Madrid, Spain; Institute of Astronomy (IOA), Cambridge, UK and Linear Accelerator Laboratory, Orsay, France during November 20, 1995 - January 13, 1996. During the visits he gave lectures on *Neural network approach to stellar spectral classification* at CfA, USA, *Stellar spectral classification by automated techniques* at IOA, UK, and *Neural networks, pattern recognition and signal processing* at Orsay, France. At the KPNO, he obtained stellar spectra for about 500 stars using their 0.9m Coude Feed Telescope during December 11-18, 1995.

IUCAA Preprints

Listed below are the IUCAA preprints released during January - March 1996. These can be obtained from the Librarian, IUCAA.

D.P. Datta *Comments on new asymptotic expansion method for the Wheeler-Dewitt equation*, IUCAA-1/96; **V. Sahni** *The large scale structure of the universe: Dynamical and statistical aspects*, IUCAA-2/96; P. Coles and **V. Sahni** *Lare-scale structure without N-body simulations: The legacy of Ya. B. Zel'dovich*, IUCAA-3/96; **L.K. Patel** and S.D. Maharaj *Stationary rotating string world models with a magnetic field* IUCAA-4/96; S.D. Maharaj and **L.K. Patel** *A note on exact spherically symmetric interior solutions in higher dimensions*, IUCAA-5/96; William C. Saslaw, Sunil D. Maharaj and **N.K. Dadhich** *An isothermal universe*, IUCAA-6/96; **Somak Raychaudhury** and William C. Saslaw *The observed distribution function of peculiar velocities of galaxies*, IUCAA-7/96; **Farooq Ahmad** *Two-particle correlation function and gravitational galaxy clustering*, IUCAA-8/96; **B.S. Sathyaprakash, Varun Sahni** and Sergei F. Shandarin *Emergence of filamentary structure in cosmological gravitational clustering*, IUCAA-9/96; **T. Padmanabhan** *Stellar dynamics and Chandra*, IUCAA-10/96; **K.S.V.S. Narasimhan**, K.S. Sastry and **S.M. Alladin** *Classification of galactic collisions*, IUCAA-11/96; **S.D. Mohanty** and **S.V. Dhurandhar** *A hierarchical search stategy for the detection of gravitational waves from coalescing binaries*, IUCAA-12/96; and **Shiv K. Sethi** *A new astrophysical constraint on radiatively decaying neutrinos*, IUCAA-13/96.

UN-ESA Meeting in Sri Lanka

Jayant Narlikar attended a meeting on small telescopes, sponsored by the United Nations and the European Space Agency at the Arthur C. Clarke Centre (ACCC) in Colombo. The occasion was the inauguration of a 45 cm Cassegrain GOTO telescope at the ACCC. It is hoped that the IUCAA facilities may be useful to the small community of astronomers in Sri Lanka.

Arthur C. Clarke with Jayant Narlikar and Priya Wickramasinghe

Congratulations to

... **Amalendu Bandyopadhyay**, Senior Scientist, Research Division, M.P. Birla Planetarium, Calcutta, who has been honoured by the NCSTC of the Department of Science and Technology, Government of India for his life time contribution to Astronomy Popularization. This is the prestigious *National Award for best Science and Technology Coverage in Mass Media* for 1995.

ICGC-87 Proceedings at Reduction Sale

(This offer is only to those with address in Indian)

The first International Conference on Gravitation and Cosmology (ICGC-87) was held in December 1987 at Goa. The last few copies of the proceedings of this conference are available at the reduced price of Rs. 225 (to cover international postage) from the publisher.

Details of the Proceedings:	
Title	**Highlights of Gravitation and Cosmology**
Editors	**B.R. Iyer, A.K. Kembhavi, J.V. Narlikar & C.V. Vishveshwara**
Publisher	**Cambridge University Press**
Actual Cost	**US $ 60.00** ***This is now available for Rs. 225.***
Hardbound, 441 pages and 1988 edition.	

Those who are interested to receive a copy of this, please send a demand draft for **Rs. 225** (Rupees Two Hundred and Twenty Five only) in favour of **'IAGRG'** *payable at Pune* with your complete address before May 1, 1996 to:

V. Chellathurai
IUCAA
Post Bag 4, Ganeshkhind P.O., Pune 411 007
INDIA

(e-mail : vch@iucaa.ernet.in)

When God attended a meet of the Humanists

Hermann Bondi, relativist and cosmologist, is also the President of the British Humanist Association. On a recent visit to Pune in India, Bondi was invited to address the members of a local rationalists group on *Positive Atheism*.

After a stimulating talk by the speaker, there were many questions from the floor. As per practice a member asking question was expected to identify himself or herself by name. However, one member launched straight away into a long comment about the status of *"God"*.

"Please tell your name first!" admonished the Chairman.

"I beg your pardon, Sir", replied the questioner; *"My name is Deo"*.

At this a wave of laughter swept the audience, leaving the speaker, however, puzzled. The Chairman explained that, although *"Deo"* is a common name in that part of India, it literally means, *"God"*.

PEP talks

held during January - March 1996

15.3.96 **S. Sridhar** on *Vortex dynamics*

Khagol **(the Celestial Sphere) is the Quarterly Bulletin of IUCAA. We welcome your responses at the following address:**

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