KHAGOL

THE
IUCAA
BULLETIN

Inter-University Centre for Astronomy and Astrophysics
An Autonomous Institution of the University Grants Commission

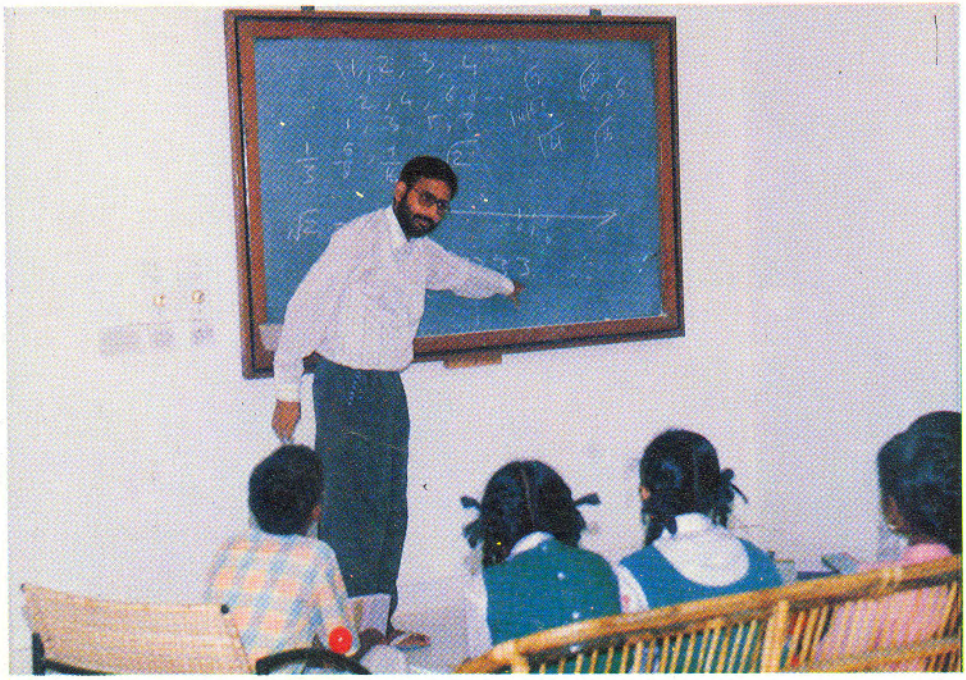
No. 15 **July 1993**

Summer Programme for School Students

From early May to mid-June the average age of visitors to IUCAA must have dropped significantly when students from the city and neighbourhood schools descended on the campus under the newly introduced Summer Programme for School Students (SPSS). Each school participating in the SPSS deputed 2-3 students from IX/X standard for a week. Each such batch was guided by an IUCAA member. The students arrived on the campus at about 10 a.m. and left at about 4 p.m. everyday and during this period they read, discussed, calculated, experimented or observed, etc. as determined by their project guides.

Projects included, studying the Foucault Pendulum , gravitational bending of light and the lens effect, the construction of a horizontal sundial, determination of Earth's shape and radius, etc. The students were encouraged to 'do it yourself'.

Sixty seven students from thirty two schools participated in the programme and it was heartening to see them interact with IUCAA members, ranging from research scholars to senior faculty members. The Library was used extensively as were other facilities. Several students wanted to visit IUCAA even after their project was over, which is an indicator of the success of the SPSS. Perhaps a long term measure of the success of the venture will be, if it motivates some of these SPSS participants towards careers in Astronomy and Astrophysics.



R. Balasubramanian explaining the concept of irrational numbers to school students

C.W. Misner during his visit to IUCAA

Welcome to IUCAA Family

IUCAA is happy to announce the selection of the fourth batch of Senior Associates and Associates, who are selected for a tenure of three years beginning July 1, 1993.

Senior Associates

- S.M. Alladin, Osmania University.
- R.E. Amritkar, Poona University.
- M.N. Anandaram, Bangalore University.
- Asit Banerjee, Jadavpur University.
- S. Banerji, Burdwan University.
- H.L. Duorah, Gauhati University.
- A.D. Gangal, Poona University.
- G.K. Johri, D.A.V. College, Kanpur.
- Pushpa Khare, Utkal University.
- S. Mukherjee, North Bengal University.
- S.K. Pandey, Ravishankar University.
- L.K. Patel, Gujarat University.
- K.Shankara Sastry, Osmania University.
- R.S. Tikekar, Sardar Patel University.
- S.D. Verma, Gujarat University.

Colloquia held during the last three months

12.4.93 G. Baskaran on *Why is high temperature superconductivity so interesting ?*
21.6.93 C.W. Misner on *Beyond stars and galaxies - do we live in a false vacuum ?*

PEP talks by Locals

14.04.93 S.N. Tandon on *Balloon - Borne Astronomy*, 21.05.93 Naresh Dadhich on *Some lanes and bylanes in Relativity.*

and by Visitors

06.04.93 C.V. Vishveshwara (IIA) on *GR and GYRO*, 14.04.93 G. Baskaran(IMSc) on *Physics in lower dimensions*, 28.04.93 K. Srinivasa Rao(IMSc) on *Life and work of Srinivasa Ramanujan.*

Associates

- Kalyanee Boruah, Gauhati University.
- Somenath Chakrabarty, Kalyani University.
- D.K. Chakraborty, Ravishankar University.
- Suresh Chandra, Gorakhpur University.
- R.K. Chhajlani, Vikram University.
- P.Das Gupta, Delhi University.
- M.K. Das, Sri Venkateswara College, New Delhi.
- B.A. Kagali, Bangalore University.
- C. Mukku, Hyderabad University.
- S.S. Prasad, U.N.P.G. College, Deoria.
- A.C. Balachandra Swamy, Saradavilas College, Mysore.
- L.M. Saha, Zakir Husain College, New Delhi.

Appointments of most of the first batch of Senior Associates and Associates are extended for three years.

Seminars held during last three months

7.4.93 J.S. Vaishya on *Wolf effect - its possible implications in optical measurements*, 13.4.93 Y.D. Mayya on *Star formation in giant extragalactic HII regions*, 20.4.93 Jayant Murthy on *Voyager observations of dust scattering in the far ultraviolet*, 21.4.93 Toivo Jaakkola on *Equilibrium Cosmology*, 26.4.93 K. Srinivasa Rao on *Quantum theory of angular momentum-selected topics*, 18.5.93 N. Panchapakesan on *Constraint on Higgs mass from electroweak Baryogenesis*, 7.6.93 S.D. Joglekar on *Superspace formulation of gauge theories*, 30.6.93 N.T. Bishop on *Horizons of two black holes.*

Miniworkshop on Gravity Waves

A miniworkshop on Gravity Waves was held at IUCAA during May 31 - June 4, 1993. The workshop was attended by many university personnel, both teachers and research students and other experts from various institutes within India. The

topics discussed at the school included, linear and post-linear gravity, Post-Newtonian, Post-Minkowskian and higher order approximation methods and data analysis techniques. There were also computer demonstrations for illustrating the data analysis techniques.

The lectures were delivered by B.R. Iyer from RRI, Bangalore ; S.V. Dhurandhar, B.S. Sathyaprakash, T. Ghosh, K. Jotania from IUCAA, and B. Bhawal from Mehta Research Institute of Mathematics and Mathematical Physics, Allahabad. There were active discussions during the lectures and also outside and the lectures were very much appreciated by the participants. Many IUCAA visitors also attended many of the lectures. It is hoped that the workshop will generate interest in this new frontier field.

Participants of the first Refresher Course in A & A

Refresher Course

Under the UGC's programme of the Refresher Courses for the College and University teachers, the first Refresher Course in Astronomy and Astrophysics (A & A) was conducted at IUCAA during May 10 - 28, 1993. Since most of the teachers have no prior exposure to A & A, as it is not part of masters programme in most universities, the course was devised at an introductory level with an eye on orientation. About 40% of the lectures were devoted to basic Physics for Astrophysics and the other two topics covered were Stellar Structure and Evolution and Extragalactic Astronomy. The main lecturers were Sanjeev Dhurandhar, S.

Parsecstones in Astronomy - 3 *J. V. Narlikar*

The Spin of the Earth

Aryabhata, the Indian astronomer of the fifth century A.D. wrote in his scientific treatise Aryabhatiya the following verse:

anulomagatirnausthaḥ
paśyatyaacalam vilomagaṃ yadvat
aclāni bhāni tadvat
samapaścimagāni Laṅkāyam.

Translated into English it means:'Just as a man in a boat going in one direction sees the stationary things on the bank as if moving in the opposite direction, so do fixed stars appear to move westward to a person at Lanka.'

India of those times shared the Greek dogma of the 'fixed Earth'. So Aryabhata's above statement appeared anomalous not only to his contemporaries but also to his successors. Astronomers like Varahamihira (sixth century), Brahmagupta (seventh century), Lalla (eighth century), Sripati (eleventh century) and even Bhaskara II (twelfth century) disagreed with the notion of a spinning Earth and advanced standard arguments like: 'How do birds return to their nests if the Earth is spinning?'

In fact , so strong was the geocentric view that many commentators on Aryabhata tried to read a different meaning into what he said above! A few commentators like Udayadivakara and Prthudaka did assert, however, that Aryabhata knew about and believed in the spin of the Earth.

It took the Copernican revolution to set the Earth spinning! Nevertheless , it is of interest to contrast the social attitudes in India and Europe towards unorthodox views. Unlike Copernicus and Galileo, Aryabhata escaped any hostile reaction or persecution but his ideas suffered from the equally unhappy experience of being ignored or misinterpreted.

Kandaswamy, N.C. Rana and D.J. Saikia . A few introductory lectures on identification of objects in the sky were given by K.S.V.S. Narasimhan. The observation sessions were conducted by Ranjan Gupta and Arvind Paranjpye. Besides, there were seminars by IUCAA-NCRA faculty and visitors.

Twenty five teachers attended the course and some of them looked quite enthusiastic and we hope that they will build on the impetus imparted.

Astronomy Workshop for Secondary School Teachers

In connection with the 6th Asian Pacific Regional Meeting of the International Astronomical Union to be held in Pune, India, during August 16-20, 1993 the Union's Working Group for the Worldwide Development of Astronomy is planning a two-day workshop during August 22-23, 1993 for teachers in secondary schools of the Indian sub-continent. The aims are to help to show how astronomy may be taught at secondary school level, and in particular, to show how the teaching of astronomy may be used to enrich the entire science curriculum. It is hoped to take advantage of the presence of visiting astronomers of international stature to provide stimulating leadership in the workshop. The speakers will include: D. Hoff, J. V. Narlikar, D. McNally, M. Othman, S.Isobe and A.H. Batten.

Number of participants will be limited to about sixty and is opened to teachers from India, Pakistan, Bangladesh, Sri Lanka and Nepal. Limited financial aid for travel to Pune is available.

Workshop on 'Astronomy Curriculum in Schools'

This workshop is to be held at IUCAA during October 25-31, 1993. Science or geography teachers of secondary and higher secondary schools are eligible for participation and they may apply in plain paper with a brief bio-data and a recommendation from the head of the school. This workshop is intended to give an exposure to the existing astronomy curriculum in the school syllabi at all levels upto the XII standard. Teachers intending to give lectures are also requested to express their intention and the correspondence be addressed to **The Coordinator, Core Programmes, IUCAA, by August 14, 1993** .

Marathi Science Writers' Meet

IUCAA is co-hosting the above meeting with the Marathi Vidnyan Parishad during September 11 - 12, 1993. The purpose of the meeting is to review the state of science writing in Marathi, the problems faced by those who venture into this field and the ways and means of improving the standard of popular science literature. About 70-80 participants from the Maharashtra region are expected to attend .

Miniworkshop on Cataclysmic Variables

A miniworkshop on Cataclysmic Variables will be held at IUCAA during August 23 -27, 1993. This workshop is intended to allow strong discussions in the current research topics in this area and related fields. The topics will include invited reviews and seminars on Multiwavelength aspects of CVs, Accretion Discs and Evolutionary aspects. The lecturers will include :

- P. Agarwal, TIFR,
- G.C. Anupama, IUCAA,
- P. Ghosh, TIFR,
- T.P. Prabhu, IIA,
- A. Ray, TIFR (yet to confirm),
- C. Tout, IOA, Cambridge, England,
- D. Wickramasinghe, ANU, Australia.

Workshop on 'Making Your Own Planetarium'

This workshop is to be held at IUCAA during November 1 - 6 , 1993 and can be participated by any school or college teacher, or even any individual astronomy enthusiast. The cost of making a simple projector will be about Rs.100/- and a simple dome housed inside a hall of capacity of about 30 people may be constructed at a cost of Rs.2000/-. These know-how's will be discussed in the workshop and each participant would have to make a projector during the period of workshop. Application in plain paper with a brief bio-data should be addressed to **The Coordinator, Core Programmes, IUCAA, by September 10, 1993.**

S. N. Tandon

MEASUREMENT OF SOLAR CONSTANT

The energy received from the Sun is a controlling factor for various phenomena occuring on the surface of the earth, and therefore a measurement of the energy flux received from the Sun is of great interest. In this project we describe a simple method of estimating this energy flux.

The energy flux received from the Sun depends on at least three factors: distance of the earth from the Sun, inclination of solar radiation with reference to the earth's surface and absorption of the radiation by the atmosphere. These factors change with the period of the year and with time of the day. In order to have a standard measure of the energy flux, solar constant is defined as: the energy flux through a unit area placed normal to the solar radiation at a distance from the Sun equal to the mean sun-earth distance. The energy flux at earth's surface at any given time, can be estimated from the solar constant by applying corrections for the two geometrical effects (distance and inclination) and the absorption in the atmosphere.

The principle of the method described here consists in absorbing the solar energy in a body (say, a disk) and measuring the consequent rate of heating. The product of the rate of rise in temperature and the heat capacity of the body would give a measure of the solar energy flux $I(\theta)$, for the zenith angle θ of the Sun during the observations. The value of $I(\theta)$ can be calculated from the observations by the following formula,

$$I(\theta) = \Delta T \rho \beta t \text{ Cal/(s cm}^2\text{)},$$

where ΔT is the rate of temperature rise per second, ρ is the density, t the thickness and β the specific heat of the disk.

However, in such a measurement several side effects occur and these need to be accounted for, before a resonable estimate of the solar constant can be obtained; we discuss below these effects, as well as ways to minimise or correct for them.

(i) Absorption of solar energy on the surface is less than total, and to improve the situation, the receiving surface could be blackened with smoke of a candle. The absorption could be further improved by making steep grooves on the surface before blackening it.

(ii) The body has a finite conductivity, consequently the temperature is not uniform. The solar constant is about 0.03 Cal/(s cm^2), and a 2 cm thick disk would develop temperature differences upto ~0.03 x 2/k $^\circ$C, where k is thermal conductivity of the disk in CGS units. A disk of aluminium (or brass) would have acceptably small temperature differences, whereas a disk of glass (or any insulator) would have unacceptably large temperature differences.

(iii) As the disk heats, it starts losing heat to the surroundings and as a consequence the rate of change in temperature keeps decreasing. After sufficient time has elapsed an equilibrium state is reached when the rate of heat loss is equal to the rate of heat input, and the temperature does not rise any more. In order to minimise loss to the surroundings, the disk should have low emissivity on all the surfaces other than that facing the Sun, and it should be protected from wind drafts.

(iv) The atmosphere absorbs part of the radiation and only a fraction of the true energy flux reaches the disk. A correction for this can be made by estimating the absorption.

To minimise the errors due to effect (iii), the readings can be taken as per the procedure discribed in the box by A. Paranjpye. The readings, taken every half a minute , are then plotted and used to find the rate of rise of temperature as shown in Fig. 1.

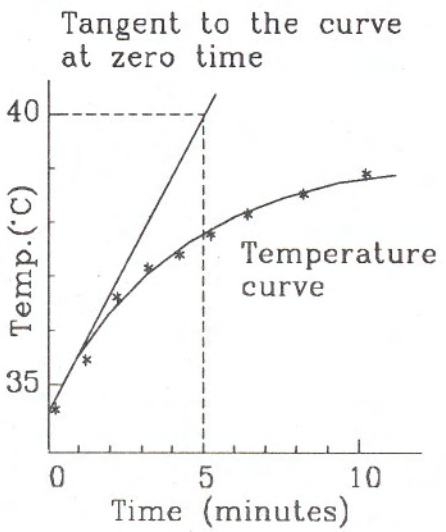


Fig. 1 : Typical readings of the temperature, show a gradual reduction in the increment. The rate of temperature rise due to the solar radiation is estimated by finding the slope of the tangent to the curve at zero time (it is 1°.1 C/min. in the above example).

The atmospheric absorption can be approximated by the equation

$$I(\theta) = I_o\, e^{-\alpha sec\theta},$$

where I_o is the flux at the top of the atmosphere, α is a constant, and $I(\theta)$ is the flux at earth for a value θ of the solar zenith angle. If two measurements are made for zenith angles θ_1 and θ_2, we can write,

$$I_o = I(\theta_1)\, e^{\alpha\, sec\, \theta_1}$$

$$= I(\theta_1) \left(\frac{I(\theta_1)}{I(\theta_2)}\right)^{\frac{sec\,\theta_1}{sec\,\theta_2 - sec\,\theta_1}}$$

Thus the effect of the atmospheric absorption can be corrected by making two observations, for two zenith angles differing by a large amount, and then applying the above equation to obtain I_o (In order to get a large enough difference, θ_1 should be chosen less than 30^o and θ_2 should be chosen more than 70^o).

A. Paranjpye

Instrument for taking the observations

To take the observations, we need to mount the detector made out of a disk of aluminium (or brass) in such a way that only the radiation from the Sun (i.e., the Sun light) should fall on the detector and it should be convenient to point it towards the Sun. The disk is, therefore, mounted in side a 60 cm long PVC tube, which has inner diameter equal to 6 cm. For the mounting, you may use the same mount as described in the last issue of *KHAGOL* (No. 14, April 1993). You may, in fact, use the same tube used for making the telescope , minus the lenses and the reducers.

Material required

- Aluminium (or brass) disk of size 30 mm x 30 mm x 10 mm: one
- Thermometer (laboratory type with 0.5 degree least count) : one
- Grease : About 5 ml (one tea spoon full)
- Thermocol of size 100 mm x 100 mm x 20 mm
- A small piece of mirror : 50 mm x 50 mm is good enough

To mount the thermometer on the detector, measure the diameter and the length of the bulb of the thermometer. It will be about 5mm in diameter and 15 mm long. Make a hole in the disk so that the thermometer would fit into it. Remember, the hole should be just big enough to slide in the thermometer without damaging it and not a bit more. It is not as difficult as it sounds. Now blacken one of the flat faces of the detector by holding it over the flame of a lighted candle. This area is to face the Sun. Now at 10 cm from one end of the tube make a hole so that the thermometer can slide though it.

Cut two pieces of thermocol (as shown in the Fig. 2), and sandwich the disk between these. Insert this assembly in the tube in such a way that the hole in the disk is in alignment with the hole in the tube; the thermocol pieces should fit tightly in the tube. Apply a bit of grease on the hole of the block and insert the thermometer in the block. Grease will help making good thermal contact between the metal and the thermometer.

Taking the observations :

Select a place where direct rays of the Sun will be ensured at least for two hours. Cover the mouth of the tube and keep pointed to the Sun. After initial rise, the temperature would stabilise in about half an hour. Now to take the observations remove the cover. To ensure that the Sun rays fall perpendicularly on the detector, put a sheet of paper under the tube. The shadow of the tube will be circular when the tube is parallel to the Sun rays. While taking the thermometer readings, hold the mirror flatly behind the thermometer (better way of doing it would be to stick the mirror behind the thermometer) and coincide the shadow of the eye with the position of the mercury. Estimate the temperature to the nearest 0.1 degrees.

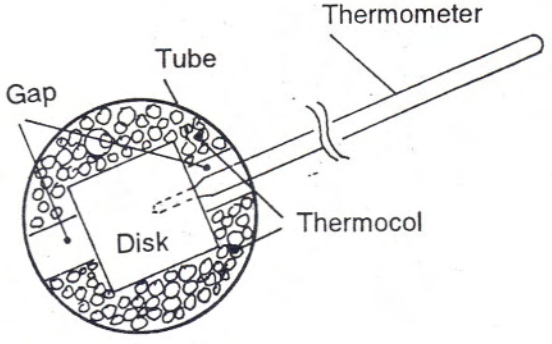


Fig. 2 : Cross section of the detector, mounted in the tube

CYGNUS, THE SWAN

Cygnus, the Swan, appears in the northeastern horizon as the Sun sets in July. For the next six months or so it will be seen in the sky soon after the sunset. By the end of December, it is just above the northwestern horizon at the time of sunset.

Large part of this constellation is in the direction of the milky way and offers many beautiful objects for naked eyes, binoculars and telescopes. This group of stars, which we now identify as a Swan, was known as a bird of some kind or the other (e.g., Hen , etc.) to the early astronomers.

Stars β, η and χ are its beak and neck. The star α Cygni, known as Deneb makes its tail and the wings are formed by δ and κ and ε, ζ and μ are on two sides.

Deneb is the 19th brightest star, whose actual luminosity is 60,000 times that of the Sun and is 25 times as massive. This star, which is at 1600 light years (ly) from us is approaching towards us at 3 metres per second. Its magnitude is 1.26.

To its northwest is a defuse nebula called North American Nebula, as some part of this nebula resembles the continent. Most of this nebula is illuminated by the light from Deneb.

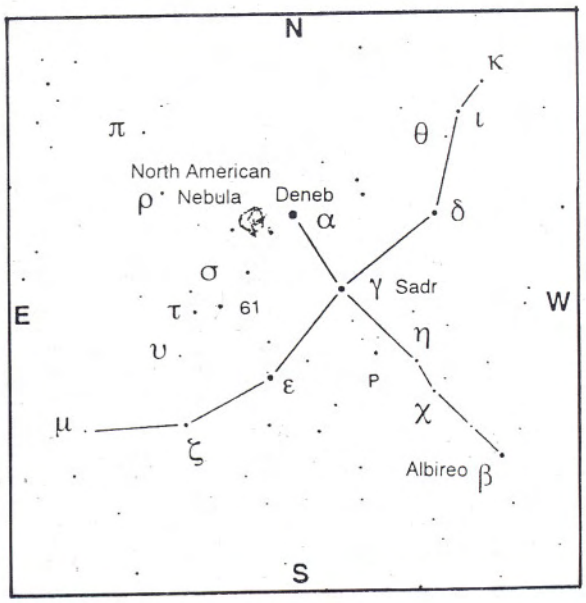
Beta Cygni, called Albireo, is the best double star in the sky. Its companion is just about 35 seconds of arc away, which can be resolved in 2 inch binoculars. Magnitude of Beta Cygni is 3.09 and appears golden yellow ("Topaz") and the companion whose magnitude is 5.11 appears bluish ("Sapphire"). It is believed to be a physical pair but no change in their angular separation is ever observed. This double star was discovered by Frederich Georg Wilhelm Struve in 1832 and he is famous for his discovery of 2343 new double stars. He started his search in 1824 using a 9 inch (23 cm) refractor.

Another famous double stars in this constellation is 61 Cygni. It was discovered by Giuseppe Piazzi in 1792 and he also discovered the first asteroid, Ceres. He found that this star has a large proper motion. Later in 1838 F. W. Bessel (Mathematician and Astronomer) made for the first time the actual distance measurement of this star by trignometrical methods. He calculated that the distance to this star to be 10.3 ly. Presently the accepted distance is 11.1 ly. It is the fourth nearest of the naked eye stars to us .This star too can be resolved in small telescopes and are almost equally bright (magnitudes 5.3 and 5.9) and show an orange tint.

P Cygni is another celebrity from this constellation. Its magnitude is 4.88. It appeared reddish star of 3rd magnitude in 1600, faded to 6th magnitude in 1620 and dropped below the naked eye visibility in 1626. It brightened up again in 1655 and reached magnitude 3.5 and vanished again 3 years later. After more such fluctuations it reached its present magnitude in 1715.

The spectrum of this star shows strong emission lines with blue shifted equally strong absorption component. Similar line profiles are also seen in other stars of O, B and A spectral types. Such line profiles are called P Cygni profile. It is suggested that such stars are going through episodes of catastrophic mass loss.

One of the strongest source of X-ray energy in the sky is Cygnus X-1. This object is thought to be the most convincing candidate for a "black hole". Black holes are those objects where gravitational forces become so strong that even light cannot escape from them. Position of this X-ray source coincides with a 9th magnitude star HED 226858. This star is a spectroscopic binary star with period of about 5.599 days. At the time of writing, according to the information received from the Central Bureau of Astronomical Telegrams, Circular No. 5813, Cygnus X-1 decreased its hard X-ray emission from early May to May 23, 1993.



Preprint list

IUCAA preprints released during April 1 to June 30, 1993 are listed below. These can be obtained from the Librarian, IUCAA.

Bagla J.S. and Padmanabhan T., *Non-linear Evolution of Density Perturbation Using Approximate Constancy of Gravitational Potential*, IUCAA-14/93; Dadhich N., Tikekar R. and Patel L.K., *On Singularity Free Cosmological Models*, IUCAA-16/93; Datt D.P., *Geometric Phase in Vacuum Instability: Applications in Quantum Cosmology*, IUCAA-18/93; Gulati R.K., Malagnini M.L. and Morossi C., *Synthesis of Stellar Mg and Fe Absorption Indices for Stellar Population Studies*, IUCAA -13/93; Nityananda R. and Padmanabhan T., *Scaling Properties of Gravitational Clustering in the Non-linear Regime*, IUCAA-12/93; Padmanabhan T., *Aspects of Quantum Field Theory*, IUCAA-15/93 ; Pitre S.N. and Dhurandhar S.V., *Algorithm for Optimally Distributing Quantised Load on Transputers with Unequal Speeds: An Application to the Detection of Gravitational Wave Signals from Coalescing Binaries*, IUCAA-17/93.

From Eternity to Here

The following story about the late Daulat Singh Kothari, a distinguished astrophysicist and educationist (and Honorary Fellow of IUCAA) may or may not be true. But knowing Kothari, it could be true:

Once Kothari paid a call on a holy man, who had made a name for performing 'miracles'. Seeking to impress the important scientist visiting him, the guru accorded Kothari a warm welcome. As they were seated on the ground, he produced a watch apparently out of nothing and kept it on the floor as a present to the guest. How did Kothari react to this demonstration of the violation of the law of conservation of matter? Pointing to the watch lying on the floor between them, he said politely: "Sir, you have brought this watch from infinity to this point. If, with your divine power, you would move it a further six inches towards me without touching, I will give up physics and become your disciple".

Kothari continued to be a physicist .

Visitors to IUCAA during April, May and June 1993.

Joanna Anosova, J. S. Vaishya, Ramakrishna Reddy, B. R. Iyer, P. C . Vaidya, Pankaj Joshi, A. R. Prasanna, Y. D. Mayya, S. D. Verma, B. A. Kagali, A. N. Anandaram, Jayant Murthy, G. Baskaran, Krishna Rao, I. Husain, N. Panchapakesan, Toivo Jaakola, D. B .Vaidya, S. H. Behere, L. K. Patel, K.S.V.S . Narasimhan, L. Radhakrishna, S. G. Tagare, K. Indulekha, U. S. Pandey, S. Banerji, R. Tikekar, K. N. Iyer, B. Ishwar, S. M. Alladin, Suresh Chandra, D. P. Datta, L. M. Khan, B. S. Krishna Murthy, Srinivasa Rao, Man Mohan, D. C. Srivastava, P. Khare, B. Bhawal, Patrick Das Gupta, B. Basu, S. Medsikar, C. W. Misner, N. T. Bishop, C.V. Vishveshwara and S. Mukherjee.

VISITS ABROAD

S.V. Dhurandhar and **J.V. Narlikar** participated in a workshop on gravitational waves held during April 26 - 29, 1993 at Perth, Australia. S.V. Dhurandhar took this opportunity to visit the AAO at Sydney, where he gave a colloquium.

A.K. Kembhavi and **T. Padmanabhan** visited the Institute of Astronomy, Cambridge during April - June 1993.

Welcome

Welcome to B.S. Sathyaprakash, who has joined IUCAA as a faculty member from ICTP, where he was a post-doctoral fellow.

... and Farewell

Farewell to Patrick Das Gupta, who has joined the Department of Physics, University of Delhi, as a faculty member

How to communicate with IUCAA

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IUCAA Academic Calendar
August 1993 - July 1994

1993

August

16	IUCAA-NCRA Graduate School First Semester begins
16-20	VI-IAU Asian Pacific Regional Meeting on Astronomy
22-23	Secondary School Teachers Meet
25-31	Miniworkshop on Cataclysmic Variables

September

11-12	Marathi Science Writers' Meet

October

25-31	Workshop on Astronomy Curriculum in Schools

November

1-6	Workshop on Making Your Own Planetarium

December

*	Introductory School on Astronomy for IIT Students
6-24	Indo-US School on AGN and Quasars
24	IUCAA-NCRA Graduate School First Semester ends
29	Foundation Day

1994

January

3-21	XX-IAU International School for Young Astronomers (ISYA)
17	IUCAA-NCRA Graduate School Second Semester begins

January and February

Jan.22-Feb.11	Indo-French School on Understanding Large Scale Structures in the Universe

February

14-18	IAGRG Silver Jubilee Conference
21-26	Workshop on Astroparticle Physics (Co-sponsored by S.N. Bose Centre for Basic Sciences)
28	National Science Day

April

*	Workshop on Two Years after COBE

May

*	IUCAA-NCRA Graduate School Second Semester ends

June and July

Jun.1-Jul.15	Vacation Students Programme
*	Introductory Summer School on Astronomy and Astrophysics

*** Dates to be finalised**