KHAGOL
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A Bulletin of the
Inter-University Centre for Astronomy and Astrophysics
(An Autonomous Institution of the University Grants Commission)

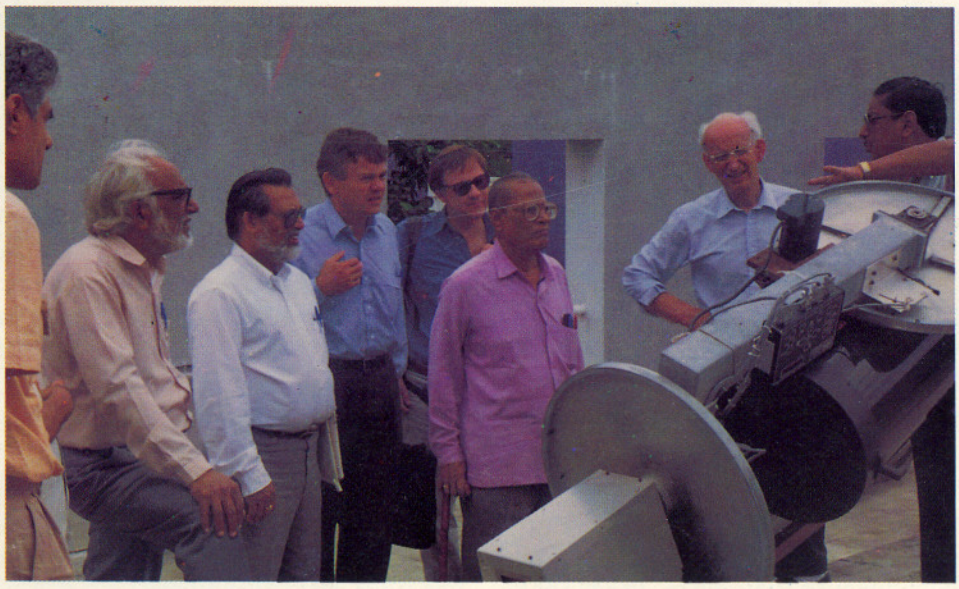
No. 20 **October 1994**

SAC CAME TO IUCAA

The fourth meeting of the Scientific Advisory Committee of IUCAA was held on the IUCAA premises from July 27 to 29. Seven out of ten members came for the meeting, including from within the country, K.D. Abhyankar (Osmania University), N. Kameswara Rao (Indian Institute of Astrophysics), N.V.G. Sarma (Raman Research Institute) and B.V. Sreekantan (National Institute of Advanced Studies) and from abroad D. Lynden-Bell (Institute of Astronomy, Cambridge), J.R. Bond (Canadian Institute of Theoretical Astrophysics, Toronto) and R. Cannon (Anglo Australian Observatory, Sydney).

The SAC visited IUCAA facilities and attended long sessions on the research work carried out by IUCAA members and associates, besides having discussions with the Director and the faculty. They left with good impressions of the progress made by IUCAA for its relatively short age but they also gave constructive criticism and practical advice for its efforts to attain a world class reputation.

The tenure of the present SAC-IUCAA will be over at the end of 1994 and we take this opportunity to thank all members for their conscientious concern for IUCAA's well-being. Also we wish another SAC-IUCAA for 1995-97, which is as good as this one!



SAC members, trying to watch the sky during 'daytime' through the Automated Photoelectric Telescope, built at IUCAA.

Young Astronomers' Meet

YAM'94 was held during August 1 - 4, 1994 at IUCAA and it was jointly organised by research scholars at IUCAA and the National Centre for Radio Astrophysics, Pune. The event was funded by the Department of Science and Technology.

Forty five research scholars, including 16 locals from all over the country participated in the meet. Seminars by participants, in which they presented their work and discussions on a few selected topics comprised the academic programme. Presentations covered the entire range of topics from Solar Physics to Structure Formation in the Universe. In addition, there were invited lectures by scientists from the local institutes and some visiting scientists.

The interaction of students from different fields has led to a better understanding and perspective of the research work being done in the country. It was decided to enlarge the scope of YAM by starting a quarterly newsletter. This should lead to an enhanced scientific interaction among the students working in Astronomy and Astrophysics.

Welcome...

to Stephen Lau and Biman Nath, who have joined as post-doctoral fellows and to Sunu Engineer, Tarun Deep Saini, K. Srinivasan and Yogesh Wadadekar, who have joined as research scholars,

and

... Farewell

to A.K. Sen, who has joined the Centre for Plasma Physics, Guwahati and Monica Valluri who has left for US.

Parsecstones in Astronomy - 8

J. V. Narlikar

The Discovery of Binary Stars

The naked eye observations show stars as point sources of light. With the advent of telescopes in the post-Galileo era it became possible to resolve a few single stellar images into doublets, indicating that stars may occur in pairs also. The first such observation was made by Riccioli in 1650 for the binary star ***Mizar*** (ζ – ***Ursae Majoris***). The credit for the observation of the closest binary system to us, in the α - ***Centauri*** star, however, goes to the French astronomer Richaud who made the observations in Pondicherry, India. In 1689 this must have been the first known modern astronomical observation from the Indian soil.

Binaries are basically detected in three ways. The first method, that of visual observations as in the above cases, gives us the so-called visual binaries. The visual method is not able to distinguish systems which are very close to each other. In such cases the spectroscopic method helps. As the two stars of a binary system go round each other their spectral lines move back and forth due to the Doppler effect. Thus even though the two member stars cannot be seen separately their combined spectrum can tell them apart. Spectroscopic binaries like these began to be spotted from 1889 when E.C. Pickering found that the bright component of the visual binary Mizar is in fact made of two stars.

The third method, that of eclipsing binaries depends on a special location of the binary orbit with respect to us : we should lie in its plane. Then as the stars go round each other they periodically eclipse one another. This causes a variation of their total brightness periodically. In 1670 Montanari detected the first eclipsing binary in the star Algol (β - ***Persei***) by observing a fluctuation in its intensity. This was confirmed by Goodricke in 1782 by demonstrating that the fluctuations are periodic with a 2.86 day period.

Binary stars have proved to be very useful objects for astronomical study. Apart from providing an additional proof that the law of gravitation applies to binary stars, they also show interesting examples of how stars evolve as they interact by one star tidally pulling matter from its companion. With the advent of X-ray astronomy, the discovery of binary X-ray sources added another dimension to these studies, including the exciting possibility of one member of an X-ray binary being a black hole. Further, the presence of a pulsar in a close binary system provides us an excellent laboratory for testing sophisticated effects predicted by theories of gravitation. But all this is for later parsecstones.

Workshop on Large Scale Structure Beyond N-body Simulations

Participants of the workshop on Large Scale Structure Beyond N-Body Simulations

A workshop on Large Scale Structure Beyond N-body Simulations, dedicated to the memory of the outstanding Russian physicist Ya.B. Zel'dovich was organised in IUCAA during July 20 - 26, 1994. The workshop dealt with frontier issues in Cosmology, which were vigorously debated both formally during the workshop and after "office" hours. The topics discussed included: the Cosmic microwave background, Reionisation of the intergalactic medium, Scaling and universality in gravitational clustering, Non-linear approximations to gravitational instability, N-body and gas dynamical simulations of large scale structure, Statistics of gravitational clustering, etc. Fifteen Indian and ten foreign scientists participated in this workshop .

IUCAA Preprints

Listed below are the IUCAA preprints released during **July to September 1994.** These can be obtained from the Librarian, IUCAA.

V. Korchagin, A. Kembahvi, Y.D. Mayya and T.P. Prabhu *Are Nuclear Hotspots in Galaxies Sites of Sequential Star Formation?* IUCAA-17/94; **B.S. Sathyaprakash** *Filtering Post-Newtonian Gravitational Waves from Coalescing Binaries* IUCAA-18/94; **Naresh Dadhich** *Inhomogeneity and Non-singularity of Cosmological Models* IUCAA-19/94 ; **F. Hoyle and J.V. Narlikar** *Cosmology* and *Action at a Distance Electrodynamics* IUCAA- 20/94 ; **R.K. Gulati, Ranjan Gupta, Pradeep Gothoskar and Shyam Khobragade** *Automated Classification of Ultraviolet Stellar Spectra* IUCAA-21/94; **F. Hoyle, G. Burbidge and J.V. Narlikar** *The Basic Theory Underlying the Quasi-Steady State Cosmology* IUCAA-22/94; **L. Sriramkumar and T. Padmanabhan** *Response of Finite-time Particle Detectors in Non- inertial frames and Curved Spacetime,* IUCAA-23/94; **B.S. Sathyaprakash, V. Sahni, D. Munshi, D. Pogosyan and A.L. Melott** Gravitational *Instability in the Strongly Nonlinear Regime: A Study of Various Approximations,* IUCAA-24/94; **T. Padmanabhan** *Inverse Compton Scattering-Revisited,* IUCAA-25/94; **V. Sahni, B.S. Sathyaprakash and S.F. Shandarin** *Voids and Adhesion Theory,* IUCAA-26/94; **Naresh Dadhich, L.K. Patel, K.S. Govinder and P.G.L.Leach** *Characterisation of Orthogonal Perfect Fluid Cosmological Spacetimes,* IUCAA-27/94; **Stephen Lau** *Spinorial Propagation Equations and the Reference Point of Quasilocal Energy,* IUCAA-28/94 and **Sucheta Koshti and Naresh Dadhich** The General Self-dual Solutions of the Einstein Equations, IUCAA-29/94.

Inter-University Graduate School on Large Scale Structures in the Universe

(Co-sponsored by UGC)

(November 21 - December 10, 1994)

Under the auspices of the University Grants Commission of India and IUCAA, the above school which is the third in the series of Inter-University Graduate Schools on Gravitation and Cosmology, will be organized at the Department of Physics, University of Mysore. The aim of this school is to strengthen the background and training of research students by offering advanced courses in general relativity, cosmology, and in the theme topic large scale structures in the universe. This school is intended essentially for Ph.D. students working in gravitation/astrophysics.

Congratulations

to **S.M.R. Ansari** and **J.V. Narlikar** for being made the Presidents of Commission on History of Astronomy and Cosmology respectively and to **G. Srinivasan** for being made the Vice-President of Commision on High Energy Astrophysics and Astronomy from Space of the IAU.

MEASURING SKY BRIGHTNESS

If you look at a cloudless sky, in addition to the shining stars, planets, etc., a glow of light from all directions is seen. The intensity of this glow is more in cities as compared to the rural areas, and therefore neighbourhood of a city is not good for astronomical observations, which need a dark sky. In this article we discuss the sources of this background light and describe a method of measuring it.

The background light consists of (a) extraterrestrial radiation, originating in the solar system and the outer regions of space, (b) radiation emitted by the excited atoms and molecules of the atmosphere, (c) the radiation of stars, etc., scattered by the atmosphere, and (d) the man-made light from earth scattered by the atmosphere.

A simple calculation can be done to illustrate that on a moonless night, the contribution of the man-made light to the background dominates in a typical urban setting. First of all, we note that most of the scattering occurs in the lower 10 km of the atmosphere and consequently the effect of man-made light extends to about 10 km from the sources. Further, if we assume that about 1 million watts of outdoor light is produced in a typical city of size 10 km x 10 km and if 50% of this light is thrown up, a total of about 100 kilowatts of light would be scattered back on an area of about 20 km x 20 km. This corresponds to a light flux of about 2×10^{-8} W/cm^2, which is comparable to the background generated by the scattering of the light from a full moon. Thus, in a large city you should look forward to large scale power breakdowns to have an opportunity to have a good view of the heavens !

Measuring the background

We had described a photometer in Astroproject - 7, (Khagol No: 19, July 1994) for the measurement of moon's brightness. The same photometer can be used for measuring the background light, provided some modifications are made in it to increase the sensitivity. First of all, the electronics circuit needs a change so as to increase its sensitivity by a factor about 10^4; the modified circuit is shown in the box. Secondly, a lens of diameter about 20 mm and a focal length of about 100 mm should be placed in front of the photodiode. The lens serves two functions when the photodiode is at its focal plane: it increases the area of light collection, and it restricts the field of view of the detector to a small solid angle.

To measure the background light, keep the photometer on a horizontal surface such that it looks at the zenith and take the readings as follows:

(i) Cover the face to block all the ingoing light, wait for 20 seconds and take 10 readings of the output every 5 seconds, let the average of these readings be R_O Volts (V).

(ii) Wait till no bright star (magnitude less than 3) is within 5 degrees of zenith, uncover the photometer and take readings as in (i) above, let the average of these readings be R_B V.

The difference of the two readings (R_B - R_O) V is a measure of the background light. However, in order to have a usable measure, this reading should be converted to a standard unit and further it should be expressed as background per unit solid angle. The reading can be converted to the standard magnitude scale by making a measurement on a star of magnitude near zero (see the list of stars in the box) as follows:

The photometer is pointed towards the star, when it is within 40 degrees of the zenith and no other bright star is near by, and readings are taken as in (i) above. Next the photometer is pointed about 10 degrees away from the star and readings are taken. If these readings are R_SV and R_{BS} V respectively, then (R_S - R_{BS}) V is a measure of the light from the star and we can write the magnitude corresponding to the background measure (R_B - R_O) V as :

$$m = -\ 2.5\ \log \left[\frac{R_B - R_O}{R_S - R_{BS}} \right] + m_s,$$

where m_s is the magnitude of the star. Further, the background per square arcsecond solid angle can be written as:

$$m_b = m + 2.5\ \log\ [\ A f^{-2} x\ 4\ x\ 10^{10}\ ]$$

$$= -\ 2.5\ \log \left[\frac{R_B - R_O}{R_S - R_{BS}} \right]$$

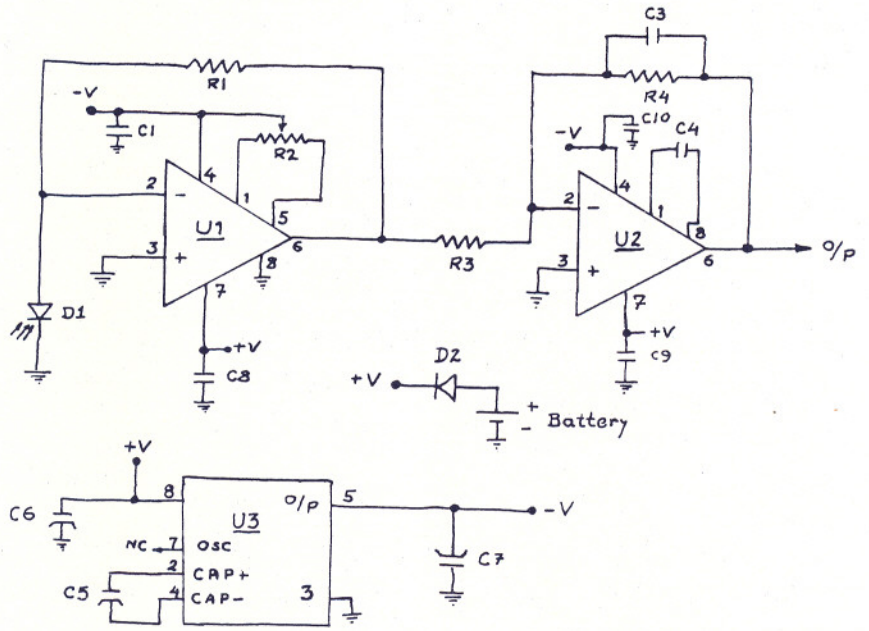
$$+\ 2.5 \log\ [\ A f^{-2} x\ 4 x 10^{10}\ ] + m_s,$$

where A is the area of the photodiode, f is the focal length of the lens, and $Af^{-2} \times 4 \times 10^{10}$ represents the solid angle of the photometer's field of view in square arcsecond.

The background level is typically in the range m_b = 22 to m_b = 17, and it is clear from the equation

for m_b that m_s must be close to zero in order to have a measurement with small errors [(R_S - R_{BS}) should be a few times (R_B - R_O)]. Such bright stars are not very common, but as the sensitivity of the photometer is quite stable, calibration with such a star can be done whenever it is available. The background light changes with the location and the time during the night, and a database of measrements at different locations and times is a very important source material for astronomers.

The Circuit



The gain of the first amplifier is ~ 10^9 V/A, and that of the second stage is ~ 200 .
i.e., the total gain is ~ 2 x 10^{11} V/A

Part List

*	R1	1000M Ω [MOX type]	
	R2	100k Ω Trimpot	
	R3	10k Ω [MFR 1%]	
	R4	3.9k Ω [MFR 1%]	
*	C1, C8, C9, C10	0.1 µF [Ceramic Disk]	
	C3	0.4 µF [Ceramic Disk]	
	C4	33 pF	
	C5, C6, C7	10 µF/16V [Electrolytic]	
*	D1	S2386-45K (Hamamatsu Make)	
	D2	1N4007	
*	U1	AD645	
	U2	LM308	
	U3	ICL 7660S	

Notes

* 1. Use a soldering gun which works on low voltage.
* 2. In case such a soldering gun is not available, any soldering should only be done after disconnecting the gun from the mains.
* **3. You would notice that this photometer requires some special components, and in case you need help in acquiring these or for any other help, please write to us.**

List of stars

Star names	Coordinates RA		Dec		Mag.
	h	m	o		
Rigel (β Ori)	05	14.5	-08	12	0.12
Capella (α Aur)	05	16.7	+45	59	0.08
Sirius (α CMa)	06	45.1	-16	43	-1.46
Procyon (α CMi)	07	39.3	+05	13	0.38
Regulus (α Leo)	10	08.4	+11	58	1.35
Spica (α Vir)	13	25.0	-11	10	0.98
Arcturus (α Boo)	14	15.7	+19	11	-0.04
Vega (α Lyr)	18	36.9	+38	47	0.03
Deneb (α Cyg)	20	41.4	45	17	1.25

Second Indo-US Workshop on Array Detectors and Image Processing

(November 28 - December 10, 1994)

(INDO-US Cooperation in Astronomy and Astrophysics)

This workshop will be at an advanced level and will deal with the technology and latest developments in the CCD's and infrared detector arrays as well as with the techniques of processing the astronomical data from these.

Introductory School on Astronomy for IIT Students

December 5 - 24, 1994

This school is intended for students of M.Sc. (Physics) who will be graduating in 1995 or 1996 and will consist of lectures and project work.

Workshop on Image Processing at University of Kerala

A workshop on Image Processing is being organised at the University of Kerala, in the second half of December 1994. The workshop will mainly concern with astronomical image processing but will also include application of the techniques to other fields. Those interested in the workshop may please contact :

S.R. Prabhakaran Nayar, Department of Physics, University of Kerala, Kariavattom, Thiruvananthapuram 695 581, Kerala.

Workshop on Computer Networks

(Co-sponsored by NCST, Bombay)

A workshop on Computer Networks will be held at IUCAA during January 2 - 13, 1995. The workshop is intended for persons concerned with computer networks, E-mail and related facilities. Interested persons may get in touch with **The Coordinator, Core Programmes, IUCAA,** for further details. Applications in the prescribed form are expected to reach before November 7, 1994.

Indo-French School on Understanding Large Scale Structures in the Universe

(Sponsored by the IFCPAR)

An Indo-French School on Understanding Large Scale Structures in the Universe will be held at IUCAA during January 30 to February 20, 1995. This is patterned in the style of Les Houches and Cargese schools and is sponsored by Indo-French Centre for the Promotion of Advanced Research (IFCPAR). There will be pedagogical lecture courses covering the following topics: Observational overview of the universe, Standard big bang model of the universe, Linear theory of perturbations, Cosmic microwave background radiation, Quasi-linear and non-linear growth of perturbations, Statistical properties of density fields and Hydrodynamic processes in structure formation. In addition, there will be several short courses and seminars on special topics.

The lecturers will include Alain Blanchard, F. Bouchet, Alain Bouquet, Yannick Mellier, T. Padmanabhan, Richard Schaeffer and K. Subramanian.

The number of participants will be limited to about 25. Interested persons from India should write to: **The Coordinator Core Programmes, IUCAA,** giving your bio-data and details of research interest. Persons from France and countries other than India should write to: Francois Bouchet, Institut D'Astrophysique de Paris, 98 BIS, Boulevard Arago, 75014 Paris, France (Fax: 00-33-143-298673, email : bouchet@iap.fr). Students should arrange for one letter of recommendation from a scientist who is familiar with their work to be sent directly so as to reach by **November 15, 1994**.

POST-DOCTORAL FELLOWSHIPS

Applications are invited for post-doctoral fellowships in astronomy and astrophysics. The duration of the fellowship is flexible within a range of one to five years with the possibility of conversion to a tenured position. IUCAA offers challenging opportunities to young research workers in theory, observation and instrumentation in astronomy and astrophysics and will be especially looking for observers and experimentalists.

RESEARCH AREAS COVERED

* **Cosmology and large scale structure**
* **Galactic and extra galactic astronomy**
* **High energy astrophysics**
* **Astrochemistry**
* **Nuclear astrophysics**
* **Quantum cosmology and quantum gravity**
* **General relativity**
* **Gravitational waves**
* **Observational astronomy**
* **Astronomical instrumentation**

Candidates should apply to **The Coordinator, Core Programmes, IUCAA,** with curriculum vitae and list of publications and arrange for three confidential references to be sent independently. All the relevant material should reach IUCAA by December 25, 1994. Candidates will be informed of the result by February 15, 1995. The fellowship will normally commence during 1995.

Visits Abroad

G.C. Anupama attended the Padova-Abano Conference on Cataclysmic Variables: Inter-Class Relations held during June 20 - 25, 1994, at Abano, Italy. She gave an invited talk entitled 'Recent Trends in Recurrent Novae.' She also visited the Observatorio di Roma, Rome, Italy, during June 26 - 28, 1994, and gave a seminar.

N. Dadhich visited the Department of Mathematics and Applied Mathematics, University of Natal, South Africa, for 3 months during April - June 1994. He was the invited lecturer at the Hanno Rund Workshop on Relativity and Cosmology, held at Durban during April 6 - 9 and gave a series of 6 lectures on the singularity free cosmological solutions of Einstein's equations.

He also visited universities of Zululand, Durban-Westville, South Africa (Pretoria), Witwatersrand (Johannesburg) and gave seminars. He participated in the workshop on Chaos and Ordinary Differential Equations, University of Durban, Westville and gave a talk on Manipulation of Einstein's Non-linear Partial Differential Equations. He also participated in one day discussion meeting on relativity at University of South Africa. Finally, he attended the workshop on Dynamics of Cosmological Models held at Department of Applied Mathematics, University of Cape Town, during June 27 - July 2.

As a part of the collaboration between India and Australia on gravitational waves, **S.V. Dhurandhar** visited the University of Western Australia (UWA) Perth, Anglo Australian Observatory, Sydney, Sydney University, and the Australian National University, Canberra.

The second harmonic of the nearest millisecond pulsar is very close to the resonant frequency of the bar detector at Perth and Dhurandhar is working on the data analysis taking advantage of this coincidence. The visit also involved finalising the collaborative agreement between Australia and India on the AIGO project. Dhurandhar delivered several talks at UWA and colloquia at the Sydney University and at the Mt. Stromlo Observatory, Canberra on the Search for Gravitational Waves.

Ajit Kembhavi visited Australia in the third week of June, 1994 to set up observational programmes in collaboration with astronomers from different observatories and university departments there. He visited the Anglo Australian Observatory at Epping, Mt. Stromlo and Siding Spring Observatories in Coonababaran, Mt. Stromlo Observatory near Canberra and the Department of Physics and Astronomy in Melbourne. He received a very positive response from astronomers in these centres and it is hoped that observing progrmmes in different areas will be initiated in the coming months.

J.V. Narlikar attended the IAU General Assembly and Symposium 168 (August 15 - 27) at the Hague, then visited the Institute of Astronomy, Cambridge (September 1 - 16) and spent a week in Egypt (September 17 - 24), lecturing at the International School for Young Astronomers.

Varun Sahni visited the United States under the Indo- US Exchange Programme between IUCAA and the Harvard-Smithsonian Center for Astrophysics. He participated in the workshop on Large Scale Structure organised at the Aspen Center for Physics, and also visited the University of Berkely, the Harvard-Smithsonian Center for Astrophysics, The Los Alamos National Laboratory and Tufts University. He gave seminars on different topics. He also attended the Rome meeting on Birth of the Universe and Fundamental Physics where he gave an invited talk on Voids and Adhesion Theory.

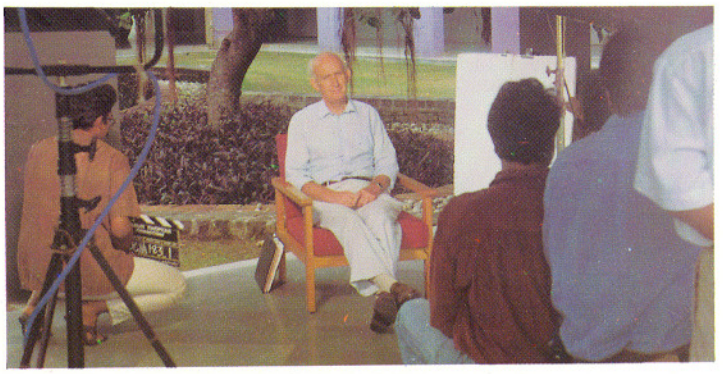
B.S. Sathyaprakash attended the 6th Asia Pacific Physics conference held at Brisbane, Australia during July 4 - 8, 1994 and presented three talks at the Gravitational Astronomy Workshop. Two of these talks were technical and the third was concentrated on the active collaboration of IUCAA and Centre for Advanced Technology, Indore, from India in the construction of Australian International Gravitational Wave Observatory (AIGO). The workshop had a fair international representation of scientists working in bar detector and laser interferometer and many of them showed keen interest on the work being carried out at IUCAA.

Seminars held during July - September

13.7.94 B.S. Sathyaprakash on A Report on the 6th Asia Pacific Physics Conference-Gravitational Astronomy Workshop and 11.8.94 on Filtering Post-Newtonian Gravitational Waves from Coalescing Binaries, 12.8.94 M. Varadarajan on A Curious Property of the Gravitational Hamiltonian, 18.8.94 U. Chattopadhayay on The Challenge of Network Reliability, 22.8.94 P. Bellanca on Fractal Spacetime, Quantum Mechanics & Scale Relativity and 15.9.94 P. Ulmschneider on Why do Almost All Stars Have Hot Outer Shells?

Colloquia held at IUCAA...

26.7.94 Bernard Jones on *The Origin of Large Scale Cosmic Structures,* 8.8.94 D. Lynden-Bell on *Mach's Principle,* 29.8.94 T. Padmanabhan on *What is the Problem in Quantizing Gravity?* and 12.9.94 P. Ulmschneider on *Is There Intelligent Life Outside the Solar System?*



D. Lynden-Bell being interviewed for a film on IUCAA

2nd Workshop on Experimental Techniques in Space Sciences and Astronomy

This workshop sponsored by IUCAA was conducted at the Department of Physics, Space Sciences and Electronics, Gujarat University, Ahmedabad in collaboration with Physical Research Laboratory (PRL) and Space Application Centre (SAC) during September 13 - 17, 1994. The main objective of this workshop was to introduce the concept of CCD, photometry, image processing and its various applications in space sciences and astronomy to university/college teachers and research scholars. George Joseph, Director, SAC was kind enough to inaugurate the workshop and O.P.N. Calla, Dy. Director, SAC gave the key note address.

There were 18 lectures by invited speakers from IUCAA, SAC, PRL, Gujarat University and Gujarat College, 5 demonstrations and 3 visits. Three days programme was arranged in the university campus and remaining two days programme was held at SAC and PRL. There were 39 participants from different parts of the country, including 5 from Nepal.

Astro-Circular Reasoning!

In his ***Fireside Astronomy,*** Patrick Moore has recounted the eventful ending of the XXI General Assembly of the IAU at Buenos Aires. Perhaps because of the heated astronomical arguments but more likely for some more earthly reason, the Conference Centre caught fire on the last day. As Moore had the responsibility of editing the Conference Newspaper every day, he had to improvise under these conditions. So the Local Organizing Committee had to find another location for the concluding session.

"Where will the session be held?" Moore asked an LOC member.

"In the Plaza opposite at 10 a.m. Can you put this in your newspaper?" The LOC member's request could certainly be met. But Moore wanted to know where and when to keep the newspapers since their normal point of collection was in the building under fire. The answer was:

"Oh, it will have to be at the Plaza at 10 a.m."

Sino-Indian School

IUCAA has entered into a programme of collaborations with astronomers in China. This will involve a series of schools and workshops to be held alternatively in China and India. The first workshop, for which the theme will be "High Energy Astrophysics", with an emphasis on galactic phenomenon like pulsars, supernovae and star bursts, will be held in Nanjing during October 11 - 22, 1994. There will be lectures by Indian and Chinese astronomers at the school, as well as presentation of papers, discussion sessions and so on. The school is being organised by the Purple Mountain Observatory, Nanjing University and Nanjing Normal University.

The next school is intended to be held at IUCAA during the later half of 1995 for which the subject matter and exact dates will be announced after the school at Nanjing. The programme also envisages exchange visits between the two countries with each visit lasting for a few months. The details of these visits will be announced in due course and proposals for visits will then be invited. The programme of schools and visits is supported by the Department of Science and Technology and the Chinese Academy of Sciences.

Visitors to IUCAA July-September 1994

July : S.R. Valluri, D. Lohiya, D.C. Srivastava, K.D. Abhyankar, S.K. Pandey, S. Matarrese, E. Branchini, P. Coles, P. Shapiro, B.J. T. Jones, I. Suisalu, S. Shandarin, P. Catelan, F. Bernardeau, N. Panchapakesan, R.P. Saxena, S.M. Chitre, T. Seshadri, J. Samuel, J.R. Bond, R. Cannon, D. Lynden-Bell, Yash Pal, R. Tikekar, P. Khare, M.N. Anandaram, P. Dasgupta, B.V. Sreekantan, N.V.G. Sarma, C. Correa, T.P. Singh, P.C. Vaidya, K. Boruah, S. Sudershan Rao.

August: S.S. Jha, N.V. Madhusudana, O.N. Srivastava, K. Rama Reddy, T. Nagarajan, A.P. Pathak, S.R. Prabhakaran Nayar, S. Banerji, S.D. Verma, L.K. Patel, M. Varadarajan, B. Pascal, K. Narayanan Kutty.

September: P. Ulmschneider, U. Narain, A. Mehta, V.R. Venugopal.

Visitors Expected

October: B. Basu, Calcutta University; A.C. Balachandra Swamy, Saradavilas College; S.G. Tagare, Hyderabad University; S. Banerji, University of Burdwan; P.V. Kulkarni, Shivaji University; Carlos Guerard, Naval Research Laboratory.

November: S. Chakraborty, University of Kalyani; G. Fazio, Harvard-Smithsonian Center for Astrophysics; John Geary, Smithsonian Astrophysical Observatory; Roger Smith, Cerro Tololo Inter American Observatory; Francisco Valdes, NOAO; Craig McCreight, NASA Ames Research Center.

December: A. Borde,Tufts University; Rosanne Di Stefano, Harvard- Smithsonian Center for Astrophysics.

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

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