IUCAA 1989-90

Annual Report
of the
Inter-University Centre for Astronomy and Astrophysics

(April 1, 1989 - March 31, 1990)

Contents

Edited by
Pramila A. Malegaonkar

COVER: *Juxtapositioned photographs of "Gole Bungalow" — the old office and "Aditi" — the present office building of IUCAA*

Design + Print: Mudra Offset

The Council and the Governing Body

The Council

1. Professor Yash Pal (President)
   Chairman, University Grants Commission
2. Professor K. Sachidananda Murty
   (Vice-President, upto June 1989)
   Vice-Chairman, University Grants Commission
3. Professor S.K. Khanna
   Secretary, University Grants Commission
4. Dr. V.R. Gowariker
   Secretary to the Government of India, Department of Science and Technology
5. Dr. U.R. Rao
   Secretary to the Government of India, Department of Space
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   Director General, Council of Scientific and Industrial Research
7. Professor G. Swarup
   Director, GMRT Project, TIFR, Pune
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9. Professor R.P. Bambah
   Vice-Chancellor, Panjab University
10. Professor M. Bhattacharya
    Vice-Chancellor, University of Burdwan
11. Professor M. Lakshmanan
    Vice-Chancellor, Madurai Kamaraj University
12. Professor M.M. Laloraya
    Vice-Chancellor, Ravishankar University
13. Professor T. Navaneeth Rao
    Vice-Chancellor, Osmania University
14. Professor Moonis Raza
    Vice-Chancellor, University of Delhi
15. Professor Satchidanand Sinha
    Vice-Chancellor, Rajasthan University
16. Professor K.D. Abhyankar
    Emeritus Professor, Osmania University
17. Professor A. Banerjee
    Department of Physics, Jadavpur University
18. Professor A.N. Mitra
    Department of Physics, University of Delhi
19. Professor N. Mukunda
    Indian Institute of Science
20. Professor Archana Sharma
    Department of Botany, Calcutta University,
    Member, University Grants Commission
21. Professor S.D. Verma
    Department of Physics, Gujarat University
22. Professor J.V. Narlikar (Secretary)
    Director, IUCAA

The Governing Body

1. Professor Yash Pal (Chairman)
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   (Vice-Chairman, upto June 1989)
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5. Professor S.C. Gupte
6. Professor M. Bhattacharya
7. Professor T. Navaneeth Rao
8. Professor Moonis Raza
9. Professor K.D. Abhyankar
10. Professor N. Mukunda
11. Professor Archana Sharma
12. Professor J.V. Narlikar

Honorary Fellows

1. Professor S. Chandrasekhar
   University of Chicago, Chicago
2. Professor W.A. Fowler
   California Institute of Technology, Pasadena
3. Professor A. Hewish
   University of Cambridge, Cambridge
4. Professor Sir F. Hoyle
   St. John's College, Cambridge
5. Professor A. Salam
   International Centre for Theoretical Physics,
   Trieste

Statutory Committees

The Scientific Advisory Committee

1. Professor J. Audouze
   Institut d'Astrophysique, Paris
2. Professor G. Burbidge
   University of California at San Diego, La Jolla
3. Professor V. Radhakrishnan
   Raman Research Institute, Bangalore
4. Professor M. Rees
   Institute of Astronomy, Cambridge
5. Professor N.V.G. Sarma
   Raman Research Institute, Bangalore (From March 1990)
6. Dr. J. Wampler
   European Southern Observatory, Garching, Munich

The Finance Committee

1. Professor Yash Pal (Chairman, UGC; Chairman)
2. Professor S.K. Khanna (Secretary, UGC)
3. Shri A.K. Mathur (Financial Adviser, UGC)
4. Professor J.V. Narlikar (Director, IUCAA)
5. Shri S.V. Panchwagh (SAO, IUCAA) — Non-member Secretary

The Academic Programmes Committee

1. Professor J.V. Narlikar (Chairman)
2. Professor N.K. Dadhich
3. Professor A.K. Kembhavi
4. Professor S.V. Dhurandhar (Secretary)

The Standing Committee for Administration

1. Professor J.V. Narlikar (Chairman)
2. Shri S.V. Panchwagh (SAO)

Director's Report

This annual report describes IUCAA's second year of existence: it was in April 1988 that the University Grants Commission formally resolved to set up IUCAA. The Calendar of Events that immediately follows this report will give the reader some idea of how we have been progressing towards our many objectives.

For nearly the first six months of this year, IUCAA's activities continued to be directed from the single room of approximately 150 sq. ft. in the Gole Bungalow allotted by the University of Poona. As the staff strength grew during this period, it was a question of musical chairs: whosoever grabbed the chair was fortunate enough to carry out his work. Those who could not, would somehow manage standing or using a spare desk, if available from the GMRT Project's office in the same bungalow.

Anticipating this crunch, IUCAA had undertaken as an emergency measure the construction of a temporary shed on its premises. The shed, named ADITI has a floor space of approximately 2000 sq. ft. and it houses IUCAA's administrative activities, the computer centre and last but no less important the tea/coffee kitchen. Phase I of IUCAA's construction programme was begun in September 1989.

Around the time that ADITI was completed the GMRT Project was able to offer us six office rooms for our academic staff and space for our library next to its own. Besides, IUCAA's four research scholars have been accommodated in the GMRT Project's hostel. We are grateful to TIFR for this hospitality at its Pune Campus.

This neighbourly cooperation is the beginning of an academic interaction that will grow as both IUCAA and the Pune Campus of TIFR expand their activities. At present the academic members of these two organizations meet at joint seminars and journal club meetings. There are plans, at present under discussion, of hosting schools, workshops and conferences under the joint auspices of IUCAA and TIFR.

Rather than describing our various activities here, I invite the reader to browse through the rest of this annual report where he or she will find them listed appropriately.

Even with its modest beginning IUCAA has had the benefit of visits by a galaxy of distinguished scientists both from within India and from abroad. We are particularly happy that we could welcome two of our Honorary Fellows, Professor S. Chandrasekhar and Professor W.A. Fowler to IUCAA during this year.

During 1989-90, IUCAA's Council met once and the Governing Body thrice. These meetings are well attended and reflect the concern the Council and Governing Body members have for the success of this new experiment within the university sector. The inputs provided by the members have proved very constructive.

IUCAA's Scientific Advisory Committee also met for the first time this year and I am grateful to Professor Geoffrey Burbidge and Professor V. Radhakrishnan for spending two days at IUCAA for intensive discussions on IUCAA's academic programmes.

This year saw IUCAA's Bye Laws and Service Conditions take the final shape and we thank the ministerial staff at UGC for providing the necessary inputs. The help and guidance speedily given by the Chairman, Secretary and Finance Adviser of the UGC have very largely contributed to the smooth management of IUCAA's various activities.

In January 1990, IUCAA launched its bulletin 'Khagol' which will give periodic accounts of our activities and progress. The frequency, at present once in three months, will increase as the tempo of activities builds up. We welcome feedbacks from the readers to *Khagol* as well as the *Annual Report*.

Finally, it is a pleasure to thank all my IUCAA colleagues, especially Naresh Dadhich, Ajit Kembhavi and Sudhir Panchwagh for their assistance throughout the year.

Jayant Narlikar

The Calendar of Events (1989-90)

April 7	Meeting of the Governing Body
June 1	Director joined on full time basis
June 26	Meetings of the Council and the Governing Body
July 21-Aug. 18	Mini-school on "Recent Developments in Non-Perturbative Quantum Gravity"
July 25-27	Selection of research scholars
August 1	Installation of e-mail
August 14	Selection of post-doctoral fellows
August 24	IUCAA moves to Aditi and TIFR, Pune campus
Sept. 4	Launch of Phase I (housing) of IUCAA's campus
Sept. 4-23	First IUCAA Graduate School on Gravitation and Cosmology
Oct. 16	First IUCAA colloquium by Professor Madhav Gadgil
Oct. 25	Installation of SUN computers
Nov. 20	Selection for core positions
Nov. 22	First journal club meeting
Nov. 28	Meeting of the Governing Body
Dec. 11-13	Workshop on "Astronomical Instrumentation"
Dec. 15, 16	First meeting of the Scientific Advisory Committee
Dec. 15, 16	Visit of Professor S. Chandrasekhar
Dec. 29	Cricket match between IUCAA and TIFR, Pune campus
Dec. 29	First Foundation Day Lecture by Professor G. Swarup
Feb. 1-3	IUCAA-CAT meeting on "Gravity Wave Detection"
Feb. 8, 9	Visit of Sir Hermann Bondi
Feb. 11	Staff picnic
Feb. 15	Library automation — first phase completed
Feb. 28	Selection of post-doctoral fellows
March 23-25	Visit of Professor W.A. Fowler
March 31	Regional discussion meeting for the Central region universities at CAT, Indore

Members of IUCAA

Academic Staff

Professor J.V. Narlikar (Director)
Professor N.K. Dadhich
Professor S.V. Dhurandhar
Professor A.K. Kembhavi

Scientific Staff

Mr. V. Chellathurai
Ms. P.A. Malegaonkar
Ms. N.V. Agashe

Administrative and Supporting Staff

Mr. S.V. Panchwagh
Mr. R.Y. Deshpande
Ms. K.M. Abhyankar
Mr. N.V. Abhyankar
Mr. Prasad Krishnan
Mr. R.D. Pardeshi
Mr. B.V. Sawant
Ms. M.A. Mahabal
Mr. S.N. Khadilkar
Mr. B.R. Gorkha
Mr. B.B. Jagade
Mr. M. Raskar
Mr. V.S. Satpute
Mr. S.R. Tarphe
Mr. K.M. Babu
Mr. A.W. Gangawane

On Contract: Ms. T. Maithreyan (upto 15.1.90)

Visiting Members of IUCAA

Visiting Professor

Professor Abhay Ashtekar
Distinguished Professor of Physics
Syracuse University, USA

Senior Associates

Professor S.M. Alladin
Centre for Advanced Study in Astronomy, Osmania University, Hyderabad

Professor S. Banerji
Department of Physics, University of Burdwan, Burdwan

Professor K.B. Bhatnagar
Zakir Husain College, New Delhi

Professor A.N. Maheshwari
Department of Physics, Regional College of Education, Mysore

Professor S. Mukherjee
Department of Physics, North Bengal University, Darjeeling

Professor N. Panchapakesan
Department of Physics, University of Delhi

Professor V.R. Venugopal
School of Physics, Madurai Kamaraj University, Madurai

Professor S.D. Verma
Department of Physics and Space Science, Gujarat University, Ahmedabad

Post-Doctoral Fellows

Dr. P. Das Gupta
Dr. A.K. Kshirsagar
Dr. B.S. Sathyaprakash

Research Scholars

Ms. V.M. Daftardar
Mr. Debiprosad Duari
Mr. T.S. Ghosh
Mr. Kanti Jotania
Ms. S.R. Koshti

IUCAA Fellows on the GMRT Project

Mr. S. Bhatnagar (upto October 24, 1989)
Ms. S. Deshwandikar
Mr. S. Upreti

Visitors to IUCAA (1989-90)

Dr. Chanda Jog (July 6 - 26), Indian Institute of Science, Bangalore.

Professor Abhay Ashtekar (July 21 - August 18), Syracuse University, USA.

Professor Tanmay Vachaspati (August 3-4), University of Cambridge, UK.

Professor C.V. Vishveshwara (September 4-11, 21-23 and March 26-28), Raman Research Institute, Bangalore.

Professor P.C. Vaidya (September 6-13), Gujarat University, Ahmedabad.

Dr. S. Sridhar (September 26-27), Indian Institute of Science and Raman Research Institute, Bangalore.

Dr. Ram Sagar (October 14-16), Indian Institute of Astrophysics, Bangalore.

Professor Madhav Gadgil (October 16), Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

Professor Rajaram Nityananda (November 20), Raman Research Institute, Bangalore.

Professor K.C. Wali (November 30), Syracuse University, Physics Department.

Professor Geoffrey Burbidge (December 11-21), CASS, University of California, USA.

Dr. David Malin (December 12-13), Anglo-Australian Observatory, Australia.

Professor S. Chandrasekhar (December 15, 16), University of Chicago, USA.

Professor L. Mestel (December 17-19), University of Sussex, UK.

Dr. Elena Terlevich (January 1-2), Royal Greenwich Observatory, UK.

Dr. Roberto Terlevich (January 1-2), Royal Greenwich Observatory, UK.

Mr. Sean Murphy (January 11), Vice-Consul, US Consulate, Bombay.

Professor M.R. Kundu (January 18), University of Maryland, USA.

Professor C.N.R. Rao (January 27), Indian Institute of Science, Bangalore.

Professor Bernard F. Schutz (January 28-30), University of Wales, Cardiff, UK.

Dr. Brian Meers (January 28-30), University of Glasgow, UK.

Dr. Sai Iyer (February 5-19), Raman Research Institute, Bangalore.

Professor Sir Hermann Bondi (February 8-9), Churchill College, Cambridge, UK.

Dr. S.K. Jain (March 3-5), Indian Institute of Astrophysics, Bangalore.

Professor William Fowler (March 23-25), California Institute of Technology, USA.

Seminars at IUCAA

Professor Tanmay Vachaspati: 'The non-relativistic Coulomb problem', August 3.

Dr. S. Sridhar: 'A solvable model of galaxy interaction', September 26.

Dr. Ram Sagar: 'Variable interstellar extinction and Pleiades problem in young open clusters', October 14.

Professor K.C. Wali: 'Supercollider — Why we need it', November 30.

Professor L. Mestel: 'Galactic magnetic fields', December 18.

Dr. Roberto Terlevich: 'Active galactic nuclei without black-holes', January 1.

Dr. Sai Iyer: 'Blackhole perturbations', February 5.

Dr. S.K. Jain: 'Development of a fast polarimeter', March 3.

Colloquia at IUCAA

Professor Madhav Gadgil: 'Diversity: cultural and biological', October 16.

Professor Rajaram Nityananda: 'Coherence in optics and astronomy', November 20.

Professor S. Chandrasekhar: 'How one may explore the physical content of general relativity', December 16.

Professor B.F. Schutz: 'The search for gravitational waves', January 29.

Professor Sir Hermann Bondi: 'Energy transfer in general relativity', February 9.

Professor William A. Fowler: 'The early universe', March 24.

Academic Activities at IUCAA

(I) Research

Cosmology: Playing the Devil's Advocate

Modern cosmology rests on two solid foundations: (1) Hubble's law which tells us that the redshift (i.e., the fractional increase in the wavelength) of any extragalactic object arises from the expansion of the universe and that it increases systematically with the distance of the source from us and (2) the radiation background in the microwaves that is all pervading and is believed to be the relic of the hot era through which the universe passed soon after its creation in a big bang.

How solid are these foundations? If the microwave background is indeed of primordial origin, the formation of galaxies and clusters should have left their imprints on the background, making it slightly lumpy. In actuality all attempts to discover the lumpiness have proved futile, including the most recent studies by the COBE (Cosmic Background Explorer) satellite. Moreover, several studies of galaxies and the quasars have turned up anomalous evidence indicating that not all redshifts conform to Hubble's law.

During 1989-90, Geoffrey Burbidge and Adelaide Hewitt at UCSD, La Jolla in collaboration with Jayant Narlikar and Patrick Das Gupta at IUCAA have carried out extensive statistical analysis of pairs of quasars and galaxies ... the former taken from the Burbidge-Hewitt Catalogue of quasars and the latter being bright nearby galaxies. They find that the association of high redshift quasars with low redshift galaxies is significant enough to cast doubts on the universality of Hubble's law.

In October 1989 five scientists, Chip Arp from the Max Planck Institut fur Astrophysik, Geoffrey Burbidge from University of California at San Diego, La Jolla, Fred Hoyle and Chandra Wickramasinghe from the University of Wales and Jayant Narlikar from IUCAA had a week long brainstorming session in Cardiff. The result was a document that highlights the observational and theoretical shortcomings of the standard hot big bang model and proposes an alternative scenario.

Apart from the shortcomings described above, there are others. For example, even with the lowest acceptable rate of expansion of the universe the age of most favoured big bang model turns out to be less than the ages of old globular clusters of stars. There is also a problem with the primordial abundance of the light nucleus lithium in the sense that the standard big bang theory predicts more lithium than actually found.

The alternative scenario proposed at Cardiff revives the steady state theory in a modified form. It envisages a universe without a beginning and without an end with 'mini bangs' occuring all over. The microwave background is supposed to arise from the absorption of excess starlight and its reradiation by dust grains in the form of iron needles.

Whatever the outcome of this effort, its proposers hope that the debate will at least prompt some uncommitted astronomers and physicists to take a critical look at the standard big bang cosmology.

What Powers the Blitzkrieg

From mid sixties it became known that a large scale blitzkrieg is going on, out there in the universe. The sites of the fireworks are quasars (Starlike but very very compact objects giving out enormous radiation) and active galactic nuclei (AGNs). The power output is so large and exotic that the conventional powering mechanism of nuclear fusion (which makes stars shine) cannot at all foot the bill. The work of over two decades has taught us that the source of energy is undoubtedly gravitation.

In late sixties Roger Penrose devised a novel process of mining the rotational energy of a spinning black hole by selectively putting particles on negative energy orbits which exist in the vicinity of the black holes's horizon. This was a very interesting mechanism but could not be considered for high energy sources as it was soon realised that the particle has to travel with relativistic speed to ride on a negative energy orbit.

Naresh Dadhich and Sanjeev Dhurandhar from IUCAA and Sanjay Wagh considered an innova-

tive variation of this process by setting a rotating black hole in a magnetic field in which electromagnetic interaction of the particle provides the required energy of a negative energy orbit thereby removing the constraint on the speed of the particle. This also results in a dramatic enhancement in the efficiency of the process. The process can now be termed as the 'Magnetic Penrose Process' and can be one of the few runners for the powering mechanism in quasars and AGNs. Dadhich and Wagh have reviewed the various aspects of this process and its relevance in high energy astrophysics in an article in the Physics Reports'.

A measure of Gravity !

The mass of a body produces a gravitational field just as the electric charge produces an electric field. Mass can hence be termed as the gravitational charge. The measure of electric charge is defined (by the Gauss theorem) as proportional to the flux of the electric field across a closed surface.

The question is: can gravitational charge (mass) be defined similarly? The answer is not so simple.

There is an inherent difficulty in defining energy in general relativity. There are, therefore, several definitions and expressions for mass of a system, none of them being completely satisfactory. In the spirit of the Gauss theorem, N.K. Dadhich has defined the effective gravitational charge of a rotating black hole and it has been applied by Dadhich and Chellathurai to compute the effective gravitational charge of a rotating black hole immersed in a uniform magnetic field. The definition does yield physically illuminating results.

The Road to Quantum Gravity

Abhay Ashtekar introduced a new type of basic variables for canonical formulation of Einstein's theory of gravitation with the advantage that the equations now involved only the polynomial functions of the basic variables. This is considered a big step forward on the road to the quantization of gravity.

His new formalism gave rise to interesting possibilities in the classical relativity as well. For instance, degenerate solutions of Einstein's equations were now permitted. Sucheta Koshti and Dadhich have obtained such solutions with the inclusion of the Cosmological term. In analogy with the Yang-Mills theory, self dual solutions of the Einstein's equations can be considered as gravitational instantons. Koshti and Dadhich have shown that the ansatz of Ashtekar and Rentlen, and of Samuel for self dual solutions with the cosmological constant forms the complete set of self dual solutions.

In recent years string theory has become a popular model of unification of fundamental interactions including gravity. Due to its internal consistency, it is possible to investigate, at least in principle, quantum effects in strong field regions within the string framework. Abhijit Kshirsagar has, in collaboration with C.P. Burgess and N. Harnbli, computed the Casimir energy of a string in the presence of spacetime boundaries. This provides the first step towards building a technology for handling pair production etc. in presence of strong fields.

String theoretic models also allow for a change of topology due to quantum fluctuations of the gravitational field. Notions like wormholes, baby-universes and recent attempts at explaining the vanishing of the cosmological constant are outgrowths of the same. Kshirsagar and Burgess, alongwith the North Carolina group have shown that these features are lot more generic to gravity coupled to matter and do not have to be stringy necessarily.

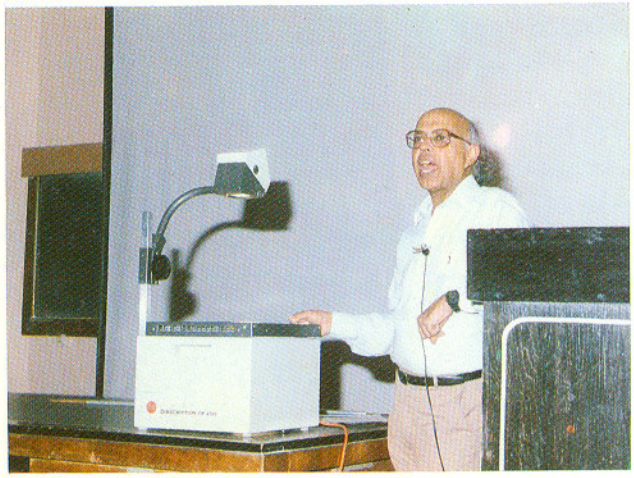
Optical observations with the Electronic Eye

The study of the distribution of optical radiation in galaxies, i.e., galaxy surface photometry, provides information on the distribution of luminous matter, mass-to-light ratio, bulge-to-disk ratio, the effect of interaction between neighbouring galaxies on their structures etc. The use of CCD (Charge Coupled Device) cameras allows galaxy surface photometry to be done rapidly and effectively, due to the high quantum efficiency and high dynamic range of the CCD detectors. A number of astronomical data analysis packages like IRAF and VISTA are now available, and the high volumes of data generated can be relatively simply analyzed.

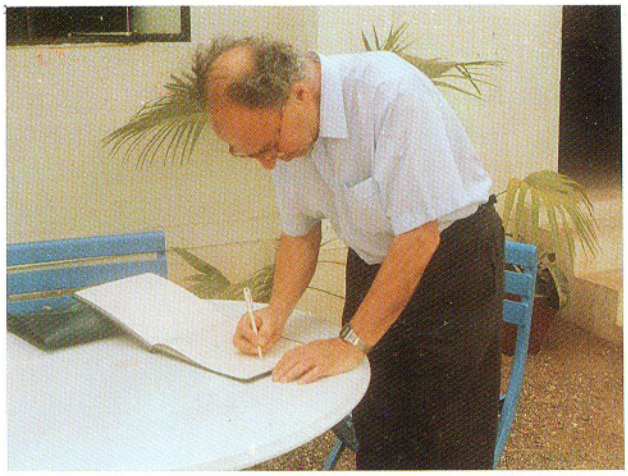
William Fowler

Abhay Ashtekar

Breaking new ground: digging for IUCAA building, phase I



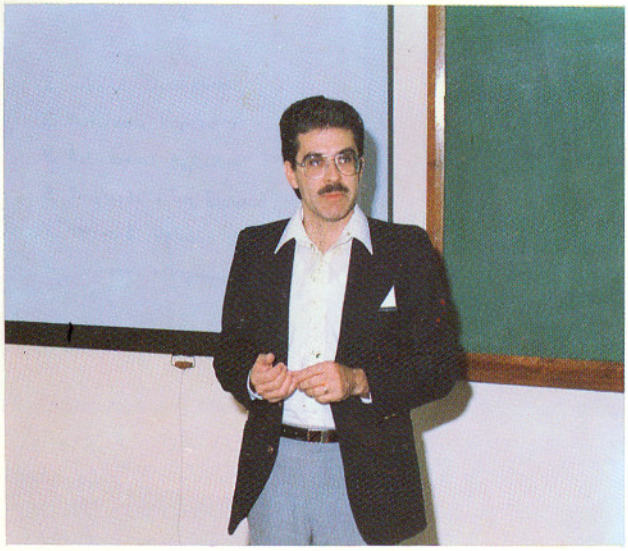
Govind Swarup: Foundation Day Lecture



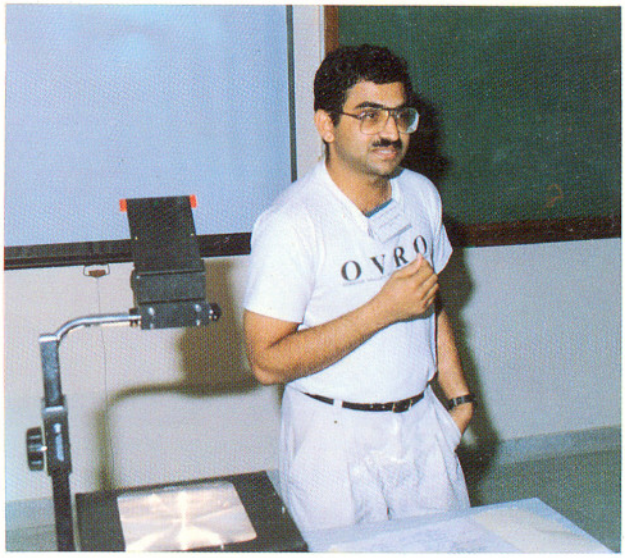
Sir Hermann Bondi

S. Chandrasekhar

Instrumentation Workshop

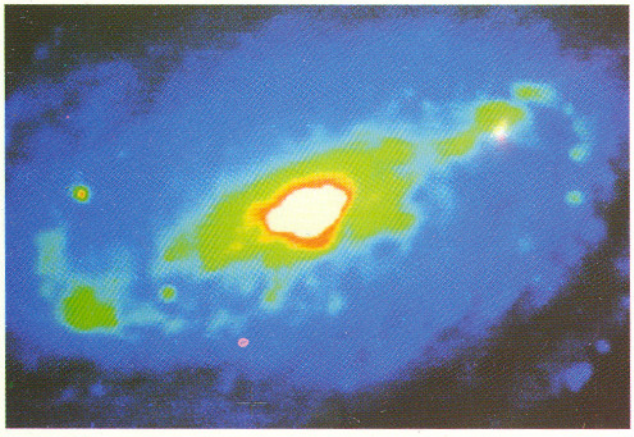


Richard Green

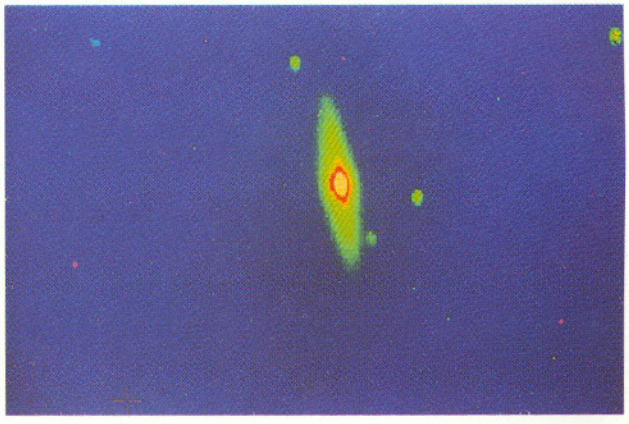


Shrinivas Kulkarni

Margaret Burbidge

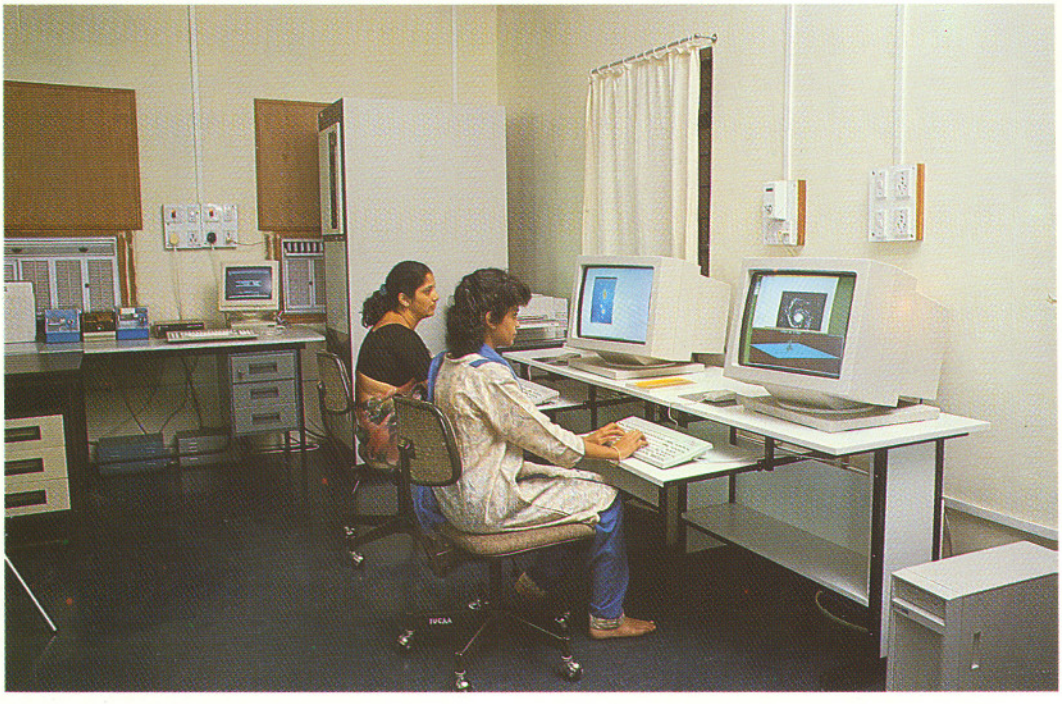


NGC 2309



SN1990G in IC 2735. The supernova is at upper left

CCD picture of galaxies were taken at the prime focus of the Vainu Bappu Telescope
as part of a IUCAA/IIA/TIFR observing programme



A view of IUCAA computer room

IUCAA has an ongoing programme of surface photometric observations of different types of galaxies under the direction of Ajit Kembhavi. The data is being obtained at the prime faces of the 2.3 m Vainu Bappu Telescope at Kavalur, which is ideally suited for such observations, as well as using the 1 m telescope of the Uttar Pradesh State Observatory at Nainital. Data on field galaxies was obtained using CCD cameras and broad band B, V, R and I filters during the 1989-90 season. The broad band data, besides being used in the manner described above, can also be used to study the distribution of colours across the galaxy, providing information about the mass function of stars, in the galaxy as a function of position, and related parameters. The broad band observations will be supplemented by observations using narrow band filters centred on prominent emission lines when pertinent. In the next season observations will be carried out on starburst galaxies, active galaxies and interacting galaxies. The analysis of the data is being done using a network of SUN computers at IUCAA. The observations and analysis are parts of collaborative programmes involving Dr. Tushar Prabhu from Indian Institute of Astrophysics, Bangalore; Dr. P.N. Bhat and K.P. Singh from Tata Institute of Fundamental Research, Bombay and Dr. Vijay Mohan from Uttar Pradesh State Observatory, Nainital.

A related ongoing programme at IUCAA is the surface photometry of a complete sample of active galaxies, data on which was obtained using different telescopes in the U.S.A. This project, which was partly funded by the Smithsonian Institution, Washington, was initiated in collaboration with Mr. Martin Elvis of the Centre for Astrophysics, Cambridge and Sanjay Wagh of Tata Institute of Fundamental Research. The data analysis was initiated at the Centre for Astrophysics and is now being completed at IUCAA.

Chasing the Elusive Gravity Waves

The direct detection of gravitational waves is one of the most challenging problems in experimental physics today. Success in this field will be of considerable significance both for astronomy, leading to new information about the universe hitherto unobtainable from the electromagnetic spectrum and for fundamental physics, where the various aspects of gravity theories can be checked.

As is now suggested the coalescing binary is the most promising source for laser interferometric detectors. Sanjeev Dhurandhar in collaboration with his colleagues A. Krolak and Dr. A. Lobo from Grup de Relativitat de l'Institut d'Estudis Catalans and Department de Fisica Fonamental, University of Barcelona have computed the signal/noise ratio when the laser interferometric detector is operated in the detuned recycling mode in the frequency band at which the sensitivity is highest the band being shifted towards the lower end (seismic barrier) of the broad band. Further work is being done in collaboration with Professor B.F. Schutz of the University of Wales, College Cardiff in estimating the time of arrival, mass parameter and the phase of the signal by analytically approximating the covariance matrix of cross-correlations between templates and the data. Recently two post doctoral fellows of IUCAA, Dr. B.S. Sathyaprakash and Dr. P. Das Gupta visited University College Cardiff for three months and the Observatory of Meudon, Paris for a month where they carried out analysis of the 100 hrs. Glasgow data from the prototype detector. In this period work on bench marking the transputers using 3L-parallel-Fortran and theoretical outputs of data analysis was undertaken. At Garching preliminary work on non stationary white noise was started. Interesting noise characteristics in the house keeping data were obtained which will help the experimentalists. They will continue the work here at IUCAA. To speed up the data analysis the computer programmes are being parallelised and put in a transputer environment.

(II) Schools and Workshops

1. An advanced miniworkshop on Quantum Gravity was held from July 21 to August 5. During this period Professor Abhay Ashtekar from the Department of Physics, Syracuse University, U.S.A. gave a series of talks on 'Recent Developments in Non-Perturbative Quantum Gravity'. Five outstation and five local active researchers participated and these lectures were held in one of the lecture halls of the Department of Physics, University of Poona.

2. IUCAA hosted an inter-university Graduate School on Gravitation and Cosmology from September 4 to 23. Forty nine graduate students and eleven resource persons participated and they were housed on the beautiful campus of the Institute of Armament Technology, Girinagar, Pune. A mark of the success of the school was the active participation by the students in tutorial and problem solving session.

3. A national workshop on Astronomical Instrumentation was held from December 11 to 13 to formulate the Instrumentation Programme and plan the Instrumentation Laboratory of IUCAA. Thirty four participants from within India and six from abroad including Professor Margaret Burbidge and Professor Geoffrey Burbidge of the Centre for Astrophysics and Space Sciences, University of California at San Diego. Dr. S.R. Kulkarni of the Astronomy Department of Caltech, Dr. Richard Green of the National Optical Astronomy Observatories, Tucson, Dr. Upendra Desai of the Goddard Space Flight Centre, NASA and Dr. K. Sivanandan of the Naval Research Laboratory, Washington, took active part in the workshop.

4. A discussion meeting on the interferometric detection of gravitational waves was organized by IUCAA jointly with the Centre for Advanced Technology (CAT), Indore on the CAT premises, February 1-3. The purpose of the meeting was to initiate feasibility studies of this frontier technology for gravity wave detection — a problem regarded as one of the key unsolved problems of physics today. The experts in this technology included Professor Bernard Schutz of University of Wales, College Cardiff, Professor Brian Meers of the University of Glasgow and Professor Alain Brillet from CNRS, Paris. There were about twenty other participants from Indian institutions invited for their experience in related areas of experiments and instrumentation. A set of clear action points emerged at the end of the discussion meeting, to be taken up further.

(III) Reports on Scientific Meretings

Mini-Workshop on Recent Developments in Non-Perturbative Quantum Gravity

Abhay Ashtekar, the first Visiting Professor of IUCAA delivered a set of lectures from July 21 to August 5 on recent developments in non-perturbative quantum gravity. The subject matter was essentially divided into two parts. The first part mainly consisted of showing that the constraints in general relativity can be put into a polynomial form by making use of the new variables. The aim of the second part was to discuss non-perturbative quantization of gravity in the framework of new variables. In what follows, we give a brief description of the above points.

In his original work, Ashtekar had demonstrated that using 2-component spinorial variables in the Hamiltonian framework one can carry out a canonical transformation of the standard phase space of general relativity (GR) and force the constraint equations of GR to take polynomial forms. Later, Samuel and, independently, Jacobson and Smolin, showed that these new spinorial variables can also be used to rewrite the action in general relativity, and consequently derive Einstein's equations in terms of these variables. However, in the first part of the lecture series, Ashtekar showed that the above results can also be obtained by making use of tetrads, and spinorial variables are by no means essential. He discussed in detail about the constraint algebra of GR while stressing on their similarities and differences with those arising in the Yang-Mills theories. In particular, he showed how the 'Gauss law' constraint generates the gauge transformation while the diffeomorphism constraint degenerates spatial diffeomorphisms. Ashtekar also drew the attention to the fact that instead of formulating the reality conditions first in terms of the old variables and then translating them to the new variables, if one begins with the new variables alone, the reality conditions are polynomial in nature. He discussed the work done in collaboration with Romano and Tate concerning the coupling of matter to gravity in this new framework. The key feature of this work is that the Hamiltonian framework is preserved upon inclusion of matter in the form of Klein-Gordon, Dirac and Yang-Mills fields.

In the second part of the workshop, Ashtekar first told the status of non-perturbative quantum gravity and discussed the failure of the perturbative approach. The central message was:

(i) Non-perturbative quantum gravity is feasible and may be a viable theory.

(ii) It is very likely that microstructure of space-time is radically different from that expected from the perturbation theory.

He began with Quantum Mechanics (QM) on manifolds and discussed some concepts in QM like Bergman Rep. Coherent States etc., applying them to the case of simple harmonic oscillator. He then discussed the ideas of Jacobson and Smolin – namely, use of traces of holonomies as solutions to Gauss and Scalar Constraint and the regularization introduced by them. He then explained Rovelli-Smolin transform and their loop space representation.

These states may be thought of as Wilson loop of Yang-Mills theory. Rovelli and Smolin have obtained infinite dimentional space of solutions to all quantum constraints. These results bring out unexpected relation between Knot theory and quantum gravity.

The next topic was to show how 2+1 Einstein gravity can be used as a toy model for testing a program for non-perturbative canonical quantization of the 3+1 theory. For that purpose he discussed the classical 2+1 gravity and constructed T^0 and T^1 variables and carried out quantization in loop representation to illustrate things clearly, he considered concrete examples which have specified topology such as 2-torus. He then studied the addition of topological term in the action.

He described 'small' and 'large' gauge transformation and their implications to the CP-violation in quantum gravity. He also discussed addition of a topological term (along the line of Chern-Simon term in Yang-Mills theories) to the action. Application of new variables to quantum cosmology was briefly described. In his last lecture, he gave a list of thirty two interesting open problems and participants are trying to solve them.

Graduate School on Gravitation and Cosmology

This graduate school was attended by 49 research workers in Gravitation and Cosmology from universities. A course of lectures covered the following topics:

(i) Geometrical Methods for Physics by Professor N. Mukunda

(ii) Relativistic Cosmology by Professor J.V. Narlikar

(iii) Introduction to Quantum Field Theory by Dr. T. Padmanabhan

(iv) Tetrads, Newman-Penrose Formalism and Spinors by Professor S.V. Dhurandhar

Professor C.V. Vishveshwara and Dr. B.R. Iyer acted as the directors of the school, while the local arrangements were made by IUCAA. At the end of the course a questionnaire was got filled from the participants concerning the various aspects of the school. From the response to the questionnaire, it is evident that the participants learnt good deal of new mathematical techniques as well as they had a glance at the new areas of research. Both the participants and the lecturers have clearly desired the continuation of such a school on a regular basis.

The school was held at the beautiful campus of Institute of Armament Technology, as IUCAA does not have its own guest house and other facilities.

Workshop on Astronomical Instrumentation

The workshop on Astronomical Instrumentation was held at IUCAA during December 11-13, 1989. It was attended by 34 experts including 6 from abroad.

The workshop had been planned by IUCAA to help focus on the following practical issues relating to its proposed Instrumentation Laboratory (IL):

a) The projects, teaching as well as R & D, that could be undertaken at the IL, with the help of students and faculty members of the universities.

b) The basic equipment necessary at IL to enable such projects to be carried out, and

c) The manpower needed at the IL to supervise and support the overall instrumentation programme.

Professor B.V. Sreekantan who chaired the Discussion Session outlined the national perspective on Astronomy and Astrophysics (A&A) in the country. He briefed about the recommendations made at the end of the meeting of astronomers and astrophysicists convened at Bangalore during August 24-26 at the instance of the Department of Science and Technology (DST) to help focus on the developmental strategies in A&A during the period of the VIII Plan (1990-95).

Professor Narlikar outlined the basic premises and expectations on which IUCAA's instrumentation programme is to be based. First as outlined in IUCAA's Project Report, the IL of IUCAA should be looked upon as a field station by the universities. As such IL should contain sophisticated facilities which are normally too expensive to be replicated in most unversity departments. Thus the Instrumentation efforts of the university sector would be divided in a complementary fashion between the university departments and IUCAA.

Further IUCAA would have an in-house core group of experts in instrumentation which would guide or collaborate with the university faculty and students wishing to use the IL facilities. It was, however, necesary to involve experts from the various national facilities also as guides/resource persons: for, in the last analysis the instrumentation efforts were geared to providing manpower to use those facilities.

The two-fold objectives of the IL set in accordance with the discussion at the Bangalore Meeting are: to help develop teaching aid instruments and to undertake advance R & D projects.

Professor Margaret Burbidge stressed the need to look upon astronomy as a branch of physics and the need to teach the subject in physics departments rather than the mathematics departments as was mostly done in the past.

Professor Srinivas Kulkarni highlighted his experience of getting graduate students to build research oriented instruments as projects. He also made the point that only the 'best' quality projects should be undertaken. At the teaching end he felt that there were M.Sc. thesis projects feasible on 1m-2m class telescopes.

Dr. Richard Green said that the goal of the instrumentation programme should be to make the observing capabilities internationally competitive and to generate self sufficiency in terms of observing support and maintenance. For this purpose the equipment at the IL has to be of international standard.

Professor S.N. Tandon pointed out that students not necessarily the brightest ones could be motivated to undertake instrumentation through participation. It was necessary to 'build' rather than 'buy' in order to genuinely bring in the culture of instrumentation.

The workshop was aimed at crystallising a viable instrumentation programme which would be carried out by IUCAA in collaboration with the various research groups in the universities and institutions. Such a programme would include, for example, the following activities:

1. Focal plane instrumentation for optical, IR, UV telescopes.
2. Payloads of space missions.
3. Image Processing.
4. Fabrication of detectors, interferometers, etc.
5. Any other instrumentation needed to get the best of the available facilities.

A list of appropriate equipments was also prepared in consultation with the experienced scientists.

Workshop on Gravity Wave Detection

Indirect evidence of the existence of gravitational radiation has been provided by observations on the binary pulsar PSR 1913+16 and this gives added impetus to the experimental development in this field.

A workshop on interferometric gravitational wave detectors was held at the Centre for Advanced

Technology (CAT), Indore from February 1-3, to consider the possibility of such an experiment in India. It was attended by twenty-five scientists including three experts, Professor Bernard Schutz, University of Wales, Cardiff; Professor Brian Meers, University of Glasgow and Professor Alain Brillet from CNRS, Orsay, Paris. In addition two Soviet scientists were present who had been at CAT for another meeting.

Professor Schutz began by describing the nature of gravitational waves, the effort being put into their detection and various astrophysical sources of gravitational waves. Professor Meers and Brillet described in detail the techniques required in the various aspects of the experiment broadly, lasers, laser optics, vacuum and seismic isolation and suspension. The demands on the sensitivity and accuracy of the experiment require the technology to be pushed to its limits in almost all its aspects. Professor S.N. Tandon described the T.I.F.R. experiment at Gouribidnur on the detection of the fifth force, Dr. A.S. Rajarao gave an account of vacuum technology in the country and Dr. D.D. Bhawalkar reviewed our capabilities in lasers and laser optics. The participants also had a tour of CAT laboratories and our colleagues from U.K., France and U.S.S.R. were impressed by the developmental work being done at CAT.

Professor Schutz and Meers were asked by the Indian participants to do feasibility calculations to find out whether a hundred metre detector could be scientifically fruitful among the proposed full scale detectors around the world. The experts came back with the verdict that a 100 metre detector operating in the narrow band mode may prove scientifically useful for, say, pulsar detection and could have similar sensitivities as the full scale detectors in their initial stages when they would necessarily be operating in the broad band mode. It would be prudent, at first to think of a prototype on which experimental expertise could be gained but at the same time allow us to be in the game with the rest of the detectors. A hundred metre detector perfectly fits the bill.

During the discussion session, it was generally felt that the experiment is technologically very challenging as well as formidable and the consensus was that an expert group should go into the various aspects of the experiment and submit a report on the feasibility of further work in this direction. The following persons were requested to take up further studies: Dr. P.K. Gupta, lasers; Dr. A.S. Rajarao, vacuum system; Professor S.N. Tandon, seismic isolation; Professor S.V. Dhurandhar, data analysis and Dr. D.D. Bhawalkar, servo systems/electronics.

(IV) The Foundation Day Lecture

This lecture has been instituted to mark IUCAA's Foundation Day, December 29. Professor Govind Swarup, Director, GMRT Project, TIFR, Pune gave the first lecture on "Search for a 'Cold Gaseous Phase' of the Universe" in Sir C.V. Raman Auditorium, Physics Department, University of Poona, on that day.

(V) Publications by IUCAA Members

a) Journals and Proceedings

S. Koshti and N.K. Dadhich (1989) Degenerate spherical symmetric cosmological solutions using Ashtekar's variables, *Class. Quantum Grav., 6*, L 223.

— (1989) On the self duality of the Weyl tensor using Ashtekar's variables, *Class. Quantum Grav., 7*, L 5.

S.M. Wagh and N.K. Dadhich (1989) The energetics of black holes in electromagnetic fields by the Penrose process, *Phys. Rep. 183*, 137.

V. Chellathurai and N.K. Dadhich (1990) Effective mass of a rotating black hole in a magnetic field, *Class. Quantum Grav., 7*, 361.

S.V. Dhurandhar, A. Krolak and J.A. Lobo (1989) Detuned recycling: Application to the detection of gravitational waves from coalescing binaries, *Mon. Not. R. Astr. Soc., 238*, 1407.

A.K. Kembhavi, S.M. Wagh and D. Narasimha (1989) Relativistic beaming of X-rays from quasars in *Active Galactic Nuclei*, IAU Symposium 134, eds. D.E. Osterbrook and J.S. Miller, (Kluwar Academic Publishers), p. 209.

C.P. Burgess, N. Harnbli and A. Kshirsagar (1989) Strings, strong fields and boundaries, *Class. Quantum Grav.*, 6, 1473.

C.P. Burgess and A. Kshirsagar (1989) Wormholes and duality, *Nucl. Phys. B 324*, 157.

J.D. Brown, C.P. Burgess, A. Kshirsagar, B.F. Whiting and J.W. York, Jr. (1989) Scalar field wormholes, *Nucl. Phys. B 328*, 213.

J.V. Narlikar (1989) Noncosmological redshifts, *Sp. Sci. Rev., 50*, 523.

— (1989) The theories of relativity, in *Horizons of Physics*, ed. A.W. Joshi (Wiley Eastern), p. 1.

— (1989) Did the Universe originate in a big bang? in *Cosmic perspectives*, eds. S.K. Biswas, D.C.V. Mallik and C.V. Vishveshwara (Cambridge University Press), p. 109.

— (1989) Relics of the big bang, in *Gravitation Gauge Theories and the Early Universe*, eds. B.R. Iyer, N. Mukunda and C.V. Vishveshwara (Kluwar Academic Publishers), p. 59.

— (1989) Recent trends in general relativity and cosmology, *Progress of Mathematics, 23*, 1.

— (1989) Applied Mathematics: A no man's land?, *Maths. Studt., 57*, 31.

— (1990) Curriculum for the training of astronomers, in *Teaching of Astronomy*, Proceedings of IAU Colloquium No. 105, eds. J.M. Pasachoff and J.R. Percy (Cambridge University Press), p. 7.

— (1990) A series of astronomy programmes for television in India, in *Teaching of Astronomy*, Proceedings of IAU Colloquium No. 105, eds. J.M. Pasachoff and J.R. Percy (Cambridge University Press), p. 342.

J.V. Narlikar and A.K. Kembhavi (1989) Non standard cosmologies, in *Galaxies and cosmology*, eds. V.M. Canuto and B.G. Elmegreen (Gordon and Breach), p. 301.

b) Books

J.V. Narlikar 'The Frontier between Physics and Astronomy': Macmillan India Ltd., 1989

— *'Brahmmand kee kuch jhalke'* (Some Glimpses of the Universe): Madhya Pradesh Hindi Granth Akademi (in Hindi), 1989

— *'Aalokam'* (Translation of 'Preshit' Science Fiction novel): Orient Longman Ltd. (in Telugu), 1990

— *'Vishvani Utpatti'* (The Origin of the Universe): Parichay Trust (in Gujarati), 1990

— *'Vidnyanachi Garudjhep'* (The Giant Leap of Science): Shrividya Prakashan (in Marathi), 1990

— *'Vidnyan ani Vaidnyanik'* (Science and the the Scientists): Shrividya Prakashan (in Marathi), 1990

(VI) Pedagogical Activities

a) Ph.D. Thesis

Mr. Ravi Kulkarni — "Spinorial Techniques in Classical General Relativity", University of Poona. (Supervisor N.K. Dadhich)

Ms. Smita Shanbhag — "Effect of a QSO on its Host Galaxy", Bombay University. (Supervisor A.K. Kembhavi)

b) Teaching

Lectures given at the M.Sc. (Physics), University of Poona

Course: Astrophysics I & II

A.K. Kembhavi: 50

J.V. Narlikar: 20

N.K. Dadhich: 10

Course: Electrodynamics

N.K. Dadhich: 25

S.V. Dhurandhar: 16

J.V. Narlikar: 5

Course: Refresher Course for Physics Teachers

S.V. Dhurandhar: 8

Lectures given at IUCAA Graduate School

S.V. Dhurandhar: 25 (Mathematical Physics)

A.K. Kshirsagar: 40 (Quantum Field Theory)

Lectures given at IUCAA Graduate Summer School

Patrick Das Gupta: 6 (Relativistic Cosmology)

S.V. Dhurandhar: 9 (Tetrads, Newman Penrose Formalism, Spinors)

J.V. Narlikar: 9 (Gravitation and Cosmology)

(VII) Seminars and Invited Talks

a) Technical Talks

N.K. Dadhich
Gravitational charge of a rotating blackhole in magnetic field: Meudon Observatory, June 16.

S.V. Dhurandhar
The inverse problem in gravitational wave detection: Meudon Observatory, Paris, May 31.

The inverse problem: 5,4,3 detectors: Max Planck Institute, Munich, June 15.

The Indian effort in gravity wave detection: Glasgow, U.K., June 28.

A.K. Kembhavi
Millisecond pulsars: University of Montreal, June 24.

Tidal capture binaries: University of Toronto, June 26.

Archival and scientific data centre for astronomy: DST Seminar on Astronomy Facilities under the VIII Plan, IIA, Bangalore, August 23-25.

CCD observations of galaxies: First Vainu Bappu Telescope Workshop, Kavalur, August 26.

X-ray beaming in quasars: Goddard Space Flight Centre, Maryland, November 26.

X-ray beaming in quasars: Kitt Peak National Observatory, Arizona, November 27.

Data in astronomy: National CODATA Conference, University of Poona, February 6.

Image processing: Physics Department, University of Delhi, February 13.

A.K. Kshirsagar
Wormholes, baby universes and all that: McMaster University, Hamilton Ont., Canada, September 19.

J.V. Narlikar
Some puzzling phenomena concerning the large scale structure of the universe: Radio Astronomy Centre, Ooty seminar on 'The Large Scale Structure and Evolution of the Universe', April 20-22.

Discrete source statistics and cosmological evolution: Centre for Astrophysics and Space Sciences, UCSD, San Diego, USA, May 16.

Archival and scientific data centre for astronomy: 13th Annual Meeting Astronomical Society of India, Srinagar, June 23.

Binary stars as tests of gravity theory: International Workshop on Binary Stars and Stellar Atmospheres, Osmania University, Hyderabad, August 7-11.

The association of QSOs with galaxies: Institute of Astronomy, Cambridge, October 4.

Time asymmetry in electrodynamics and cosmology: International Seminar and Workshop on 'Time' arranged by the Max Muller Bhavan and the National Centre for the Performing Arts, Bombay, October 9-14.

Cosmological problems that can be attempted with a large optical telescope: DST Workshop on 'Scientific requirements motivating a large national telescope for optical/IR astronomy.

Large scale structure of the universe; facts and theories: XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

Education through astronomy: Indian Science Congress, Cochin, February 5.

The response of the universe to micro-interactions: Symposium on 'Chance and determinism in Science', Cochin (organised by the Indian Institute of Advanced Study Shimla), February 5.

Evolution of stars: Refresher Course for Physics Teachers, Department of Physics, University of Poona, February 19.

The mathematical base of science: VI Annual Session of the Gujarat Science Academy, Bhavnagar, February 24.

Science and Society: Tata Management Training Centre, March 9.

Space, Time and the Cosmos: Singapore Independence 25th Anniversary Celebrations — Indian Programme - Science Week - Science Symposium at the National University of Singapore, March 31.

B.S. Sathyaprakash
Techniques of Gravitational Wave Data Analysis at XV IAGRG Conference, Siliguri, November 4-7.

b) Popular Talks

N.K. Dadhich

Evolution of our concepts of space and time: Jyotirvidya Parisanstha, April 16.

Space, Time and the Universe: National Defence Academy, Khadakvasla, January 24.

Newton's laws revisited: INS Shivaji, Lonavla, February 17.

S.V. Dhurandhar

Gravitational Waves, Jyotirvidya Parisanstha, Pune, April 30.

A.K. Kembhavi

Pulsars: Jyotirvidya Parisanstha, Pune, May 16.

Adhunik technology ani antaralache vedh: lecture in Marathi delivered at annual conference of amateur astronomers from Maharashtra at Thane, December 24.

A.K. Kshirsagar

Pracharya Richard Feynman; Vyakti Ani Karya: Marathi Vidnyan Parishad, Pune, February 27.

J.V. Narlikar

Human endeavers to understand the universe: Tagore Memorial Lecture, IIT Kharagpur, April 3.

Nature of the universe: Birla Public School, Bombay, April 14.

Nature of the universe: Enrichment Seminar for Standard IX of Atomic Energy Education Society Schools, May 2.

Nature of the universe: Department of Physics, University of Kashmir, Srinagar, June 22.

Water transport and its ecological effect: Second Semester, Sea Oration of the Society for Clean Environment and Bombay Institute of Technology — K.C. College, Bombay, July 21.

The search for extraterrestrial intelligence: Institution of Electronics and Telecommunications Engineers, Pune, August 4.

Vishvarachaneche Vaidnyanik Siddhant (Scientific theories of the origin of the universe): Jnana-Prabodhini, August 19.

Men and books: Sahitya Akademi, New Delhi, August 26.

Vishvachi Rachna (Origin of the universe): Jidnyasa, Fergusson College, Pune, October 9.

The fun of doing mathematics: B.V. Singbal Memorial Lecture, Goa, November.

Finger prints in space: Centenary Endowment Lecture to the Intelligence Bureau, New Delhi, December 22.

Anuvidnyanache pranete — Dr. Homi Bhabha (The initiator of Atomic Energy — Dr. Homi Bhabha): AIR, January 26.

Convocation address to Marathwada University, Aurangabad, January 28.

Stars as fusion reactors: DAE-C.V. Raman Lectures of the Indian Physics Association, Wilson College, Bombay, February 14, and SIES College, Bombay, February 15.

Observing the Cosmos: National Defence Academy, Khadakvasla, February 17.

Vishvachi Sahal (A journey through the universe): Srijan Anand Vidyalaya, Kolhapur, March 3.

Vedha Vishwache (Observing the universe): TV appearance, Bal Chitravani programme, March 15.

The Origin of the Universe: AIR, March 27.

Reaching Out to the Heavens: TV script and appearance, UGC-EMRC programme on GMRT & IUCAA, March 30.

B.S. Sathyaprakash

Birth and Death of Stars: Spicer Memorial College, Pune, October 17.

(VIII) Non-Technical Articles

J.V. Narlikar

Creativity, Society and Science
India International Centre Quarterly, Futures, Special Number, Spring 1989, p. 25.

Reaching out to the Heavens
India Digest, May/June 1989, p. 2.

Khagolshastrachi Vaidnyanik Chaukat (The scientific framework of astronomy) (in Marathi)
Suryamalechi Kahani, ed. Niranjan Ghate, Pramod Prakashan, Pune, p. 5.

Vidnyan, tantradnyan ani Marathi bhasha (Science and Technology and Marathi language) (in Marathi)
Ruchi, August 1989.

Vidnyan ani tantradnyanachi Maharashtratli Char dashake (Four decades of Science and Technology in Maharashtra) (in Marathi)
Souvenir issue of Jagatik Marathi Parishad, August.

What is India's Role in the Study of the Cosmos?
Times of India, October 3.

Cambridge (in Marathi)
Maharashtra Times Diwali Number 1989, p.3.

Pustake, Lekhak ani mi (Books, Authors and I) (in Marathi)
Maharashtra Times, December 17.

Chip Arp chi vaidnyanik jhunj (The scientific battles of Chip Arp) (in Marathi)
Sakal, February 1.

(IX) Collaborative Programmes and Conferences

a) Collaborative Programmes

IUCAA-Cardiff collaboration:

Detection of gravitational wave is the most challenging experiment in physics today. If successful, it will lead to a new view of the universe through gravitational wave astronomy. The experiment is very difficult and requires enormous outlay of resources both in money and expertise. There is a global effort being invested in this project. Laser interferometry with large arms is the generally accepted technique.

With a view to probe the possibility of initiation of work in this direction, Professors N.K. Dadhich and S.V. Dhurandhar visited the Gravitational Wave Laboratory at Orsay, Meudon Observatory and Universities of Wales, Cardiff and Glasgow. Professor S.V. Dhurandhar also visited the Max-Planck Institute for Astrophysics and Quantum Optics. They had very useful discussions with the scientists working on this project for several years.

Professor Bernard F. Schutz of the University of Wales is the global leader of the signal analysis of gravity wave detectors. As a first step to build up collaboration, Professor Schutz agreed to have two post-docs from IUCAA for a period of 3 months each to work on the data analysis of signals from detectors.

This collaboration has taken off excellently, Drs. P. Das Gupta and B.S. Sathya Prakash had a very fruitful visit to Cardiff during December-February, and Professor Schutz and Dr. Brian Meers of the Glasgow University visited IUCAA in February and participated in the Workshop organised at CAT, Indore to assess our technological capability in the context of the requirements of the experiment.

IUCAA-CFA collaboration:

Martin Elvis of the Harvard-Smithsonian Centre for Astrophysics (CFA), Ajit Kembhavi of IUCAA and Sanjay Wagh are involved in a project on the surface photometry of active galaxies. The data set consists of galaxies identified with a complete sample of HEAO-1 X-ray sources. Broad band fluxes in the optical region were obtained by various observers using Palomar and CTIO telescopes. The images are being processed to obtain for each galaxy in the sample the nuclear luminosity, various galaxy model parameters, distribution of colours etc.

Preliminary processing of the sample has been completed at CFA, and further work is in progress at IUCAA. The project is supported by a grant from the Smithsonian Institution, Washington and was initiated while Ajit Kembhavi and Sanjay Wagh were at the Tata Institute of Fundamental Research, Bombay.

b) Conferences

N.K. Dadhich
XII ICGRG, Boulder, Colorado, U.S.A., July 2-8.

DST meeting on VIII Plan Facilities in Astronomy & Astrophysics, IIA, Bangalore, August 24-26.

The First Vainu Bappu Telescope Workshop, Kavalur, August 26-27.

XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

S.V. Dhurandhar
XII ICGRG, Boulder, Colorado, U.S.A., July 2-8.

XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

Workshop on "High Performance Computing", C-DAC, Pune, March 1-4.

A.K. Kembhavi
XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

IAU Colloquium 124 on "Paired and Interacting Galaxies", University of Alabama, Tuscaloosa.

DST meeting on VIII Plan Facilities in Astronomy & Astrophysics, IIA, Bangalore, August 24-26.

The First Vainu Bappu Telescope Workshop, Kavalur, August 26-27.

A.K. Kshirsagar
International Colloquium on Modern Quantum Field Theory, TIFR, Bombay, January 8-14.

Instructional Workshop on Quantum Chromodynamics, IISc, Bangalore, March 26-31.

P.A. Malegaonkar
XVII IASLIC Conference, Rajasthan University, Jaipur, December 27-30.

J.V. Narlikar
Astronomical Society of India Meeting, Srinagar, June 22-25.

DST meeting on VIII Plan Facilities in Astronomy & Astrophysics, IIA, Bangalore, August 24-26.

Workshop on Cosmology, University of Wales, Cardiff, September 25-29.

DST Workshop on Scientific Requirements Motivating a Large Optical Telescopes, Bangalore, October.

Indo-French Workshop on Science-Image-Society, Surajkund, Haryana, October 21-27.

Indo-US Workshop on Mathematics Education, Goa, October 30-November 7.

XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

Careers in Research: One day seminar arranged by the Marathi Vidnyan Parishad, V.G. Vaze College, Mulund, December 31.

Annual Meeting of the Marathi Vidnyan Parishad, Junnar, January 6-7.

Annual Meeting of the Gujarat Science Academy, Bhavnagar, February 24-25.

B.S. Sathyaprakash
ASI meeting, Srinagar, June 22-25.

XV IAGRG Conference, North Bengal University, Siliguri, November 4-7.

A Modern course in Quantum Mechanics, IIT Madras, May.

(X) Awards and Distinctions

J.V. Narlikar
Honorary Fellow of the Institute of Electronics and Telecommunications Engineers

Kendriya Hindi Sansthan Atmaram award for writing in Hindi

DAE Raman Lecture Award of the Indian Physics Association

Corresponding Fellow of the Third World Academy of Sciences

Honorary Professor of the Tata Institute of Fundamental Research

Honorary Professor of the Jawaharlal Nehru Centre for Advanced Studies

Indira Gandhi Prize for Popularization of Science for 1990. (Indian National Science Academy)

Facilities at IUCAA

Library

The IUCAA Library is being developed as a major collection of the literature on astronomy, astrophysics and related areas. In one year of operation it has acquired about 2500 books and catalogues, and hopes to increase its holdings very substantially in the next 2 years. The astronomical collection is supported by literature from the general areas of physics and mathematics. There are also small number of books on the other basic sciences, arts and humanities. The library is being developed in such a manner that it benefits research workers as well as students and less experienced persons coming to IUCAA for summer school, refresher courses and the like.

IUCAA now subscribes to about a hundred periodicals, many of which arrive by airmail. The idea is to have an up-to-date collection of scientific journals to which the university and the astronomical community has easy access.

A novel feature of the IUCAA Library is that all its functions are computerized. The software, developed "ab initio" by M/s Algorhythms in close consultation with IUCAA staff, resides on a network of IBM-PC compatibles. All user services like literature searches, issue of books, reservations etc. are computerized. The computerization also extends to all library management functions like acquisition of books and periodicals, accessioning and cataloguing, circulation monitoring etc. The software is user-friendly and has been designed in such a manner that it can be easily installed in various university departments and institutions, on a single PC-AT or a network, at a reasonable cost.

Computer Centre

IUCAA has started developing a network of workstations to serve its computing and image processing requirements. The network at the present consists of a SUN 4 server with 32 Mbytes core memory, disk space of about 2 Gigabytes and various peripherals, a SUN 386i workstation, and PC-compatibles using the NFS protocol. Two SPARC stations are expected to arrive soon. The network is expected to expand rapidly in the coming year, as the demand for computers goes up due to increase in the number of academics at IUCAA as well as visitors from the universities. In keeping with emerging trends the world over, it has been decided to base most of the computing at IUCAA on workstations. This permits a flexible approach which can be tailored to needs and resources, taking into account developments in computing technology which now occur over a timescale of several months.

High speed computing which cannot be handled by workstations is at present done using the NEC mini-super computer of the National Informatics Centre (NIC) at Pune. A terminal at IUCAA is connected to the NIC computer. As the need for such computers grows at IUCAA during the next year, a suitable mini-super or super computer will be acquired.

IUCAA has a local area network of PC-compatibles of various kinds. This is employed to implement the library, accounts and administration software packages, as well as for word-processing, drafting and computer courses for students. The computer centre also provides facilities for typesetting, desktop publishing and E-mail.

Interaction with Universities

IUCAA wishes to build up its interaction with universities through various programmes: (a)organisation and co-sponsorship of conferences, schools, workshops at IUCAA as well as on the university campuses and ensuring participation of university scientists, (b) Associateship programme and (c) IUCAA faculty visiting various universities for lectures and discussions. As the strength of the IUCAA faculty grows so will its interaction with universities.

Professor Yash Pal, Chairman, UGC has appointed a committee consisting of Professor Rais Ahmed, N. Mukunda and J.V. Narlikar for suggesting ways and means for building up interaction between IUCAA and universities. The committee's recommendations have served as guidelines for planning the programmes.

Schools and Workshops:

Reports on various events organised by IUCAA have already been mentioned, the following is the list of events in which university scientists participated.

1. Professor Abhay Ashtekar conducted a miniworkshop at IUCAA in July-August on Non-Perturbative Quantum Gravity. A couple of university scientists attended the same.

2. Inter University Graduate School held at Pune in September had 49 participants, most of whom were the research scholars from the universities.

3. Workshop on Astronomical Instrumentation was held at IUCAA in December for chalking out experimental and instrumentation programmes for IUCAA. A couple of experts from universities participated in it.

The following meetings were cosponsored by IUCAA for supporting participation of university scientists in them.

1. Meeting of Indian Association of General Relativity and Gravitation held at North Bengal University, Siliguri in November.

2. IAU Symposium 142 on Basic Plasma Processes on the Sun held at IIA Bangalore in December.

Regional Discussion Meetings:

With a view to initiating a dialogue with the universities and to solicit their cooperation in teaching and research in Astronomy and Astrophysics (A&A) on their campuses IUCAA proposes meetings with faculty members of the universities.

The first meeting of this kind was held on 31 March 1990 at the Centre for Advanced Technology, Indore, for the central region. It was attended by faculty members from A.P.S. University, Rewa, Devi Ahilya Vishwavidyalaya, Indore Jiwaji University, Gwalior; Vikram University, Ujjain and two faculty members from IUCAA.

Professor Dadhich briefed the university representatives about the programmes and facilities available at IUCAA, and invited everyone from the universities interested in A&A to make use of them. The following points emerged during the ensuing discussion:

1. M.Sc. syllabi are being revised in many universities. This opportunity should be taken to introduce 1 or 2 semester courses in A&A. Laboratory astrophysics experiments, as well as observations using the 3" telescopes which many universities already have, should be made an integral part of the course.

2. IUCAA should provide help in developing A&A syllabi for theoretical as well as practical work. IUCAA should arrange short lecture courses by its faculty in departments offering A&A.

3. IUCAA should soon start the services of providing lists of recent publications, photocopies of papers etc. to the university community.

Similar meetings will be held at IIT Kanpur during April 20-22, 1990 and at Calcutta University on May 26, 1990.

Associateship Programme:

One of the key programmes to strengthen IUCAA's interaction with universities is the Associateship programme through which university academics can visit IUCAA for extended periods on a regular basis for 3 years. They can make use of the facilities available at IUCAA and carry on un-interrupted research work aided by IUCAA's visitors and core members.

The first batch of 8 Senior Associates has been nominated by the Chairman, Governing Body of IUCAA. They are listed elsewhere in this report.

Visits to University campuses:

IUCAA's faculty visits various university campuses and colleges for giving lectures and discussions. Professor Narlikar has visited in this connection Osmania University, Shivaji University and universities of Cochin, Marathwada, Goa, Kashmir, North Bengal, Bhavnagar, and various colleges in Pune and Bombay.

IUCAA
Inter-University Centre for
Astronomy and Astrophysics
Post Bag 4,
Ganeshkhind,
Pune 411 007

Audited Balance Sheet as at 31st March 1990

Funds & Liabilities		Rs. Ps.	Property & Assets	Rs. Ps.
1. **Trusts Funds or Corpus**			1. Fixed Assets	1,05,55,273.74
Balance as per last Balance Sheet	65,50,000		2. Investments (Bank of Baroda)	4,00,000.00
add: received during the year from University Grants Commission	63,00,000	1,28,50,000.00	3. Current Assets	4,55,235.84
			4. Cash on hand	5,794.16
2. **Other earmarked Funds** Building Fund - Grant received from University Grants Commission		62,00,000.00	5. Cash at Bank	25,92,082.45
			6. Amount receivable	15,58,984.82
3. U.G.C. Grant received in advance for the year 1990-91		10,00,000.00	7. Telephone Deposit	42,000.00
4. Current Liabilities		4,47,900.02	8. Car Advance to Staff	65,200.00
			9. Advance for Expenses	7,400.00
			10. Income & Expenditure A/c	48,15,929.01
	Total	2,04,97,900.02	Total	2,04,97,900.02