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

An Autonomous Institution of the University Grants Commission

(April 1, 1992 – March 31, 1993)

Contents

The Council and the Governing Body

The Council

President G. Ram Reddy
Chairman
University Grants Commission

Vice-President S.K. Khanna
Vice-Chairman
University Grants Commission

Members P. Rama Rao
Secretary to the Government of India
Department of Science and Technology

U.R. Rao
Secretary to the Government of India
Department of Space

S.K. Joshi
Director General
Council of Scientific and
Industrial Research

Y.N. Chaturvedi
Secretary
University Grants Commission

S.C. Gupte
Vice-Chancellor,
University of Poona

G. Swarup
Director
National Centre for Radio Astrophysics

R.N. Basu
Vice-Chancellor,
Calcutta University

M.N. Faruqui
Vice-Chancellor
Aligarh Muslim University

M.I. Savadatti
Vice-Chancellor
Mangalore University

K.N. Chatterjee
(till December 31, 1992)
Vice-Chancellor
North Bengal University

D. D. Jadeja
(till December 31, 1992)
Vice-Chancellor
Sardar Patel University

H.K. Manmohan Singh
(till December 31, 1992)
Vice-Chancellor
Punjabi University

M.D.K. Kuthalingam
(till December 31, 1992)
Vice-Chancellor
Madurai Kamaraj University

K.D. Abhyankar
(from January 1, 1993)
Emeritus Professor
Osmania University

A. Banerjee
(till December 31, 1992)
Department of Physics
Jadavpur University

R.R. Daniel
(from May 28, 1993)
Secretary, COSTED

H.S. Mani
Mehta Research Institute of Mathematics
and Mathematical Physics

Jafar Nizam
(till September 1992)
Ex-Vice-Chancellor
Kakatiya University
and Member of UGC

P. Jayarama Reddy
(from October 1992)
Vice-Chancellor,
Sri Venkateswara University
and Scientist Member of UGC

P.M. Mathews
(till December 31, 1992)
Department of Theoretical Physics
University of Madras

R.K. Thakur
(till December 31, 1992)
School of Studies in Physics
Ravishankar University

S.K. Trehan
(till December 31, 1992)
Centre for Advanced
Study in Mathematics
Panjab University

S.N. Tandon
IUCAA

M.S. Sodha
(from January 1, 1993)
Vice-Chancellor
Lucknow University

Rudraiah Nanjundappa
(from January 1, 1993)
Vice-Chancellor
Gulbarga University

Bashiruddin Ahmed
(from January 1, 1993)
Vice-Chancellor
Jamia Millia Islamia

G.S. Randhawa
(from January 1, 1993)
Vice-Chancellor
Guru Nanak Dev University

N.C. Varshneya
(from January 1, 1993)
Department of Physics
Roorkee University

A.K. Sen
(from January 1, 1993)
Department of Physics
Calcutta University

H.S. Gurm
(from January 1, 1993)
Department of Astronomy
and Space Sciences
Punjabi University

Member Secretary — J.V. Narlikar
Director, IUCAA

The Governing Body

Chairman	G. Ram Reddy
Vice-Chairman	S.K. Khanna
Members	Y.N. Chaturvedi
	R.R. Daniel (from May 1993)
	S.C. Gupte
	G. Swarup
	R.N. Basu
	M.N. Faruqui
	H.S. Mani
	Jafar Nizam (till September 1992)
	P. Jayarama Reddy (from October 1992)
	M.I. Savadatti
	S.N. Tandon
Member Secretary	J.V. Narlikar

Honorary Fellows

1. S. Chandrasekhar
   University of Chicago, USA

2. W.A. Fowler
   California Institute of Technology, USA

3. R. Hanbury Brown
   Andover, England

4. A. Hewish
   University of Cambridge, England

5. Sir Fred Hoyle
   Bournemouth, England

6. D.S. Kothari†
   New Delhi

7. Yash Pal
   New Delhi

8. A.K. Raychaudhuri
   Calcutta

9. A. Salam
   International Centre for Theoretical Physics
   Trieste, Italy

10. P.C. Vaidya
    Gujarat University, Ahmedabad

† expired on 04.02.93

Statutory Committees

The Scientific Advisory Committee

K.D. Abhyankar
Osmania University, Hyderabad

J.R. Bond
Canadian Institute for Theoretical Astrophysics
Toronto, Canada

R.D. Cannon
Anglo-Australian Observatory, Sydney, Australia

D. Lynden-Bell
Institute of Astronomy, Cambridge, England

N.C. Mathur
Indian Institute of Technology, Kanpur

R. Ramachandran
Institute of Mathematical Sciences, Madras

N. Kameswara Rao
Indian Institue of Astrophysics, Bangalore

N.V.G. Sarma
Raman Research Institute, Bangalore

B.V. Sreekantan
National Institute of Advanced Studies, Bangalore

R.K. Thakur
Ravishankar University, Raipur

J.V. Narlikar (Convener)
IUCAA

The Finance Committee

G. Ram Reddy (Chairman)
S.K. Khanna (Member)
Y.N. Chaturvedi (Member)
L.S. Narayanan (Member)
J.V. Narlikar (Member)
T. Sahay (Non-Member Secretary)

The Users' Committee

J.V. Narlikar (Chairman)

Vice-Chancellors

M. Bhattacharya, University of Burdwan
M.N. Desai, Gujarat University
V. Iyengar, Osmania University

Scientists

K.B. Bhatnagar, Zakir Husain College, Delhi
H.L. Duorah, Gauhati University
S.N. Tandon, IUCAA
N.K. Dadhich, IUCAA (Convener)

The Academic Programmes Committee

J.V. Narlikar (Chairman)
N.K. Dadhich
S.V. Dhurandhar
A.K. Kembhavi
T. Padmanabhan
N.C. Rana
S.N. Tandon (Convener)

The Standing Committee for Administration

J.V. Narlikar (Chairman)
T. Sahay (Secretary)

Members of IUCAA

Academic Staff

J.V. Narlikar (Director)
N.K. Dadhich
S.V. Dhurandhar
R. Gupta
A.K. Kembhavi
T. Padmanabhan
N.C. Rana
V. Sahni
S.N. Tandon

Scientific Staff

N.U. Bawdekar
R. Chaware
V. Chellathurai
P. Chordia
M. Deshpande
G.B. Gaikwad
A.M. Kane
P.A. Malegaonkar
V. Mestry
A. Paranjpye
R. Radhakrishnan

Administrative and Support Staff

T. Sahay (Senior Administrative Officer)
K.M. Abhyankar
N.V. Abhyankar
R. Barke
S.L. Gaikwad
B.R. Gorkha
B.S. Goswami
R.S. Jadhav
B.B. Jagade
M.M. Karnik
S.N. Khadilkar
J.B. Koli
P. Krishnan
M.A. Mahabal
S. Mathew
S. Mirkute
E.M. Modak
K.B. Munuswamy
K.C. Nair
N. Pargaonkar
R.D. Pardeshi
R. Rao
M.A. Raskar
M.S. Sahasrabudhe
S. Samuel
B.V. Sawant
S. Shankar
D.R. Shinde
D. Surti
V.R. Surve
A. Syed
S.R. Tarphe

Post-Doctoral Fellows

G.C. Anupama
D.P.K. Banerjee
R.K. Gulati
P. Das Gupta
J.C. Hwang
A.K. Kshirsagar
B.S. Sathyaprakash
A.K. Sen

Research Scholars

J.S. Bagla
R. Balasubramanian
V. Chickarmane
D. Duari
T.S. Ghosh
K. Jotania
A. Mahabal
D. Munshi
A.N. Ramaprakash
L. Sriramkumar

Project Appointees

J. Apte
R. Kalesh
G. Molakala
S. Pitre
A. Sohoni (DST Project)
N. Srivastava (Project Scientist)

Organizational Structure of IUCAA

IUCAA's project report envisaged an 'eightfold way' for IUCAA's academic activities. To systematise them, the following organizational structure was created as from August 1, 1992, with the persons in charge mentioned in brackets underneath.

The Director
(J.V. Narlikar)

Chairman, Core Programmes
(S.N. Tandon)

Head, Post–Doctoral Research
(S.V. Dhurandhar)

Head, Computer Centre
(A.K. Kembhavi)

Head, Library and Documentation
(A.K. Kembhavi)

Head, Publications
(T. Padmanabhan)

Head, M.Sc. and Ph.D. Programmes
(T. Padmanabhan)

Head, Instrumentation Laboratory
(S.N. Tandon)

Chairman, Visitor Programmes
(N.K. Dadhich)

Head, Associateship Programmes
(N.K. Dadhich)

Head, Workshops and Schools
(S.V. Dhurandhar)

Head, Guest Observer Programmes
(A.K. Kembhavi)

Head, Science Popularization and Amateur Astronomy
(N.C. Rana)

Awards and Distinctions

S.V. Dhurandhar

Appointed as the data analysis consultant to the Australian International Gravitational Observatory (AIGO) Project, 1992.

Abhijit Kshirsagar

Selected as Associate of the Indian Academy of Sciences, 1992.

J.V. Narlikar

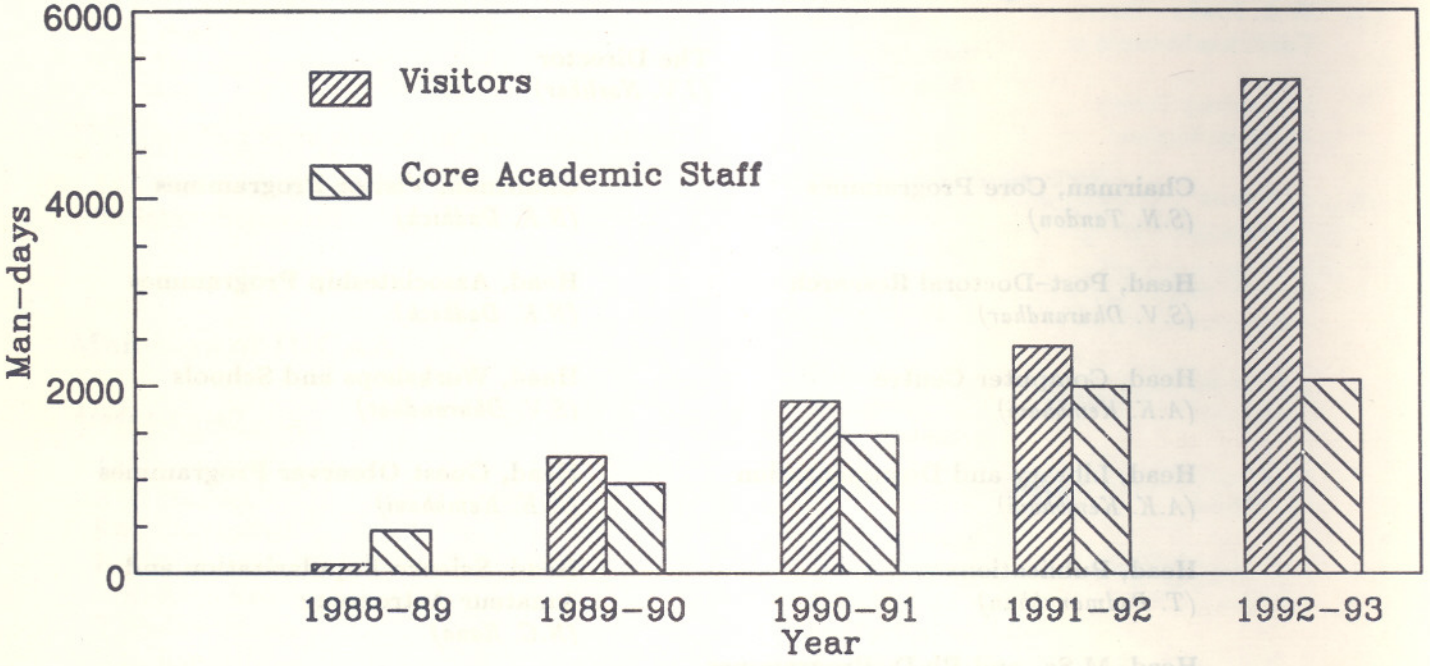
FICCI Award 1991-92 for Physical Sciences including Mathematics.

Elected Fellow of Third World Academy of Sciences, 1993.

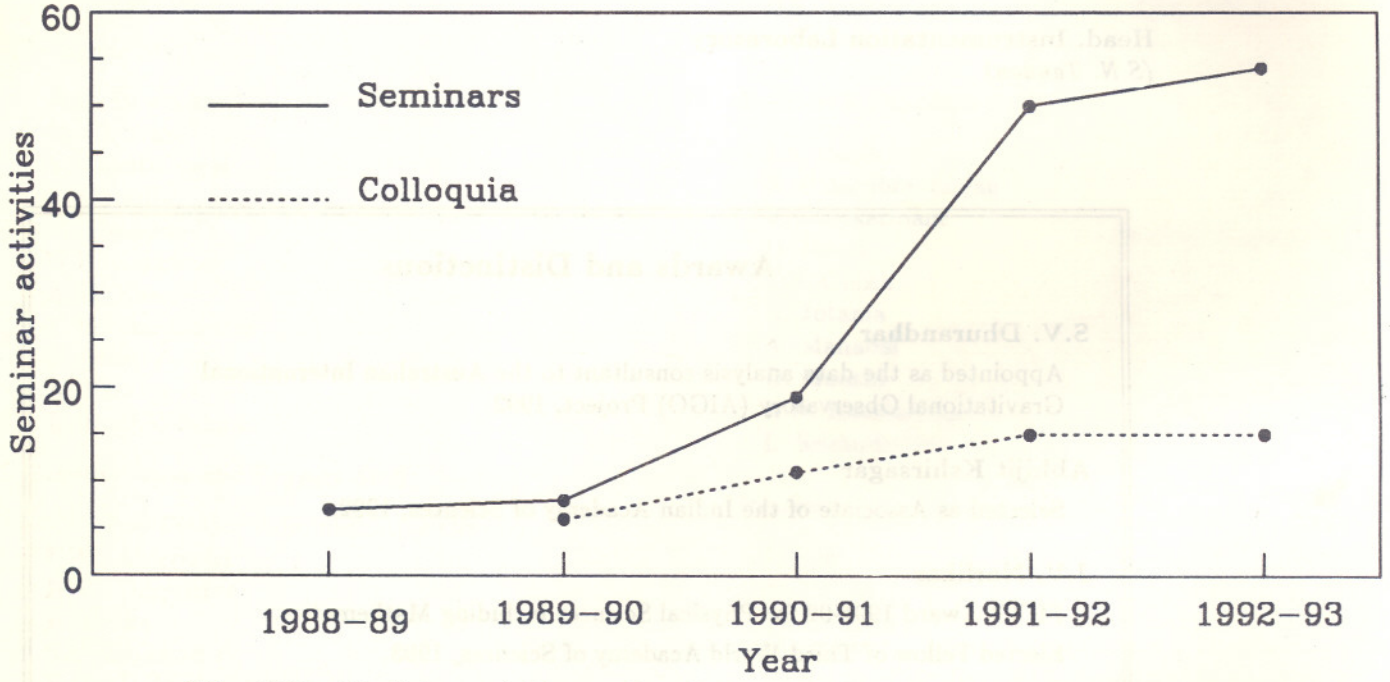
T. Padmanabhan

Birla Science Prize - 1991.

VISITOR MAN-DAYS IN COMPARISON WITH CORE ACADEMIC STAFF MAN-DAYS



SEMINAR ACTIVITIES*



* In 1992-93, Informal Discussion Group meetings are included in seminars

Director's Report

The year 1992–93 had a special significance in the brief history of IUCAA. On December 28, 1992, our institutional buildings were dedicated to their users by Chairman Professor Ram Reddy. Present on the occasion were wellwishers of IUCAA from far and near. All of us felt specially privileged that the Dedication Address on the occasion was delivered by Professor S. Chandrasekhar of the University of Chicago, who also happens to be an Honorary Fellow of IUCAA. Before his address Professor Chandrasekhar pressed a button that, under remote control, released the bob of the Foucault Pendulum in the Aryabhata Building. It was also a happy coincidence that this year's Foundation Day Lecture was given by Professor Yash Pal who, as the Chairman, UGC had unveiled the Foundation Stone of IUCAA four years earlier.

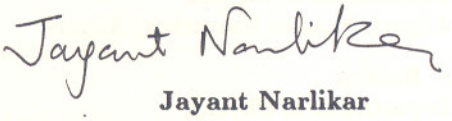
The **Aryabhata** Building contains the academic and administrative offices of IUCAA, and forms the centrepoint of the institutional complex. Other parts of the complex also carry Indian names. The block of lecture halls is called **Bhaskara**, the instrumentation laboratory and the computer centre are housed in **Brahmagupta** while the library is in the **Varahamihira** Building : all named after Indian astronomers of the 5^{th}–12^{th} centuries. The odd one out is the Canteen Building, named **Ballava** after the name adopted by Bhima in the *Mahabharata* in his disguise as a cook! The hostel and the guest flatlets are respectively named **Nalanda** and **Takshashila**, after our ancient seats of learning. The entire institutional complex is called **Devayani** (the Indian name for Andromeda) while the housing colony nearby is called **Akashganga** (the Milky Way). For astronomers, Andromeda and the Milky Way are neighbouring galaxies in a vast universe stretching to billions of light years.

With the dedication of the institutional buildings, IUCAA's academic activities have picked up considerably. Although the accompanying graphs show the rising trend, the full impact will be seen only next year. We are now looking forward to the completion of the 500 seater auditorium sited next door to **Aditi**, the modest shed that provided shelter to IUCAA in the early days. The auditorium will be ready for the 6^{th} Asian Pacific Regional Meeting on Astronomy of the International Astronomical Union to be held in Pune during August 16–20, 1993.

This Annual Report gives a comprehensive picture of IUCAA's activities. The usage of our facilities by the academics from universities and colleges has been increasing steadily but there is considerable scope for improvement. *May I urge all Vice-Chancellors to look upon IUCAA as a field station created for their university and college campuses?* If they allow greater mobility to their teachers, researchers and students, an inter-university centre has much to offer them.

We were deeply grieved when we lost Professor D.S. Kothari, an Honorary Fellow. An astrophysicist from the 1930s, Professor Kothari had played a key role in shaping our university system. He had a soft corner for us at IUCAA, and we will miss him.

In his address at the Dedication Ceremony, the Chairman had expressed his pleasure at the progress made by IUCAA in the short span of time since it was founded on December 29, 1988. A large part of the credit for this achievement goes to our mother agency, the UGC, which has extended prompt help and cooperation whenever asked for. I also thank all my colleagues for their dedicated support during IUCAA's formative phase.



Jayant Narlikar

Visiting Members of IUCAA

Visiting Professors

Abhay Ashtekar
Syracuse University, USA

C.V. Vishveshwara
Indian Institute of Astrophysics, Bangalore

Senior Associates

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

S.M.R. Ansari
Department of Physics
Aligarh Muslim University, Aligarh

S. Banerji
Department of Physics
University of Burdwan, Burdwan

B. Basu
Department of Applied Mathematics
Calcutta University, Calcutta

K.B. Bhatnagar
Department of Mathematics
Zakir Husain College, Delhi

H.L. Duorah
Department of Physics
Gauhati University, Guwahati

A.K. Goyal
Department of Physics
Hans Raj College, Delhi

B. Ishwar
Department of Mathematics
Bihar University, Muzaffarpur

A.N. Maheshwari
Cochin University of Science and Technology
Kochi

S. Mukherjee
Department of Physics
North Bengal University, Darjeeling

B.K. Pal
Department of Physics
Himachal Pradesh University, Shimla

N. Panchapakesan
Department of Physics and Astrophysics
University of Delhi, Delhi

L.K. Patel
Department of Mathematics
Gujarat University, Ahmedabad

L. Radhakrishna
Department of Mathematics
Shivaji University, Kolhapur

S.G. Tagare
School of Mathematical and CIS
University of Hyderabad

R.K. Thakur
School of Studies in Physics
Ravishankar University, Raipur

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

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

Associates

F. Ahmad
Department of Physics
University of Kashmir, Srinagar

G.M. Ballabh
Department of Astronomy
Osmania University, Hyderabad

S.H. Behere
Department of Physics
Marathwada University, Aurangabad

Suresh Chandra
Department of Physics
University of Gorakhpur, Gorakhpur

D.P. Datta
Department of Mathematics
NERIST, Arunachal Pradesh

B.N. Dwivedi
Department of Physics
Banaras Hindu University, Varanasi

K. Indulekha
Department of Physics
Mahatma Gandhi University, Kottayam

K.N. Iyer
Department of Physics
Saurashtra University, Rajkot

Z.H. Khan
Department of Physics
Jamia Millia Islamia, New Delhi

Pushpa Khare
Department of Physics
Utkal University, Bhubaneswar

S. Mahajan
Department of Physics,
St. Stephen's College, Delhi

Man Mohan
Department of Physics
Kirori Mal College, Delhi

Udit Narain
Department of Physics
Meerut College, Meerut

S.R. Prabhakaran Nayar
Department of Physics
University of Kerala, Trivandrum

S.K. Pandey
School of Studies in Physics
Ravishankar University, Raipur

U.S. Pandey
Department of Physics
University of Gorakhpur, Gorakhpur

A. Qaiyum
Department of Physics
Aligarh Muslim University, Aligarh

R. Ramakrishna Reddy
Department of Physics
Sri Krishnadevaraya University, Anantapur

L.M. Saha
Department of Physics
Zakir Husain College, Delhi

A.K. Sapre
School of Studies in Physics
Ravishankar University, Raipur

P.P. Saxena
Department of Mathematics and Astronomy
Lucknow University, Lucknow

A. Sharma
Department of Physics
Kurukshetra University, Kurukshetra

T. Singh
Department of Applied Mathematics
Banaras Hindu University, Varanasi

D.C. Srivastava
Department of Physics
University of Gorakhpur, Gorakhpur

S.K. Srivastava
Department of Mathematics
North Eastern Hill University, Shillong

R.S. Tikekar
Department of Mathematics
Sardar Patel University, Vallabh Vidyanagar

D.B. Vaidya
Department of Physics
Gujarat College, Ahmedabad

Visiting Fellows

J. Anosova
A. Beesham
S.V. Chervon
V.I. Korchagin
L. Kiseleva

Visitors

L. Kiseleva (April 1-June 14)
Russian State Pedagogical University, Russia

A. Anosova (April 1-July 31)
St. Petersburg University, Russia

M. Dwivedi (April 2-10)
Ravishankar University, Raipur

D.P.K. Banerjee (April 5- 8)
Physical Research Laboratory, Ahmedabad

T.P. Prabhu (April 12-13)
Indian Institute of Astrophysics, Bangalore

A.K. Sen (April 12-14)
Physical Research Laboratory, Ahmedabad

C. Jog (April 13)
Indian Institute of Science, Bangalore

N.D. Haridass (April 13-15)
Institute of Mathematical Sciences, Madras

S.M. Alladin (April 20-25)
Osmania University, Hyderabad

R. Ramakrishna Reddy (April 27-May 15)
Sri Krishnadevaraya University, Anantapur

S.D. Verma (April 27-28)
Gujarat University, Ahmedabad

K.B. Bhatnagar (April 27-29)
Zakir Husain College, Delhi

H.L. Duorah (April 27-28)
Gauhati University, Guwahati

P. Bhattacharjee (April 27-May 2)
Tata Institute of Fundamental Research, Bombay

S.G. Tagare (May 1-June 30)
University of Hyderabad, Hyderabad

K.N. Iyer (May 7-24)
Saurashtra University, Rajkot

S. Banerji (May 9-31)
University of Burdwan, Burdwan

S. Mukherjee (May 9-June 18)
North Bengal University, Darjeeling

G.M. Ballabh (May 11-June 4)
Osmania University, Hyderabad

A.R. Prasanna (May 13-17)
Physical Research Laboratory, Ahmedabad

K.S.V.S. Narasimhan (May 17-June 16)
Madras

S. Shivagurunathan (May 18-July 18)
Birla Institute of Technology and Science, Pilani

R.S. Tikekar (May 18-June 21)
Sardar Patel University, Vallabh Vidyanagar

B.N. Dwivedi (May 20-30)
Banaras Hindu University, Varanasi

G. Yellaiah (May 20-26)
Kakatiya University, Warangal

R.S. Bisht (May 20-24)
Physical Research Laboratory, Ahmedabad

H.I. Pandya (May 20-22)
Physical Research Laboratory, Ahmedabad

V.R. Venugopal (May 20-June 30)
Madurai Kamaraj University, Madurai

P. Vivek (May 20-June 20)
Indian Institute of Technology, Kanpur

Pushpa Khare (May 21-June 20)
Utkal University, Bhubaneswar

S.M. Alladin (May 21-June 3)
Osmania University, Hyderabad

S.D. Verma (May 22-June 7)
Gujarat University, Ahmedabad

S. Srianand (May 24-June 20)
Utkal University, Bhubaneswar

K.B. Bhatnagar (May 27-June 11)
Zakir Husain College, Delhi

L.M. Saha (May 27-June 11)
Zakir Husain College, Delhi

L.K. Patel (June 1-21)
Gujarat University, Ahmedabad

Udit Narain (June 1-July 19)
Meerut College, Meerut

Sushil Kumar (June 1-30)
Meerut College, Meerut

M.S.Z. Chaghtai (June 2-15)
Aligarh Muslim University, Aligarh

S. Chandra (June 3-17)
University of Gorakhpur, Gorakhpur

S.K. Pandey (June 4-30)
Ravishankar University, Raipur

D.C. Srivastava (June 5-29)
University of Gorakhpur, Gorakhpur

Dr. N. Panchapakesan (June 7-27)
University of Delhi, Delhi

P.V. Kulkarni (June 8-11)
Sangli

T. Padmanabhan (June 15-20)
Tata Institute of Fundamental Research, Bombay

Jeeva Anandan (June 30-July 2)
University of South Carolina, USA

D.P. Datta (July 5-August 15)
NERIST, Arunachal Pradesh

Devendra Sahu (July 11-August 10)
Ravishankar University, Raipur

S.R. Valluri (July 17-August 9)
The University of Western Ontario, Canada

B.A. Kagali (July 20-27)
Bangalore University, Bangalore

M.N. Anandram (July 20-27)
Bangalore University, Bangalore

A. Beesham (July 21-February 5)
University of Zululand, South Africa

M.I. Savadatti (July 22-25)
Mangalore University, Mangalore

G.K. Mehta (July 23-24)
Nuclear Science Centre, New Delhi

M.D. Tiwari (July 23-26)
University Grants Commission, New Delhi

G. Rajasekaran (July 23-25)
Institute of Mathematical Sciences, Madras

N. Kumar (July 23-26)
Indian Institute of Science, Bangalore

C. Jog (July 27-31)
Indian Institute of Science, Bangalore

Gordon Love (July 28-August 5)
University of Durham, U.K.

S.V. Chervon (August 5-February 29)
Moscow State University at Ulyanovsk, Russia

Mayank Mehta (August 8-12)
Indian Institute of Science, Bangalore

M.P. Bora (August 14-18)
Gauhati University, Guwahati

B.K. Agrawal (August 22-26)
Allahabad University, Allahabad

S.C. Malik (August 22-29)
Indira Gandhi National Centre for the Arts, Delhi

B.N. Saraswati (August 22-26)
Indira Gandhi National Centre for the Arts, Delhi

K. Vatsyayan (August 22-25)
Indira Gandhi National Centre for the Arts, Delhi

O. Guillaume (August 22-28)
French Embassy, Delhi

C. V. Vishveshwara (August 23-September 16)
Indian Institute of Astrophysics, Bangalore

P.M. Bhargava (August 23-27)
Centre for Cellular and Molecular Biology, Hyderabad

C. Chakraborty (August 23-27)
Centre for Cellular and Molecular Biology, Hyderabad

A.K. Chakravarty (August 23-29)
Astro Society, Calcutta

H.A.A. Azmi (August 23-28)
Jamia Hamdard, Hamdard University, New Delhi

A. Hussain (August 23-28)
Jamia Hamdard, Hamdard University, New Delhi

P.K. Mukhopadhyay (August 23-28)
FAMTSIT, Jadavpur University, Calcutta

N. Mukunda (August 23-28)
Indian Institute of Science, Bangalore

Raja Ramanna (August 23-24)
National Institute of Advanced Studies, Bangalore

B.V. Subbarayappa (August 23-30)
Indian Institute of World Culture, Bangalore

E.C.G. Sudarshan (August 23-28)
University of Texas, Austin

S.K. Ghatak (August 24-26)
Indian Institute of Technology, Delhi

R. Ballestracci (August 24-26)
French Consulate, Delhi

Laxman Shastri Joshi (August 24-27)
Pradnya Pathashala Mandal, Wai

M.P. Rege (August 24-27)
Pradnya Pathashala Mandal, Wai

O. Siddiqui (August 24-25)
Tata Institute of Fundamental Research, Bombay

J. Audouze (August 24-26)
Institut d'Astrophysique, Paris

H.L. Duorah (August 28-September 17)
Gauhati University, Guwahati

P.P. Saxena (August 28-September 15)
Lucknow University, Lucknow

K. Duorah (August 28-September 17)
Gauhati University, Guwahati

Biplab Bhawal (August 29-31)
Mehta Research Institute of Mathematics and Mathematical Physics, Allahabad

Gordon Love (September 1- 4)
University of Durham, U.K.

S.M. Alladin (September 7-27)
Osmania University, Hyderabad

A.K. Sapre (September 8-23)
Ravishankar University, Raipur

Man Mohan (September 8-23)
Kirori Mal College, Delhi

T.P. Prabhu (September 9-10)
Indian Institute of Astrophysics, Bangalore

N.M. Singhi (September 13-15)
Tata Institute of Fundamental Research, Bombay

S.K. Pandey (September 20-October 14)
Ravishankar University, Raipur

V.R. Venugopal (September 20-December 4)
Madurai Kamaraj University, Madurai

S.S. Jha (September 21-30)
Tata Institute of Fundamental Research, Bombay

K.P. Singh (September 24-27)
Tata Institute of Fundamental Research, Bombay

K.S.V.S. Narasimhan (September 25-October 18)
Madras

N. Srivastava (September 27-29)
University of Allahabad, Allahabad

R. Ramakrishna Reddy (September 27-October 16)
Sri Krishnadevaraya University, Anantapur

Ravi Kumar (September 27-October 16)
Sri Krishnadevaraya University, Anantapur

T.R. Seshadri (September 27-October 2)
University of Delhi, Delhi

Ashoke Sen (September 27-28)
Tata Institute of Fundamental Research, Bombay

J.R. Estrada (September 27-29)
World Cultural Council, Mexico

E.M. Wild (September 27-29)
World Cultural Council, Mexico

L. Hernandez (September 27-29)
World Cultural Council, Mexico

E. Medellin (September 27-29)
American and Mexican Television, Mexico

Kiran Shanker (October 4- 6)
Allahabad University, Allahabad

M. Diwan (October 7-December 7)
Stanford University and SSC Laboratory, USA

R.P. Saxena (October 8-21)
University of Delhi, Delhi

B.K. Datta (October 8-23)
ICSC World Laboratory, Calcutta

Devendra Sahu (October 8-22)
Ravishankar University, Raipur

Neeharika Thakur (October 8-22)
Ravishankar University, Raipur

D.K. Chakraborty (October 8-25)
Ravishankar University, Raipur

Alain Omont (October 18-20)
Institut d'Astrophysique, Paris

B.V. Sreekantan (October 18-20)
National Institute of Advanced Studies, Bangalore

C. Mukku (October 26-29)
University of Hyderabad, Hyderabad

R.S. Tikekar (October 29-November 14)
Sardar Patel University, Vallabh Vidyanagar

L.K. Patel (October 29-November 14)
Gujarat University, Ahmedabad

Laxmi Desai (October 29-November 14)
Gujarat University, Ahmedabad

M.I. Savadatti (November 1- 5)
Mangalore University, Mangalore

R. Ramaswamy (November 1- 2)
Jawaharlal Nehru University, New Delhi

E. Islam (November 5-13)
National Council of Science Museums, Calcutta

S.V.R. Murthy (November 5-13)
National Council of Science Museums, Calcutta

R. Cowsik (November 8-10)
Indian Institute of Astrophysics, Bangalore

M.C. Pande (November 9-11)
Uttar Pradesh State Observatory, Nainital

N. Kameswara Rao (November 10-11)
Indian Institute of Astrophysics, Bangalore

R. Nityananda (November 10-12)
Raman Research Institute, Bangalore

B. Lokanadham (November 10-11)
Osmania University, Hyderabad

Pramod Rathod (November 10-21)
Bombay

L.N. Gawande (November 11-20)
Shri Shivaji Science College, Amravati

B.R. Trivedi (November 11-21)
Baroda

V.S. Taiwade (November 11-21)
Bombay

H.V. Mone (November 11-21)
Bombay

K. Raja (November 11-21)
G.T.M. College, Tamil Nadu

P.B. Doad (November 11-21)
Akola

S.G. Nene (November 11-20)
Rajkot

A.K. Chakravarty (November 11-22)
Astro Society, Calcutta

A.K. Heblekar (November 11-21)
College of Arts and Science, Goa

S. Chakravarty (November 11-22)
Alipurdar College, West Bengal

M.P. Bora (November 11-21)
Gauhati University, Guwahati

M.W. Kasture (November 11-21)
Nanded

R.K. Mittal (November 11-21)
Nehru Planetarium, Allahabad

S.S. Patil (November 11-21)
Pratap College, Amalner

N. Mukunda (November 15-18)
Indian Institute of Science, Bangalore

M.L. Kurtadikar (November 17-28)
J.E.S. College, Jalna

S.K. Popalghat (November 17-28)
J.E.S. College, Jalna

P. Khare (November 18-December 3)
Utkal University, Bhubaneswar

S.S. Ali (November 21-December 12)
Aligarh Muslim University, Aligarh

D. Banhatti (November 21-December 12)
Madurai Kamaraj University, Madurai

A. Chakraborty (November 21-December 12)
Physical Research Laboratory, Ahmedabad

Ajit Desai (November 21-December 12)
Gujarat Communications and Electronics, Baroda

S.C.P. Halakatti (November 21-December 12)
Karnatak University, Belgaum

Sr. Leony Mary (November 21-December 12)
Stella Maris College, Madras

Alka Misra (November 21-December 12)
Lucknow University, Lucknow

Bani Mukherjee (November 21-December 5)
Indian School of Mines, Dhanbad

R.S. Pandey (November 21-December 12)
University of Gorakhpur, Gorakhpur

D. Panigrahi (November 21-December 12)
Jadavpur University, Calcutta

G. Alagar Ramanujam (November 21-December 12)
N.G.M. College, Pollachi

Devendra Sahu (November 21-December 12)
Ravishankar University, Raipur

Amitava Sil (November 21-December 12)
Jadavpur University, Calcutta

R. Srianand (November 21-December 12)
Utkal University, Bhubaneswar

Neeharika Thakur (November 21-December 12)
Ravishankar University, Raipur

V.V. Kunte (November 21-December 12)
Bombay

T.P. Prabhu (November 22-December 11)
Indian Institute of Astrophysics, Bangalore

P.P. Saxena (November 22-December 11)
Lucknow University, Lucknow

K. Indulekha (November 22-December 11)
Mahatma Gandhi University, Kottayam

R. Cowsik (November 23-25)
Indian Institute of Astrophysics, Bangalore

C.S. Unnikrishnan (November 23-25)
Tata Institute of Fundamental Research, Bombay

Geetha Jayaram (November 25-27)
Osmania University, Hyderabad

V. Korchagin (November 26-February 17)
Rostov University, Russia

S. Chakrabarti (November 29-December 4)
Tata Institute of Fundamental Research, Bombay

P.R. Pisharoty (November 30)
Pune

H. Yilmaz (December 3- 6)
Hamamatsu Photonic Systems Corporation, Japan

Y. Mizobuchi (December 3- 6)
Hamamatsu Photonic Systems Corporation, Japan

S.G. Tagare (December 6-January 4)
University of Hyderabad, Hyderabad

U.C. Joshi (December 13-31)
Physical Research Laboratory, Ahmedabad

T.P. Singh (December 13-19)
Tata Institute of Fundamental Research, Bombay

S. Shandarin (December 13-29)
University of Kansas at Lawrence, USA

R. Sheth (December 13-22)
University of Virginia, USA

W. Saslaw (December 13-19)
University of Virginia, USA

S. Inagaki (December 13-22)
Kyoto University, Japan

F. Bouchet (December 13-22)
Institut d' Astrophysique, Paris

S. Raychaudhury (December 13-22)
Harvard University, USA

C. Jog (December 13-23)
Indian Institute of Science, Bangalore

M.K. Das (December 13-23)
Sri Venkateswara College, New Delhi

D. Narasimha (December 13-19)
Tata Institute of Fundamental Research, Bombay

R.D. Prabhu (December 13-23)
Indian Institute of Astrophysics, Bangalore

N. Mukunda (November 15-18)
Indian Institute of Science, Bangalore

M.L. Kurtadikar (November 17-28)
J.E.S. College, Jalna

S.K. Popalghat (November 17-28)
J.E.S. College, Jalna

P. Khare (November 18-December 3)
Utkal University, Bhubaneswar

S.S. Ali (November 21-December 12)
Aligarh Muslim University, Aligarh

D. Banhatti (November 21-December 12)
Madurai Kamaraj University, Madurai

A. Chakraborty (November 21-December 12)
Physical Research Laboratory, Ahmedabad

Ajit Desai (November 21-December 12)
Gujarat Communications and Electronics, Baroda

S.C.P. Halakatti (November 21-December 12)
Karnatak University, Belgaum

Sr. Leony Mary (November 21-December 12)
Stella Maris College, Madras

Alka Misra (November 21-December 12)
Lucknow University, Lucknow

Bani Mukherjee (November 21-December 5)
Indian School of Mines, Dhanbad

R.S. Pandey (November 21-December 12)
University of Gorakhpur, Gorakhpur

D. Panigrahi (November 21-December 12)
Jadavpur University, Calcutta

G. Alagar Ramanujam (November 21-December 12)
N.G.M. College, Pollachi

Devendra Sahu (November 21-December 12)
Ravishankar University, Raipur

Amitava Sil (November 21-December 12)
Jadavpur University, Calcutta

R. Srianand (November 21-December 12)
Utkal University, Bhubaneswar

Neeharika Thakur (November 21-December 12)
Ravishankar University, Raipur

V.V. Kunte (November 21-December 12)
Bombay

T.P. Prabhu (November 22-December 11)
Indian Institute of Astrophysics, Bangalore

P.P. Saxena (November 22-December 11)
Lucknow University, Lucknow

K. Indulekha (November 22-December 11)
Mahatma Gandhi University, Kottayam

R. Cowsik (November 23-25)
Indian Institute of Astrophysics, Bangalore

C.S. Unnikrishnan (November 23-25)
Tata Institute of Fundamental Research, Bombay

Geetha Jayaram (November 25-27)
Osmania University, Hyderabad

V. Korchagin (November 26-February 17)
Rostov University, Russia

S. Chakrabarti (November 29-December 4)
Tata Institute of Fundamental Research, Bombay

P.R. Pisharoty (November 30)
Pune

H. Yilmaz (December 3- 6)
Hamamatsu Photonic Systems Corporation, Japan

Y. Mizobuchi (December 3- 6)
Hamamatsu Photonic Systems Corporation, Japan

S.G. Tagare (December 6-January 4)
University of Hyderabad, Hyderabad

U.C. Joshi (December 13-31)
Physical Research Laboratory, Ahmedabad

T.P. Singh (December 13-19)
Tata Institute of Fundamental Research, Bombay

S. Shandarin (December 13-29)
University of Kansas at Lawrence, USA

R. Sheth (December 13-22)
University of Virginia, USA

W. Saslaw (December 13-19)
University of Virginia, USA

S. Inagaki (December 13-22)
Kyoto University, Japan

F. Bouchet (December 13-22)
Institut d' Astrophysique, Paris

S. Raychaudhury (December 13-22)
Harvard University, USA

C. Jog (December 13-23)
Indian Institute of Science, Bangalore

M.K. Das (December 13-23)
Sri Venkateswara College, New Delhi

D. Narasimha (December 13-19)
Tata Institute of Fundamental Research, Bombay

R.D. Prabhu (December 13-23)
Indian Institute of Astrophysics, Bangalore

Sanjay Wagh (December 13-30)
Central India Research Institute, Nagpur

Anunay K. Choudhary (December 13-24)
Sri Venkateswara College, New Delhi

O. Lahav (December 16-22)
Institute of Astronomy, Cambridge

M.P. Khanna (December 22-25)
Panjab University, Chandigarh

D.P. Datta (December 23-31)
NERIST, Arunachal Pradesh

S. Iyer (December 24-31)
Physical Research Laboratory, Ahmedabad

B.K. Pal (December 24-February 15)
Himachal Pradesh University, Shimla

C.K. Shah (December 24-30)
INFLIBNET, Ahmedabad

L.K. Patel (December 25-31)
Gujarat University, Ahmedabad

R.K. Thakur (December 25-January 1)
Ravishankar University, Raipur

S.H. Behere (December 25-30)
Marathwada University, Aurangabad

B. Ishwar (December 26-31)
Bihar University, Muzaffarpur

Udit Narain (December 26-January 8)
Meerut College, Meerut

N.V.G. Sarma (December 27-January 1)
Raman Research Institute, Bangalore

S. Banerji (December 27-31)
University of Burdwan, Burdwan

S. Mukherjee (December 27-January 4)
North Bengal University, Darjeeling

G.M. Ballabh (December 27-30)
Osmania University, Hyderabad

V.R. Venugopal (December 27-31)
Madurai Kamaraj University, Madurai

K.B. Bhatnagar (December 27-January 2)
Zakir Husain College, Delhi

L.M. Saha (December 27-January 1)
Zakir Husain College, Delhi

C. V. Vishveshwara (December 27-31),
Indian Institute of Astrophysics, Bangalore

P.P. Saxena (December 27-31)
Lucknow University, Lucknow

R. Ramakrishna Reddy (December 27-31)
Sri Krishnadevaraya University, Anantapur

R.S. Tikekar (December 27-31)
Sardar Patel University, Vallabh Vidyanagar

J. Primack (December 27-29)
University of California at Santa Cruz, USA

K.D. Abhyankar (December 27-31)
Osmania University, Hyderabad

A. Banerjee (December 27-31)
Jadavpur University, Calcutta

R.D. Cannon (December 27-January 5)
Anglo-Australian Observatory, Sydney, Australia

R.V. Karandikar (December 27-31)
Hyderabad

D. Lambert (December 27-30)
University of Texas, USA

Suresh Chandra (December 27-31)
University of Gorakhpur, Gorakhpur

S. Chandrasekhar (December 27-30)
University of Chicago, U.S.A.

H.L. Duorah (December 27-January 4)
Gauhati University, Guwahati

K. Indulekha (December 27-30)
Mahatma Gandhi University, Kottayam

Ashok Goyal (December 27-31)
University of Delhi, Delhi

Pramod Kumar (December 27-29)
INFLIBNET, Ahmedabad

S. Mahajan (December 27-30)
St. Stephen's College, Delhi

Vijay Mohan (December 27-31)
Uttar Pradesh State Observatory, Nainital

A.N. Maheswari (December 27-30)
Cochin University of Science and Technology, Cochin

B. Lokanadham (December 27-31)
Osmania University, Hyderabad

A. Padamsee (December 27-30)
Bombay

N. Panchapakesan (December 27-30)
University of Delhi, Delhi

S.K. Pandey (December 27-January 2)
Ravishankar University, Raipur

S.R. Prabhakaran Nayar (December 27-30)
University of Kerala, Trivandrum

L. Radhakrishna (December 27-31)
Shivaji University, Kolhapur

N. Kameswara Rao (December 27-31)
Indian Institute of Astrophysics, Bangalore

B. Sinha (December 27-30)
Variable Energy Cyclotron Centre, Calcutta

P.C. Vaidya (December 27-January 1)
Gujarat University, Ahmedabad

R.K. Verma (December 27-29)
Physical Research Laboratory, Ahmedabad

S.D. Verma (December 27-31)
Gujarat University, Ahmedabad

Yash Pal (December 27-January 4)
New Delhi

W. Saslaw (December 27-30)
University of Virginia, USA

G. Ram Reddy (December 27-29)
University Grants Commission, New Delhi

D.C. Srivastava (December 27-31)
University of Gorakhpur, Gorakhpur

Avinash Sharma (December 27-31)
Kurukshetra University, Kurukshetra

D. Narasimha (December 27-30)
Tata Institute of Fundamental Research, Bombay

Pankaj Joshi (December 27-30)
Tata Institute of Fundamental Research, Bombay

Zahid Khan (December 27-31)
Jamia Millia Islamia, Delhi

P.V. Kulkarni (December 27-30)
Sangli

B.R. Iyer (December 28-30)
Raman Research Institute, Bangalore

T.P. Prabhu (December 28-31)
Indian Institute of Astrophysics, Bangalore

K.P. Singh (December 28-31)
Tata Institute of Fundamental Research, Bombay

R. Cowsik (December 28-30)
Indian Institute of Astrophysics, Bangalore

C.S. Unnikrishnan (December 28-30)
Tata Institute of Fundamental Research, Bombay

S. Chakrabarti (December 28-30)
Tata Institute of Fundamental Research, Bombay

Pushpa Khare (December 28-30)
Utkal University, Bhubaneswar

P.C. Agrawal (December 28-30)
Tata Institute of Fundamental Research, Bombay

K.M.V. Apparao (December 28-30)
Tata Institute of Fundamental Research, Bombay

J.R. Bond (December 28-January 8)
Canadian Institute for Theoretical Astrophysics, Toronto, Canada

D. Lynden-Bell (December 28-January 10)
Institute of Astronomy, Cambridge, England

M.R. Deshpande (December 28-29)
Physical Research Laboratory, Ahmedabad

S.K. Ghosh (December 28-30)
Tata Institute of Fundamental Research, Bombay

T.N. Rengarajan (December 28-30)
Tata Institute of Fundamental Research, Bombay

Alak Ray (December 28-30)
Tata Institute of Fundamental Research, Bombay

T.P. Singh (December 28-30)
Tata Institute of Fundamental Research, Bombay

B.V. Sreekantan (December 28-January 1)
National Institute of Advanced Studies, Bangalore

S.P. Tarafdar (December 28-30)
Tata Institute of Fundamental Research, Bombay

S.K. Trehan (December 28-30)
Panjab University, Chandigarh

R. Ramachandran (December 30-January 1)
Institute of Mathematical Sciences, Madras

P.S. Parihar (January 2- 9)
Ravishankar University, Raipur

S. Babtiwale (January 3-9)
Ravishankar University, Raipur

Priyanka Pandey (January 3- 9)
Ravishankar University, Raipur

K. Velmurugan (January 3- 8)
Loyola College, Madras

S. Mohin (January 3- 9)
Indian Institute of Astrophysics, Bangalore

A.V. Raveendran (January 3-9)
Indian Institute of Astrophysics, Bangalore

L.N. Gawande (January 3- 8)
Shri Shivaji Science College, Amravati

B.R. Trivedi (January 3-10)
Baroda

S.K. Srivastava (January 4-February 2)
North Eastern Hill University, Shillong

M.N. Anandram (January 6-16)
Bangalore University, Bangalore

M.B.K. Sarma (January 27-29)
Osmania University, Hyderabad

D. Schramm (January 27-29)
University of Chicago, USA

R. Hanbury Brown (February 6-10)
University of Sydney, Australia

Neeharika Thakur (February 13-March 23)
Ravishankar University, Raipur

Devendra Sahu (February 13-March 23)
Ravishankar University, Raipur

R. Cowsik (February 14-16)
Indian Institute of Astrophysics, Bangalore

S. Chakrabarty (February 14-20)
University of Kalyani, West Bengal

A.C. Gupta (February 14-27)
University of Gorakhpur, Gorakhpur

S. Konar (February 14-21)
Raman Research Institute, Bangalore

P.S. Ramkumar (February 14-21)
Raman Research Institute, Bangalore

Anisul Ain Usmani (February 14-20)
Jamia Millia Islamia, Delhi

K. Sakthi Murugesan (February 14-20)
University of Madras, Madras

S.C. Pandey (February 14-21)
Kumaun University, Nainital

R. Ramachandran (February 14-20)
Raman Research Institute, Bangalore

S. Sowmyaraman (February 14-21)
Indian Institute of Science, Bangalore

Srabani Sengupta (February 14-21)
Bombay

Firoza Sutaria (February 14-20)
Tata Institute of Fundamental Research, Bombay

Alak Ray (February 14-16)
Tata Institute of Fundamental Research, Bombay

S. Mishra (February 14-20)
University of Delhi, Delhi

P. Ghosh (February 14-17)
Tata Institute of Fundamental Research, Bombay

P.C. Vaidya (February 15-17)
Gujarat University, Ahmedabad

V. Urpin (February 17-19)
Tata Institute of Fundamental Research, Bombay

V.R. Venugopal (February 17-20)
Madurai Kamaraj University, Madurai

D.D. Gaur (February 21-22)
Bombay Hospital Research Institute, Bombay

Shiv K. Sethi (February 22-26)
University of Delhi, Delhi

B.K. Pal (February 28-March 17)
Himachal Pradesh University, Shimla

N.K. Notani (March 5)
Bhabha Atomic Research Centre, Bombay

G.S. Lakhina (March 13-15)
Indian Institute of Geomagnetism, Bombay

Y. Matogawa (March 15-16)
Institute of Space and Astronautical
Sciences, Tokyo

G. Sikka (March 15-16)
Department of Science and Technology, New Delhi

S.K. Pandey (March 16-23)
Ravishankar University, Raipur

T.R. Seshadri (March 23-April 1)
Mehta Research Institute of Mathematics
and Mathematical Physics, Allahabad

S. Mukherjee (March 18-April 12)
North Bengal University, Darjeeling

C.V. Vishveshwara (March 28-April 10)
Indian Institute of Astrophysics, Bangalore

R. Srianand (March 29-April 25)
Utkal University, Bhubaneswar

Shivajirao Medsekar (March 30-April 4)
Nasik

Calendar of Events

April 1	Occupation of hostel commences
June 1-July 16	The Second Vacation Students' Programme
June 3-27	Introductory Summer School in Astronomy and Astrophysics (Jointly with NCRA at IUCAA)
June 30	Shifting of Administrative, Academic Offices, Library to Institutional buildings
July	Establishment of dedicated four-wire data-link between IUCAA and NCST, Bombay
July 1	Third batch of Senior Associates and Associates join IUCAA
July 7	Shifting of Director's Secretariat to Institutional buildings
August 17	IUCAA-NCRA Graduate School : First Semester begins
August 24-27	Workshop on Bhutas: The Nature of Matter (Jointly with Indira Gandhi National Centre for the Arts at IUCAA)
September 7-12	Regional School on Introductory Astronomy at Jalna
November 1	Full scale canteen services made operational from Ballava
November 12-20	Workshop on Amateur Telescope Making at IUCAA
November 23-December 11	DST sponsored SERC School on Active Galactic Nuclei and Quasars at IUCAA
December 14-23	Workshop on Galaxy Distribution Functions (Jointly with TIFR at IUCAA)
December 16–25	Final Shifting of Library, Computer Centre and Instrumentation Laboratory
December 20	IUCAA-NCRA Graduate School : First Semester ends
December 28	Dedication Ceremony to launch IUCAA's Institutional Buildings Dedication address by Subrahmanyam Chandrasekhar on The Series Paintings of Claude Monet and the Landscape of General Relativity
December 29	Foundation Day Lecture by Yash Pal on Paralleling and Networking India
December 29-30	Dedication Seminars
December 30-31	Scientific Advisory Committee Meeting

January 4-9	Minischool on Photometry with Small Telescopes at IUCAA
January 15	IUCAA-NCRA Graduate School : Second Semester begins
February 15-20	Minischool on Pulsars at IUCAA
February 20-21	Third National Amateur Astronomers' Meet at Ahmedabad
February 28	National Science Day Quiz and other programmes for school children in the morning and Open house for general public in the afternoon
March 10-15	Regional School on Introductory Astronomy at University of Kerala, Trivandrum
March 22-26	Miniworkshop on 'Techniques for Astronomical High Resolution Optical and IR Spectroscopy at IR Observatory, Mount Abu

Pedagogical Activities

Colloquia

E.C.G. Sudarshan: *Quantum mechanics beyond the Hilbert space*, August 27

N.M. Singhi: *On four colour problem*, September 14

Ashoke Sen: *Black holes and other classical solutions in string theory*, September 28

H.V. Sahasrabuddhe: *A computational study of Hindustani music*, October 12

B.V. Sreekantan: *The Universe as seen in high energy radiations*, October 19

R. Ramaswamy: *Quantum chaos: The wave mechanics of classically chaotic systems*, November 2

N. Mukunda: *Aspects of the relationships between physics and biology*, November 16

P.R. Pisharoty: *Water*, November 30

D.N. Schramm: *Shadows of creation: The origin of structure in the universe*, January 27

R. Hanbury Brown: *The pursuit of high-angular resolution*, February 8

R. Cowsik: *Double beta decay Tellurium nuclides*, Februrary 15

D.D. Gaur: *A new laparoscopic surgery*, February 22

N.K. Notani: *Genetic transformation in bacteria, plants and man*, March 5

C.V. Vishveshwara: *The cosmic picture book*, March 29

Seminars

D.P.K. Banerjee: *Spatio-kinematic studies of planetary nebulae*, April 7

A.K. Sen: *Photopolarimetric studies of comets*, April 13

N.D. Haridass: *Gauge independence in quantum gravity*, April 14

Arati Chokshi: *Simulations of faint galaxy fields*, April 29

P. Bhattacharjee: *Ultra high-energy cosmic rays from topological defects*, April 30

R. Ramakrishna Reddy: *Spectrochemical analysis*, May 12

K.N. Iyer: *Computerised ionospheric tomography*, May 22

J. Anosova and L. Kiseleva: *On actual presence of discordant redshifts of the galaxies in the compact groups*, May 27

S. Mukherjee: *Problems in higher dimensional cosmology*, June 12

Jeeva Anandan: *What is the electromagnetic field?* July 1

Ramesh Narayan: *Accretion discs*, July 10

Chanda Jog: *Starbursts triggered by central over-pressure in interacting galaxies*, July 28

Gordon Love: *Observing through the atmosphere with adaptive optics*, July 29

S.R. Valluri: *Photoproduction of gravitational radiation in static electromagnetic fields*, August 6

Navita Srivastava: *Investigation of airglow emissions*, August 7

Mayank Mehta: *Euclideanization of fermions*, August 10

S.V. Chervon: *Nonlinear sigma models and gravitation*, August 18

P.P. Saxena: *Some aspects of cometary coma*, September 4

Biplab Bhawal: *Semiclassical decay of ground states in gravity*, September 8

Tarun Ghosh: *Density perturbations, gravity waves and CMBR anisotropy*, September 15

K.P. Singh: *ROSAT sky-survey: New results on galaxy clusters and AGNs*, September 25

R.P. Saxena: *Cosmological implications for the Higgs and the top*, October 20

S.V. Chervon: *Selfgravitating nonlinear sigma models for inflation scenarios*, October 28

N. Mukunda: *Quantum kinematic approach to the geometric phase*, November 17

Milind Diwan: *Rare decays of kaons*, November 24

Huseyin Yilmaz: *New theory of gravitation*, December 4

V. Korchagin: *Generation of spatial structures in disc galaxies by internal mass-transfer process*, December 10

A. Beesham: *Cosmology with bulk viscosity*, December 11

S. Chandrasekhar: *Newton's Principia: Its relevance for a student of today*, December 28

Sarbani Basu: *The spatial and temporal evolution of gas and heavy elements in the galaxy*, January 29

Jai-chan Hwang: *On cosmological perturbations*, February 9

P.C. Vaidya: *Tachyon in an Einstein universe*, February 16

Shiv K. Sethi: *On constructing viable extended inflation models*, February 23

G.S. Lakhina: *Role of current sheets in astrophysical plasmas*, March 15

Public Lectures

Jean Audouze : *Past, present and future of our universe*, August 25

Jose Rafael Estrada : *Development of a new consciousness - a practical challenge for the present*, September 28

PEP Talks

[Graduate students of IUCAA initiated a series of informal after-dinner lectures and discussions named as PEP (Perceptions of Evolving Physics) talk. There is continuing active participation of the students and faculty members of IUCAA, NCRA as well as members from other institutions.]

T. Padmanabhan: *Mach's Principle*

Kanti Jotania: *Gravitational waves*

Ashoke Sen (TIFR): *What are strings?*

T.R. Seshadri (University of Delhi): *Extended inflation*

Jayant Narlikar: *Arrow of Time in electrodynamics*

J.S. Bagla: *Equivalence principle on the anvil of experiment*

R. Ramaswamy (JNU): *Chaos and fractals*

R. Nityananda (RRI): *Entropy*

K. Subramanian (NCRA): *Where do cosmological magnetic fields come from?*

Naresh Dadhich: *Ashtekar Variables*

Milind Diwan (Stanford University): *Neutrinos*

D. Lynden-Bell (IOA): *Straight lines in curved spacetime*

R.D. Cannon (AAO): *Multi-object spectroscopy*

D.J. Saikia (NCRA): *Unification schemes*

A. Paranjpye: *David Malin's Astrophotographs*

P. Das Gupta: *Spontaneous symmetry breaking*

D. Munshi: *Aarseth's N-Body code*

P. Gothoskar (NCRA): *Neural networks for fun*

S.V. Dhurandhar: *Gravitational Waves*

IDG (Informal Discussion Group) Meetings

A.P. Rao (NCRA): *Interstellar turbulence in the solar neighbourhood*

N.K. Dadhich: *Active and passive gravitational mass of Schwarzschild sphere*

A. Kshirsagar: *A fresh look at the optical jet of 3C273*

P. Gothoskar (NCRA): *Reappearance of Comet Halley*

R. Sinha (NCRA): *The anisotropy of the cosmic microwave background - I*

V. Sahni: *The anisotropy of the cosmic microwave background - II*

D.J. Saikia (NCRA): *BL Lac objects*

C. Debiprasad: *Sodium cloud around Jupiter*

G.C. Anupama: *Accretion induced collapses from cataclysmic variables*

A.K. Kembhavi: *Gamma ray bursts*

P. Das Gupta: *Magnetic monopoles*

S. Kandaswamy (NCRA): *Magnetic fields in high z protogalaxies?*

Y. Gupta (NCRA): *The mystery of Geminga*

S.N. Tandon: *Hunting for comets*

N.K. Dadhich: *Report on GR13*

S.V. Dhurandhar: *Report on GR13*

R. Athreya (NCRA): *Ages of high redshift galaxies*

R. Gupta: *Oxygen abundance inhomogeneities on surface of a magnetic Ap star*

T. Padmanabhan: *Questioning the basics : Is the universe a fractal?*

S. Kandaswamy (NCRA): *Photo ionisation instabilities in the early intergalactic medium*

N.C. Rana: *Mass extinction and impact hypothesis*

A.K. Kembhavi: *Faint features in elliptical galaxies*

D.J. Saikia (NCRA): *Some results from polarisation studies of radio sources*

K. Aswathanarayan (NCRA): *Nonlinear gravitational evolution of phases and amplitudes in one-dimensional cosmological density fields*

S.N. Tandon: *^{57}Co Gamma-Ray flux from SN1987A*

S. Bhatnagar (NCRA): *Imaging at low frequency*

J.V. Narlikar: *Cosmology and the avoidance of divergences in quantum electrodynamics*

T. Ghosh: *Cosmic string scenarios after COBE*

V.R. Venugopal (Madurai Kamaraj University): *On the recent pulsar supernova associations*

P. Ghotoskar (NCRA): *Wide field mapping*

V. Sahni: *Statistical discriminators of large scale structures*

S. Ananthakrishnan (NCRA): *Solar wind and interplanetary disturbances*

D.P.K. Banerjee: *Design for an imaging grating spectrometer*

P. Das Gupta: *International conference on fundamental aspsects of quantum theory*

V.K. Kapahi (NCRA): *K band imaging and spectroscopy of high redshift radio galaxies*

K. Jotania: *Measuring stochastic gravity wave background with laser interferometer*

V.K. Kulkarni (NCRA): *Evolution of the quasar population at redshifts < 2*

A. Kshirsagar: *Employing a brain to do astronomy*

B. Datta (IIA): *A new equation of state for neutron stars*

Academic Programmes

(I) RESEARCH AT IUCAA

The following description relates to research originating at IUCAA through the core members, post-doctoral and visiting fellows and research scholars. The next section describes the research work carried out by IUCAA associates using the Centre's facilities.

Quantum Gravity and Cosmology

As a part of continuing effort to understand fully the structure of gravity described by pure spin-connection variables, *A. Kshirsagar* has proposed a definition for the euclidean path integral for gravity described by these variables. It employs the classical two-form action due to Capovilla et al. The path integral involves integration over the two-form fields Σ^a (corresponding to the metric in the usual formulation), the auxiliary matrix field ψ^{ab} (ensuring the crucial constraint which guarantees the equivalence of this formulation to the usual one), and the spin-connection variables.

Two of the three steps in the evaluation of this path integral have been effected. The two-form field can be integrated out completely by the standard techniques. This leads to an effective action involving the connection fields and the matrix field. The action for the matrix field looks exactly like the Penner-model action for two dimensional gravity and thus this formalism strongly hints at a dynamical triangulations approach for four dimensional gravity. The next step is to integrate out the matrix field. For this purpose, *Kshirsagar* has developed a diagramatic perturbation theory approach and furnished the relevant Feynman rules (The perturbation approach is a mere convenience and is in principle summable to all orders). A byproduct of this expansion is shown to be a natural generation of the topological term for the gauge field representing the connection. The major result of this exercise is that the resulting effective action for the gauge field turns out to be *non-polynomial* as opposed to at most quartic, even for the case of vanishing cosmological constant.

Work is currently under progress in developing methods to perform the spin-connection integration. The action has a complicated form which obscures the choice of gauge fixing terms and the computation of the Faddeev-Popov factors. *Kshirsagar* is currently working out the coupling of a Kalb-Ramond field to gravity in this formulation (which is interesting from the viewpoint of providing an 'external clock' for quantum gravity) as well as analysing wormhole type solutions in this formalism.

Newton's laws of motion appear simplest in an inertial frame when a specific time coordinate is used. Free particles remain unaccelerated in this frame. A

hierarchy of limiting procedures ($G \to 0, c \to \infty, \hbar \to 0$) is required to obtain the Newtonian limit from the exact, quantum gravitational, description of the universe. *T. Padmanabhan* has shown that the inertial time coordinate and the conventional notion of particles will emerge only if restrictions are placed on the solution to Wheeler-DeWitt equation describing the universe.

The action for a massive particle in special relativity can be expressed as the invariant proper length between the end points. In principle, one should be able to construct the quantum theory for such a system by the path integral approach using this action. On the other hand, it is well known that the dynamics of a free, relativistic, spinless massive particle is best described by a scalar field which is equivalent to an infinite number of harmonic oscillators. *Padmanabhan* has clarified the connection between these two apparently dissimilar approaches by obtaining green function for the system of oscillators from that of the relativistic particle. This is achieved through defining the path integral for a relativistic particle rigorously by two separate approaches. This analysis also shows a connection between square root Lagrangians and system of harmonic oscillators which is likely to be of value in a more general context.

Tarun Souradeep has extended earlier work of Padmanabhan and Narlikar, wherein the universe is considered to originate under quantum fluctuations of the empty Minkowski spacetime. He finds that under reasonable physical assumptions, small inhomogeneities in quantum conformal fluctuations can act as seeds of the observed scale–invariant spectrum.

J.V. Narlikar and F. Hoyle have revived their earlier interest in the quantization of the Wheeler-Feynman absorber theory of radiation. They have shown that a natural cut off to the quantum electrodynamic integrals is provided by the event horizon of the steady state cosmology, thereby making the artificial step of renormalization unnecessary.

Classical Gravity

Very close to the big bang singularity, the only thing we know about the universe is that it is in highly dense state. Matter may possess unusual properties under such conditions. Hence one should keep one's mind open on the nature of matter as well as symmetry properties of the universe at early times. It is hence desirable to go beyond the cosy setting of spherical symmetry, homogeneity and isotropy of the standard Friedman-Robertson-Walker model for a realistic scenario at early times. Lifshitz and coworkers have argued that geometry of spacetime close to the singularity is described by the empty space Kasner solution. With all this in view, L.K. Patel and *N.K. Dadhich* have imposed the Kasnerian time evolutions to cylindrical models filled with (a) perfect fluid with heat flow and null radiation flow and (b) with viscous fluid. They obtain a number of interesting results: a static perfect fluid distribution on Kasnerisation yields a time dependent distribution with the same equation of state and with or without heat flow. The same metric for different range of a parameter can either describe a viscous fluid or a fluid with radiation flow and there is some correspondence between string dust distribution and geodesic viscous fluid.

In 1990, Senovilla found an interesting class of exact cosmological solutions of Einstein's equations that were free of singularity. All physical and geometric parameters were finite and had acceptable behaviour. One might wonder how these solutions bypass the general singularity theorems. It turns out that the assumption of existence of "trapped surfaces" which may seem very natural and obvious in black hole situations, may not be so, for cosmology is not obeyed by this class of solutions. This has given rise to singularity free cosmology, i.e., one does not necessarily have to invoke quantum effects and modification of Einstein's theory for dealing the big-bang singularity. One can have as high a matter density as one wants for the solution has a free parameter that can be suitably chosen.

Patel and *Dadhich* have considered the question of how robust the singularity free framework is for inclusion of viscosity, heat flux, etc. They have been successful in incorporating heat flux, though viscosity changes sign at $t = 0$, which is physically unacceptable. They found a new class of solutions representing perfect fluid with stiff matter equation of state, $\rho = p$.

The interesting feature of this model is that its matter - free limit (when density is switched off) gives rise to two empty spacetime (not flat) solutions. They can be considered singularity free analogue of Kasner solution. Their source may be a complicated and complex distribution of gravitational waves.

As is well-known, the Killing symmetries have played very important role in studying exact solutions of Einstein's equations. Of late there have been investigations involving conformally Killing vectors. Varsha Daftardar and *Dadhich* have studied the gradient conformal Killing vector and perfect fluid distribution.

Cosmology and Large Scale Structure

It is generally believed that structures in the universe form through the growth of small inhomogeneties via gravitational instability. When the inhomogeneties are small (i.e., when the density contrast, $\sigma(R) = \langle(\delta M/M)^2_R\rangle^{1/2}$, at the relevant scale R, is small), it is possible to study its dynamics analytically using the linear perturbation theory. However, to compare the theory with observations, we need to

understand the nonlinear regime. Though this can be achieved by extensive numerical simulations, such an approach often does not lead to increased physical understanding. It would be definitely worthwhile to develop analytical approaches to the study of nonlinear regime. *T. Padmanabhan* and R. Nityananda have developed one such method based on the conjecture that average (scaled) pair velocity $h(a,x) = \langle v_{pair}(a,x)\rangle/(-\dot{a}x)$ depends on a and x only through the local density contrast σ; that is, $h(a,x) = h[\sigma^2(a,x)]$. This conjecture leads to the result that *the exact, non-linear density contrast* $\sigma(a,x)$ *is a universal function of the density contrast in the linear theory,* $\sigma_L(a,l)$*, evaluated at a scale* $l = x(1+\sigma^2)^{1/3}$. This universality is well borne out in the exact numerical simulations. What is more, this allows one to compute analytically the *exact* density contrast from the known linear theory result. There are several possible applications for such a result.

It is well-known that the statistical properties of the density field will change in the non-linear regime. *Padmanabhan* and K. Subramanian have developed a method to study the statistics of the density field in the non-linear regime, using the Zeldovich approximation. When the shear term of the velocity field is not too large, one can obtain a reasonably good analytic approximation to this probability distribution. The properties of this distribution can be used in the comparison of theory and observations in order to discriminate between the various cosmological models.

Padmanabhan and Subramanian have also developed a generalised version of Zeldovich approximation which is applicable both in the radiation dominated and matter dominated epochs. This approximation allows one to follow the growth of inhomogeneities from the time the mode enters the Hubble radius until it turns around. Comparison of the results with standard spherical model shows that the analytic approximation is quite good even in the nonlinear regime. Detailed application to Cold Dark Matter (CDM) models and seeded models are also studied.

A remarkable feature of the large scale structure of the Universe is the presence of voids – volumes of order 10^3h^{-3} Mpc^3, virtually devoid of the presence of galaxies. The existence of voids was spectacularly demonstrated with the discovery of the Bootes void, an underdense region of size about 10^5h^{-3} Mpc^3 by Kirshner and his collaborators in 1981. Since then successive redshift surveys as well as deep pencil beam surveys have confirmed that voids are a salient feature of the large scale structure of the universe, and that galaxies seem to lie preferentially along sheets and filaments separating voids. *B.S. Sathyaprakash*, Sergei Shandarin and *V. Sahni* have studied the properties of voids using a semi-analytic approach to model non-linear gravitational instability, known as the adhesion approximation. Their simulations – carried out using 128^3 particles in a cubical box with side 128 Mpc – indicate that the void spectrum evolves with time and that the mean void size in the standard Cosmic Background Explorer (COBE) normalised CDM model, scales as $\bar{D}(z) = \bar{D}_0(1+z)^{-1/2}$, where $\bar{D}_0 \simeq 13$ Mpc

They have also found a strong correlation between the sizes of voids and the value of the primordial gravitational potential at void centers. This observation could, in principle, pave the way towards reconstructing the form of the primordial potential from a knowledge of the observed void spectrum.

A central result of this analysis is that voids can have a topology which is nontrivial. The results for the CDM model show that one out of every 10 voids is likely to have some substructure, such as a filament or a pancake passing through it. Recent observations indicating the presence of mini-pancakes within at least two voids, confirm the opinion that the void topology, together with the void spectrum, is likely to be a very useful statistical indicator of the large scale structure of the universe.

The big bang cosmology having held the centre stage for nearly three decades, the announcement by the COBE satellite of the detection of minute anisotropy of temperature distribution of the microwave background on scales of 10 degrees and above was regarded by many as the final proof that the hot big bang scenario was correct. Several investigations were triggered by the COBE results to decide which of the structure formation and dark matter scenarios would be consistent with them.

Padmanabhan and D. Narasimha have performed a comprehensive study of the constraints imposed on the density contrast of COBE in conjunction with other observations. Many popular models for the galaxy formation are based on power spectra which behave as $P(k) = Ak$ for small k and flattens at large k. The resulting mass fluctuation $(\delta M/M)^2_R \equiv \sigma^2_{gal}(R)$ can be constrained by galaxy surveys up to $R \approx 60h^{-1}Mpc$. On the other hand, the recent COBE results constrain the dark matter spectrum at very large scales ($R \gtrsim 10^3h^{-1}Mpc$). The COBE results $(\Delta T/T)_{rms} = (1.1 \pm 0.2) \times 10^{-5}$ and $(\Delta T/T)_Q = (0.48 \pm 0.15) \times 10^{-5}$ are consistent with a scale invariant spectrum, $\sigma_{DM}(R) = (R_0/R)^2$ at large scales with $R_0 \simeq (23.9 \pm 2.1)h^{-1}Mpc$. This is consistent with APM data and large scale streaming velocity measurements (both of which require $\sigma_{gal}(50h^{-1}Mpc) \simeq 0.2$) provided the scale invariant spectrum is extrapolated from $3000h^{-1}Mpc$ to $50h^{-1}Mpc$. The fact that the extrapolated COBE result matches with galaxy survey results at $50h^{-1}\ Mpc$ suggests that biasing is not significant at $R \gtrsim 50h^{-1}\ Mpc$. On the other hand

a CDM spectrum, normalised to COBE value, will overshoot galaxy survey results at small scales. Such a spectrum can be consistent with observations only if the biasing varies with scale and $b < 1$ at small scales. Comparing the shape of $\sigma(R)$ at $R \lesssim 60h^{-1}Mpc$, determined from galaxy surveys (IRAS, CfA, and APM), with the COBE result, *Padmanabhan* and Narasimha find that a relatively rapid bend in $\sigma(R)$ around $R \approx (40-60)h^{-1}Mpc$ is needed. They show that simple models to describe this bend based on spectra of the form $P(k) \cdot = Ak[1 + (k/k_c)^n]^{-1}$ are severely constrained.

Tarun Souradeep and *Varun Sahni* have assessed the relative contribution to the COBE - measured microwave anisotropy arising both from relic gravity waves as well as primordial density perturbations originating during inflation. They have shown that the gravity wave contribution to the CMBR anisotropy depends sensitively upon n – the primordial spectral index with $\delta_k^2 \propto k^n$, and increases as n decreases. As a result, for $n < 0.84$ the contribution from gravity waves towards $\delta T/T$ is greater than the corresponding contribution from density perturbations, whereas for $n > 0.84$ the reverse is true. ($n = 0.84$ corresponds to an expansion index $p = 13.5$ in models with power-law inflation $a \propto t^p$). Their results show that for scale-invariant spectra ($n = 1$), gravity waves generate only a small fraction of the CMBR anisotropy measured by COBE. Applying these results to the cold dark matter scenario for galaxy formation, they find that in general CDM models with tilted power spectra ($n < 1$), require the biasing parameter to be greater than unity, on scales of $16h_{50}^{-1}$ Mpc. They have also obtained an expression for the COBE - normalised amplitude and spectrum of the stochastic gravity wave background and compared it with the sensitivity of planned laser-interferometer gravity wave detectors. The results show that the amplitude of gravity waves is somewhat smaller than the sensitivity of the current generation of terrestrial bar and beam detectors indicating that the best hope for the detection of the stochastic gravity wave background may lie with a space based *laser - interferometer.*

The structures which form in the universe at redshifts $z \lesssim 10$ can be detected and studied using the redshifted 21 cm line emission from the neutral hydrogen. Subramanian and *Padmanabhan* computed the expected number, N, of protocondensates which will emit a flux higher than S, at various redshifts, in the CDM and HDM models. The models are normalised using the COBE results. They have compared the results with the present and expected sensitivities of various telescopes for the detection of protocondensates. In the CDM models the predicted fluxes and abundances of protocondensates are such that they may be detectable at $z \simeq 3.3$, corresponding to the frequency of 327MHz at which many groups are now operating. At lower redshifts, the detectability of these structures critically depends on their neutral hydrogen content. In the redshift range around $z \simeq 5$, *individual* protocondensates will not be detectable. However, the excess variance due to fluctuations with small density contrasts will be detectable with somewhat large (say, about 60 hours) integration time. At still higher redshifts, it would be virtually impossible to see any signal with even such large integration time. Biased CDM models predict larger fluxes, but somewhat lower abundances. Finally, the HDM models - when normalised using COBE - do *not* lead to detectable number of sources ('pancakes') at redshifts $z \gtrsim 2$.

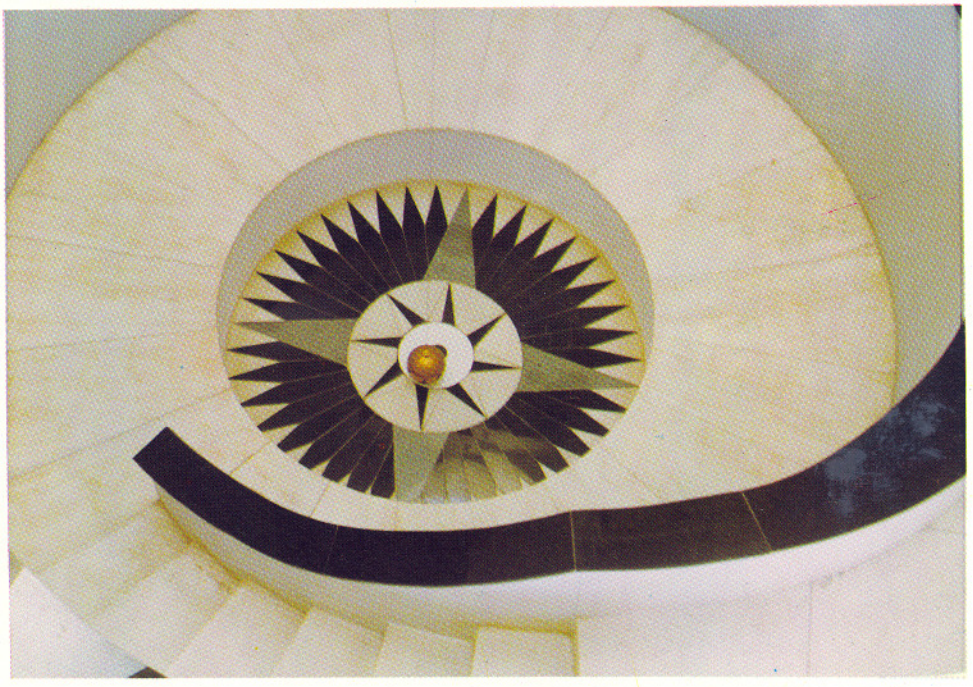
Padmanabhan, Subramanian and A. Kumar have also analysed in detail how the HI line profile from a single protocluster evolves as it decouples from Hubble expansion and collapses. This calculation is based on the following assumptions: (i) The protocluster consists of small scale clumps of HI gas, as is likely in heirarchical clustering theories of galaxy formation. (ii) The density profile of the protoclusters is spherically symmetric and the density contrast is a decreasing function of the radius. The evolution of the protocluster can then be studied exactly using the spherical model, allowing one to determine the expected 21 cm line profile.

There were a few sceptics who felt that the knots into which the big bang theorists were tying themselves to survive the constraints of COBE indicated that a fresh and entirely new approach to cosmology was called for, at least as a viable alternative to the standard hot big bang. With this spirit *J. V. Narlikar* collaborated with F. Hoyle and G. Burbidge to work on the quasi steady state cosmology (QSSC).

The QSSC replaces the single big bang event of universal creation by recurring mini-creation events (MCEs) distributed in a boundless space and time. The MCEs are triggered off by particle creation near collapsed massive objects through the medium of a scalar field, the C-field. The C-field has negative energy and stresses and inflates the space. The universe therefore expands exponentially with a time scale of the order of 10^{12} yrs. but superposed on this motion are shorter duration oscillations lasting typically about 4×10^{10} yrs. These arise from the switching on and off of the creation mechanism. The MCEs may be of varying sizes ranging from $10^3 M_\odot$ to $10^{15} M_\odot$ and the QSSC is able to relate them to many issues of astronomical interest, e.g., structure formation, the nature of dark matter, synthesis of light nuclei, the microwave background, the active galactic nuclei and the quasi stellar objects.

Narlikar and *Patrick Das Gupta* have calculated the emission of gravity waves from the MCEs. It turns

The Dome : The holes in the Dome depict the starry heavens as on IUCAA's Foundation Day, December29, 1988 at 8:30 p.m.

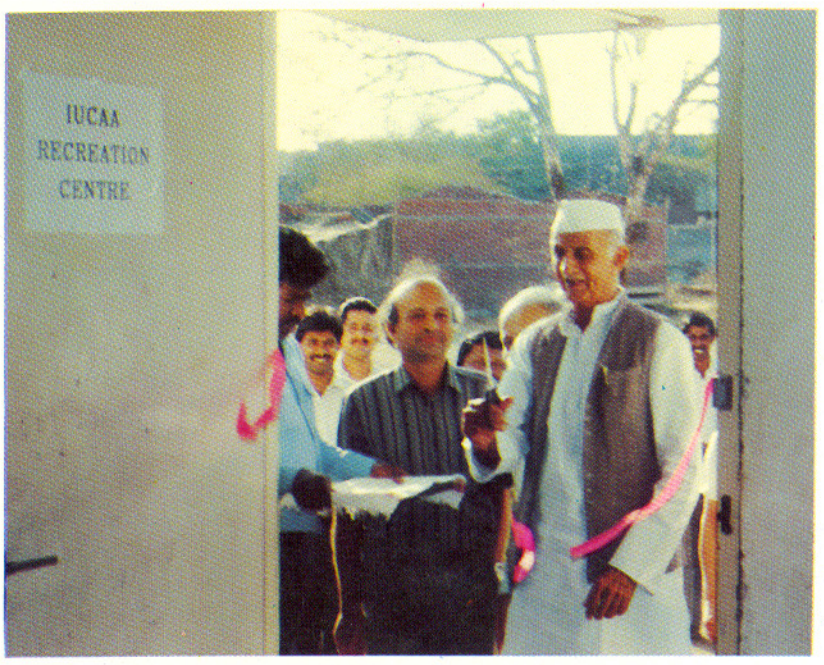


The Foucault Pendulum : It was set in motion by Professor S. Chandrasekhar on IUCAA's Dedication Day, December 28, 1992

The Nalanda Hostel with the Sierpinski Triangle

Post-doctoral apartments in the Takshashila Guest House

The planting of
JACARANDA MIMOSAFOLIA
by Professor S. Chandrasekhar on
December 28, 1992



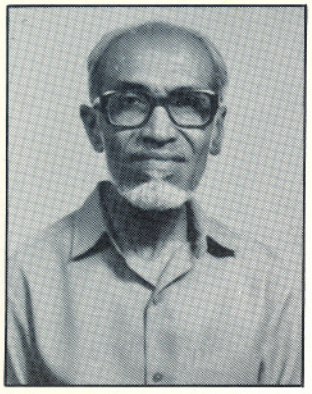
P.C. Vaidya has just cut the ribbon, inaugurating the 'IUCAA Recreation Centre' in the ADITI building

Young visitors observing through the 14-inch telescope, with the help of local amateur astronomers. Every fourth Friday of the month is a Public Night at IUCAA when visitors are welcome to view the starry heavens.

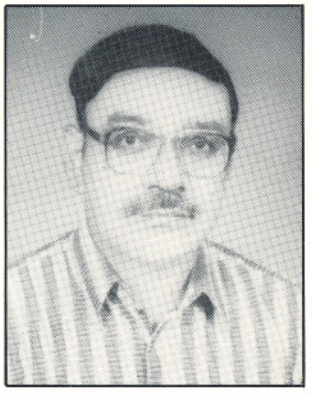
N.C. Rana critically examines the collimation of one of the 6 inch telescopes made at the telescope making workshop

SAC Member Donald Lynden-Bell
from the University of Cambridge

SENIOR ASSOCIATES of IUCAA

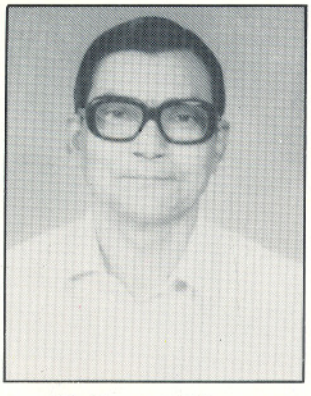


S M Alladin



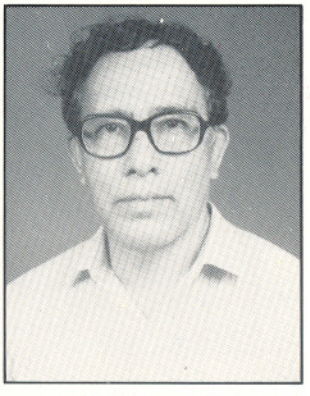
S M R Ansari

S Banerji



Baidyanath Basu

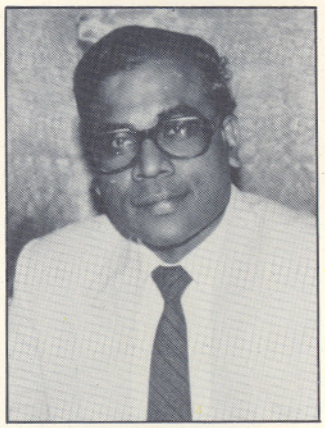
K B Bhatnagar



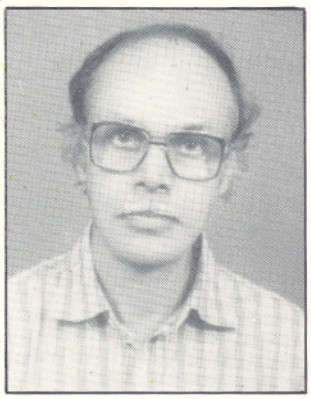
H L Duorah

Ashok K Goyal

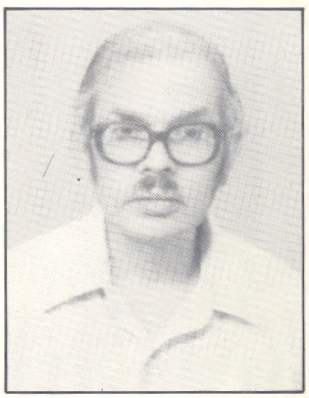
Bhola Ishwar



A N Maheshwari



S Mukherjee

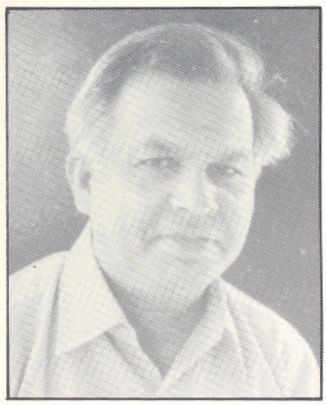


B K Pal

N Panchapakesan

L K Patel

L Radhakrishna



R K Thakur

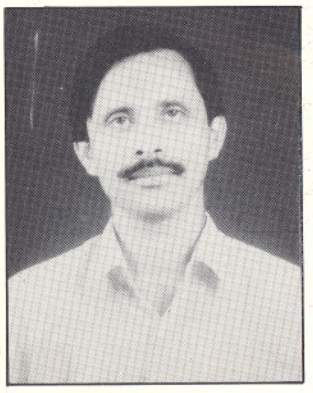
V R Venugopal

S D Verma

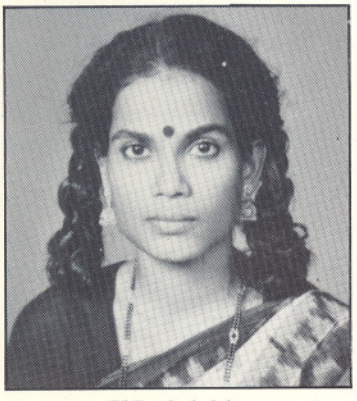
ASSOCIATES of IUCAA

Farooq Ahmed

S H Behere

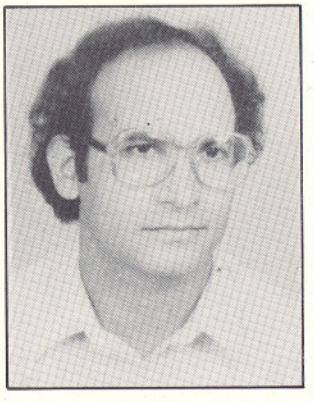


D P Datta



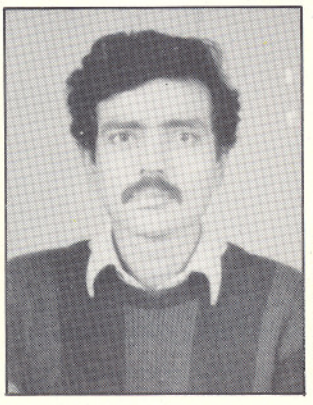
K Indulekha

K N Iyer

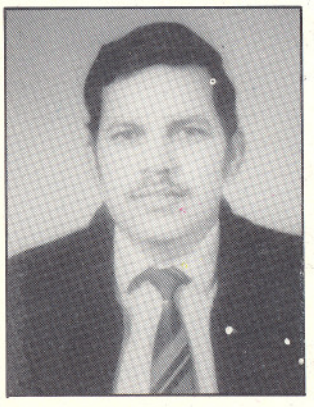


Zahid H Khan

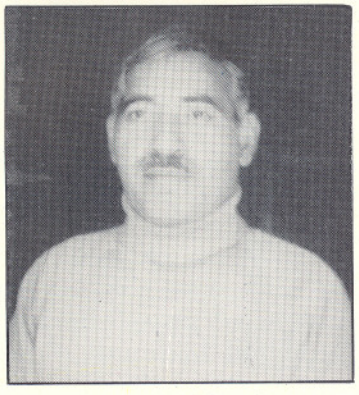
Pushpa Khare



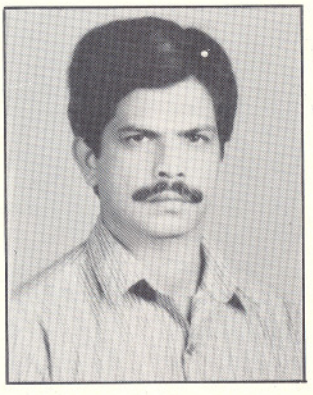
Shobhit Mahajan



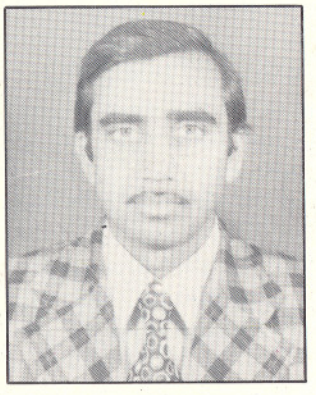
Man Mohan



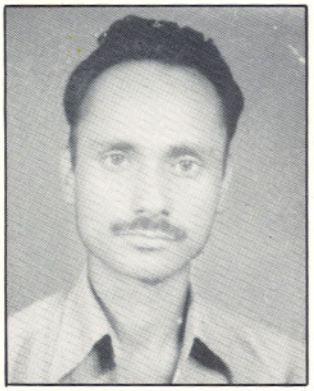
Udit Narain



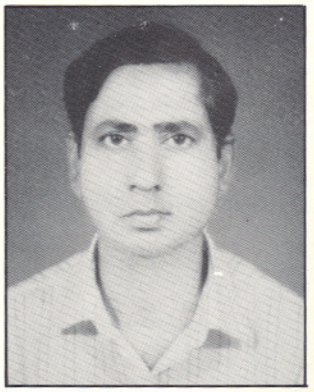
S R Prabhakaran Nayar



S K Pande



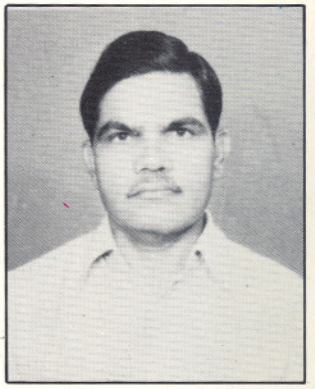
U S Pande



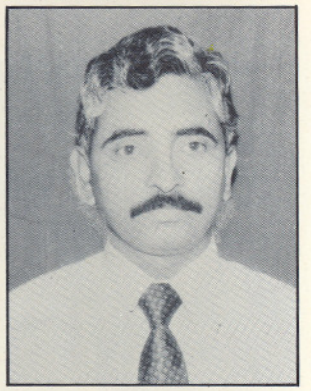
Abdul Qaiyum

L M Saha

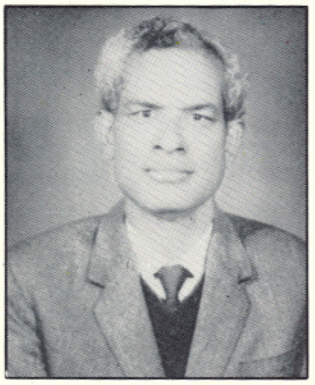
A K Sapre



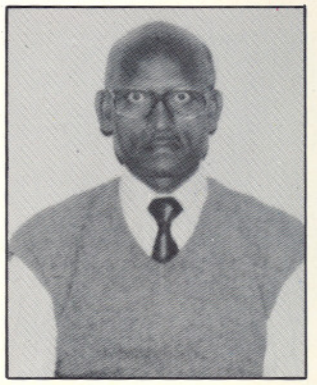
P P Saxena



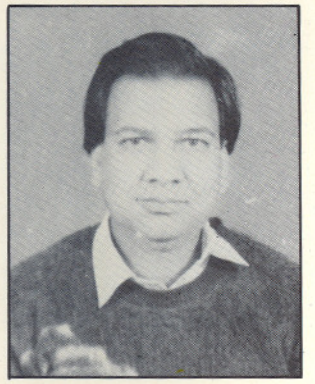
Avinash Sharma



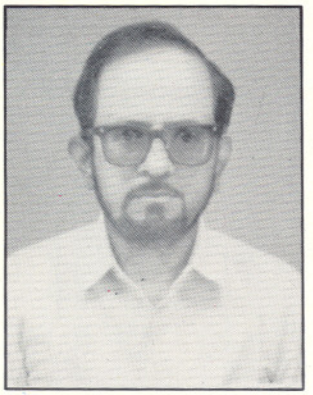
Triloki Singh



D C Srivastava



S K Srivastava



R S Tikekar

B D Vaidya

out that LIGO type detectors can detect sufficiently anisotropic MCEs of masses $\geq 10^3 M_\odot$. Further, the gravity wave background produced by the MCEs may have discernable effects on the timing of millisecond pulsars.

Gravitational Waves

The work on gravity waves can be broadly divided into two catagories: (1) Signal analysis of gravitational waves : (a) Coalescing binaries, (b) Pulsars; (2) Computer modelling of the interferometer : (a) Seismic isolation, (b) Interferometric optics.

1. Signal analysis of gravitational waves

(a) Coalescing binaries : S.V. Dhurandhar and *B.S. Sathyaprakash* have extended their earlier work on the scheme for searching for coalescing binary signals to the more realistic case of coloured noise in the interferometer. A bank of digital filters is constructed corresponding to points in the parameter space of the signals which is expected to detect signals of a minimal strength above a preassigned threshold. Results are first obtained for a general noise profile and then applied to the special case of standard recycling.

The search for signals is instituted by computing correlation of the data with every filter in the bank. The problem is hence parallelisable and they have used the parallel machines at C-DAC and PARAS software to carry out the numerical experiment and a speed of 33.4 Mflops was obtained on 64 nodes. Recently, they have developed a load balancing algorithm to optimise the task. *S. Pitre* is converting the algorithms in OCCAM which is expected to enormously speed up the programme, which is suited for online data analysis.

Recent work by Thorne shows that secular corrections to the orbit of coalescing binaries are crucial in the filtering process of detecting the signal. It is necessary to check how well the bank of filters works with this new element. This work is in progress. This is the most urgent and important problem in gravitational wave data analysis.

(b) Pulsars : The signal from a pulsar is expected to be weak in general and an integration time of weeks or months would be needed to obtain a reasonable signal to noise ratio. But since the earth, and with it the detector, moves in this period of time the signal is modulated both in amplitude and frequency. This signal has to be filtered out. The signal depends on about a dozen or so parameters corresponding to the different orientations of the detector, source, etc. and is very complex. Detailed calculations have been carried out for the quadrupole waveform for an almost spherical neutron star spinning about an arbitary axis. At the moment the Fourier transform of the signal is being studied by numerical and analytical methods. Parallel algorithms are being devised such as block FFT, etc. This work is being done by *K. Jotania* and *Dhurandhar.*

2. Computer modelling of the interferometer

(a) Seismic isolation : Problems on modelling the seismic isolation system on computer are being looked into. The problem involves basically solving the sound wave equation with complicated boundary conditions arising out of the geometry of the springs. This work will be done in collaboration with the Australians. A promising start has been made by *Pitre, Dhurandhar*, D. Blair and Ju Li. The first step is to model the isolation as a combination of springs and pendulums. For the case of, a pendulum, spring and a damper, the quality factor Q has been computed. This will give an estimate of the thermal noise which varies inversely as Q.

(b) Interferometer optics : An Indo-French proposal has been submitted which deals with the modelling of deformation of mirrors due to non-uniform heating and the subsequent effect on the light field in a laser cavity. The stability of the stored power in the cavity is of paramount importance in the functioning of a laser interferometric gravitational wave detector. It is important to find the criteria for stability and the tolerances. This work is planned for the near future.

Work is also in progress in developing an analytical approximation of Fourier transform for a single direction sky search for pulsars by *Jotania*, *Dhurandhar* and S. R. Valluri. They have done feasibility study and this work may be extended to all-sky, all-frequencies search for pulsars.

An important aspect in the understanding of gravitational waveform emitted by an astrophysical system is the influence of the past evolution of the system on its present gravitational internal dynamics. This hereditary influence, often referred to as gravitational wave tail, can be thought of as caused by the gravitational waves emitted by the system in the past and subsequently scattered off the curvature of spacetime back onto the system. Such tail terms not only cause a change in the amplitude but also the phase of the waveform. The magnitude of the effect is of $O[c^3]$ and hence is a very tiny effect. Now, it is well known that the matched filtering technique, which is used in pulling a signal out of a noisy detector output, is highly sensitive to the phase of the signal at each instant of time and thus it is possible to detect the effect of tails in gravitational waveform emitted by a system. *Sathyaprakash* has investigated, in collaboration with L. Blanchet, the possibility detecting the effect of tails in the wave form emitted by a coalescing binary using the first generation

of interferometric gravitational wave detectors (e.g., LIGO and VIRGO). These investigations indicate that for signal-to-noise ratios larger than about 10 it is possible to separate out the effect of tail from other effects. This will be so if the rms signal in the time series is of the same order as the rms noise.

Detection of gravitational waves using matched filtering technique necessiates a very precise knowledge of the incident wave form. With the advent of interferometric detectors there has been effort world over to obtain an accurate waveform from numerical simulations using hydrodynamical codes that incorporate different levels of post-Newtonian approximation. It is desirable to have the first integral of the Euler equation describing the motion of the fluid to be able to carry out numerical simulations. Till recently it has been possible to obtain such a first integral only at the Newtonian approximation and, in some cases, including the back reaction force. *Sathyaprakash* in collaboration with T. Damour and S. Bonazzola, has worked out the first integral of the equation that includes the first post-Newtonian term and the Newtonian back reaction potential of a binary system. The simulations are underway.

There is intensive interaction between *Dhurandhar* and his collaborator groups elsewhere :

(i) Cardiff : Strong interaction with Cardiff continues on various problems in gravitational wave data analysis. There is a frequent exchange of ideas and problems. The problems involve coalescing binaries, pulsars, etc.

(ii) Australia : India will be responsible for the data analysis and software development aspect of the AIGO project of building a large scale detector and *Dhurandhar* will be heading this project. Talks are in progress about collaborating on the vacuum aspect of the detector. This work will be supervised by CAT, Indore on the Indian side.

(iii) France : Recently a proposal on modelling an interferometer has been submitted to the Indo-French exchange programme. The collaboration will be between IUCAA and CNRS, Orsay, France. The proposal is about the modelling of the deformation of mirrors due to non-uniform heating and the subsequent effect on the light field in a laser cavity. The stability of the stored power in the cavity is of paramount importance in the functioning of a laser interferometric gravitational wave detector. It is important to find the criteria for stability and the tolerance to misalignments, deformations, etc.

IUCAA's programme of 'Numerical computations in gravitational waves' continues with C-DAC. A programme simulating the online detection of coalescing binary signals has been written on the parallel machines. The code is now being written in OCCAM, which is a language suited to transputers and is expected to perform at atleast twice the previous speed we got with parallel Fortran. Computer modelling of seismic isolation problems is also being studied in collaboration with Australia.

A proposal to DST has been submitted on gravitational wave data analysis and software development and has been recently approved. The proposal envisages data analysis of coalescing binaries and pulsars and optimally orienting a network of detectors.

Quasars and Extragalactic Astronomy

In extragalactic astronomy, *Debiprosad Duari* and *J.V. Narlikar* have examined the latest available catalogues of absorption line systems of quasi stellar objects to test the viability of the intervening galaxies hypothesis (IGH) of their origin. They find that no known selection effects can explain the deviation of the observed line distribution from that predicted by the IGH. *Duari* is now examining in greater detail the distributions of specific metal lines, such as Mg II and C IV.

N.C. Rana and Pushpa Khare (Utkal University) are working on rapid chemical evolution of high red-shift galaxies in C IV and Ly-α due to the intervening medium.

N.C. Rana and Sujan Sengupta have worked on the explanation of periodicity in red-shift distribution of galaxies and QSOs in a homogeneous, scalar field model of the universe.

The study of the distribution of light in galaxies provides information on the distribution of visible mass, the properties of different galactic components like bulge, disk and spiral arms, the distribution and type of stars in different regions, the presence of star forming regions, star bursts, interactions with other galaxies and so on. The observations of galaxies providing such information involve a moderately large optical telescope (1^m - 2^m), a CCD camera and an image processing system. *Ajit Kembhavi, G.C. Anupama* and *Ashish Mahabal* have been involved in such observation and analysis, using data obtained from the Vainu Bappu Telescope, as well as from various telescopes abroad. The observations have been made using broad band and narrow band filters. Standard software packages like IRAF have been used, but programs have also been developed at IUCAA covering various aspects like the fitting of deconvolved radial profiles. Galaxies of various types have been studied to examine the changes which occur in the distribution of HII regions in passing from normal to

Sersic–Pastoriza to Seyfert galaxies. The maximum entropy and Lucy deconvolution algorithms have been used to identify compact regions, which are later studied photometrically using different methods. A beginning has also been made in the application of the techniques of neural networks in image processing. The work using the data from the Vainu Bappu Telescope has been done in close collaboration with T.P. Prabhu (IIA) and K.P. Singh (TIFR). A group of astronomers at Ravishankar University, led by S.K. Pandey and including Devendra Sahu and Neeharika Thakur have collaborated with *Kembhavi* and Vijay Mohan (UPSO) in observations using the UPSO 1m telescope and the data processing, which has been carried out in the IUCAA computer centre.

D.P.K. Banerjee is involved in an ongoing observational programme, in collaboration with Physical Research Laboratory for studying the velocity fields in selected spiral galaxies and AGNs. Observations are presently being carried out, mainly at the 2.34 metre Vainu Bappu Telescope using a high-resolution, imaging Fabry-Perot Spectrometer.

Galactic Dynamics and Evolution

For the current year, the chemical evolution of the Galaxy continues to be the main area of research of *N.C. Rana*. An age–metallicity relation and a vertical scale height corrected metallicity distribution of the local G-dwarf stars were derived, and a two–parameter, closed box model of chemical evolution of the disc was developed by *Rana* and Sarbani Basu.

This model was tested against several possible ramifications. The investigations include : (i) the new mass function of stars in the solar neighbourhood which was found to give a period of oscillation of the sun about the local mid–plane of the disc, that matched well with the period of terrestrial, biotic mass extinction (*Rana* and Chinmoy Das, Presidency College); (ii) the astration of local interstellar abundance of Deuterium being only a factor of two compared to its pre-disc abundance (*Rana* and P. Kausalya, Anna University); (iii) the compatibility of the assumed age of 13 Gyr for the Galactic disc to that derived from the observed Th/Nd ratio in the local dwarf stars (*Rana* and Sonali Shah, University of Baroda); (iv) the metallicity distribution of the F–dwarfs in the solar neighbourhood (*Rana* and A.D. Jana, Vidyasagar University); (v) the stellar multiplicity ratio measured in the η–Carina nebula similar to that of the field stars (*Rana* and Bindu Gajria, St. Xavier's College); (vi) the cooling curve for a statistically average white dwarf derived from a combination of their luminosity function and the predicted birth rate from the latest initial mass functions of stars (*Rana* and S.R. Pathak, NCRA); (vii) a mass luminosity ratio of the local stars derived from their present day mass functions (*Rana* and M. Chandola, Fergusson College); and (viii) an explanation for the non–detection of interstellar comets over past 150 years using the model mass function of stars (*Rana* and *A.K. Sen*). Also in progress, is a possible form of mass function of stars forming from progenitor clouds of mass ranging up to 10^4 $M_\odot$ to be derived for magnetic field and turbulence dominated clouds (*Rana* and K. Indulekha, Mahatma Gandhi University).

Rana also worked with Titus Mathews (Cochin University) on the calculation of the astrophysical S-factor for the reaction ^{8}Li (α, n) ^{11}B and its implication on the primordial Li abundance in the standard Big Bang Nucleosynthesis; Rajat Roy and *Rana* have worked on the hydrodynamic evolution of the Galactic structure.

V.I. Korchagin has developed a model, describing the dynamics of clusters correlated in space and time of massive star in star-burst galaxies as a propagating wave of star formation. He has also calculated the spectrophotometric evolution of 'hot-spots' in star-burst galaxies using theoretical stellar evolutinary tracks. Determining of continuum and main emission line's intensities in accordance with theoretical fluxes of ionizing photons emitted by OB stars in 'hot spots' and comparison with observational intensities of 'hot spot' galaxies and determination of theoretical parameters of the model has been carried out by him in collaboration with T. Prabhu and *A. Kembhavi*.

Stellar Physics

A project has been initiated by *Rana* with *Ravi Gulati* and Basu on the compilation of more than a thousand local dwarf stars on the basis of their isochrone age, metallicity, and surface gravity, in order to prepare self–constitent relations such as, the age–metallicity relation, the metallicity distribution and the star formation rate of stars belonging to various spectral classes. Already, new calibrations for the mass–luminosity relation and composition dependent surface gravity and luminosity relations are obtained.

Anupama with Prabhu (IIA) has obtained the spectra of novae N Pup 91, N Cyg 92, RS Oph, TCrB and GK Per using both the VBT and 102 cm telescope at VBO. Spectra of N Cyg 92 were analysed and the preliminary results presented as a poster paper 'Optical Spectrum of Nova Cygni 1992' at the 2nd Haifa conference on cataclysmic variables and related physics, January 11-14, 1993, Eilat, Israel which *Anupama* attended. *Anupama* has also analysed the spectra of the recurrent novae V3890 Sgr, 18 days after its 1990 outburst. The electron density, mass of the ejected ionized shell, the helium abundance and the temperature and radius of the ionizing source were estimated using the observed emission line fluxes.

With the aim of forming a computer code for automatic spectral classification, work has been initiated for developing software based on a library of synthetic stellar fluxes and observed spectra. This work is being carried out by *R.K. Gulati*, in collaboration with *Ranjan Gupta*.

Intrumentation

Ranjan Gupta is developing a prototype automated photoelectric telescope which has been mechanically assembled and nearing completion. Under the research training programme, IUCAA will be training Bangalore University teachers for fabricating the second automated telescope in the coming months.

A.K. Sen is assisting the Physics Department, Gauhati University, in setting up a small observatory with their 6-inch Zeiss reflector telescope. H.L. Duorah at Gauhati University is interested in the above programme.

(II) WORK DONE BY ASSOCIATES

IUCAA core members and associates have ongoing collaborations and the work described in (I) above includes work carried out with the participation of associates. This section highlights the work initiated by the associates wherein IUCAA's facilities and environment have played a supportive role. The description given below covers a wide range of astronomy and astrophysics, general relativity and cosmology.

A maximum likelihood programme has been developed and used to analyze the Lyman alpha lines in the spectra of 35 quasars. Both the intermediate as well as high resolution data were shown to indicate a differential evolution with redshift of these lines as a function of their rest equivalent width. The rate of chemical evolution of high redshift galaxies was obtained by analyzing quasar absorption data for C IV, Mg II and Lyman limit systems. (Pushpa Khare).

Some analytic studies have been carried out for orbits, merging time and for angles of deflection, etc. for colliding galaxies (S.M. Alladin and G.M. Ballabh). Interacting pairs of galaxies have been investigated for their far infrared and microwave characteristics and it seems that interaction has no effect on these characteristics (V.R. Venugopal).

Loss of equilibrium is supposed to give rise to the eruptive phenomena in Solar physics, force free magnetic fields may lead to loss of equilibrium (S. Chandra). Equivalent electric circuit elements of Alfven waves in solar coronal holes of different temperatures and magnetic field strengths have been studied (Udit Narain).

Investigations of non-linear stability of cluster of stars sharing galactic rotation, chaotic motion of satellite and chaos in non-linear dynamical system have been carried out. (K.B. Bhatnagar and L.M. Saha).

The role of bulk compressibility in evaluating the surface energy of nuclear matter at the crust of a neutron star has been studied (H.L. Duorah). Production rate of H_2O molecules as an indicator for the surface temperature of the cometary nucleus has been proposed (P.P. Saxena). A study of luminosity function and its evolutions for QSOs using a large enough sample is being pursued (A.K. Sapre). Fabrication of automated optical telescope, CCD camera and photometer has been initiated (S.D. Verma).

The singularity free inhomogenous solutions of Einstein's equations, recently obtained by JMM Senovilla, are being investigated for realising Linde's chaotic inflationary model of the universe (S. Mukherjee). Inclusion of viscosity, heat and null radiation flow in inhomogenous cosmological solutions with and without singularity is being investigated. (L.K. Patel, R.S. Tikekar). Shear free perfect fluid distributions in $(n + 2)$ dimensions has been studied to generalise the results obtained in 4-dimensions (D.C. Srivastava). Electronegativity differences, ionization potentials and dissociation energies have been studied for astrophysically important molecules. The ionization potentials obtained are found to be in excellent agreement with the experimental results (R.R. Reddy). Magnetoconnection in a rapidly rotating inviscid fluid has been analysed to find the steady state solution of the Ginzburg-Landau equation (S.G. Tagare). The extension of the Standard Model of particle theory has been considered in view of the solar neutrino puzzle (B.K. Pal). The implications of the Berry's phase in semiclassical gravity and its relevance to the issue of back reaction are being studied (D.P. Datta).

(III) SCIENTIFIC MEETINGS

Workshops :

Galaxy Distribution Functions : IUCAA hosted an Indo-USA binational workshop on galaxy distribution functions organised by W.C. Saslaw (University of Virginia and Cambridge University) and S.M. Chitre (TIFR, Bombay) during December 13-23. About 40 astrophysicists, cosmologists and students attended, from India as well as from France, Germany, Japan, Russia, U.K. and U.S.A. The workshop discussed the physics of distribution functions, their comparison with computer experiments and their relation to other statistical descriptions of galaxy clustering. In addition to 90 minutes review talks each day there were extensive discussions which led to new results, clarifications and collaborations on many topics.

Mini-Workshops :

Photometry with Small Telescopes : A miniworkshop on 'Photometry with Small Telescopes' was held at IUCAA, during January 4 - 8, 1993. The workshop was arranged mainly to introduce the interested university groups in the various aspects of Photometry with small telescopes. There were 11 participants from various universities and colleges. Lectures on theoretical and observational aspects of Photometry were delivered by S. Mohin and A.V. Raveendran of IIA, Bangalore and Ranjan Gupta, Arvind Paranjpye, A.K. Sen and S.N. Tandon of IUCAA. The participants were also actively involved in the photometric observations of variable stars using IUCAA's 14" Celestron telescope. Ranjan Gupta was the co-ordinator of the school.

Techniques for Astronomical High Resolution Optical and IR Spectroscopy : A miniworkshop on 'Techniques for Astronomical High Resolution Optical and IR Spectroscopy' was conducted during March 22-26, 1993 at the Gurushikhar Infrared observatory, Mt. Abu. The aim of this workshop was to bring together various workers in this area and give inputs to the planning of the future high resolution spectroscopic instruments in our observatories. Lectures on various aspects of different high resolution spectrometers were delivered by N.K. Rao of IIA, Bangalore, C. Debi Prasad of USO, Udaipur, J.N. Desai, B.G. Ananda Rao, T. Chandrasekhar and N.M. Ashok of PRL, Ahmedabad and Ranjan Gupta and R.K. Gulati of IUCAA, Pune. Discussion sessions on optical coatings interference filters and FTS data acquisition system were covered by S.D. Rawat and D.V. Subhedar of PRL. The participants (total 10) included university and college teachers and research students. Ranjan Gupta, IUCAA and J.N. Desai, PRL were the co-ordinators of the workshop.

Schools :

Introductory Summer School in Astronomy and Astrophysics: DST sponsored annual summer school in introductory astronomy and astrophysics was organized jointly with the National Centre for Radio Astrophysics at IUCAA during June 3-27. About 40 students of physics and engineering attended the school. Lectures were delivered by IUCAA-NCRA academics along with visiting faculty from institutions in other cities. Introductory lectures, interaction with astronomers and project assignments made up the programme . Sanjeev Dhurandhar of IUCAA and Vijay Kapahi of NCRA were the Directors of the school.

SERC School on Active Galaxies and Quasars : The Science and Engineering Research Council of the Department of Science and Technology has agreed to sponsor five advanced schools in astronomy and astrophysics over a five year period. The first of these schools, on active galaxies and quasars, was held at IUCAA, during November 22 – December 11. Participants included 25 interested and actively working research scholars as well as senior persons from university departments and research institutes. Observational and theoretical topics were covered, providing a broad review of the current state of knowledge on AGN, quasars and related objects like starburst galaxies by Sandip Chakrabarti, Naresh Dadhich, Sanjeev Dhurandhar, Chanda Jog, Ajit Kembhavi, Pushpa Khare, T.P. Prabhu, D.J. Saikia and Kandaswamy Subramanian. Tutorial sessions were conducted by G.C. Anupama and Debiprosad Duari. Seminars were presented by astronomers on topics of current interest. The lectures at the school have provided a comprehensive summary of the field, valuable introduction to methods and techniques, as well as ideas for research. The course directors were Naresh Dadhich and Ajit Kembhavi.

Regional School on Introductory Astronomy (at J.E.S. College, Jalna) : A regional school on introductory astronomy, was arranged mainly for B.Sc and M.Sc students of various colleges in Marathwada Region in Maharashtra, at J.E.S. College, Jalna during September 7-12. Participants included 72 students and 6 teachers. Lectures on observational and theoretical aspects of astronomy and astrophysics were delivered by Ranjan Gupta, Arvind Paranjpye, N.C. Rana and A.K. Sen of IUCAA and S.H. Behere and S.C. Mehrotra of Marathwada University. 3" optical telescope and 8" Celestron APT were used for observations by the participants. Ranjan Gupta and M.L. Kurtadikar were the co-ordinators of the school.

Regional School on Introductory Astronomy (at University of Kerala, Trivandrum) : A regional school on introductory astronomy was conducted at the Department of Physics, University of Kerala, Kariavattom, Trivandrum during March 10–15, 1993. The school was organized mainly for final year M.Sc., B.Tech. students and teachers in Kerala and Tamil Nadu. Inspite of the examination season, the school was attended by more than 90 local and outstation participants including the research students of the Department. The topics covered in the school included star formation, solar astrophysics, galaxy, interstellar medium, gravitation, black holes, radio astronomy, magnetic field in the universe, helio and stellar seismology and the institutions and facilities available for astronomy research in India. The lecturers included C.V. Vishveshwara, IIA; V.R. Venugopal, Madurai Kamaraj University; D.C.V.Mallik, IIA; K. Indulekha,

M.G. University, Kottayam; Ajit Kembhavi, IUCAA and S.R. Prabhakaran Nayar, Kerala University. During the school the participants could get a glimpse of the recent developments in Astronomy and Astrophysics and could gain enthusiasm in the field since the sessions were highly interactive. In addition to the regular topics, Ajit Kembhavi gave a general talk on "Computer Networks and Electronic Mail". Some of the participants could visit the university observatory which was established in 1837 and at present forms the centre of popularization of astronomy activities in Trivandrum.

Mini-School :

Pulsars : The minischool on Pulsars was held at IUCAA during February 15 -20, 1993. The minischool was originally to be held at Osmania University, Hyderabad but due to unavoidable cicumstances had to be shifted to IUCAA. The school was attended by research scholars and young research workers who are actively interested in the area of Pulsars. The topics discussed at the school included - radio and x-ray pulsars, binary and millisecond pulsars, evolution of massive stars, neutron stars, supernovae, association between pulsars and supernovae remnants and magnetic fields in neutron stars.

The lectures were delivered by Bhaskar Datta, IIA; Pranab Ghosh, TIFR ; Ajit Kembhavi, IUCAA; Alak Ray, TIFR ; Vadim Urpin, TIFR and V.R. Venugopal, Senior Associate of IUCAA.

The scope and quality of the lectures were highly appreciated by the students attending the minischool and the lecturers found the students actively participating in the discussions and showing a great deal of interest in the areas presented. It is hoped that the interest generated amongst young research workers will lead to their active participation in the field in the coming years.

Seminars :

Dedication Seminar : The dedication of IUCAA to its users took place on December 28, 1992. To mark this occassion a two-day seminar was arranged on December 29 and 30. The speakers at this session included S. Chandrasekhar, W.C. Saslaw, J.R. Bond, S.F. Shandarin, Yash Pal, D. Lynden-Bell, R.D. Cannon, K.D. Abhyankar, G. Swarup, R. Cowsik and J.V. Narlikar. The variety of topics from Networking in India to Exact Solutions describing Relativistic Disks were covered in this seminar. Most of the audience who came for the Dedication Ceremony also participated in this seminar and the discussions which followed.

IUCAA-IGNCA Seminar on Bhutas : The seminar on the nature of matter was arranged jointly by IUCAA and the Indira Gandhi National Centre for the Arts, New Delhi at IUCAA during August 24-27. Eleven scientists from such diverse disciplines as biology, nuclear physics, particle physics, astrophysics, relativity and cosmology exchanged views with 11 scholars of oriental traditions ranging from the history and philosophy of science to vedanta, nyayashastra, ayurveda and unani medicine. Observers from University of Poona and other local institutes also participated. The liveliness of the discussions was a promising sign for future interdisciplinary dialogues between the 'two cultures'.

(IV) VACATION STUDENTS' PROGRAMME (VSP)

The second Vacation Students' Programme started on June 1 and concluded on July 16 under the supervision of the 9 IUCAA faculty members and post-docs. There was considerable response and out of selected 15 students, 13 students joined, 12 completed the programme and one student was preselected for the next years' graduate school. The programme consisted of lectures and project work.

(V) PUBLICATIONS

• by IUCAA Academic Staff

a) Journals

Prabhu, T.P., Mayya, Y.D. and **Anupama, G.C.** (1992) Gain Calibration of CCD Systems at VBO, J. Astrophys.Astr., **13**, 129.

Anupama, G.C. (1992) Studies of classical and recurrent novae, Dissertation abstract, PASP., **104**, 308.

Anupama, G.C., Duerbeck, H.W., Prabhu, T.P. and Jain, S.K. (1992) Spectral evolution of nova V443 Scuti 1989, Astron. Astrophy., **263**, 87.

Seema, P., Anandarao, B.G., **Banerjee, D.P.K.**, Jog, N.S. and Patel, R.T. (1992) A photon-counting, imaging Fabry-Perot Spectrometer for kinematic studies of extended astronomical objects, PASP, **104**, 1091.

Mukherjee, S., Paul, B.C., **Dadhich, N. and Kshirsagar, A.** (1992) Gravitational instantons with a scalar field, Phys. Rev. D, **45**, 2772.

Patel, L.K. and **Dadhich, N.** (1992) Cylindrical universes with heat and null radiation flow, Astrophys.J., **401**, 433.

Dhurandhar, S.V., Bhavsar, V. and Gujar, U. (1993) Analysis of z-plane fractal images from $z \leftarrow z^{\infty} + e$ for $\alpha < 0$ *in* Computers and Graphics, **17**, 89.

Ghosh, Tarun Souradeep and Sahni, Varun (1992) Quantum effects near a point mass in (2 + 1) - dimensional gravity, Phys. Rev. D, **46**, 1616.

Ghosh, Tarun Souradeep (1993) Generation of seed perturbations from quantum cosmology, Astrophys. J., **402**, 375.

Ghosh, Tarun Souradeep and Sahni, Varun (1992) Density perturbations, gravity waves and cosmic microwave background, Mod. Phys. Lett. A, **7**, 3541.

Jotania, K., Wagh, S.M. and **Dhurandhar, S.V.** (1992) Signal analysis of the post-Newtonian gravitational wave form of coalescing binaries, Phys. Rev. D, **46**, 2507.

Bhat, P.N., Singh, K.P., Prabhu, T.P. and **Kembhavi, A.K.** (1992) VRI Photometry of M67 for CCD Standardization at 2.3 m VBT, J. Astrophys. Astr., **13**, 293.

Koshti, S. (1992) Massless Einstein-Klein-Gordon theory in the spin connection formulation, Class. Quant. Grav., **9**, 1937.

Narlikar, J.V. (1992) The concepts of "beginning" and "creation" in cosmology, Philosophy of Science, **59**, 361.

Narlikar, J.V. (1992) The mystery of redshift periodicities, Journal of Indian Institute of Science, **72**, 273.

Narlikar, J.V. (1992) Strengths and weaknesses of the big bang cosmology, Bull. Astr. Soc. India, **20**, 1.

Arp, H.C., Burbidge, G., Hoyle, F. and **Narlikar, J.V.** (1992) Big bang continued, Nature, **357**, 287.

Narlikar, J.V. and Arp, H.C. (1993) Flat spacetime cosmology: A unified framework for extragalactic redshifts, Astrophys. J., **405**, 51.

Padmanabhan, T. (1992) Structure Formation in the Universe : comparison of some observations and models, Current Science, **63**, 379.

Padmanabhan, T. and Subramanian, K. (1992) Galaxy Formation, Bull. Astr. Soc. India, **20**, 1.

Padmanabhan, T. and Narasimha, D. (1992) Constraints on the shape of the density spectrum from COBE and galaxy surveys, Mon. Not. R. Astron. Soc., **259**, 41p.

Padmanabhan, T. and Singh, T.P. (1993) A comparison of various approaches to the back reaction problem, Ann. Phys., **221**, 217.

Rana, N.C. (1992) Chemical evolution of the solar neighbourhood, Bull. Astr. Soc. India, **20**, 177.

Rana, N.C. and Basu, S. (1992) A derivation of the age-metallicity relation and initial mass function of stars in the solar neighbourhood, Astronomy and Astrophysics, **265**, 499.

Basu, S. and **Rana, N.C.** (1992) G-dwarf metallicity distribution curves assuming an inhomogeneous interstellar medium, Astrophysics and Space Science, **196**, 1.

Basu, S. and **Rana, N.C.** (1992) Multiplicity corrected mass function of main sequence stars in the solar neighbourhood, Astrophys. J., **393**, 373.

Joshi, U.C., **Sen, A.K.**, Deshpande, M.R. and Chauhan, J.S. (1992) Photopolarimetric studies of comet Austin, J. Astrophys. Astr., **13**, 267.

Ghosh, S.K., Bisht, R.S., Iyengar, K.V.K., Rengarajan, T.N.,**Tandon, S.N.** and Verma, R.P. (1992) Far infrared observations of NGC 4945 and Circinus galaxies, Ap. J., **391**, 111.

b) Proceedings

Dhurandhar, S.V. (1992) Gravitational wave detection *in* "Gravitation and Cosmology", Proc. of the XV IAGRG Conference held at the North Bengal University, November 4-7, 1989, p.45.

Gulati, R.K. (with M.L. Malagnini and C. Morossi) (1992) Synthetic Mg and Fe indices for cool stars, pp.21–25, *in* Feedback of chemical evolution on the stellar content of galaxies : Proceedings III DAEC Workshop, Observatorie de Paris/Meudon, October 12–16, 1992; edited by Alloin, D. and Stasinksa, G.

Gupta, Ranjan (1992) APTs for Indian Universities, 249 *in* Robotic Telescopes in the 1990s. Proc. Symp. 103 A.S.P. Meeting at University of Wyoming 22-24, 1991 edited by A.V. Filippenko (A.S.P. Conf. Ser. Vol. 34, 1992).

Kshirsagar, A. (1993) Constraints of pure-connection formulation of GR with nonzero cosmological constant, *in* Proceedings of the 6th Marcel Grossman meeting on General Relativity, Kyoto, ed. Nakamura, T. (World Scientific Publishing Co.), p.129.

Narlikar, J.V. (1992) Reference frames in cosmology, Teaching About Reference Frames from Copernicus to Einstein *in* Girep'91 Proceedings Eds Kuhnelt, H., Berndt, M., Straszel, M. and Turlo, J. (Nicholas Copernicus University Press: Torun), p.112.

Sathyaprakash, B.S. (1992) Techniques of gravitational wave data analysis *in* "Gravitation and Cosmology", Proc. of the XV IAGRG Conference held at the North Bengal University, November 4-7, 1989, p.56.

c) Books

Books edited :

Mukherjee, S., Prasanna, A.R. and **Kembhavi, A.K.** (1992) "Gravitation and Cosmology", Proc. of the XV IAGRG Conference held at the North Bengal University, November 4-7, 1989 [Wiley Eastern Ltd].

Narlikar, J.V., Indu Banga and Chanda Gupta (1992), Philosophy of Science: Perspectives from Natural and Social Sciences, (Indian Institute of Advanced Study, Shimla and Munshiram Manoharlal Publishers, Delhi, 1992).

Books authored :

Narlikar, J.V. Ganitatalya Gamati-Jamati (in Marathi) (1992), (Manovikas Prakashan, Bombay, 1992).

Narlikar, J.V. Vishvachi Rachana (in Marathi) (1992), (Wiley Eastern, Delhi, 1992).

Narlikar, J.V. Antaralatil Sphot (in Marathi) (1992), (Sahitya Akademi, Delhi, 1992).

Narlikar, J.V. Introduction to Cosmology, 2nd Edition (Cambridge University Press, Cambridge, 1993).

Padmanabhan, T. (1993), 'Structure Formation in the Universe', (Cambridge University Press, Cambridge, 1993).

d) Book Reviews

Narlikar, J.V. (1992), *Abdus Salam – A Biography* by *Jagjit Singh*, (The Independent, September 5).

Narlikar, J.V. (1992), *Samsar ke mahan ganitagya* by Gunakar Mulay, (Dharmayug, May 16).

Narlikar, J.V.(1993), *Genius : Richard Feynman and modern physics* by *James Gleick*, (The Independent, The Metropolis, Saturday March 20-21, 1993).

Padmanabhan, T., (1992), *Astrophysics - Stars and Galaxies* by *K.D. Abhyankar*, (Tata McGraw-Hill, New Delhi, 1992 & Phys. Education, 10, January-March, 1993).

e) Popular Science Articles

Narlikar, J.V. (1992), Anguish and Joy in the unexpected, [The Sunday Times of India Review, April 5].

Narlikar, J.V. (1992), A Scientific Appraisal of Astrology, [The Radical Humanist Magazine, Vol. 56 No.6, September].

Narlikar, J.V. (1992), Cross-pollinating Indian universities, [The Weekend Observer, October 17].

Narlikar, J.V. (1992), Indian astronomy: past, present and future and French collaborations, [MAEER's MIT Pune Journal, November- January, 9].

Narlikar, J.V. (1992), Science and the Scientific Outlook : On a Decline?, [Business India, March 22].

Narlikar, J.V. (1992), Khagolvidnyanatil suras ani chamatkarik goshti, Articles 1-4, [Pasay, August-December, p.4, 4, 2, 4].

Narlikar, J.V. (1992), Gangepasun grantakade, [Tamasa-tarang, London, June; also reproduced in The Maharashtra Times, December 13, 1992].

Padmanabhan, T. (1992), Playthemes, '2001', (Science Today, April & May).

Padmanabhan, T. (1992), Milestones in Science, '2001' (Science Today, April & May).

Padmanabhan, T. (1992), Ripples: Seeds of cosmic structure, (Weekend Observer, May 16).

Padmanabhan, T. (1992), Bridge over the quantum Universe, (New Scientist, October 10).

Padmanabhan, T. (1993), Intelligent-bug, Cosmic Canvas - 1, (Economic Times, January 16).

Padmanabhan, T. (1993), March of heaven, Cosmic Canvas - II, (Economic Times, February 13).

Padmanabhan, T. (1993), In tune with nature, Cosmic Canvas - III, (Economic Times, March 13).

Paranjpye, A. (1993), Sky gazing in February, (Indian Express, February 3).

Paranjpye, A. (1993), Sky gazing in March, (Indian Express, March 1).

• **by Associates/Senior Associates**

a) Journals

A.K. Raychaudhuri and **S. Banerji** (1990) Spherical shells of positive density - can they be of non-positive mass?, Pramana 34, 383.

T.K. Dey and **S. Banerji** (1991) Were all white holes in the early universe converted into black holes?, Phys. Rev. D, **44**, 325.

M.K. Ray and **S. Banerji** (1991) Robertson-Walker metric with general spatial curvature as viscous magnetohydrodynamical solutions, Acta Ciencia Indica P, **17**, 311.

S. Chandra, V.P. Gaur and M.C. Pande (1991) Partition functions of the Hydrogen 3 + molecular ion, J. Quant. Spectro. Sc. Radiat. Transfer. **45**, 57.

V.P. Gaur, M.C. Pande and **Suresh Chandra** (1992) Equilibrium constants of the molecular ion (Hydrogen 3 +), Astrophy. Space Sci., **191**, 147.

D.P. Datta (1993) Semiclassical backreaction and Berry's phase, Modern Physics Letters A, **8**, No. 3, 191.

D.P. Datta (1993) Berry's phase and energy conservation in a gravity-scalar system, Modern Physics Letters A, **8**, No. 7, 601.

H.L. Duorah (1992) Self-bound matter and pulsar, J. Assam Sci. Soc. **34**, 44.

P. Arvindakshan and **K.N. Iyer** (1992) Solar and lunar tidal variations in total electron content, Ind. J. Radio Space Phys., **21**, 354.

K.N. Iyer (1992) CO_2 LIDAR system for atmospheric studies, Physics Education, **9**, 135.

S. Mahajan, A. Mukherjee, **N. Panchapakesan**, R.P. Saxena and S.K. Sethi (1991) A lower bound on the Higgs Boson and top quark mass from constraint on the Higgs coupling, Modern Physics Letter A, **6**, 1701.

S. Mukherjee and B.C. Paul (1990) Higher dimensional cosmology wiht Gauss-Bonnet terms and the cosmological constant problem, Phys. Rev. D, **42**, 2595.

S. Mukherjee, B.C. Paul, N. Dadhich and A. Kshrisagar (1992) Gravitational instantons with a scalar field, Phys. Rev. D, **45**, 2772.

Udit Narain and S. Kumar (1993) On electric circuit approach of coronal heating: A review, Bull. Astron. Soc. India, **21**, 1.

B.K. Pal (1993) Neutrino astro-particle physics, Physics Education, January - March, **9**, 4.

L.K. Patel and **R.S. Tikekar** (1991) Conformally flat radiating collapsing solutions, Math. Today, **9**, 19.

L.K. Patel, S.S. Koppar and T. Singh (1991) Some new radiating Kerr-Newman solutions, Pramana - J. Phys., **37**, 1.

L.K. Patel and N.K. Dadhich (1992) Cylindrical universes with heat and null radiation flow, Astrophys. J., **401**, 433.

R. Ramakrishna Reddy and S. Anjaneyulu (1992) Analysis of the moss and Ravindra relations, Phys. Stat. Sol. B **174**, K91.

R. Ramakrishna Reddy, M. Ravi Kumar and T.V.R. Rao (1993) Temperature and concentration dependence of energy gap and refractive index in certain mixed crystals and semiconductors, Infrared Phys. **34**, 103.

R. Ramakrishna Reddy, S. Anjaneyulu and C.L.N. Sarma (1993) Relationship between energy gap, refractive index, bond energy and the szigeti charge in polyatomic binary compounds and semiconductors, J. Phys. Chem. Solids, **54**, 635.

R. Ramakrishna Reddy, A.S.R. Reddy and S. Anjaneyulu (1993) Relations between electronegativity differences, ionization energies and dissociation energies, Journal of Molecular Structure (Theochem), **280**, 17.

P.P. Saxena and Alka Misra (1992) Production rate of H_2O molecules as indicator of the surface temperature of cometary nucleus, Bull. Astr. Soc. India, **20**, 297.

R.S. Tikekar and **L.K. Patel** (1992) Non-adiabatic gravitational collapse of charged radiating fluid spheres, Pramana (J. Phys.), **39**, 17.

R.S. Tikekar and **L.K. Patel** (1992) Some exact solutions of string cosmology in Bianchi III space-time, Gen. Rel. Grav. **24**, 397.

b) Proceedings

K.S.V.S. Narasimhan and **S.M. Alladin** (1993) The effect of multiplicity of stellar encounters and the convergence of collision integral in the stellar system *in* Instability, chaos and predictability in celestial mechanics and stellar dynamics, Proceedings IAU Colloquium 132 Delhi, India, October 10-13, 1990, K.B. Bhatnagar (ed.), pp.209-216, Nova Science Publishers, Inc., New York.

K.B. Bhatnagar (1993) Chaos *in* Instability, chaos and predictability in celestial mechanics and stellar dynamics, Proceedings IAU Colloquium 132 Delhi,

India, October10-13, 1990, K.B. Bhatnagar (ed.), pp.3-12, Nova Science Publishers, Inc., New York.

D.P. Datta and **S. Mukherjee** (1992) Boundary conditions and quantum cosmology, *in* Gravitation and Cosmology: Proc. 15th IAGRG Conference, North Bengal University, November 4-7, 1989, S. Mukherjee, A.R. Prasanna and A.K. Kembhavi (eds.), pp. 143-157.

L.M. Saha (1993) On instability leading to chaos in dynamics systems, *in* Instability, chaos and predictability in celestial mechanics and stellar dynamics, Proceedings IAU Colloquium 132 Delhi, India, October 10-13, 1990, K.B. Bhatnagar (ed.), pp.47-60, Nova Science Publishers, Inc., New York.

(VI) PEDAGOGICAL ACTIVITIES

a) IUCAA–NCRA Graduate School

N.K. Dadhich	Electrodynamics and Radiative Processes
T.S. Ghosh	Electrodynamics and Radiative Processes (Tutorial sessions)
A.K. Kembhavi	Galactic and Stellar Physics (15 lectures)
A. Kshirsagar	Methods of Mathematical Physics
T. Padmanabhan	Galactic and Stellar Physics (15 lectures)

b) M.Sc. (Physics), University of Poona

S.V. Dhurandhar	Special and General Relativity
D. Duari	Astrophysics II (Tutorial sessions)
R. Gupta	Laboratory Sessions
A.K. Kembhavi	Astronomy and Astrophysics
J.V. Narlikar	Cosmology

c) Lecture Courses

A.K. Kembhavi

Quasars, SERC School on Active Galactic Nuclei and Quasars, IUCAA, November 22-December 11 (8 lectures).

Fourier transforms, IUCAA, September (4 lectures).

T. Padmanabhan

General Relativity and Cosmology, IUCAA, September-October (15 lectures).

Quantum theory in curved spacetime, IUCAA, January-February (5 lectures).

N.C. Rana

Stellar Astrophysics, IUCAA, June (4 lectures).

Basic Astrophysics, Jalna, September (6 lectures).

Basic Astronomy, Siliguri, October (12 lectures).

Early Universe, IIT, Kharagpur, November (4 lectures).

Galactic Astronomy, Birla Planetarium, March (12 lectures).

d) Supervision of Projects

G.C. Anupama	S. Sethi (VSP) *Analysis of spectrum of recurrent nova V3890 Sagittarri*
S.V. Dhurandhar	N. Vivek (VSP) and K. Das Gupta (VSP) *Blackholes*
	R. Balasubramanian (Graduate School) *Gravity Waves*
	S. Barve (M.Sc.) and S. Sane (M.Sc.) *Optimally orienting a single laser interferometric detector*
R. Gupta	R.C. Issac (VSP) *Theoretical estimation of the Instrumental profile of Fabry-Perot Spectrometer*
A.K. Kembhavi	A.N. Ramaprakash (Graduate School) *Gamma-ray bursts*
	A. Mahabal (Graduate School) and N. Deshmukh (M.Sc.) *Galaxy Imaging*

	N. Thakur (Ph.D. Preliminaries) *Spiral galaxy imaging*
	D. Sahu (Ph.D. Preliminaries) *Elliptical galaxy imaging*
	D. Sita (Ph.D. Preliminaries) *Image Processing*
	V.S. Kamat (Summer School) and M.T.M. Yunus (Summer School) *Magnetic fields and pulsars*
A. Kshirsagar	D. Parashar (VSP) *Problem of Solar Neutrinos*
	A. Garde (Summer School) *Lie algebras in Particle Physics*
J.V. Narlikar	A.D. Maybhate (M.Sc.) *Observational tests for cosmological models.*
	D. Munshi (Graduate School) *Action-at-a-distance electrodynamics*
T. Padmanabhan	P.K. Divekar (M.Sc.) *Radiation from uniformly accelerated charge*
	L. Sriramkumar (Graduate School) *Schwarzschild spacetime*
N.C. Rana	P. Kousalya (Summer School) *Astration of deutrium in the solar neighbourhood*
	C. Das (Summer School) *Mass extinction due to oscillation of Sun about the mid-galactic plane*
	S. Shah (Summer School) *Galacto-chemical evolutions of Th and Nd*
	A.D. Jana (Summer School) *Metallicity distribution of the F-dwarf stars in the solar neighbourhood*
	B. Gajria (Summer School) *Stellar multiplicities and signatures for the supernova-induced star formation in the Eta-Carinae nebula*
	G. Vidya (Summer School) *The problem of solar neutrinos*
	M. Chandola (Summer School) *The problem of Lithium-7*
	R. Jamkhedkar (VSP) *Construction of a Yagi Radio Antenna*
	U. Kamath (VSP) *The third integral of motion for the Galaxy*
	S. Ramani (VSP) *An estimation of the astrophysical S-factor for* $^{8}Li\ (,r)\ ^{11}B$
	S.R. Pathak (Graduate School) *The cooling curves for white dwarfs*
V. Sahni	H. Pandya (VSP) *Vacuum energy of a cylindrical universe*
	J.S. Bagla (Graduate School) *A study of the Zeldovich approximation*
S.N. Tandon	H.A. Sarvaiya and S.S. Gandhi (B.E.) *On photometer cum position detector*
	J.A. Modi, H.J. Chheda and C.N. Ruparel (B.E.) *On controller for microstepper motor*
	Rajesh Nayak (VSP) *On mirror copying and influence of surface defects on images*
	Arul Vedamanickam (VSP) *On elastic distortions of mirrors*

(e) Ph.D.

V. Chellathurai was awarded Ph.D. degree in Mathematics by the University of Poona in May. The title of his thesis was "Effective gravitational charge of stationary spacetimes" and N.K. Dadhich was his thesis supervisor.

(VII) SEMINARS, SPECIAL LECTURES AND COLLOQUIA DELIVERED BY IUCAA MEMBERS ELSEWHERE

(a) Seminars

G.C. Anupama

The 1990 outburst of V3890 Sgr, (Astronomisches Institut, Muenster, F.R.G, January 28).

The old nova GK Persei, (Astronomisches Institut, Muenster, F.R.G., February 16).

Nova cygni 1992, (Astronomisches Institut, Muenster, F.R.G., February 18).

Classical and recurrent novae, (15th ASI meeting, BARC, Bombay, March 2-5).

D.P.K. Banerjee

Spatio-kinematics of planetary nebulae, (TIFR, Bombay, April 2).

S.V. Chervon

Nonlinear sigma models and cosmology, (IIA, Bangalore, January 29).

Nonlinear sigma models and cosmology, (Jadavpur University, Calcutta, February 6).

N.K. Dadhich

Kasnerian cylindrical viscous universes, (Tufts University and Chicago University, USA, June 18, 22).

Taking Bertrand's theorem to general relativity, (McGill University, Canada, June 25).

Rotating black holes in magnetic field, (McMaster University, Canada, June 26).

Magnetic Penrose process, (New York University, USA, July 7).

On active and passive gravitational mass of a fluid sphere in general relativity, (Natal University, South Africa, October 10).

Ashtekar's new variables, (University of Cape Town, South Africa, October 12).

S.V. Dhurandhar

Aspects of gravitational wave data analysis of coalescing binaries, (Tufts University, USA, June 19).

Filtering the coalescing binary signal, (St. Louis University, USA, June 22).

Filtering coalescing binary signals, (McGill University, Canada, June 25).

Gravitational wave detection, (McMaster University, Canada, June 26).

D. Duari

Statistical Study of QSO redshift distribution, (Observatory di Brera, Italy, July 17).

T.S. Ghosh

Density perturbations, gravity waves and the CMBR anisotropy, (BCSPIN winter school on particle physics and cosmology at the interface, Puri, January 15).

R.K. Gulati

Synthesis of stellar spectral features in stellar populations, (Punjabi University, Patiala, November 5).

The MgII index for stellar population studies, (15th ASI meeting, BARC, Bombay, March 4).

A.K. Kembhavi

Relativistic beaming in quasars, (Beijing Observatory, China, May 5).
Soft X-ray excess in quasars, (Shanghai Observatory, China, May 14).

A. Kshirsagar

Path-integral for pure spin-connection formulation of gravity, (Institute of Mathematical Sciences, Madras, October 23).

An approach to quantisation of gravity, (Raman Research Institute, Bangalore, December 23).

J.V. Narlikar

Gravity waves from mini-creation events, (University of Cambridge, University of Durham, University of Cardiff, June 23–July 19).

The role of mathematics in physical sciences, (M.S. Huzurbazar Memorial Lectures, Bombay Mathematical Colloquium, Bombay, August 17).

Non-cosmological redshifts, (BCSPIN winter school on particle physics and cosmology at the interface, Puri, January 15).

Linkages between amateur and professional astronomers, (All India Amateur Astronomers' Meet, Ahmedabad, February 13).

Particle physics and the early universe, (International Committee on Future Accelerators (ICFA), TIFR,

Bombay, February 24).

T. Padmanabhan

Conceptual Problems in Quantum Gravity (Delhi University, September 24).

COBE results and Structure Formation (Delhi University, September 25).

V. Sahni

The Adhesion model and the large scale structure of the universe, (SISSA, Trieste and Padova University, Italy, October).

Voids in the cosmological Adhesion model, (University of Sussex, Institute of Astronomy, Cambridge, Royal Observatory, Edinburgh, Newcastle-upon-Tyne, UK, October–November).

A.K. Sen

The mystery of interstellar comets, (PRL, Ahmedabad, August 27).

Polarization measurements, (Jalna, September 7-12).

Cometary Physics, (Jalna, September 7-12).

Introduction to observational astronomy, (Gauhati University, September 24).

Experiments with small telescopes, (Gauhati University, October 29).

(b) Lectures

G.C. Anupama

Stellar photometry, School on Image Processing, (October 9-12, 2 lectures).

S.V. Chervon

Introduction to nonlinear sigma models, (Miniworkshop on geometry and its application in physics, S.N. Bose NCBS, Calcutta, February 2, 1 lecture).

Differential geometry approach to self-gravitating NSM, (Miniworkshop on geometry and its application in physics, S.N. Bose NCBS, Calcutta, February 4, 1 lecture).

N.K. Dadhich

Einstein's theory of Gravitation, (School on Active Galaxies and Quasars, November 22-December 11, 3 lectures).

S.V. Dhurandhar

Gravitational waves, (Introductory Summer School in Astronomy and Astrophysics, June, 2 lectures)

Blackhole electrodynamics and its applications in astrophysics, (SERC school on Active Galactic Nuclei, December 9-11, 3 lectures).

R.K. Gulati

Synthesis of stellar spectra, (Miniworkshop on Techniques for Astronomical High Resolution Optical and IR Spectroscopy, IR Observatory, Mt Abu, March 22-26).

R. Gupta

Optical techniques I, (Introductory Summer School in Astronomy and Astrophysics, IUCAA, June 8).

Optical techniques II, (Introductory Summer School in Astronomy and Astrophysics, IUCAA, June 9).

Telescope and human eye, (Regional School on Introductory Astronomy, J.E.S. College, Jalna, September 7-12).

Atmospheric effects, (Regional School on Introductory Astronomy, J.E.S. College, Jalna, September 7-12).

Stellar spectra, (Regional School on Introductory Astronomy, J.E.S. College, Jalna, September 7-12).

Astronomical Photometry, (Regional School on Introductory Astronomy, J.E.S. College, Jalna, September 7-12).

Astronomical spectroscopy, (Regional School on Introductory Astronomy, J.E.S. College, Jalna, September 7-12).

Astronomical spectroscopy, (Inter University Consortium, Indore, October 15).

Photometer construction and APT, (Miniworkshop on Photometry with small telescopes, IUCAA, January 4-8).

Tandem Fabry-Perot Spectrometer, (Miniworkshop on techniques for astronomical high resolution optical and IR spectroscopy, IR Observatory, Mt Abu, March 22-26).

A.K. Kembhavi

Quasar continuous radiation: Nature and evolution, (Workshop on Observational Cosmology, TIFR, Bombay, April 7).

Galaxy surface photometry, (Purple Mountain Observatory, Nanjing, May 14).

Pulsars, (School of Astronomy, North Bengal University, October 30-November 3, 2 lectures).

Careers in physics and astronomy, (Phatak Class, Pune, January 15).

Radio Pulsars, (Miniworkshop on Pulsars, IUCAA, February 15-20, 3 lectures).

VBT observation of galaxies, (15th ASI Meeting, Bombay, March 3).

Computer networking and e-mail, (Cochin University, March 8, Kerala University, Trivandrum, March 11).

Distances in astronomy, (Cochin University, March 9).

Pulsars, (Cochin University, March 9).

Stars, (Regional School on Introductory Astronomy, March 10-12, 2 lectures).

Observation : Extra–galactic astronomy, (Madhya Pradesh Council of Science and Technology, Bhopal, March 19).

V.I. Korchagin

Spatial structures in star-bursting galaxies, (IIA, Bangalore, February 23).

Nonlinear oscillations of star formation on star-gas systems with phase transitions, (International Conference on Panchromatic view of galaxies - evolutionary puzzle, Kiel, Germany, March 8-12).

Generation of grand design and Flocculent spiral density waves by nonlinear mass-exchange processes in a multicomponent rotating disc, (International Conference on Panchromatic view of galaxies - evolutionary puzzle, Kiel, Germany, March 8-12).

Dynamics of stellar content of hot-spot region of active galaxies, (International Conference on Panchromatic view of galaxies - evolutionary puzzle, Kiel, Germany, March 8-12).

A. Kshirsagar

Gravity without metric, (IMSc., Madras, November 27).

J.V. Narlikar

Alternative cosmologies, (BCSPIN Winter School on Particle Physics and Cosmology at the interface, Puri, January 15–17, 3 lectures).

T. Padmanabhan

Constraints on structure formation from recent observations, (Workshop on Observational Cosmology, TIFR, Bombay, April 9, 2 lectures).

Structures in the universe, (Introductory Summer School in Astronomy and Astrophysics, IUCAA, June 15, 16, 2 lectures).

Structure formation in the universe, (IIT, Kanpur, October 1).

Statistical mechanics of finite gravitating systems, (Miniworkshop on Galaxy Distribution Functions, IUCAA, Pune, December 28).

Anisotropies in MBR and constraints on models for structure formation, (Miniworkshop on Galaxy Distribution Functions, IUCAA, December 29).

COBE Results and their implications for cosmological models, (Workshop on the "COBE and Cosmology" at IMSc, Madras, January 22).

Anisotropy in the cosmic microwave background and the implications for cosmological theories, (15th ASI meeting, Bombay, March 4).

A. Paranjpye

(i) Basic concepts in Astronomy, (ii) Optical telescopes, (iii) Nebulae and Clusters, (Regional School on Introductory Astronomy, Jalna, September 7-12).

Optical telescopes and mounts, (Workshop on telescope making, IUCAA, November 12-20).

Solar System Photometry, (Minischool on Photoelectric Photometry with Small Telescope, IUCAA, January 4-9).

N.C. Rana

Chemical evolution of the galaxy, (IUCAA, June, 2 lectures).

V. Sahni

Cosmology, (Introductory Summer School in Astronomy and Astrophysics, IUCAA, June, 2 lectures).

Large scale structure of the universe, (School on Active Galactic Nuclei and Quasars, IUCAA, December).

Post-COBE predictions for inflationary gravity wave and density perturbation spectra, (First Iberian meeting on gravitation, Evora, Portugal, September).

The adhesion model and the statistics of voides, (Workshop on Galaxy Distribution Functions, IUCAA, December).

A.K. Sen

CCD detectors, (Regional School on Introductory

Astronomy, Jalna, September 7-12).

Cometary photometry, (Miniworkshop on Photometry with small telescope, IUCAA, January 4-8)

Photopolarimetric techniques in astronomy, (Miniworkshop on Photometry with small telescope, IUCAA, January 4-8)

S.N. Tandon

New generation optical telescopes and plans for a large optical telescope in India, (15th ASI meeting, Bombay, March 3).

(c) Popular Lectures

D.P.K. Banerjee

Planetary nebulae and late stages of stellar evolution, (Jyotirvidya Parisanstha, Pune, October 15).

N.K. Dadhich

Space and time: From Galileo to Einstein and beyond, (University of Mauritius, October 17).

Black holes, (University of Mauritius, October 18).

A.K. Kembhavi

Planets - old and new, (Marathi Vidyalaya, Nagpur, April 25, in Marathi).

Planets, (Sneha Sabha, Pune, September 18, in Marathi).

Pulsars, (Wadia College, Pune, February 25).

Elementary astronomy, (4 radio talks on AIR, Pune, February-March, in Marathi).

A. Kshirsagar

Krishna-vivar, (radio talk on AIR, Pune, July 13).

Guru-shishyanchi jodi: Fred Hoyle and Jayant Narlikar, (radio interview of J.V. Narlikar, Pune, August 28).

J.V. Narlikar

The challenges and excitement of doing astronomy and astrophysics, (Foundation Day Lecture at Mangalore Univerity, Mangalore, September 9).

Vaidnyanik drishtikon (in Marathi), (Babasaheb Ambedkar Memorial Lectures, Ekata Shikshan Prasarak Samstha, Satara, December 5).

...anirmitiche siddhant (in Marathi), (Babasaheb Ambedkar Memorial Lectures, Ekata Shikshan Prasarak Sanstha, Satara, December 6).

The joy and anguish of doing science, (Spic-Mackay, Fergusson College, Pune, February 17).

Manoranjanatun ganit (in Marathi), (Pioneer Education Trust, Bombay, February 20).

The strange world of black holes, (Silver Jubilee Lecture at Patkar College, Bombay, February 20).

T. Padmanabhan

The Universe - past, present and future, (Jyotirvidya Parisanstha, Pune, September 12).

Physical principles governing the scales of structures, (University of Madras, January 23).

A. Paranjpye

Planets, (Bal Shikshan Mandir English Medium, Pune, April 6).

Milky way galaxy, (at children's camp conducted by Balak Vikas Mandal, Pune, Bavdhan, April 24).

How and what to observe in the sky, (at children's Adventure Training Camp, organised by Bombay Engg. Group and Centre, Training Battalion 2, Purandhar Fort, May 19).

Some mathematical calculations required during the observations, (Khagol Mandal, Bombay, August 8).

Optical designs of different types of telescopes (Khagol Mandal, Bombay, August 8).

Nebulae and star clusters, (Jyotirvidya Parisanstha, Pune, August 16).

What do amateur astronomers do? (in Marathi) (Dnyana Prabhodhini Navanagar Vidyalaya, Nigdi, September 4).

V. Sahni

The universe after COBE, (Jyotirvidya Parisanstha, Pune, May).

A.K. Sen

End of life on earth in 2126, (Jyotirvidya Parisanstha, Pune, November 29).

(d) Colloquia

A.K. Kembhavi

Optical imaging of galaxies, TIFR Bombay, November 18.

A. Kshirsagar

The joy of superstrings, Tata Research and Design Centre, Pune, December 5.

T. Padmanabhan

Quantum Gravity - A status report, IIT, Kanpur, September 30.

(e) Participation in Conferences

S.V. Dhurandhar

GR13 International Meeting, June 28-July 4, Cordoba, Argentina.

D. Duari

International School on "Particle Astrophysics and Cosmology", June 20-30, Erice, Italy.

International School of Physics on "Galaxy Formation", July 21-31, Varenna, Italy.

T.S. Ghosh

BCSPIN Winter School on "Particle Physics and Cosmology at the interface", January 2-17, Puri, India.

Workshop on "Observational Cosmology", TIFR, Bombay, April 14-18.

J.V. Narlikar

Workshop on "Observational Cosmology", TIFR, Bombay, April 14-18.

Oriental Workshop for College Teachers of Nagpur University regarding Astronomy and Astrophysics syllabus, conducted by Nagpur Chapter of Indian Physics Association, at Department of Physics, Nagpur University, Nagpur, April 24–26.

Visit to the U.K. under the Inter-Academy Exchange Programme between Indian National Science Academy and Royal Society, London, June 22–July 20.

Indo–French Seminar on "History of Development of Science in India and in France", Indo–French Centre for the Promotion of Advanced Research, at Madras, October 20–23.

Seminar on "Vidnyan, Tantradnyan va Bharatiya Samaj", BARC Bombay Maharashtra Mandal, BARC, Bombay, November 21.

International Seminar on "Prakriti – Nature and Man – An Integral Vision", Indira Gandhi National Centre for the Arts, New Delhi, January 11.

BCSPIN Winter School on Particle Physics and Cosmology at the interface, Puri, January 12–18.

All India Amateur Astronomers' Meet, Ahmedabad, February 13.

ICFA (International Committee on Future Accelerators) 93 India School on Instrumentation in Elementary Particle Physics, TIFR, Bombay, February 24.

R. Radhakrishnan

Automated IUCAA library : Oral presentation at Library and Information Services in Astronomy and Astrophysics Workshop during A.S.I. meeting, BARC, Bombay, March 2-5, 1993.

PARALLELING AND NETWORKING INDIA

Fourth IUCAA Foundation Day Lecture

by

Professor Yash Pal

Thank you very much Jayant, and Professor Chitnis. Chitnis has given three-fourth of my talk already. This is one of the problems we have had for a long time - we forestall each other. Nevertheless, it has been a marvellous association I have had, both with Chitnis and Jayant, over a number of years.

Indeed, I have had the good fortune to work with, and to know, a large number of people in this audience; they should not be surprised by anything which I say today. However, since I, myself don't yet know what I will actually say, perhaps I will surprise both you, and myself.

At the outset let me say what a personal joy it is for me to be here today and to see this remarkable institution take off in such a magnificent manner. Many things were revealed to you about how this Centre came to be, including the whole concept of IUCs. But you were not told that when I was discussing the possibility of such a centre with Professor Bhide, who was very active in promoting this as the Vice-Chancellor of University of Poona, one of the conditions was that we should be able to persuade Jayant to leave TIFR to come to lead this effort. And I did twist his arm a little, though he himself became so enthusiastic about the idea that he decided to sever his connection with TIFR and come here, and I think that is why one is so sanguine about the future of this particular Centre. I want to thank him for accepting this challenge.

NETWORKING

Now briefly about networking. I think my whole life has been spent doing just that. Perhaps I am one of those who cannot do wonderful things by themselves, but delight in helping other people do wonderful things. I believe that is one of the essential attributes of an agent of networking. Get remarkable people to work together and something would come out of it.

This Centre, IUCAA, is one of those beautiful things. But I will briefly tell you about a few others.

During last 4/5 years one of the things which has been raised to a new level of operation is the programme connected with the Countrywide Classroom. This involves a number of universities getting together to produce enrichment type educational programmes and telecasting them 2 hours a day on the National T.V. Network. I have often talked of "cunning alliances". I may mention that the origin of this programme goes way back to when Chitnis and I were together at the Space Applications Centre in Ahmedabad. Indian National Satellite had not yet come. We were trying to make it come. We were both convinced that a proper communication system for India would be that in which we had a large number of low power transmitters serving local communities, but networked together via satellite, so that you could combine the intimacies of the local with the opening of windows to the country and the world at large. More about that part later but one thing which occured to us - we thought that there is one distributed constituency around, spread all over the country, which could begin to be served by common programmes without waiting for the local programming to come up. This was in the area of higher education, since many courses were at similar levels and a lot of it was done in one language; we said it could even be done in two languages. We were in many advisory committees and discussions. We were amongst the promoters trying to persuade the government to have a national satellite. The Planning Commission was by no means fully persuaded nor the Telecommunication Ministry, or the Education Ministry. When discussions about INSAT utilization were happening we managed to get a note put in a cabinet paper that when the satellite comes, a couple of hours a day would be allocated to the University sector because that way we can network a constituency which is widely distributed around the country. Well, the satellite did come and I found nothing was hapenning - at that time I happened to be in the Planning Commission. I requested to meet with the Vice-Chairman of UGC - Rais Ahmed, who was another networker. I said something to the effect: "Look, though you may not know that this is hidden in a cabinet decision, you prepare a note and send it to the I & B Ministry. I will call a meeting of everybody together and let us clinch it, let us reserve these two hours or they will be gone". It is through this kind of rather clandestine collaboration that we ensured that these two hours were available and that is how it was possible to start telecasting almost as soon as the satellite came, even when we did not have many programmes of our own readv for telecast.

Like many of the things which one does, possibility of regression is ever present. It is quite possible now - one hears all kinds of rumours - that in order to make some more money in these days of competition and "opening-up" to the world - when Doordarshan and I & B Ministries have been asked to earn more of their keep - that some of these programmes may be taken off Doordarshan. We had dreams of expanding, with Hindi and other languages. But there are many others who would rather sell time for movies, programmes like MTV, serials, etc. etc., so as to compete with the foreign satellite programmes for advertising revenues. We are fighting this battle still but one is a bit nervous,

and I do not know where it will go. But let me come back to the organisation and chemistry of the Countrywide Classroom programme.

Since Chitnis has said so many nice and not-so-nice things about me, I can say almost the same number or more about him. Now, being a Chairman of UGC you do not run a programme yourself, you are not an operator. By the time I came to UGC, Chitnis had just retired. Luckily, I inherited the enthusiasm of both, Madhuriben Shah and Rais Ahmed. But I know that the spirit of the programme needed nourishment and vision, to which I couldn't devote sufficient time. I needed help. So, with the approval of the Commission I requested Chitnis to come in as an unpaid consultant. "Will you please come and look after this programme and give it the soul it requires?" And I let all the colleagues know, in the universities and everybody else, that what Chitnis says I have already said. So Chitnis started holding DARBARS all over the country. That is how he got this habit of travelling and now you can't keep him in one place. With 15 collaborating universities and a meeting one place or another every month, the programme has developed a personality of its own, largely due to the work done by Professor Chitnis. (Now Chitnis, you better say nice things after I finish).

However, there was one element over which I had agonised over a long period of time, almost for three and a half years. There were these universities which were autonomous bodies. We had also insisted that the media centres which were set up within the universities should also have a degree of autonomy. So we were dealing with doubly autonomous entities and we wanted them to work in creative harmony, while receiving funds from the parent autonomous body, normally the UGC! Why were these media centres working together? Nobody could make them work together except the kind of informal arrangement which we had worked out involving Professor Chitnis and all the coordinators of these centres. While it was clear that ultimately this would need some appropriate structure, we did not want to imprison them into a single centre. No, not even like IUCAA. That would be too tight. So how do we design a structure which takes care of this multiple autonomy, allowing independent creative operation, a structure under which people do not feel constrained and yet have the possibility of doing things together, of fertilising each other's ideas and gaining through each other's strengths? This took a long time to think through and finally when we had the solution it looked so very simple. We said, alright all these coordinators have learnt to work together so let them represent the working council of the structure, continuing to meet as they now do. Nothing drastic will happen. We just have to have a body registered, with some of these people, some outsiders, heads of some universities and a few persons from the UGC including the Chairman. Since UGC does the major funding, the Governing Body would be chaired by the Chairman, UGC or his nominee. At the operational level there would be a Director with a small set up for interfacing with other agencies, training, capsuling and coordinating. The members of the Consortium would be the participating universities but there would be room for some Associate Members from amongst those groups or agencies who are committed to educational media and are outside the UGC family. Incidentally, some difficulties were raised by the Government after I left UGC, but I am told that finally the papers have gone and the Consortium for Educational Communication will be registered as an autonomous society pretty soon. (This has happened since this talk was given.) Another person who strove for this purpose was also an old colleague of mine, Mr. Karnik, who is the Director of this Consortium and under whose leadership I see a great future for this particular activity.

A whole lot of other things, one was dreaming of, could also be done, though many lie in the future. Besides the IUCAA, there is another Centre in Delhi which is called the Nuclear Science Centre; it is operating and was indeed the first such centre to come up, largely through the initiative of Rais Ahmed, and a number of university scientists. It is on a similar basis. It is not owned by any single university, it is also an autonomous organisation belonging to all the universities. It has an accelerator. I have a little cubicle there - they allow me to sit there though I have no official position in the Centre. I am delighted to see that for the first time in the history of India, as many as 30-35 university groups are working at that one centre. They are not only working there, they are also doing joint experiments, they are designing and building equipment together. They have access in a manner as if the facilities were their own. They come from various places. Students are there. Such an accelerator also exists at TIFR, but many friends from TIFR and IIT's also come. Dr. G.K. Mehta is the current Director.

What a delight it was the other day, when one of the nuclear physicists from TIFR, CVK Baba, probably one of our best experimental nuclear scientists, who was in Delhi giving a set of lectures there, said to me, you know Yash I think now the future lies here not at TIFR. (I see that my TIFR friends look shocked) I asked, why? He said we have to cooperate largely because in TIFR "there are people only my age, very few young people, and this place is full of young people".

In addition, we have another Centre of an entirely different flavour, which got established with assistance from Dr. Bhide. Bhide, who was the Vice-Chancellor at Pune, has been a tremendous colleague and an

instigator in many of these things. With a rather remarkable meeting of minds, following a constructive dialogue with Dr. M.R. Srinivasan, the then Chairman, Atomic Energy Commission, we set up a Consortium - again an Autonomous Body - to be able to use and enhance some of the facilities of Department of Atomic Energy. The Department of Atomic Energy has a wonderful experimental research reactor in Bombay. They have a cyclotron in Calcutta and they are setting up at the High Technology Centre in Indore, an electron synchrotron machine, with a synchrotron light source. At one point I wrote to the Chairman, Atomic Energy Commission reminding him that they had an idea some years ago to set up a synchrotron in Indore. What had happened to that? If they had decided to give it up we would like to collaborate on behalf of the universities to get such a machine built. I think that moved the synchrotron project. They said no, we are building the machine and would welcome university participation. It was decided that the cooperating universities would design two beamlines for this purpose and take part in using the machine. Out of this arose a Memorandum of Understanding between DAE and UGC, for their mutual benefit, and IUC-DAEF was born as an autonomous body.

After giving these four examples of rather passionate efforts to give more initiative and opportunities to our universities, let me get to the meat of my topic for today. Lest someone accuse me of a bias against National laboratories, I would like to remind you that not only did I begin at TIFR, but my whole personality was shaped there. I still consider it to be a unique institution. I also helped to build the Space Applications Centre, which is also one of the remarkable Centres of the world. But I do have an argument.

After independence when we started building laboratories in large numbers, the slogan was that we must set up centres of excellence, we must collect good people to create viable groups in a few places, so that we can give examples of how good work could be done in this country. So the CSIR set up a large number of laboratories and then TIFR, PRL, Atomic Energy laboratories, many others were set up. We were also a little bit impressed by the example of some other countries. This was not such a bad idea in itself, but we were so taken up by major laboratories that the emphasis on developing and funding universities sort of went away. Till early 70s UGC, which is responsible for funding the universities, did not even have a budget head called research. They were not supposed to fund research, only teaching. So the only research funding which universities ever got was through the so-called extra-mural activities of CSIR. I know Department of Atomic Energy also used to fund research but the total money at one point which the Board of Nuclear Research used to disperse to universities was of the order of 8 lakhs for all the universities together, and this was also considered marvellous by the universities because they had no other source. Other sources have emerged during last 10 years or so and after a while DST, DRDO and UGC started coming in and universities started getting a bit more but the major facilities were mostly set up outside. I once calculated that the total funding done in the universities by CSIR, DST and everybody else over the last 40 years, specifically for research in sciences, was equal to or less than one year's budget of BARC! It is nothing against BARC. But that is what has been done to the universities. So clearly at this point in time one has to establish ways in which one can learn to have common facilities, share facilities including national facilities and change policies and directions. Get people together to network, to be able to work together, to be able to fertilise each other, to be able to go to places as a matter of right, not because of someone's goodwill. This is the idea one has tried to propagate. How far it will go I don't know. 5-6 places have been set up. More are needed.

Incidentally, we have not forgotton humanities and social sciences. We worked out an arrangement with the Institute of Advanced Studies in Shimla. This Institute was in trouble. At one point, they wanted to close it down. There has been frequent talk of moving it away from its magnificent building in Shimla, the old Viceroy's house. They have been saying, "how can you use such a historical place for a thing like an Institute of Advanced Studies. Only 30/40 fellows go there. Yes, Dr. Radhakrishnan decided this, but Dr. Radhakrishnan was only a philosopher". "The beautiful location can be better used as a hotel and you can accommodate forty odd fellows who work there in a small building in Delhi or some other place". There was such a move, which is not yet completely squashed. At that time I was an ex- officio member on the Governing Council of Institute of Advanced Studies and I did a crafty thing. I rather like the place. I was delighted that they published about ten books a year. I am impressed with what happens there. People can interact and they can be alone. The chemistry of the place is special and could be made even more special. So we worked out an arrangement through which the Institute of Advanced Studies would also act as an Inter-University Centre for Humanities and Social Sciences for the UGC. All it would cost is about 10 lakhs a year, for additional facilities, for having associates and lot of people from universities come in. This will also give more visibility and additional importance to the Institute, so that it may become more difficult to move it. A Memorandum of Understanding was signed and the Inter-University activities are in full swing. I hope the Institute

continues to stay in that place.

Finally, there is another project which I believe is exceedingly important for networking. I am sorry it is not being pushed at the level at which I thought it should be moving. It was started a little late - bad times these days. This idea was to set up an institution, an organisation or arrangement through which all universities, all research laboratories and most libraries and data banks would be interconnected through an Information and Library Network. The project for this was developed with the help of people coming from everywhere, librarians and information technologists from universities, CSIR, Atomic Energy, Electronics, Space, C-DOT, everybody. It took a year and half. Then a few people were locked up in a room for a period of three months to prepare the final project report - very technical, quite detailed and comprehensive. There are dozens of universities in this country who have stopped subscribing to even a single foreign journal. Imagine doing research when not a single journal comes to the university! They do not have money for it. No college gets any science journal of any kind. Even popular science journals are being cut out. All major universities are also cutting their subscription lists every year. Imagine the state of a country in this situation. After the project report was ready we did talk with everybody, and practically everybody agreed. Some wonderful things in this country are also terrible things in this country. When you talk about something passionately and with conviction, giving all your arguments people tend to agree with you. However, sometimes it is horrible that they agree with you so quickly because this means that nothing is likely to happen.

I had a friend in Hoshangabad, working in science education and all manner of developmental activities at the grass root level for a number of years. I had worked with him for a while. Once I asked him, "Look Anil, you know everybody in Delhi. You know the people in the Planning Commission, all the Ministers, most of the Secretaries, everybody talks to you. Why can this idea not be spread?" He said, "You know Yash, what happens when I go and talk to people is that they only appreciate me". If you try to move a mass that is soft and mushy by kicking it, it just compresses a little bit, but slowly comes back to its original state. It is true that you feel good when it gives a little, without even hurting your toe, but ultimately almost nothing happens. I believe that is the most frustrating opposition you can encounter because if an adversary kicks you back you probably kick it harder or you can come after augmenting your forces. But if he does not do anything, just squeezes a little, then nothing happens. Many a times this is the kind of thing which one encounters. So, there was a lot of appreciation from all over for the INFLIBNET programme, Planning Commission and everybody else. But I suspect that at the basic level, the urgency is missing. I tend to think that this may be due to a rather dangerous part of the present day climate. Many people seem to think that total development can occur now merely through changes in fiscal policies and so-called free enterprise. Thatcherism is the only answer to problems of development. Nothing else is required by way of capability building. Just open up. Let the industries bring in what they want, change some economic and trade policies and everything else would develop, education, science, technology, everything would happen. I think, this is a very dangerous frame of mind. I am sorry, you may do wonderful cosmology and astrophysics and deep science, but unless you also worry about these things you are not going any place nor is the country. We have to worry one way or another.

So, that project, which incidently is an IUCAA project, is going, but in a small way. I had hoped that by now it would be up and running and all the universities and institutions would be connected. I may mention that the total scope of the project was not just confined to sharing library resources but also to enable people to access each other, even to gossip about their work. I have met some wonderful people in small colleges and universities all over the country, struggling in isolation, without contact with live concerns in their subject. Take just a single person doing some work on superconductivity or laser physics in North Bengal University. For how long, and how often, can he come if he is doing something and wants to test his hypothesis or needs help? If on the other hand he had access to an INFLIBNET bulletin board where he could say I need this and this information and I have done that, any comments? Ten other people may read it elsewhere and may talk to him even get new ideas themselves. I personally feel that in a country this large, in a country where people with special interests are so thinly distributed in so many places, including colleges and universities and so on, a facility of this nature might effect a major transformation. You can't possibly put everyone together in a laboratory like TIFR or PRL. Instead you can bring them together in terms of being able to talk to each other, exchange information and send notes. That is the way in which the country could develop not only in a few isolated locations but all over. May be, new nuclei would emerge and new things would begin to happen, even in our present elite laboratories. This was not easy to do in the days gone by, but now it is rather simple.

People say Ah! you have telephones, why don't you use telephones? Heaven's sake, have you ever tried using a telephone in a university? If you give a telephone to a university it is either used by the registrar, his staff or may be the Vice-Chancellor.

Ordinary teachers, and graduate students, or librarians can't come near it. I think one has to design a system which is seen openly to be meant just for this purpose, you have to have a messaging network, not a telephone network. it should not even look like a telephone even if it is a telephone. It should be done differently. So, this was the idea. One proposed to put a small satellite dish on top of every institution or library. One will also forget about the whole network and exchanges of P & T. You have a separate network entirely with the computers of kind Bhatki here makes. Perhaps they are too fancy for this and you could use simpler computers on each of the dishes and more capability on the central hub and you are on with a packet network creating a fantastic new community of academic transactions all across the country. A networked community in which Paralleling of learning and creativity can occur. That is the example of what I mean by Paralleling and Networking India.

Many people, of course, come and say that all this is very well, but these things are just emerging around the world, we have talked to friends in Britain and elsewhere and even they are just beginning to design library networks and such facilities, so why don't we wait till the technology and software mature and take it up later? I find such a suggestion demeaning at worst and bit thoughtless at best. It does not recognise that one has to completely reverse the mode of development in countries like ours who do not have all the inherited infrastructure on the ground. We should first create all these data networks and messaging systems of this kind, even if we do not get a telephone in our home nor even in our office. The priority for us is not to provide an answering machine and a telephone in every home and office. But I want in each institution a place which is connected to such a network. Of course you could get an extension to this place, but that is secondary; it is not a great hassle to walk to the library. What I am suggesting does certainly smack of modernity, but a very very important modernity, an appropriate and poor modernity of a vital nature. Let this come first. It is impractical to think of cables and optical fibres going to every hut in India. At this stage it is not possible. Even installation of a telephone costs something like 20 times per capita GNP of India. What is the point of even dreaming of putting optical fibre links into all the thatched huts and pavements of the country? I would rather have a messaging system, with a terminal available in each habitation. This is doable and this is of a different nature. I want a system of this kind where all the villagers can not only talk to each other if they want, but also access information, send messages, get weather data, check on market prices, find out whether they should drive their tractor 20 kms to the fertiliser depot or not, make bus reservations and all manner of things. Let us introduce this first, even though this is a stage which is coming later in industrialised countries. Here I want this to come first. Telephones and optical fibres can follow. I suggest this kind of thinking is necessary in this country. We have to have different versions of modernity, even of the latest techniques and technologies.

PARALLELING

Professor Chitnis talked about that old experiment called Satellite Instructional Television Experiment (SITE). Chitnis, people have forgotten about SITE. So, don't just say SITE and assume they know what you are talking about. I was horrified the other day when I said something about SITE and saw only uncomprehending blank faces, till I realised that I was talking to some 25 year old people, who were only 7 when SITE happened. I am sure many in this audience have never heard of it. Basically, it was an adventure in development communication in which Chitnis and I were involved. Satellite television was about to be invented and we launched a major programme to see how we could bring education and development messages to people in the countryside. Incidentally, this was the first time a large scale direct satellite television reception by small parabolic dishes was done anywhere in the world. We had 2400 terminals in this experiment, in a few thousand villages in the remotest possible areas of this country - the least developed. The ground systems were prepared by us and the satellite was borrowed from the US. Systems were installed and maintained by us and we in ISRO took responsibility for doing the part of the software also and doing the social evaluation. During this period I had an opportunity to spend about three months with my wife and children travelling from village to village. We wanted to see how things were working, what people thought of the programmes, how they coped with this invasion from the skies. After a few weeks of this interaction I began to feel that rest of the world - Delhi, Ahmedabad, Europe, America, i.e. all the places with which most of us relate are more or less irrelevant to the bulk of humanity living in our country-side. They have nothing whatsoever to do with them. Except in a distant sort of way, may be not so distant from our core, but certainly from our daily drives. Even nice laboratories like this, or most others - they seemed so remote, so irrelevant and so unconnected. Many of these villagers had never turned a knob before. No radio, no instrument of any kind. It was an eerie kind of feeling particularly when your mind was full of satellites, band widths and noise figures. And yet, in the middle of this, when it came down to real living, relationships, empathy, curiosity about the meaning of this universe, music, fun and laughter, a sense of balance, there is so much depth, so much beauty. There is so much commonsense, so much appreciation of things in a different way. Now, nobody

has given words of our kind to that commonsense. Nobody has given words of our type to their knowledge, all kinds of knowledge, including knowledge of how to live at a deep level. Local remedies and local crafts and compentances and all manner of things. We have not converted all these into information and knowledge which we can put in our computers or occassionally retrieve it to marry with our kind of knowing to make something whole.

After this exercise, one became quite humble about this idea of trying to educate the so called uneducated through a uniform shower from the skies. In fact we had partly suspected this. That is why we had decided right in the beginning that in the middle of this overall broadcasting exercise where wisdom would come from the sky to everybody, we will also do another experiment. We had set up a small transmitter about 60 kms away from our lab in the Kheda district of Gujarat. Besides the national segment, programmes for this were made often in association with people living there and many times by those people themselves in their language. The broadcast then became a part of their own local networking and was a fantastic success and a tremendous experience. In fact it was only flowing from this experience that we developed the design for the T.V. communication system of the country using a satellite. After a number of discussions and in meetings held mostly in Ahmedabad, it was decided that while direct reception from satellite would enable us to maintain countryside development channels, the emphasis would be on a large number of low power transmitters, interconnected via satellite. The low power transmitters with a coverage radius of 25/30 kms should allow local programming, (perhaps run by colleges and universities) where people talk of intimate issues and problems. Then in order to ensure that they do not become parochial or cut off from the world, they should be networked via satellite so that occassionally programmes from the Centre, abroad and other places can also come. This was the design of the communication envisaged on the basis of our experiments. Intense paralleling, covering the whole country, coupled with meaningful networking. Now the interesting thing is that this is precisely the set-up which has come up in the country. There are 900 localised transmitters. So we were successful in terms of getting our design accepted but the tragedy is that they are only being used for rediffusion, for bringing programmes via satellite either from the state capitals or from the Centre in Delhi or from outside, and the local programme and the intimacy have not been allowed to develop. Locality would spawn initiatives even if we should start by talking about the price of vegetables in the local market, some little pond which needs cleaning, school master not coming, roads being flooded, even advertising of the local things. I do not know why we are afraid of this. Somehow we are suspicious of paralleling, we are afraid of real decentralising. We believe in wisdom is rare and must be supplied centrally from somewhere.

This is a general problem. For example, we believe that for schools, wisdom must come only from the National Council of Educational Research and Training. They often produce beautiful textbooks in which many of people sitting here participate and they must be right because sitting in Delhi they must know all the children in the country. These books are then copied in the states. States actually try to "improve" on this material, saying that if NCERT can make such tough books for children we are also clever. We will improve upon them. We will make them tougher. More and more information is packed in. There are toughened varieties of NCERT books being used in many states and they proudly proclaim, "Look at our text books, they are even better than NCERT books, which means more titles and more definitions and less understanding than even the NCERT books. So the real challenge is to awaken to this - No really good things can be done centrally. You cannot have little children have the same curriculum in Kerala as you have in M.P. or Kashmir. You cannot because it must relate, it must be grouted there. In fact in this regard I have come to a firm conclusion. We parallel or we perish. This needs some elaboration.

This country is full of a large number of beautiful experiments in education, also many efforts in integrated development. Many insightful activities are going on. We do not hear of them too much on national news or the establishment agenda, except in a patronizing way. You do not get a Ph.D. working with these groups. Their's is considered disorganised non-academic knowledge. It does not enter text books. But never mind, let me come back to the nagging question: why can't we take the experience and working of a few of these groups and replicate it all over the country? Why don't we enlarge it? We find that like the NCERT books, as soon as you try to enlarge it to cover the country and all sections of society you get into a lot of problems. I have a feeling - it may be otherwise in other countries - that we have not quite appreciated the true character of our country. We are not one country in the same sense as many other countries - I mean the diversity in this country is greater than the total diversity in Europe. And we think somehow this diversity will be taken care of through mindless slogans of unity in diversity, some programmes on Republic Day, some festivals of all the communities shown on T.V., a few Naga dances, Urs at Ajmer, Gurbani from Golden temple and church sermons at Christmas. I think there is much more richness to this diversity, each way of thinking, even different ways of absorbing science - other ideas using analogues of local sayings,

local "kahawats", local ways. We somehow feel that too much emphasis on the hues of our spectrum will take us away from nationalism, from the "mainstream" and we are afraid of it. Instead we should appreciate that being a cultural composite gives us advantages which physical composites have in material science. I think we have to move away from this mindset to develop our varied richness through paralleling - an enormous amount of paralleling - without demanding, of course, uniformity of all parallel efforts. I don't think I have to tell this audience about the strength of paralleling as compared to non-paralleling. Here is the big boss of parallel computing, Bhatkar, of the Centre for Advanced Computing in Poona University. (Poona University has learnt a little bit about paralleling.) If we do this kind of thing, we will realize that the true nature of our unity lies in Networking. This is how I see the future for this very special nation. How do we move in this direction?

PARALLELING, NETWORKING AND MANAR

This is the month - it is not quite a month since that abominable happening in Ayodhya. Three years ago the Association of Indian Universities met in Srinagar and we had passed a resolution. Two years ago we met in Ahmedabad and we passed another resolution. But with what results I ask myself. Some months ago I was asked to come to Chandigarh by an academic institute working on problems of rural development and talk about "Problems of Academics in India". Perhaps they expected me to talk about libraries, travel, books, journals and other difficulties. I thought about it a little and suggested that I would rather talk about "Academic as a problem in India". They accepted. Let me share the gist of my argument with you.

I think it is true that we have been singularly unsuccessful, during later part of this century, after Gandhi and Nehru went away, in creating a true image and identity for our country. Many of us in academia would say, "well look, it is not my job. I am a cosmologist, physicist, astrophysicist, a social scientist. I am a geologist. I work on international affairs", and so on. Now what is this thing symbolised by Ayodhya. I suggest this is a problem which is now endemic. There is a virus going around on this earth. It is happening in Europe, Yugoslavia - ethnic cleansing - in one form or another. After the controlling influences in Soviet Union disappeared, it has started to happen in the old republics of Soviet Union. Manifestations of this kind in Germany. Things are not yet settled in Northern Ireland, whole lot of things in Africa, Latin America, certainly even the US, and a rather virulent form here. What is this due to? Firstly, we know that this particular virus is not transmitted genetically. This king in our brains certainly does not remain when we die. We are not born with this. It is certainly communicated to us when we are little, along with all the beautiful things which enable cultures to survive along with values, ways of living, what it means to be human. This happens inspite of all kinds of disturbing influences and pressures of living. Unfortunately, those of us once infected also communicate this social virus to the young at the time when they are most susceptible. It is sad to say but majority of the people in this world are infected, though not necessarily sick, with one or another of these viruses. The virus grows when there are many other social and economic reasons for people to be frustrated - you know when you are in trouble, when you have difficulties. Nazism and anti- semitic madness grew during the depth of depression - may be the virus was there all the time. So the virus is endemic. We have to avoid all situations where it would start to multiply. How do we stop its growth? I suggest that you can stop its growth by keeping it dormant for a very very long time, by doing somethings which have meaning. Diverting attention, making sure that the conditions in which it will bloom and flower do not come. In addition, of course, we must devise social vaccines which, to be effective, are best delivered at the same vulnerable stage of our life when we are learning languages and forming our world view. I hardly see any discussion on these problems. I hardly see any academic work on this. I hardly see any kind of real serious effort on this, on the part of people who ought to be thinking. We leave it to politicians, we leave it to religious leaders. Indeed we leave it to people who are most ignorant, and often most bigoted, and who have a terrible vested interest in seeing that this virus does not go away. Most of us can persuade ourselves that this topic does not belong in our department. Just as we build iron walls between our normal discipline-based departments we also say that this particular problem cannot be encompassed within the limits of discourse in my department, this is somebody else's business. How then are we going to do anything about this? In fact, when we look at the situation, as far as this country is concerned, I find it miraculous that we have time to do cosmology and listen to such beautiful lectures.

We live in a country where half of our people cannot read and write. I don't think that people who cannot read and write are necessarily the most virulent and worst affected by the virus - usually it is people who can read and write, even a few of those who teach and study science, are the ones worst affected and transmit the virus across generations.

Sixty to seventy percent of the people in this country do not have any sanitation facilities. Atleast half of our people, if not more, do not have easy access to safe drinking water - one can go on adding to the list. In regard to some of these basic deprivations, we are close to the bottom of heap. Yet, we have done so much. At the time of independence we did not even

make a chalkstick, not even a fountain pen, nothing was made in this country. A watch strap was "Made in England", fountain pens came from elsewhere, not a pin or a paperclip was made here and we have learnt to do all that. We now make paperclips, washing machines, satellites, rockets, motorcars, atomic power plants, telescopes and all manner of things. Also our discotheques and 5-star hotels are as nice as elsewhere. But, simultaneously we have come to a situation in which as Professor Bhide and I have said on many occasions - there is the emergence of a new natural ratio - the ratio 20:80, in the world and within India. 20% of the Indian world lives in a very different way as compared to 80% of our world, not necessarily better in terms of the true human condition, but very different. And 20% of the globe lives very differentlyy from the remaining 80%. As time goes by the distance between 20% and 80%, both internationally and nationally within India, goes on increasing. The 80% are moving up a little but the top is going up much faster. Some of the frustrations in our country, some of the most difficult problems in the land, I suggest, arise from this very situation. You may do all you can, but if this remains those viruses will keep on blooming, sometimes here, sometimes there. They will be exploited and I don't think we will ever be at peace unless we address the problem of this stratification. Also, I doubt whether internationally there will be real peace. There are possibilities of all kinds of genocide, both nationally and internationally, unless we do something about this in the near future.

We have not sat down often enough to create images or pictures of what a good life could be, at this point of time in our country. Our good life cannot be, we know it cannot be, a copy of the life as lived in western Europe or USA. It is impossible for all the world to live like that. We realise it. The western world realises it Because if we all were to begin to live like that the planet itself won't stand for it. It is an impossibility, will never happen. But we also recognise that a whole lot of things which make for a good life do not require high consumption. You require adequate sustenance and facilities, but you also require companionship and friends, freedom from crime born of aquisitiveness, room for individual creativity, music, compassion and love. Some luxuries, yes. But others have very negative inputs into the sum of what constitutes a good life. Now, have we tried such exercises, perhaps drawing on some examples of what we already have? I normally talk like this to social scientists. But, I think all of us have a responsibility, somehow. Who will create these images of good life? Politicians try but more often than not they are in terms of slogans. Who will help to create this good life, unless we are all involved, intellectually and emotionally? These are things which, besides being very disturbing, are, I suggest, engrossing and provide a tremendous challenge to all manner of deep thinking. It is possible to create systems and organisations, as also the techniques and technologies, which will take us towards our own versions of modernity, with less differentiation in levels, with a deeper tinge of quality. Never before has the pressure of global trends been so inexorable. Never before has the world changed at such a rate in terms of techniques, technology, the so called information explosion, everything happening at such a fast rate and yet thrusting towards more inequality, more stratification, more social instability and continuing decline of human poise and feeling of well-being. No wonder that the endemic viruses also bloom more often. I do believe we need to introduce some new elements of coupling in our own society.

Two years ago, two and a half years ago, amongst many other things, I did a rather irresponsible thing. When I was Chairman of the UGC, I sent out a letter to university Vice-Chancellors, also to a lot of other people, even in Government, suggesting that considering this situation, time had come to do something drastically different. Maybe for a year our education can be done somewhat differently. Nothing would be lost if we closed down our colleges, universities and may be some schools for a year and let everybody have a deep engagement with society. You could make 100 million people literate in a year. You could provide some water, work in the areas of health and environment. While trying to do this under various situations, you also couple with people, and in doing so you find out how well does your knowledge work in reality, in regard to your own country. If it does not work what is missing. Does your knowledge, capability or expertise lie only in slots which are not available in the country? Are there lot many spaces between these slots which are empty and what can you do to fill them? Perhaps we can write 10,000 diaries and 5,000 new text-books, and come back and re-do our education.

We had lot of discussion on this. We were surprised at how many people thought that it was not a completely crazy idea. Planning Commission welcomed this, Rajiv Gandhi welcomed it - he was in opposition at that time. Chandrasekhar who was the Prime Minister also welcomed the idea. Also a large number of political leaders from other parties, academics, Vice-Chancellors, even teacher's unions. This is one of marvellous things in our country. Capacity to think unconventionally has not completely disappeared. Of course, some people were afraid that students let loose in society will create havoc. I doubt it.

A few things started but then you know all manner of things happened last year also. Mandal agitations, elections, Rajiv Gandhi assasination. So it simmered down a bit. After that you know about the burgeoning of the literacy movement and the BJGVJ started about a year ago. We have movement called the Bharat

Jan Gyan Vigyan Jatha, a people's science movement, with a difference. People's Science Movements are a special attribute of this country. I consider them as one of the hopes of this country. By the middle of next month people would have gone through hundreds of workshops, theme workshops, discussions, software preparations and hundreds of localised Jathas. All manner of people would have been touched in something like 50,000 locations in the country. New groups and people would emerge, and would be identified. Some actual work would have happened and hopefully a number of mini-projects and programmes identified. It was intended that the post-Jatha phase this time would be a preparation, an activitation, for a continuing Mass Action for National Regeneration (MANAR). Time has come when each of us must take a sabbatical (not to Chile or Caltech) of one day a week, a month in a year and a year in five and so on where we can deeply engage with our society. Let there be a churning, a "manthan", in our society, to make our knowledge whole, to fill the gaps, to mix across strata, to couple our book learning with ethnic knowledge and wisdom, to teach and to learn, and also, using our mind and bodies both, help to distill a new integrated personality for our society. Let us move away from the situation where, in Bhide's words, 20% of our people are in a conduction band and the rest 80% in the valence band. Let us help to create a new crystal and a new mode of conduction.

Our compromise with a fragmented approach to life and knowledge is perhaps best illustrated by the fact that we have in existence several different systems of medicine in the country. Supposedly meant for human beings whose sicknesses are fairly common. Everyone recognises the merits of several Ayurvedic, Unani and Siddha remedies, also the value of other ethnic knowledge that has come to us through the ages. With certificates from abroad the active ingredients of several plant and herbal medicines used for long in this country are also incorporated in our so-called modern system. Of course, the importance of new science and technology now beginning to pervade medicine has to be recognised. So why is it impossible to move in a direction where most of our health care experts and paramedics begin to be trained in a special Indian way, including the best of what the modern medicine has to offer, alongwith all the wonders of diagnostics and surgery, and proving the validity or otherwise of a large number of other health support remedies, which are used by everyone, including doctors, but do not find a place in certified text books of modern medicine? When are we going to write our original text-books or pharmacopias? For example, the importance of mind over body is beginning to be increasingly recognised in the Western medicine, even more with new studies in neurobiology and brain research. Was this not empirically stressed, and formed its real essence, by the word Yoga? Do people in modern medicine learn anything about this?

What I am suggesting is that even this has to be shaken up and put together. Our education in all areas needs a renewal. Some people say, "Oh! My God, you are talking of a cultural revolution. See, what happened in China." Yes, I am talking of a cultural revolution but I am not talking of a cultural revolution directed from top or forced on to people. In fact, I am not even sure that some of the vitality one sees in the present day China, its ability to cope, unlike the Soviet Union, with the post coldwar turmoil and the rate at which China is developing - that they would have happened except for its cultural revolution. They had lot of horrible things at that time but many wonderful things also resulted from that experience. I have talked to many Chinese - but that aside. We do not want that kind of cultural revolution, with Red Guards, demolishing everything - that is not our culture - but we need some kind of cultural revolution of another kind, in which everyone participates - administration, institutions and individuals, and everyone is transformed. In fact, those countries who appear to be riding a tiger they dare not get off, for fear of being eaten up, also need it. The so-called developed countries are also prisoners of this age. They must have growth, with mandatory unemployment, inequalities and social tensions, or they have depression, with more unemployment - that is not the way to live. We have to find new ways of building societies.

When I started speaking we were 87 million in this country. By now there are 87 million and 2500 people. So, let us stop talking and let us get on with Paralleling our country. Let us have initiative in many many places and let us engage in an intensive Networking, technically, emotionally. Let us have a large number of Inter-University centres, inter-school centres and I wish you a marvellous future Jayant. I hope you will achieve fantastic excellence but I hope your excellence will not be assessed only in terms of normal measures, such as number of scientific papers, Ph.Ds produced or even bright new ideas in Astronomy, but also the extent to which you participate in Paralleling and Networking the active minds of this country. I am sure you will do it.

Thank you very much.

Facilities

(I) Computer Centre

The IUCAA computer centre has now been established in its new premises but the resources available here are only a fraction of those available throughout the institute. The computers distributed across the building are now linked together by an ethernet network so that scientific as well as administrative information can be exchanged between the nodes. The computer centre has managed to keep pace with developing technology so that it always has had the most advanced workstations available as a part of this network. The resources in the centre are being heavily used by the faculty and students at IUCAA as well as long term and short term visitors. Excellent software which is now available, as well as the ease with which it can be used, has prompted many non-professional users to benefit from the available resources. A data link is now available between IUCAA and National Centre for Software Technology (NCST), Bombay which allows instant access to data all over the world. With the help of the Department of Electronics, New Delhi and the NCST, IUCAA has made available the E-mail facility to some university departments which are now able to communicate with Astronomical Centres all over the world by E-mail, or by remotely accessing computers in IUCAA. This promises to be an extremely significant development as it makes available rather scarce resources at low cost to scientists in different locations, some of which are quite remote.

(II) Astronomical Data Centre

The Astronomical Data Centre (ADC) which was set-up about 18 months ago with the help of a DST project grant is now ready for use by the astronomical community in India. During 1992-93 a number of software packages have been developed which allow the larger number of astronomical catalogues to be accessed very easily even by users who are not familiar with computer programming. Using E-mail the data can be accessed from outside IUCAA. The ADC supplies to many users data from its collection as well as that obtained from abroad upon request from interested users. The ADC has also acquired many archival databases, and is able to access other larger databases based abroad on behalf of users. The software developed was demonstrated at the XVth meeting of the Astronomical Society of India in Bombay in March 1993. A comprehensive list of catalogues and related papers published during the years 1984–1991 has been compiled by Professor K.S.V.S. Narasimhan and is available, on specific request, to the users of the ADC.

(III) Library

The IUCAA Library was shifted to its new and permanent premises on December 20. The library has continued to grow during the last one year and now has approximately 8000 books and subscribes to 175 journals and periodicals, most of which arrive by airmail. The aim of the library has always been to provide up-to-date literature to the constant stream of visitors to IUCAA as well as to its own faculty and students. The library also provides support to university and college departments in the form of book loans for short periods, lists of reference and so on. The library has managed to build up its collection of literature, which is quite often out of print, by donations of books and periodicals from many sources. It is especially grateful to K.D. Abhyankar, the late V.V. Narlikar, Jal Moose, T.K. Menon, V. Sahni and M.S. Vardya for their books and periodicals which have immeasurably enriched the IUCAA library. The library has been taking advantage of literature available on electronic media to increase its archival collection and to make the current literature easily and profitably accessible to users.

(IV) Instrumentation Laboratory

In the Insturmentation Laboratory several instruments for observations in the visible band are being developed. These are individually described below :

(i) A photometer has been developed, which uses a low noise photodiode $\ll$ 10 fempto Watts for an exposure of one second as the detector and which can be used for observing stars as faint as eighth magnitude with an 20 cm telescope. Based on this design, university groups, etc. can develop photometers for their use in the laboratory.

(ii) A CCD Camera is being developed with low noise and low dark current – read noise of less than 10 electrons is expected. This involves cooling of the CCD with liquid nitrogen and use of low noise electronics. The electronics has been fabricated locally.

(iii) An automated telescope is being developed for photometric work. This telescope is designed around a compact optical tube of 14 inch aperture, which is commercially available, and can be used for observations under computer control. The hardware of the telescope is ready and the software is being done. Based on this design, university groups etc. can develop their own telescopes for their own use in the laboratory.

For the development of the various instruments,

the laboratory has been furnished with the required facilities : electronics fabrication and test instruments, vacuum system and optical benches with a variety of components.

(V) Recreation Centre

IUCAA now offers to its members several recreational facilities as listed below :

1. *Tennis Club*

Two tennis courts are available and are maintained at a good level of performance. Tennis commands excellent enthusiasm and this facility is shared with the NCRA. Tennis tournaments are held each year with the players from IUCAA and NCRA.

2. *Cricket*

A cricket pitch has been constructed on IUCAA grounds. The annual IUCAA vs NCRA Foundation Day match was played on this pitch on December 20, 1992 with a resounding victory for IUCAA.

3. *Indoor Games*

The Aditi Building has been converted temporarily into a recreation club which houses table tennis, carrom, a modest gymnasium and a recreation library. Each year since 1990, tournaments have been held in table-tennis and carrom. The library at the moment has about 250 books and several magazines and is growing rapidly. The gymnasium consists of barbells, dumbells, bench press, bull worker, parallel bars and an exercycle.

Science Popularization Programmes

(I) National Science Day

As in the previous years, IUCAA celebrated the National Science Day on February 28, 1993. About 25 schools in the city of Pune participated in various programmes which included quiz contest, lectures, slide shows, cartoon contest, painting contest, etc. Each school had sent a team of four students, accompanied by one of the science teachers.

The programme started at 9 a.m. in the lecture hall, Bhaskara 3, with a warm note of welcome by the Director, J.V. Narlikar. This was followed by a slide show of astronomical objects by Arvind Paranjpye and lectures by Varun Sahni and Ajit Kembhavi. Varun Sahni in his lecture on 'Recent excitements in cosmology' and Ajit Kembhavi in his talk in Marathi on 'Astronomy for school children' highlighted the prospects of observational astronomy in a spirit of motivating the school children towards studying astronomy.

The students were then divided into four batches, each of which, by rotation, visited IUCAA's Computer Centre, Library and the Instrumentation Laboratory. The students were introduced to the modern computing facilities, e-mail service, various graphics and numerical packages, the automated library service and so on. The students also enjoyed their visit to IUCAA's dome (depicting the overhead sky as on its first Foundation Day at 8:00 p.m.) and the Foucault's pendulum. Tarun Souradeep, who was in charge of explaining the physics of the Foucault pendulum to the school children, was impressed by the questions asked by them.

The students also got an opportunity to have a peep through the telescopes to see Venus in broad day light, the sunspots on a screen, holograms and teleodoscope. Another major attraction was an in-house planetarium demonstrating simulated sky with all stars up to the fourth magnitude, made using a simple plastic ball projector lit by an ordinary flash bulb. This demonstration was made possible due to dedicated assistance of B.V. Sawant, Navita Srivastava and Madhvi Dinakaran. The cartoon and the painting contests were also a great success. Each team was asked - in the letter of invitation - to send a painting of 'Meghnad Saha' as 1993 happens to be his birth centenary year. Out of more than thirty entries which were received, the first, second and third prizes went to Yogesh Kadam of Modern High School, Sujit Kumar Pal of Badriyah High School and Abhijit Kar of Kendriya Vidyalaya, NDA, respectively.

The last item was a quiz contest, conducted by Patrick Das Gupta (in English) and Abhijit Kshirsagar (in Marathi). St. Vincent's High School bagged the first prize, Kendriya Vidyalaya, Ganeshkhind, the second prize and Hindustan Antibiotics School, the

third. As a part of the quiz, there was also a device-making contest, the theme for which was the 'IUCAA logo'. Each team was given a piece of wire to make the design of the logo within 30 seconds.

The Director distributed the prizes to the winning teams and concluded the morning session.

In the afternoon, IUCAA was open to the visitors from the general public who visited computer centre and the library and were shown the dome, Foucault's pendulum, and the planetarium. About 200 visitors came to IUCAA on the National Science Day.

(II) Amateur Telescope Making

As part of its ongoing programmes on popularisation of astronomy and promotion of amateur astronomy in the country, IUCAA organised a National Workshop on Amateur Telescope Making during November 12-20 in its premises. Fifteen amateur astronomers, ranging from undergraduate students to college principals and retired professors, participated in the programme by invitation. Arvind Paranjpye of IUCAA and Kiran Shah of Jyotirvidya Parisanstha assisted Pramod Rathod, an engineering student from Bombay invited as an expert instructor. The Indian Institute of Astrophysics, Bangalore had kindly gifted 15 mirror blanks, each of 6 inch diameter and ground to f/8 spherical, together with pitch laps, powder and flats. For this we are grateful to R. Cowsik, Director, A.K. Saxena and his colleagues at IIA. The participants figured their mirrors, polished and performed the Foucault test. While the mirrors were being aluminised in Bombay and eye-pieces were being procured, the participants assembled the wooden Dobsonian mounts with the help of skilled carpenters. The participants were allowed to take their telescopes, to be used by their local Astrosocieties. At least 6 participants had acquired enough practice to run such workshops on their own in future. The cost of material per telescope turned out to be about Rs. 1800, out of which IUCAA's contribution has been about Rs. 1400. The quality of optics was good enough for future observations by the respective groups of amateur astronomers.

(III) Amateur Astronomers' Meet

The third National Amateur Astronomers' Meet was held this year at Vikram A. Sarabhai Centre for Science Community, Ahmedabad during February 13-14, 1993. IUCAA co-sponsored the meeting by contributing towards the expenses, particularly for participants from universities. About 70 outstation participants and about 80 local ones attended the Meet to give seminars and exchange ideas. An exhibition of the 110 Messier objects photographed by Mr. Ajay Talwar and his friends from Bombay was a notable feature of the meet.

(IV) Observational Astronomy

A.K. Sen was invited by H.L. Duorah of Gauhati University during September 21-24 and October 30-November 3, to assist them to set up and demonstrate experiments for observational astronomy with their 6" zeiss reflector. Experiments like the determination of period of rotation of sun, heights of lunar mountains, polar axis alignment of a telescope, etc., were explained through practical demonstrations and related theoretical lectures. The experiments are designed for inclusion in the M.Sc (Physics) practical classes.

Participation in National Projects

S.N. Tandon was involved, as Chairman of a working group set up by DST, in a feasibility study for a National Large Optical Telescope. A report of the study was submitted to DST in July 1992 and it recommends the size (4.2m), and the basic design for the telescope involving modern features such as a thin active mirror and alt-azimuth drive to reduce overall size and costs.

A.K. Kembhavi has set up the Astronomical Data Centre as a national facility at IUCAA under a project grant from the DST.

Administration

After achieving fair amount of automation in the area of Accounts and Purchase, we have taken automation in Personnel, Guest House Management and Canteen Management. We have also developed systems to make all relevant data available regarding our visitors. To keep the staff abreast about the latest methods of management in their respective fields, the following staff were deputed to courses conducted by other organisations :

1. K. C. Nair, Purchase and Stores Officer - Material Management Course conducted by Institute for Training and Management Development, Dehradun.

2. E.M. Modak, Establishment Officer - Diploma in Industrial Security, Safety and Labour Laws conducted by Symbiosis International Cultural and Education Centre, Pune.

D. V. SATHE & CO.
CHARTERED ACCOUNTANTS

THE BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE IX [VIDE RULE 17(1)]
REGISTRATION NO. F-5366
INTER UNIVERSITY CENTRE FOR ASTRONOMY & ASTROPHYSICS
POST BAG 4. GANESHKHIND, PUNE 411007

BALANCE SHEET AS AT 31ST MARCH 1993

ASSETS & PROPERTIES	SCHEDULE NO.	AMOUNT RS. PS.
Fixed Assets [W D V]	[A]	110,500,684.19
Investments	[B]	4,846,200.00
Current Assets - stock	[C]	818,027.40
Cash & Bank Balances	[D]	1,986,478.79
Amounts Receivable	[E]	243,235.79
Advances to Staff	[F]	202,621.85
Advances towards Purchases		64,856.88
Deposits	[G]	642,878.00
Sixth Asia Pacific Conference		33,818.00
Income & Expenditure a/c	[H]	46,481,304.52
	Total Rs.	165,820,105.42

Represented by FUNDS & LIABILITIES	AMOUNT RS. PS.	AMOUNT RS. PS.
Trust Fund Or Corpus		
Grant in Aid from U G C		
Balance as per last Balance Sheet	46,400,000.00	
Received during the year	32,100,000.00	
		78,500,000.00
Other Earmarked Funds		
Building Fund		
Grant in Aid from U G C		
Balance as per last balance sheet	55,100,000.00	
Received during the year	31,000,000.00	
		86,100,000.00
Sixth Asia Pacific Conference		120,000.00
National Science Day Reserve a/c		
balance as per last balance sheet	276,103.00	
Additions during the year	140,990.00	
Less spent out of the fund	49,311.50	
		367,781.50
Current Liabilities - Amounts Payable	[I]	732,323.92
	Total Rs.	165,820,105.42

AUDITORS' REPORT
As per our separate report attached of even date.
For D. V. SATHE & CO.
Chartered Accountants
Sd/-
(Mrs. B. D. Sathe)
Partner

The above Balance Sheet to the best of my/our belief contains a true account.

Sd/-
Trustee/Director

Sd/-
Chiarman U G C
Date : June 10, 1993

The Library

The Computer Centre

The Instrumentation Laboratory