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Welcome to...

Emmanuel Rollinde, who has joined as a Post-doctoral Fellow. His research interest are Structure Formation Scenario - Reionisation, QSOs Absorption Spectra, and Semi-Analytical and Inversion Methods.

Subharthi Ray, who has joined as a Post-doctoral Fellow. His research interests are Neutron and Strange Stars, Rotation, Effect of Charge and Magnetic Fields, Quasinormal Modes, and QCD.

... Farewell to

Rajesh Nayak, who has joined the Observatoire de la Cote d'Azur, Nice, France, as a Post-doctoral Fellow.

Tirthankar Roy Choudhury, who has joined the SISSA, Trieste, Italy, as a Post-doctoral Fellow.

Congratulations

... to **T. Padmanabhan** on being the recipient of the **13th G.D. Birla Award** of the K.K. Birla Foundation, *and*

on being awarded the **Miegunah Fellowship for 2004** by the Melbourne University, Australia.

Fifteenth Foundation Day lecture of IUCAA

The fifteenth Foundation Day lecture was delivered by Professor Ashis Nandy, Honorary Professor, Centre for the Study of Developing Societies, on the topic "*Darkness of the City*".

Ashis Nandy delivering the fifteenth IUCAA Foundation Day Lecture

This talk left much of the audience with new fodder for thought. Ashis Nandy's key theme was the manner in which cities define themselves and the interrelationship between city and the slum in the cities. Reversing old stereotypes, Ashis Nandy made the audience rethink on the relationship between the city and its underbelly, and suggested that slums aim at a counter culture and a critique of the dominant ideology. In this sense, a different sociological and cultural perspective is provided by marginalised space in our cities.

Contents...

Introductory Summer School on Astronomy and Astrophysics

The School proposed to be held during May 17 - June 18, 2004 at Pune, is designed to introduce the students of physics, mathematics, electronics engineering and technology to the exciting fields of Astronomy and Astrophysics (A & A). No previous knowledge of A & A is necessary, although familiarity with the basic principles of mathematics and physics will be required.

The school funding is expected from the Department of Science and Technology, New Delhi, and will be hosted by Inter-University Centre for Astronomy and Astrophysics (IUCAA) and National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research, Pune.

We expect to have about 35 students participating in this programme. The programme of the school will consist of lectures, covering fundamentals of A & A as well as recent developments in the field. In addition, participants will take part in individual projects under suitable guidance. The lecturers for the school will be drawn from the leading A & A centres in the country, so that the participants will get an exposure to the work being done in these fields. There is a possibility for a few motivated students, to spend an additional week at IUCAA / NCRA after the school.

Eligibility: Students completing their 1st year M.Sc. (physics/applied mathematics/astronomy/electronics) or 3rd year B.E./B.Tech. in 2004 can apply. Exceptionally bright and motivated students completing their B.Sc.(physics) in 2004 may also apply.

How to apply: In plain paper, in the following format : 1. Name, 2. Sex, 3. Date of birth, 4. Address for communication, 5. Qualifications (standard X onwards) with institution / year / subjects / class / grade / percentage of marks obtained, 6. Short write-up giving motivation for applying for the school, 7. Previous summer schools attended, if any, 8. Names and addresses of two referees (these referees should be teachers/project guides, etc.), and 9. Signature with date.

The applicants should request the above referees to send their confidential assessments/recommendations (not character certificates) under separate envelopes. Applications and referee reports should reach **The Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, by March 15, 2004. The selected candidates will be informed by April 15, 2004. The selected candidates will be provided with travel, board and lodging for the duration of the school.

IUCAA ASSOCIATESHIP PROGRAMME

IUCAA is a centre of excellence for research in Astronomy and Astrophysics and related subjects, and one of its mandates is to encourage research and development in these areas in the University sector. An important component of IUCAA's academic activities is the Associateship Programme, under which faculty members of Indian universities or colleges can visit IUCAA for periods of short and long durations over a span of three years, to develop their research interest and expertise.

During these visits, Associates can conduct their own research, or work in collaboration with faculty members at IUCAA, and with visitors from India and abroad. Associates can use facilities at IUCAA like the library, the advanced computing centre and instrumentation laboratory. They can participate in observational programmes using national and international facilities, including IUCAA's own 2 m optical and infrared telescope being set up at Giravali.

The Associateship Programme has been designed to promote mobility and to this end, the travel and local living expenses of an Associate for these visits will be borne by IUCAA as per its rules. Associates will continue to carry out the existing commitments at their parent organization. However, since IUCAA has been created by the UGC as a field station for these activities, it is expected that those visiting IUCAA under this programme will be treated as on duty by their respective organization.

Applications, on plain paper, are invited under this programme for the fifteenth batch of Associates for the period from July 1, 2004 to June 30, 2007. Interested persons should forward their application through the heads of their departments or institutions, along with their biodata, list of publications and a brief write-up on the work they intend to carry out as Associates of IUCAA. Applications should be sent to **The Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, so as to reach before April 30, 2004. In addition, each applicant should arrange for two experts in the field to send their confidential assessment of the applicant directly to the above address. Those who had applied last year, but were not selected, are requested to update their application if they would like to be considered again for a Visiting Associateship. The selected candidates will be informed by June 15, 2004.

A. Pramesh Rao and S. Ananthakrishnan
National Centre for Radio Astrophysics
Tata Institute of Fundamental Research, Pune

The Giant Metrewave Radio Telescope

Abstract: The Giant Metrewave Radio Telescope (GMRT) is a major new facility available for radio astronomical observations at metre wavelengths. This summary describes the current state of GMRT with emphasis on the features that are of relevance to a potential user.

Introduction

One of the most challenging problems faced by radio astronomers has been the poor angular resolution of radio telescopes. Since all radio telescopes are diffraction limited, the angular resolution is equal to λ/D, where λ is the wavelength and D is the size of the aperture. The radio band covers frequencies from 30 MHz to 300 GHz with wavelengths going from 10 m to 1 mm. Compared to an optical telescope of the same size, (optical wavelength is about 0.5 micrometre), the angular resolution of radio telescopes at metre wavelengths, is about a million times poorer. Building bigger radio telescopes (increasing D), while easier than in the optical case, is not a solution, since a radio telescope operating at 1 m should have a diameter of 200 km to have the same angular resolution as a 10 cm optical telescope. Since telescopes of such sizes are not technically feasible, radio astronomers have followed the route taken by optical astronomers, when they wanted telescopes larger than what was technically possible (Michelson 1920) and have perfected interferometry techniques.

If one wants to form an image as in a camera or a telescope, the obvious way to proceed is to use one or more lenses or curved mirrors. But, even if one does not have any lenses or mirrors, one can still form an image. The simple pin hole camera forms an image but suffers from poor angular resolution, since the aperture D is necessarily small. However, if one makes a second pinhole and makes the light source quasi-monochromatic (either intrinsic or by using a filter), then in the image plane one sees an interference fringe pattern, from which one can measure the visibility amplitude $[(I_{max} - I_{min})/(I_{max} + I_{min})]$ and phase (position of the observed fringe maxima compared to that expected for a planewave normal to the screen). When the field of view is small, it can be shown that the complex fringe visibility is proportional to the 2-dimensional Fourier transform of the incident angular spectrum corresponding to the spatial Fourier component $\mathbf{u} = \mathbf{x}/\lambda$ and $\mathbf{v} = \mathbf{y}/\lambda$, where **x** and **y** are the separation of the two pin holes, **z** being perpendicular to the screen (Born & Wolf 1989). Thus, if one has an array of screens with 2 pin holes at all possible relative orientations upto a maximum separation of **d,** and one measures all the complex visibility functions (Fourier components), then one could feed all the Fourier components into a computer, do an inverse Fourier transform and produce an image of the object as would have been seen with a lens of diameter **d**. One has avoided lenses, but paid a price in complexity, but in the radio case where the technology does not support building "lenses" larger than a 100 m or so, this is the only way to go.

The radio equivalent of the 2 pin hole system is the '2 element adding interferometer', which consists of 2 antennae tracking a source in the sky. The electric fields received by the antennae are brought on cable to a common place where they are added and detected. Representing the amplitude and phase of the electric field by complex number E, the power output of the interferometer is

$$\mathbf{I} = (\mathbf{E}_1 + \mathbf{E}_2)(\mathbf{E}_1 + \mathbf{E}_2)^* \\ = |\mathbf{E}_1|^2 + |\mathbf{E}_2|^2 + 2|\mathbf{E}_1||\mathbf{E}_2| \cos(\phi_1 - \phi_2).$$

The third term, which corresponds to the interference can be used to determine the complex fringe visibility. The 2 element interferometer measures one spatial Fourier component of the source. Due to the rotation of the earth, the orientation of the source with respect to the antenna separation changes with time and the interferometer measures different Fourier components and traces a track on the 2-D Fourier plane. If there are N such antennae suitably located, the electric fields from all the antennas can be brought to a central location, with appropriate electronics so that each antenna forms an interferometer with every other antenna giving $N(N-1)/2$ pairs, each of which measures the visibility function on a track in the Fourier plane.

All these Fourier components are recorded, calibrated, Fourier transformed and processed to produce an image of the source, with a resolution equivalent to the largest separation between the antennas which could be many kilometres. Inspite of the fact that all the Fourier components have not been measured, good quality images can often be made by appropriate image processing. This whole process is referred to as Earth Rotation Aperture Synthesis and is the principle behind the most powerful radio telescopes in the world.

The basic aim while building GMRT was to realise a very sensitive and state-of-the-art aperture synthesis radio telescope array in the frequency range of 30–1500 MHz, which was lacking in the world astronomical scene. There are advantages in building such an array in India. Because of the low frequencies, *(i)* the surface accuracy requirements are not so stringent and the construction labour intensive resulting in lower cost; *(ii)* low frequency

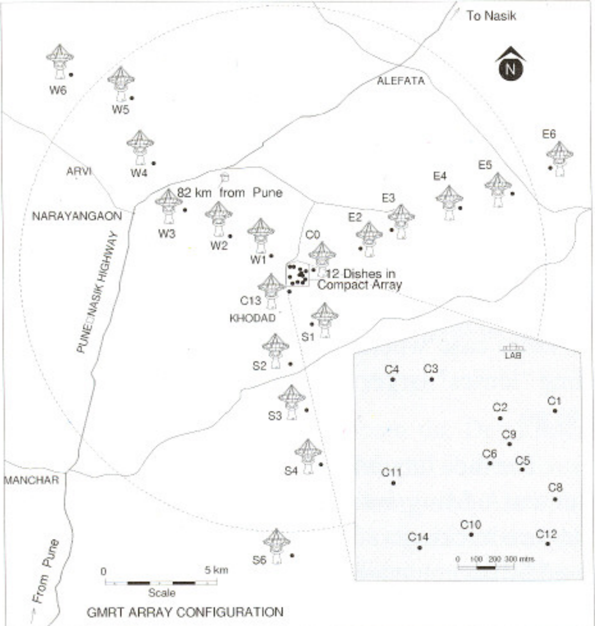

Fig. 1: Layout of the antennas of GMRT. The central square is shown in the inset.

electronics is relatively inexpensive; *(iii)* very high angular resolution is not required, since the interesting science at low frequencies is in diffused extended regions. The disadvantages of low frequencies are that *(i)* sky background noise is higher; *(ii)* ionospheric distortion increases towards lower frequencies and *(iii)* man made radio noise is higher.

GMRT — Specifications

The GMRT consists of thirty 45 m diameter antennae spread over 25 km. Half the antennas are in a compact, randomly distributed array with a diameter of about 1 km. The remaining antennae are on 3 arms of length 14 km (North West, North East and South) with 5-6 antennas on each arm. The longest baseline is 26 km and the shortest, 100 m, which comes down to about 60 m with projection effects. The array configuration is shown in Fig. 1 and the **u-v** coverage for some declinations are shown in Fig. 2. The telescope (Latitude = 19.1°, Longitude = –74.05°) is located near Khodad village, which is about 80 km north of Pune.

The facility is run by the National Centre for Radio Astrophysics, Pune, which is a part of the Tata Institute of Fundamental Research, Mumbai, India. Successful completion of GMRT has required the participation of a large number of scientists and engineers and supporting staff. Many other institutions in India, such as the Raman Research Institute, Bangalore and the Bhabha Atomic Research Centre, Mumbai have also built significant part of the hardware.

Antennas and Feeds

The GMRT antennas are 45 m alt-azimuth mounted dishes (Fig. 3). The reflecting surface is formed by wire mesh and the efficiency of the antennas varies from 60% to 40% from the lowest to the highest frequency. The total weight of the moving structure, excluding the counterweight of 34 tonnes, is only 82 tonnes, making it one of the lightest antennas of its size. The dishes can go down to an elevation of 16°, giving a declination coverage from –55° to +90°. The slew speed of the antennas is 30°/min in azimuth and 20°/min in elevation and they are not operated when winds are higher than 50 km/h. There is a rotating turret at the focus on which the different feeds are mounted. The feeds presently available are the 151, 325, 610/235 and the 1000–1420 MHz feeds.

Both the orthogonal polarizations are brought from each antenna. The orthogonal polarizations are circular for all feeds except the 1420 MHz feeds which are linear. The L-Band feed is a corrugated horn that was designed and fabricated by the Raman Research Institute, Bangalore, India. The 610/235 MHz feed is a dual concentric coaxial cavity, and with both feeds at the focus at the same time, the system allows simultaneous observations at 610 and 235 MHz with one polarisation at each frequency. The 325 MHz feed is a Kildal feed (half wave dipole over a ground plane with a beam forming ring in front, Kildal 1982) and the 151 MHz feed consists of two orthogonal pairs of dipoles in front of a plane reflector. A 50–70 MHz feed for the system is under development.

Control System

The control of the whole array is done by a distributed system of microprocessors that communicate with and are controlled from a workstation in the control room. At the base of each antenna is the Antenna Base

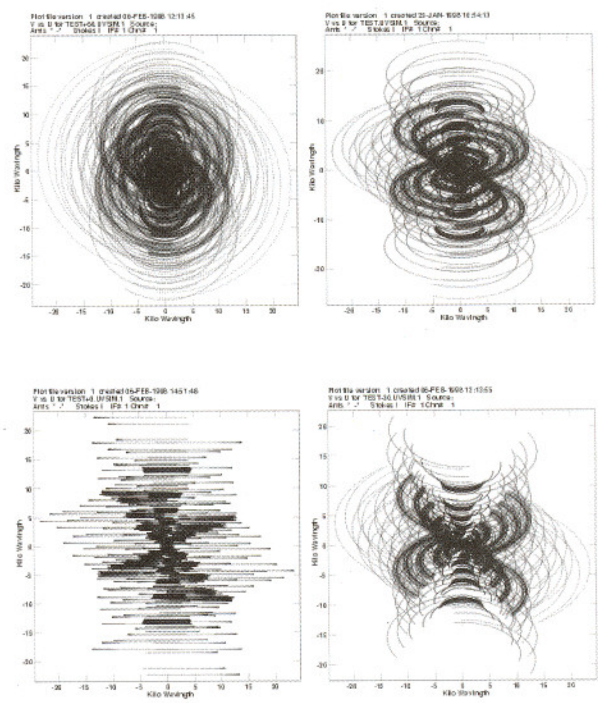

Fig. 2: u–v coverage for the GMRT at 4 declinations for 1 m wavelength.

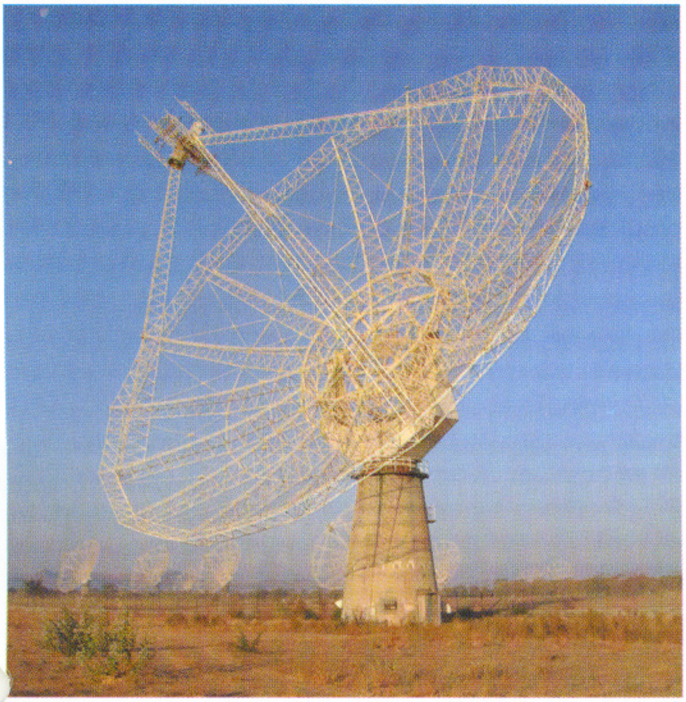

Fig. 3: A few of the GMRT antennas in the central square.

Computer (ABC), which controls all functions at the antenna. The ABC generates tracking commands for the Servo Computer and issues instructions to the various Monitor and Control Modules (MCMs) that control the state of the RF, IF Local Oscillator and feed positioning systems. The servo system, designed by the Reactor Control Division of the Bhabha Atomic Research Centre, Mumbai ensures that a source is tracked with an rms error of ~1′. The ABC collects monitoring signals from the various subsystems and periodically sends them back to the control room. The control instructions and return telemetry information are sent on the same optical fibres used for the radio signals and there are various displays for the user to ensure that the system is healthy. User generated control file can also instruct the main computer.

Electronics

At the focus of each antenna, each feed has 2 low noise amplifiers, (one for each polarization), followed by a noise injection facility, where the user can select 4 noise values. The two RF signals are down converted to two IF bands of 32 MHz width at the bottom of each antenna and sent to the receiver room on optical fibre links. In the central receiver room, each signal is converted to 2 baseband signals with user selectable bandwidths that go from 16 MHz to 62.5 KHz in binary steps. The baseband signals are fed to a digital FX type spectral correlator which actually multiplies the electric fields from all the antennas in pairs, to give the visibility function as a function of frequency.

The GMRT can also be at present used for a single antenna VLBI observation at frequencies up to 1665 MHz. The flexible local oscillator frequencies as well as timing is based on VCXO's, GPS and Rubidium standards.

Digital Back End

The 2 baseband signals are handled by 2 nearly independent correlator systems. The GMRT correlator which is an FX type, runs at 32 MHz, but can be programmed to use only every 2^{nth} sample, so that the effective sampling interval is larger and the bandwidth narrower. The basic components of the system are the samplers, delay system, the FFT pipeline and the multiplier and accumulator (MAC). The baseband signal is sampled (4 bits) and compensated for propagation delays. The data stream is Fourier transformed to give 256 frequency channels across the band, but while multiplying and averaging, adjacent frequency channels are averaged giving effectively 128 channels across the band. The channel width depends on the base band filter and the effective sampling interval and can range from a maximum of 128 KHz to 0.5 KHz with the total bandwidth ranging from 16 MHz to 64 KHz in each sideband for each polarisation. The voltage spectrum from each antenna is multiplied with that from all antennae (including itself) and the resultant (30 × 31/2) × 128 signals for each polarisation are averaged for 128 ms in the hardware, before being read out and further integrated. The hardware provides a variety of facilities like fringe stopping, delay compensation, Walsh and noise switching demodulation, window functions before Fourier transforming and the possibility of blanking the signal for interference rejection. The 2 sideband correlator system gives 4 outputs, 2 RR and 2 LL, effectively doubling the bandwidth of the system. However, it can also be reconfigured to give the 4 Stokes parameters for one of the 2 baseband systems. The full spectral line data is recorded with user selectable integration time that can be a multiple of 8 × 128 ms = 1.024 s. The default integration time is 16 s which generates 53 Mbytes of data every hour. There are options to record only a subsection of the baseline and frequency channels if one needs much shorter integration times.

The output of the FFT pipeline can also be sent to the GMRT Array Combiner (GAC) (built at the Raman Research Institute, Bangalore) where signals from different antennas can be combined to give a single time series of spectra with a sampling interval of ~16 ms. The data from the antennas can be combined either coherently (voltage) or incoherently (power) depending on the users requirements. The output of the GAC can be recorded for VLBI, pulsar search, etc. or sent to the pulsar backends, where one has facilities for dedispersion (both coherent and incoherent), polarimetry, etc. The measured system parameters of GMRT are shown in Table 1.

Current Status

The GMRT has been in operation since 2000 and currently all the subsystems are operational except the 50-70 MHz system, that is yet to be installed. Routine observations are being made at all the other GMRT bands though the 150 MHz band is heavily affected by interference

	Frequency (MHz)				
	151	235	325	610	1420
Primary Beam (Degrees)	3.8	2.5	1.8	0.9	0.4*(1400/f)
System Temperature (K)	450	180	100	90	70
Antenna Temp (K/Jy/ Antenna)*	0.35	0.3	0.35	0.3	0.25
Synthesised Beam (arcsec)					
Whole Array	20	13	9	5	2
Central Square	420	270	200	100	40
Largest Detectable Source (arcmin)	68	44	32	17	7
Theoretical Sensitivity (rms image noise mJy for 1 MHz and 1 min)					
Whole Array	5.2	2.6	1.3	1.3	1.2
Central Square	10.4	5.2	2.6	2.6	2.4
Observable frequency range (MHz)	150 to 158	230 to 250	305 to 360	570 to 650	850 to 1450
Typical rms Sensitivities Obtained from 2 to 3 hours of imaging using full bandwidth (mJy)	10	2	1	0.1	0.05
Typical Dynamic Ranges	~200	>500	>500	>2000	>5000
*1 Jy = 10^{-26} Watts/m²/Hz.					

Table 1: Measured parameters of GMRT.

for which remedial actions are being taken. Except for a weekly maintenance period from Wednesday morning to Thursday evening, the GMRT is used 24 hours of the day, seven days of the week. It has been used for a variety of observations ranging from the Sun, Jupiter, galactic objects like pulsars, x-ray binaries, the galactic centre, HII regions and supernovae and extra galactic objects like nearby galaxies, radio galaxies, clusters of galaxies, spectral line observation of the 21 cm Hydrogen line and OH maser lines at a variety of redshifts and so forth. An image of the nearby spiral galaxy NGC 2997 is shown in Fig. 4.

Being the most powerful radio telescope in the world

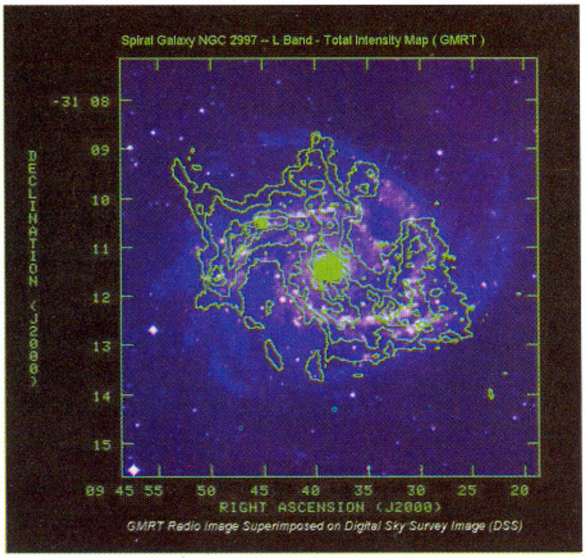

***Fig. 4:** GMRT radio contour of the nearby spiral galaxy NGC 2997at 21 cm, superposed on false colour optical image.*

in the metre wavelength band, there is considerable interest in the radioastronomy community in using the GMRT. For the optimal utilisation of the GMRT, the GMRT Time Allocation Committee (GTAC) has been set up. The GTAC periodically informs the international astronomy community of the capabilities of the GMRT, invites proposals for projects utilising GMRT, reviews them and if scientifically viable, allocates GMRT time. These projects are scheduled on the telescope over the next 3-4 months and the astronomer carries out his observation and either analyses the data locally or takes the data home for analysis. Since 2002, 4 such cycles have been completed and the 5th GTAC cycle has started in Dec 2003. For each GTAC cycle, 50 to 60 proposals are received and many of them get scheduled. Fig. 5 gives a summary of the statistics of the received proposals in the first 4 GTAC cycles. Further details of GMRT as well as information regarding how to apply for GMRT observing time, can be found in the website http://www.ncra.tifr.res.in.

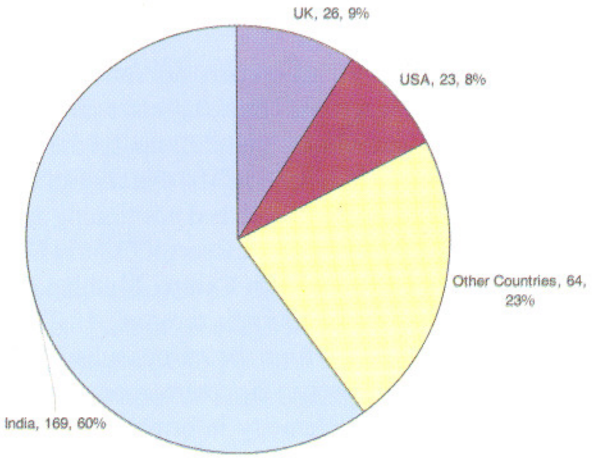

***Fig. 5:** Chart showing proposals received for observations with GMRT during the first 4 GTAC cycles.*

References

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Swarup, G., Ananthakrishnan, S., Kapahi, V.K., Rao, A.P., Subrahmanya, C.R. & Kulkarni, V.K. 1991, *Current Science*, **60,** 95

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Vacation Students' Programme 2004

IUCAA invites applications for the fourteenth Vacation Students' Programme (VSP). Students selected under the VSP will spend seven weeks at IUCAA to work on specific research projects under the supervision of the IUCAA faculty. The programme will conclude with seminar presentations of the projects by the participants, and an interview. Those who perform well will be preselected to join IUCAA as research scholars to do Ph.D. after the completion of their degree and other requirements.

Students who will enter the final year of the M.Sc. (physics/applied mathematics/astronomy/electronics)/ B.Tech./B.E. courses in the academic year 2004- 2005 are eligible to apply. Applications, in plain paper, giving the academic record of the applicant as well as two letters of recommendations from teachers, mailed directly, should reach **The Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, by March 15, 2004. The selected candidates will be informed by April 15, 2004 for the programme to be held during May 17 - July 2, 2004.

Visitors during October to December 2003

Saibal Ray, K.S. Sastry, M. Bagchi, S. Bhowmick, S. Daw, S. Cahudhuri, S. Pote, S. Barway, S.G. Ghosh, D.W. Deshkar, B. Ishwar, B.S. Kushwah, U. Dodia, K.S. Umesh, A. Khugaev, A.A. Usmani, S. Siddiqui, R. Verma, Koshy George, A. Beesham, R.K. Upadhyay, D.P. Bhatt, R. Tikekar, K. Jotania, R. Jotania, S.K. Pandey, H.P. Singh, B. Schutz, E.P.J. van den Heuvel, U.C. Joshi, T.P. Prabhu, A.K. Sen, K.P. Harikrishnan, A. Goyal, T.R. Seshadri, S.R. Choudhury, P. Khare, S.N. Hasan, A. Omont, S. Rastogi, K. Shanthi, A. Toporensky, F. Coppolani, Y. Shtanov, Moncy John, N. Katz, A. Lazzarini, B. Dasgupta, S. Sahayanathan, A. Thampan, Ng. Ibohal, C.D. Ravikumar, K. Nagarkar, R. Chowdhury, S. Ghosh, D. Choudhuri, D.V. Gadre, Nagendra Kumar, V.H. Kulkarni, M. Govender, N. Mukunda, A.K.Gupta, A. Nandy, L. Chaturvedi, Ved Prakash, P. Prakash.

IUCAA Preprints

Prasad Subramanian, S. Ananthakrishnan and P. Janardhan, *Giant Meterwave Radio Telescope observations of an M2.8 flare: insights into the initiation of a flare-coronal mass ejection event*, IUCAA-40/03; Saibal Ray and Basanti Das, *Tolman-Bayin type static charged fluid spheres in general relativity*, IUCAA-41/03; Ujjaini Alam, Varun Sahni, Tarun Deep Saini and A.A. Starobinsky, *Exploring the expanding universe and dark energy using the statefinder diagnostic*, IUCAA-42/03; Saibal Ray, Sumana Bhadra and Anand S. Sengupta, *Relativistic anisotropic charged fluid spheres with varying cosmological constant*, IUCAA-43/03; Jatush V. Sheth, *Morphology of Mock SDSS Catalogues*, IUCAA-44/03; T. Padmanabhan, *Gravity and Thermodynamics of Horizons*, IUCAA-45/03; A.A. Usmani, *S-wave ANN potential*, IUCAA-46/03; T. Roy Choudhury and T. Padmanabhan, *Quasi normal modes in Schwarzschild-De Sitter spacetime : A simple derivation of the level spacing of the frequencies*, IUCAA-47/03; Yasin Memari, *Reconstructing features of the inflationary scattering potential from primordial power spectra* IUCAA-48/03; Arman Shafieloo and Tarun Souradeep, *Primordial power spectrum from WMAP*, IUCAA-49/03.

Seminars

16.10.2003 S.N. Tandon on *Detectors for ultra violet imaging telescope in astrosat*; 28.10.2003 Atul Deep on *Supernova 1a : Their role in cosmography*; 8.11.2003 S. Rai Choudhury on *Flavour changing decays of the B-meson*; 8.11.2003 E.P.J. van den Heuvel on *Gamma ray burst research, status and prospects*; 8.11.2003 U.C. Joshi on *Deep survey of inner galaxy from SAAO and spectroscopic observations from HCT*; 8.11.2003 Pushpa Khare on *Some aspects of QSO absorption lines studies*; 8.11.2003 Rajaram Nityananda on *Overview of GTAC observations at the GMRT*; 8.11.2003 T.P. Prabhu on *Indian Astronomical Observatory, Hanle*; 1.12.2003 Subhabrata Majumdar on *Prospects for future sunyaev-zel'dovich surveys*; 4.12.2003 Neal Katz on *Galaxy formation : some problems and some answers*; 10.12.2003 and 11.12.2003 T. Padmanabhan on *New perspective on classical and semiclassical gravity*; 18.12.2003 Arun Thampan on *Differentially rotating magnetised neutron stars.*

Colloquia

23.10.2003 Nitin Nitsure on *Mathematics and Sets*, and 8.12.2003 Albert Lazzarini on *LIGO : Status, Results of the first science run, and future plans.*

For the Younger Minds - 7

T. Padmanabhan

The white mice that live on a planet around Aldebran are proud of the shape of their planet. It is an axisymmetric solid body of constant density. The shape is such that the gravitational field is as high as it could possibly get (for the given mass of the planet) on the north pole, which is at one end of the symmetry axis. Determine the shape of the planet.

Answers to the questions which appeared in Khagol - October 2003

Since the precession rate is small — something which we verify at the end — we can adopt a geocentric view and think of the mass of the sun, $M_\odot$, as distributed around earth along a thin circular ring of radius d (equal to the mean earth-sun distance) as far as computation of the torque causing the precession is concerned. The rotation axis of earth is inclined at an angle $\theta \approx 23.5$ degrees to the normal to the plane containing the ring. A perfectly spherical earth, of course, will feel no torque from the ring; but since the earth has bulge around equator with equatorial and polar radii differeing by $\Delta R/R \approx 1/300$, there will be a torque, as if earth is a small dumbbell with masses $\delta M \approx M(\Delta R/R)$ located at the ends of a rod of length $2R$. This net force F is due to the *difference* in the gravitational force of the ring on the two masses of the dumbell; so $F \approx (2GM_\odot \delta M/d^3)(R\cos\theta)$ and the corresponding torque is $T \approx F(2R\sin\theta)$. The rate of precession will be $\Omega \approx T/J\sin\theta$ (since $\mathbf{\Omega} \times \mathbf{J} \simeq \mathbf{T}$) where $J \approx (MR^2)\omega$ is the angular momentum due to daily rotation of earth. Combining all these and using $(GM_\odot/d^3) = \nu^2$ where ν is the period of revolution of earth around the sun, we get $\Omega \approx 4(\nu^2/\omega)(\Delta R/R)\cos\theta$. The corresponding period is $(2\pi/\Omega) \simeq 3 \times 10^4$ yrs which is close to the observed value.

Visitors Expected

January: Uday Chakraborti, Kolkata; Laxmikant Chawre, Pt. Ravishankar Shukla University; Vaishnavi T., American College, Madhurai; Suryadeep Ray, HRI, Allahabad; S.K. Srivastava, NEHU, Shillong; Pandey V.N., RRI, Bangalore; Hasan P., Osmania University; B. Ahmedov, Institute of Nuclear Physics, Tashkent; Parvabati Chingangbam, Jamia Millia Islamia, Delhi; Faheem Hussein, The Abdus Salam Intl.Centre for Theoretical Physics, Trieste, Italy; Shukre C., RRI, Bangalore; Rabin Chetri, Sikkim College, Gangtok; Tsujikawa Shinji, Research Centre for the Early Universe, Japan; Gareth Amrey, School of Mathematics, Univ. of Kawajulu, Natal, South Africa; Narsimham, IIT, Kharagpur; Horton Newsom, University of New Mexico, USA; Klypin Tolia, University of New Mexico, USA; Anupama G.C., IIA, Bangalore; Ambastha A., Udaipur Solar Observatory; Sanwal B.B., State Observatory, Nainital; Vivekananada Rao P., Osmania University, Hyderabad; Jog N.S., PRL, Ahmedabad; Parihar P., IIA, Bangalore; Pant P., State Observatory, Nainital; Gosain S., Udaipur Solar Observatory; Lee Samuel Finn, Penn State Univ.; Brian Schmidth, Mount Stromlo Observatory, Australian Natl. Univ.; Yun-Song Piao, Interdisplinary Center for Theoretical Studies, Bejing.

February: Arun Thampan; Sivarani Thirupathi.

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