KHAGOL खगोल

IUCAA

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The 21st Meeting of the Astronomical Society of India

Participants of the 21st Meeting of the ASI

The 21st Meeting of the Astronomical Society of India was held during February 5 -8, 2002 at IUCAA, Pune. About 180 participants attended the meeting. The scientific programme was rich in texture and had the following components: (a) About seventeen invited plenary talks spread over five sessions dealing with Sun and Solar System, Stars, Our Galaxy, Galaxies and Cosmology, Gravitational Wave Astronomy and High Energy Astrophysics. (b) One day of discussion on the Decadal Vision of Astronomy document, which was being prepared by the panels appointed for this purpose. (c) One session dealing with ASTROSAT and the

Welcome . . .

Sanjay K. Sahay, who has joined as a Project Scientist. His research interest is Gravitational Wave Data Analysis.

Amir Hajian Forushani, who has joined as a Research Scholar.

. . . Farewell

Thierry Morel, who has joined Palermo University, France, as a faculty member.

Archana Pai, who has joined Observatoire de la Cote d'Azur, Nice, France, as a post-doctoral fellow.

Contents...

IUCAA Telescope as well as reports from the activities being carried out at different Observatories. (d) Two public lectures on Cosmology and Lunar Science. In addition, a visit to the IUCAA Telescope and GMRT sites was arranged on February 9.

Financial assistance for this meeting was provided [in addition to funds from IUCAA and ASI] by the following organisations - Council of Scientific and Industrial Research, New Delhi; Department of Science and Technology, New Delhi; Harish Chandra Research Institute, Allahabad; Indian Institute of Astrophysics, Bangalore; Indian Space Research Organisation, Bangalore and Raman Research Institute, Bangalore.

The proceedings of the Meeting will be published as a special issue of the Bulletin of Astronomical Society of India.

S. Seetha delivering a talk during one of the ASI sessions

National Science Day

The 28th of February is celebrated as National Science Day all over India. On this day in the year 1928, the "Raman Effect" was discovered for which Professor C. V. Raman was subsequently awarded the Physics Nobel Prize. IUCAA celebrated the National Science Day as a major annual event by organizing special programme for school students and observing open house for general public. An exhibition entitled '100 Years of Nobel Prize' marked the main feature this year's celebrations.

This exhibition was inaugurated by I. K. Mukherjee, Director General, National Council of Science Museums, Kolkata on February 25, and was open for the public till March 7. Nehru Science Centre (NSC), Mumbai, that made this exhibition possible, adopted an innovative approach in the display of information on 734 Nobel Laureates in all the subjects and over a span of 101 years and presented it through panels and index frame. G. A. Rautela, Director, NSC, Mumbai, took personal interest in setting up the exhibition in Pune. Shivaprasad M. Kened, who was the man behind making of the exhibition, provided valuable inputs in setting up the exhibition and was present on the day of the inauguration. Rout Mathur of NSC was deputed to interact with visitors. He had help from two volunteers Ashish Kate and Sushrut Bhanushali (both in Jr. College) of the Sky Watchers' Association of Pune.

The exhibition was kept open from 11:30 a.m. till 3:00 p.m., exclusively for students and from there onwards till 7:30 p.m., general public was allowed. It was estimated that total of about 8000 people visited the exhibition.

Programme for the Schools Students

The programme for the school students consisted of quiz, essay and drawing competitions and lecture demonstrations. Five students each from 82 schools were invited to participate in various competitions. This programme was conducted on Saturday, February 23 and began with Jay Narlikar giving a brief introduction on the importance of celebrating the National Science Day.

Essay and drawing competitions along with quiz elimination round were held from 9:30 a.m. to 10:30 a.m. During this period Shyam Tandon initiated a "Dialogue with teachers on experiments in school" with the teachers accompanying the students.

A lecture - demonstration was given by C. K. Desai of the Exploratory, Bharatiya Vidya Bhavan, Pune, from 11:30 a.m. to 12:30 p.m. on doing physics experiments.

After the lunch break, at 2:00 p.m. final quiz competition was conducted to the top 5 teams selected after the elimination round. This competition was held on stage in front of an audience. The highlight of this year quiz competition was some video clippings of experiments that were shown and the contestants were asked to answer questions based on the clips. Shyam Tandon was also

Glimpses of the National Science Day caught in the lens by Arvind Paranjpye

present to give expert's comments and to comment on the answers given. Jayant Narlikar gave away the prizes.

Jatush Seth, Tarun Souradeep, Harvinder Jassal and Amir H. Forushani judged the entries for drawing competition. The essays were judged by Varun Sahni, Nirupama Bawdekar, Vinaya Kulkarni, Ujjaini Alam, Tapas K. Das and Mangala Narlikar. Anand Sengupta, Anup Nair, Sanjit Mitra, Hum Chand Verma and Subbashish Aich conducted the quiz competitions. Parampreet Singh and Ujjaini Alam conducted the quiz on stage.

Prize winners

Drawing Competition

1st Prize
Masidwalla Hydershah
Don Bosco High School

2nd Prize
Raj Pravin Tatiya
Crescent High School

Honourable Mention
Punit Patel
Sanghavi K.M High School

Essay Competition (Marathi Medium)

1st Prize
Kakade Ashish Anil
Bharat English School

2nd Prize
No prize was given

Honourable Mention
Ashwini Satish Gaikwad
N.M.V Girls' High School

Rohini Roopchand Lipare
Jain Girls' High School

Essay Competition (English Medium)

1st Prize
No prize was given

2nd Prize
No prize was given

Honourable Mention
Ramchandani Madhu
Jai Hind High School

Moksha Sharma
Kendriya Vidyalaya, Range Hills

Yugal Tiwari
Loyola High School

Quiz Competition

1st Prize
Shyam Jade, Sameer Garg, Sandeep Gangakhedkar
St. Vincent's High school

2nd Prize
Adithya Srinivas Rao, Saurabh Prajulla Chatradeo, Nipun Avinash Dharmadhikari
Vidya Bhavan High School

3rd Prize
Vinayak Vishnu Ranade, Amod Suhas Jog, Chinmay Vivek Nivargi
Abhinava Vidyalaya English Medium

The other two teams which qualified for the quiz competition were -
Rohit Prakash Pandharkar, Mandar Dilip Phatak, Radhika Atul Marathe of Jnana Prabodhini Prashala, and

Aditya Akole, Sudeep Pradhan, Kshiteesh Phansalkar Panditrao Agashe School.

The Open Day

IUCAA's gates were thrown open to the public on February 28 at 2:30 p.m. People were allowed to move around IUCAA Campus and see different exhibits. The Foucault's pendulum was explained to the public by Dilip Sathe, Dept. of Physics, Dadawala Jr. College, Pune.

Faculty members of IUCAA displayed their research work and the research work carried out elsewhere in the world through popular posters in the foyer of Varahamihira. A. N. Ramaprakash organized this poster exhibition. A demonstration of laser speckle was given in the Instrumentation Laboratory by H. K. Das and Abhay Kohak.

Vinaya Kulkarni arranged a special demonstration on how to make an amateur telescope. Tushar Purohit and Parag Deotare of Sky Watchers' Association of Pune demonstrated steps involved in grinding and polishing of mirrors. Mayuresh Prabhune of Khagol Vishwa demonstrated how to test the mirrors. Ashish Kuvelkar, a software engineer, who runs the Amateur Astronomers' Club of the Centre for Development of Advance Computing, showed his telescope and explained its functions to the public.

Video films on astronomy, physics and mathematics were screened. Raju Gorkha and Rajesh Parmar from IUCAA carried out the screening.

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Imaging through turbulence with adaptive optics

1 Adaptive Optics : Principle

Light travels extremely large distances from an astronomical source, before reaching the Earth. Hence, the wavefront arriving above the Earth's atmosphere from a point source will be a plane wavefront. However, properties of the atmosphere like density and temperature are rapidly and randomly changing from place to place and time to time. Besides, no optical system is perfect. These effects manifest themselves as deviations of the wavefront from what is expected in an ideal situation. Large (diameter $>\sim$ 10 cm) astronomical telescopes never used to achieve the theoretical diffraction limited performance because of the above reasons.

An Adaptive Optics (AO) system is one that is capable of adjusting itself to compensate for both residual imperfections of the optical system as well as the atmospheric turbulence effects, thereby making it possible to achieve near theoretical resolution limits with large ground based telescopes.

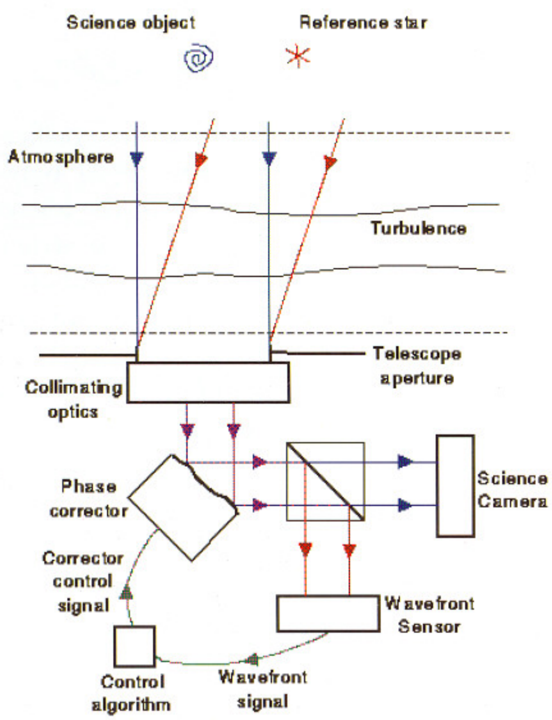


Figure 1: Block schematic of an AO system. (Adapted from http://op.ph.ic.ac.uk/research) [1]

As shown in fig. 1, an AO system uses a reference point source (like an unresolved star) close to the astronomical source of interest. This point source provides a reference plane wavefront that propagates through the same atmospheric patch and telescope optics as the wavefront from the astronomical target. Light from both the target as well as the reference are collimated and then reflected off a deformable mirror called corrector, the purpose of which will be clear soon. After reflection, light from the reference source is separated at a beam-splitter and fed into a wavefront sensor. Here, phase deviations of the observed reference wavefront from an ideal wavefront are estimated at several points across the aperture. These phase deviations are used to estimate how much the corrector, mentioned above, has to be deformed so that these wavefront phase departures are nullified. Accordingly, signals are applied to the deformable mirror, thereby correcting the phase departures of the wavefronts from both the target as well as the reference.

2 Adaptive Optics : Reality

The simple description of an AO system given above does not throw light on the practical difficulties of implementing a real life one. In the following sections we take a closer look at some of these aspects.

2.1 Telescope's Local Environment

Relatively slow changes in the figure of the primary mirror and potentially the alignment between optical components can be caused by temperature changes across the primary mirror and also the telescope structure. In a similar way, effects of gravity can also produce systematic changes in the image quality, as the telescope structure tracks the movement of the target in the sky. These effects fall within the realm of active optics in which sensors placed at strategic locations provide feedback about the state of the system (figure, alignment, etc.) and corrective measures are taken to offset any causes of image quality degradation. The active control system operates at a relatively low temporal frequency of 0.001-10Hz.

The active control has to also deal with strong winds, as are often present at the high altitude sites, where most modern observatories are located. The ability of an active telescope system to cope with the local environment is often stretched to its limits by the presence of substantial power in the higher frequency components (few Hz) of the wind power spectrum, which manifests itself as wind buffeting.

The large thermal mass of the telescope, especially of the primary mirror, delays it from reaching thermal equilibrium with the surroundings. A temperature difference of even 1K between the primary mirror and the air immediately above it, can cause significant turbulence and image quality degradation. Modern telescope and enclosure design involve detailed study of the thermal properties of the materials used as well as strict budgeting and active control of heat sources in and near the enclosure.

Even though an AO system is, at least in principle, capable of compensating for these local effects through wavefront corrections, the current approach is to employ a separate active system to monitor and control the optics, mechanics and thermal environment of the telescope, so as to eliminate/minimize the relatively slow-varying and systematic image degrading effects. Such active control is essential, since it then leaves the AO system to deal primarily with atmospheric turbulence.

2.2 Atmospheric Turbulence

Sunlight and other energy sources heat the Earth's atmosphere non-uniformly and produce temperature variations over large scales. Convection processes and winds, especially when disturbed by obstacles in their path, mix air masses of varying temperatures, thereby facilitating transfer of energy to smaller size scales, usually known as eddies. The random microstructure of the temperature inhomgeneities lead to random fluctuations in the refractive index[2]. The eddies could then be thought of as packets of air each with a charateristc refractive index and moving in a random direction at the local wind speed. Due to the random refractive index fluctuations, a plane wavefront propagating through the atmosphere, no longer remains plane, but becomes corrugated, since the speed of light varies inversely as the refractive index. The wavefront surface deviation is given by the integral of the refractive index along the line of sight in the near-field approximation, neglecting diffraction and scattering effects, $\delta = \int n(z)dz$. This approximation is valid when the turbulent layer height h above the telescope satisfies the condition $h < l^2/\lambda$, where l is the typical eddie dimension.

Since the spectral dispersion of air is extremely small over the visible and near IR wavebands, the optical pathlength changes due to turbulence are wavelength independent. This is crucial to the working of AO systems, because often the wavefront sampling is done at a wavelength which is different from that at which the target is to be observed. Thus a deformable mirror placed in the path of the wavefront can, in principle, compensate for the pathlength differences at all wavelengths, thereby achieving broadband image quality. The low atmospheric dispersion also implies that it is advantageous to implement AO systems at longer wavelengths, since a given pathlength fluctuation translates to only a smaller phase fluctuation at a longer wavelength.

The statistics of the atmospheric turbulence and its effects on light propagation was first studied in detail by Kolmogorov[3] and later improved upon by many others (see references in [4] and [5]). It is known that the spatial fluctuation of the refractive index as quantified by the spatial structure function, which is the variance of the difference between the refractive indices at two points expressed as a function of the distance ρ between the points follows a power law[3], [5],

$$D_n(\rho) = \langle |n(r) - n(r+\rho)|^2 \rangle = C_n^2 \rho^{2/3}, \qquad (1)$$

where C_n^2 is the spatial index structure coefficient. The corresponding phase variations ($\frac{2\pi}{\lambda}\delta$) between two points separated by a distance ξ at the telescope entrance aperture is given by the phase structure function defined in a similar way to eqn. 1 above. To a good approximation, the upper atmosphere can be considered to be stratified into plane parallel layers, each with a different structure of turbulent mixing. The spatial phase structure function at the telescope aperture can then be written as

$$D_\phi(\xi) = 6.88(\xi/r_0)^{5/3}. \qquad (2)$$

Here, r_0 is a length called Fried parameter, defined by,

$$r_0 = 0.185\lambda^{6/5}(AM)^{-3/5}\left[\int C_n^2(h)dh\right]^{-3/5}, \qquad (3)$$

where (AM) is the airmass along the line of sight and the integral is over the refractive index variations at different heights h in the atmosphere. It can be shown that the root mean square phase fluctuation over a circular aperture of diameter r_0 is 1 radian[5]. At visual wavelengths, typical values of r_0 ranges from 5 cm during bad weather to 20 cm during stable atmospheric conditions.

If the angular separation between the target and reference point source is large, wavefronts from the two traverse different patches of the atmosphere and the distortions they undergo will not be correlated. The mean square error of the wavefront phase due to a single turbulent layer at height $h/(AM)$ is obtianed by replacing ξ in eqn. 2 by $\theta h/(AM)$. Then the isoplanicity angle, defined as the angle over which the rms phase error is less than 1 radian is given by $\theta_0 = 0.314 r_0 (AM)/h$. Typical values of θ_0 ranges from 2" at visual wavelengths to about 10" at near-IR wavelengths. Due to difficulty in finding a suitable guide star very close to the target, some AO systems use an artificial guide star produced by resonant back-scattering of a laser beam in the upper atmosphere.

In addition to the variation from point to point, the refractive index along a line of sight fluctuates over time also. Similarly to eqn. 1, the time structure function of the refractive index is defined as,

$$D_n(\tau) = \langle |n(r,t) - n(r,t+\tau)|^2 \rangle. \qquad (4)$$

Now, if the refractive index fluctuations are assumed to be stationary, one gets the relation $n(r, t+\tau) = n(r - v\tau, t)$, where v is the wind velocity. This assumption can be justified, at least locally, based on observations which show that the lifetimes of the eddies are considerably longer than the time it takes for an eddie to cross the line of sight when travelling at typical wind velocities. When this assumption is folded into eqn. 4, it reduces to the form of eqn. 1. Therefore, the time structure function of wavefront phase at the telescope entrance will be given by,

$$D_\phi(\tau) = 6.88 (v\tau/r_0)^{5/3}, \qquad (5)$$

under the near-field approximation. One can now define a time scale over which the rms phase fluctuations are less than 1 radian, given by $\tau_0 = 0.314 r_0/v$. Values of τ_0 range typically between 3 and 10 milliseconds at visual wavelengths.

2.3 Effect of Atmospheric Turbulence on Image Quality

If the rms phase error over the telescope is less than about 1 radian, the image quality degradation is not noticeable. On the other hand, a linear increase in rms phase error above 1 radian degrades the image quality exponentially. A parameter used to measure image quality is the Strehl ratio, which is defined as the ratio of the intensity at the central core of the actual image to the intensity at the central core of a perfect diffraction limited image. In the absence of turbulence, a perfect optical system having a circular aperture of diameter D, will concentrate 84% of the total light from a point source in a central disk of angular diameter $\theta_D = 2.44\lambda/D$ and the remaining light will be scattered over several diffraction rings around the core. The effect of atmospheric turbulence is to break down this image into a large number of speckles. Each speckle will have a typical angular diameter given by the diffraction limit θ_D, but the speckles will be spread over a disk (seeing disk) of angular diameter $\theta_{r_0} = 2.44\lambda/r_0$. Hence, for a typical astronomical telescope with $D > 20cm$, the seeing disk defines the best achievable resolution limit for exposure times $>> \tau_0$). At the best observing sites under the best observing conditions the seeing disk could be as small as 0.3". Compare this with the diffraction resolution limit of 0.03" for a 4 m telescope at visual wavelengths. However, if the exposure times are much shorter than τ_0, defined after eqn. 5 above, one would get a large number of individual speckles spread over θ_{r0} as the fine structure of the seeing becomes visible.

Thus, if the telescope diameter $D < r_0$, atmospheric turbulence has no effect in the image quality. In this regime, the wavefront could be thought of as having overall random tilts across the aperture, which mainly shows up as small random shifts in the centroids of images of point sources. When $r_0 < D < 10r_0$, image motion becomes the dominating effect of turbulence. In this range, considerable improvement in image quality can be obtained by a simple form of AO called tip-tilt correction, in which only the overall gradient of the wavefront across the aperture is compensated for. For $D > 10r_0$, tip-tilt correction alone yields only marginal effects for compensating atmospheric turbulence. However, other sources of image motion such as wind buffeting, tracking errors, etc. may be reduced by image stabilization for such large telescopes.

Performances achieved by a number of working astronomical AO systems is compiled in Table. 1.

Telescope	Instruments	AO system/ Wav.Sen. λ	Performance Strehl Ratio	Lim. Mag. Guide Star	Guide Star offset (″)	Comp. Technique
Palomar 200″	PHARO	PALAO/ 1050nm	K-0.5,J-0.1	V>11	40	Shack-Hartmann
CFHT 3.6m	FOCAM, KIR	PUEO/ Visible	K-0.56,H-0.41, J-0.27	K>15.5,H>15.0, J>14.3	K-40,H-30, J-20	Curvature
Calar-Alto 3.5m	Ω-Cass, 3D, CHARM	ALFA/ Sod. Vap.	K-0.23	Laser Guide Star	10	Shack-Hartmann
ESO 3.6m	SHARPII + COMIC	ADONIS/ Visible	K-0.5,H-0.3, J-0.2	V>9	30	Shack-Hartmann
Gemini N 8m	QUIRC	HOKUPA'A/ Visible	H-0.5,K′-0.5	R>15	18	Curvature
W. M. Keck 10m	KCAM, NIRSPEC	AO/ Visible	K-0.5,H-0.35, J-0.15	R>14	40	Curvature
WHT 4m	CCD, IR	NAOMI/ Visible	K-0.65	K>8		Shack-Hartmann
VLT 8m	SPIFFI	SINFONI/ Visible	K-0.44,H-0.25, J-0.1	V>13	30	Curvature
VLT 8m	CONICA	NAOS/ Visible & IR	Ks-0.7	V>18	60	Shack-Hartmann
SUBARU 8m	CIAO, IRCS	AO/ Visible	K-0.21,H-0.09, J-0.03	R>14	30	Curvature

Table 1: A list of astronomical AO systems currently in operation

2.4 Wavefront Compensation

The daunting task of wavefront compensation is to estimate the minimal set of parameters that define the wavefront error at each instant, calculate the corrections to be applied and actually apply these corrections to the corrector before the nature of the wavefront error changes within the next few milliseconds. In this last section, we take a quick look at two popular strategies that are employed to achieve this.

The first one is the zonal approach (or Shack-Hartmann), in which the reference wavefront is broken into $O(D/r_0)^2$ zones and the optical path length as well as the local gradient or curvature within each of these zones is measured and corrected for. The other technique (called curvature technique) involves the modal approach in which the wavefront distortion is represented as the sum of a series of orthogonal whole-aperture functions or modes. The largest order term included in the sum defines the finest correction to be made. The most popular choice is the Zernike modes ([4], [5]), since the first few terms of this series correspond to familiar optical aberrations such as wavefront tilt, defocus, astigmatism and coma. However, for random atmospheric wavefront errors, the Zernike coefficients are truly not statistically independent. A better choice is the Karhunen-Loève series which are obtained by diagonalization of the Zernike covariance matrix.

References

[1] Many of the AO-related websites do not necessarily deal with astronomy, but nevertheless provide useful information about the technique. For eg., http://caao.as.arizona.edu/links.html. Imperial College Photonics group has provided a good introduction to the subject at http://op.ph.ic.ac.uk/research/.

[2] Goodman, J. W., 1985, *Statistical Optics*, John Wiley & Sons, for a detailed discussion of the nature of atmospheric turbulence and its effects on astronomical imaging.

[3] Komogorov, A., 1961, *Turbulence, Classic Papers on Statistical Theory*, Wiley-InterScience.

[4] Hardy, J. W., 1998, *Adaptive Optics for Astronomical Telescopes*, Oxford Series in Optical and Imaging Sciences, deals all the way from a nice historical introduction to current trends and future prospects.

[5] Roddier, F., 1999, *Adaptive optics in Astronomy*, Cambridge University Press, is a great collection of articles by practitioners of the art, including descriptions of real AO systems.

Thirty minute talks were given to the general audience in Chandrasekhar Auditorium. Ranjan Gupta talked on "The telescope of this century" and Ram Gopal Vishwakarma delivered a talk "On the theory of Indian Ephemeredes". These talks were in Hindi. Tapas K. Das and Kandaswamy Subramanian gave talks on 'The monster in the middle and his smoking gun - How massive black holes fuel the cosmic powerhouse" and "Fabric of Spacetime" respectively.

Question and answer session, a programme introduced in the year 2000, has gained tremendous popularity. Chandrasekhar Auditorium was packed to its full capacity of 500 seating for an hour long programme this year too. Jayant Narlikar and Ajit Kembhavi answered the questions (both in English and Marathi) ranging from pure astronomy (such as rings of planet to masses of neutron stars) to questions of social interest (astronomy against astrology) with a standard mix of - black holes, big bang and Bermuda Triangle. Arvind Paranjpye moderated the session.

Non-academic staff of IUCAA provided the general support in organizing all the programmes. The reception desk was (wo)manned by Savita Dalvi, Meena D'Sa, Swati Gujar, Kalpana James, Manisha Kharade, Susan Kuriakose, Nilima Magdum, Dipika Mathew, Ratna Rao, Varsha Surve and Afroz Sayed. Necessary support in organizing the complete programme was provided by Santosh Bhujbal, G. B. Gaikwad, S. U. Ingle, Kumar Munnuswami, Balaji Swant and Shankar Waghole under the supervision of Tushar Agarkar, V. Chellathurai, Santosh Khadilkar, E. M. Modak, K. C. Nair, and Shehlata Shankar.

All these events were organized by Ajit Kembhavi and Arvind Paranjpye.

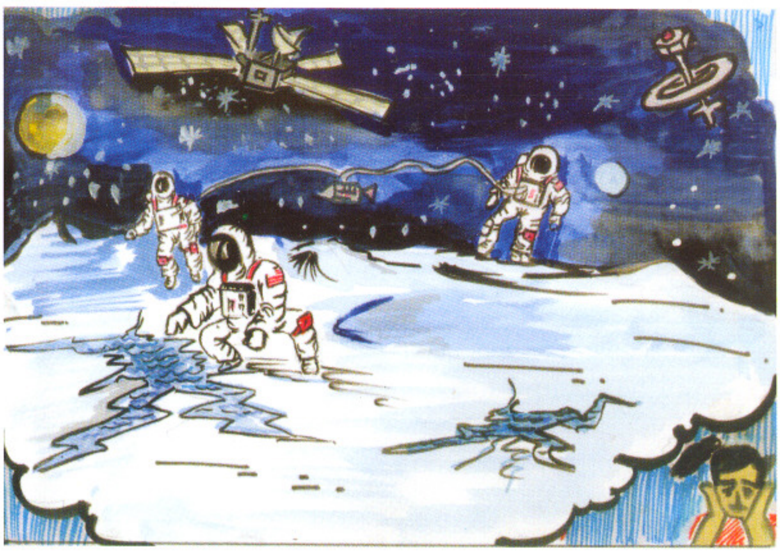
Prize- winning Drawings

One day I witnessed the Total Solar Eclipse

First Prize
Masidwalla Hydershah
Don Bosco High School

Second Prize
Raj Pravin Tatiya
Crescent High School

What lies (hidden in the oceans) under the ice sheets of Europa?



Catch the Comet Ikeya-Zhang

A comet that was discovered by two amateur astronomers Kaoru Ikeya in Japan and Daqing Zhang in China independently on the night of February 1, 2002 and named "**Ikeya-Zhang**", pronounced "ee-KAY-uh JONG" had brightened enough to be seen with naked eyes in the second week of March. The comet will be visible in the pre-dawn hours of April. For more information on observing the comet visit

http://www.iucaa.ernet.in/~scipop

Arvind Paranjpye

POST-DOCTORAL POSITION IN VIRTUAL OBSERVATORIES AND ASTRONOMY FROM LARGE DATABASES

Applications are invited for a post-doctoral position available at IUCAA as a part of a project entitled "Virtual Observatory-India". This project is funded by the Ministry of Information Technology, Government of India and is supported by Persistent Systems Pvt. Ltd., Pune. Applicants with a Ph.D. in any area of **astronomy** or **astrophysics**, or **physics** or **computer science** with interest in working in areas covered by the project, will be considered.

The selected candidate is expected to work closely with Ajit Kembhavi at IUCAA and his collaborators in the project from various institutions in India and abroad. There will be opportunity for cutting-edge inter-disciplinary work, with possibilities of travel to some of the leading centres in the world. The research areas covered by the position will include **large area surveys, multi-wavelength astronomy, image processing, visualization, simulations, data management and data mining.**

The position is for a period of two years. The initial appointment will be for one year, and will be renewed for a second year subject to satisfactory performance. Extension to a third year is a possibility. Apart from the fellowship, the candidate will be provided with suitable accommodation and other facilities as applicable to post-doctoral fellows at IUCAA.

Applications (in plain papers) should be sent to the Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune - 411 007, India, (e-mail : vch@iucaa.ernet.in) with CV, list of publications and a brief summary of current research interests. Three letters of recommendation, from experts who know the candidate's research work, should be sent directly to the above address. Any further details regarding this position may be obtained from the Coordinator, Core Programmes, IUCAA.

The completed application should reach IUCAA by May 31, 2002.

Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions (FIST)

Department of Science and Technology (DST) (Ministry of Science and Technology), Government of India has invited proposals for consideration of support under the "Fund for improvement of S&T infrasturcture (FIST)" scheme. The Scheme is intended to provide basic infrastructure and enabling facilities for promoting R&D activities in new and emerging areas attracting fresh talents in universities & other educational institutions.

The application needs to be submitted on or before May 31, 2002.

For details please contact: Dr. A. Mukhopadhyay, Director, Science & Engineering Research Council (SERC) Division, Department of Science and Technology (DST), Technology Bhavan, New Mehrauli Road, New Delhi - 110 016, Tel: 011-656 7373, Extn 445, Email: tsd@alpha.nic.in.

IUCAA Preprints

Listed below are the IUCAA preprints released during January - March 2002. These can be obtained from the Librarian, IUCAA (library@iucaa.ernet.in).

S.G. Ghosh and Naresh Dadhich, *Gravitational collapse of null strange quark fluid and cosmic censorship*, IUCAA-1/2002; Patrick Petitjean, R. Srianand and Cedric Ledoux, *Molecular hydrogen at z_{abs} = 1.973 toward Q 0013-004: Dust depletion pattern in damped Lyman-α systems*, IUCAA-2/2002; Sushan Konar and Arnab Rai Choudhuri, *Diamagnetic screening of the magnetic field in acreeting neutron stars*, IUCAA-3/2002; Ninan Sajeeth Philip, Yogesh Wadadekar, Ajit Kembhavi and K.Babu Joseph, *A difference boosting neural network for automated star-galaxy classification*, IUCAA-4/2002; T. Padmanabhan, *Thermodynamics and/of horizons: A comparison of Schwarzschild, Rindler and deSitter spacetimes*, IUCAA-5/2002; T. Padmanabhan, *Entropy and energy of a class of spacetimes with horizon: a general derivation*, IUCAA-6/2002; Naresh Dadhich, *The relativistic world: A common sense perspective*, IUCAA-7/2002; Varun Sahni, *The cosmological constant problem and quintessence*, IUCAA-8/2002; Ranjeev Misra and Ronald E. Taam, *The effect of dissipative corona on the structure and stability of cold optically thick accretion disks at high accretion rates,* IUCAA-9/2002; T. Padmanabhan, *Evolution of the correlation function for a class of processes involving non local self-replication,* IUCAA-10/2002.

Workshop on Photometric Data Reduction and Analysis

A small telescope (12" Meade LX200) with SSP-3A automated photometer (OPTEC) has been obtained by J.E.S. College, Jalna, under a DST supported project sanctioned to M. L. Kurtadikar of the college. With a view to use the telescope for observational work effectively, a workshop on Photometric Data Reduction and Analysis was organized at J.E.S. College, Jalna, during January 14-18, 2002, intended mainly for teachers and M.Sc. students. Thirty one teachers, thirty five students and three amateur astronomers/researchers attended the workshop.

Lectures were arranged on Fundamentals of Astronomical Photometry (Ajit Kembhavi, IUCAA), Spectroscopy in Astronomy (Ranjan Gupta, IUCAA), Variable Stars, Light Curves, Observational Projects (S. K. Pandey, Pt. Ravishankar Shukla University, Raipur), Astronomy Basics, Observational Programmes (P. Vivekananda Rao, Osmania University), Using Small Telescopes for Binary Stars and Comets (N. M. Ashok, PRL), Occultations (T. Chandrasekhar, PRL), Physics in Astronomy (Suresh Chandra, SRTM University, Nanded), CCDs in Astronomy (S. K. Popalghat, J.E.S. College, Jalna) and Astronomical Facilities in India (M. L. Kurtadikar, J.E.S. College, Jalna). A Sky Observation Session was conducted by Nandan Phatak and demonstrations were given by P. Vinu, S.K.Popalghat and M.L.Kurtadikar of J.E.S.College.

A popular talk in Marathi by Ajit Kembhavi, 'Navi Srishti Nave Graha', was also arranged for the public of Jalna in the evening of January 14.

Ranjan Gupta and M.L.Kurtadikar were the coordinators of the workshop.

Seminars

03.01.2002 Judith Bishop on *Present and future prospects for programming languages*; 24.01.2002 Zoltan Haiman on *Probing the end of the dark ages*; 25.01.2002 James A. Rose on *Multiple merging events in the A3128/A3125 double cluster of galaxies*; 18.02.2002 Menas Kafatos on *Accretion onto black holes* and 14.03.2002 Sujan Sengupta on *Atmosphere of substellar-mass objects: Brown dwarfs and extra solar giant planets*.

Visitors Expected

April: B. Ahmedov, Institute of Nuclear Physics, Uzbekistan; M. Ermamatov, Institute of Nuclear Physics, Uzbekistan; Nagendra Kumar Chauhan, K.G.K. (PG) College, Moradabad; H. Sikka, K.G.K. (PG) College, Moradabad; D.B. Vaidya, Gujarat College; B. Basu, Calcutta; M.L. Kurtadikar, J.E.S. College, Jalna; N. Druguet, ESPEO, France; and J. Lasue, Ecole Polytechnique, France.

May: B. Ahmedov, Institute of Nuclear Physics, Uzbekistan; M. Ermamatov, Institute of Nuclear Physics, Uzbekistan; M.L. Kurtadikar, J.E.S. College, Jalna; D.Lohiya, Delhi University; A.K. Mittal, University of Allahabad; K. Indulekha, M.G. University, Kottayam; Babu Joseph, CUSAT; N. Sajeeth Philip, St. Thomas College, Kozhencherry; T. Chatterjee, Calcutta; R. Ramakrishna Reddy, Sri Krishnadevaraya University, Anantapur; N. Ahmed, Sri Krishnadevaraya University, Anantapur; Sasikala Devi, Sri Krishnadevaraya University, Anantapur; K.P. Harikrishnan, CUSAT; S.G. Ghosh, SSES Science College, Nagpur; A.C. Kumbharkhane, SRTM University, Nanded; S. Chakraborty, Jadavpur University; K. Jotania, BITS, Pilani; Udit Narain, Meerut College; P. Vivekananda Rao, Osmania University, Hyderabad; P. Khare, Utkal University, Bhubaneswar; M.C. Sabu, Christ College, Rajkot; S. Sahijpal, Panjab University, Chandigarh; P.K. Suresh, University of Hyderabad; and P.K. Srivastava, DAV College, Kanpur.

June: A. Banerjee, Jadavpur University; S. Datta, Calcutta; V.K. Gupta, University of Delhi; J. Grain, ENSPG, France; J. Magri, ENSPG, France; B. Ishwar, B.R.A. Bihar University; K.N. Iyer, Saurashtra University; P. Khare, Utkal University; Yogesh Mathur, University of Delhi; A.K. Mittal, Allahabad University; B.C. Paul, North Bengal University; M. Sami, Jamia Millia Islamia; T.R. Seshadri, University of Delhi; Santokh Singh, Deshbandhu College, Delhi; B.K. Sinha, S.C. College; D.C. Srivastava, D.D.U. Gorakhpur University; Anisul Ain Usmani, Aligarh Muslim University; Lalan Prasad Verma, M.B. Govt. P.G. College, Nainital; N.K. Lohani, M.B. Govt. P.G. College, Nainital; and A. Pradhan, Hindu Degree College, Ghazipur

Colloquium

11.02.2002 Sunil K. Gupta on *Excitement of experiments in cosmic ray astrophysics.*

A Research Scholar at Seventy five- Plus

In the 'Living Biographies of Great Scientists' by Henry Thomas Dana Lee Thomas, the following account appears of the last decade in the life of Lord Kelvin. Despite his pioneering contributions to thermodynamics and electricity during the nineteenth century, Kelvin found the new developments in atomic physics bewildering and mentioned this at the golden jubilee celebrations of his professorship at GlasgowUniversity.

'....Three years after his jubilee he resigned his professorship at the University of Glasgow. The trustees informed him that they would have been glad to retain his services, but he shook his head. "No sentimentality, if you please. I have outlived my usefulness."

'....So he left the professorship. But not the University. As long as there was breath in his body he could never break the last tie with old Glasgow. At the beginning of the academic year of 1899 this aged scholar of seventy-six walked into the registration room along with the undergraduates and enrolled his name - "Lord Kelvin, Research Student." He was at last too wise to teach. From now on he would only learn.'

With this anecdote, the 50th in the series that was run continuously from the first issue of Khagol, we conclude this particular column.

Editor

Visitors during January - March

Gary Ferland, P. Vinu, Ninan Sajeeth Philip, E. van den Heuvel, P. Khare, N. Mukunda, S.R. Choudhury, A. Omont, M. Dey, B. Schutz, F. Ahmad, K. Sinha, S.K. Pandey, M. Sami, M. Varadarajan, L. Chaturvedi, L.K. Patel, James Rose, S. Kumar, Yash Pal, Charles Correa, Manjula Rao, Charles Jencks, C.V. Vishveshwara, Paul Smith, P.K. Srivastava, S. Barway, C.D. Ravikumar, Sunil Gupta, U. Narain, K. Pandey, S. Ray, S. Varadarajan, M. Kafatos, G.S. Khadekar, M. Fujimoto, I.K. Mukherjee, R.K. Kochar, Barve, B.B. Sanwal, N. Bhat, S. Sunder, S. Bhattacharyya, S. Sengupta, M. Ermamatov, B. Ahmedov, S. Kulkarni and B.B. Walwadkar.

About 150 visited IUCAA to attend the 21st Meeting of the ASI.

Please note the change in Telephone and Fax numbers !!!

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

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