KHAGOL

THE
IUCAA
BULLETIN

Inter-University Centre for Astronomy and Astrophysics
An Autonomous Institution of the University Grants Commission

No. 14 **April 1993**

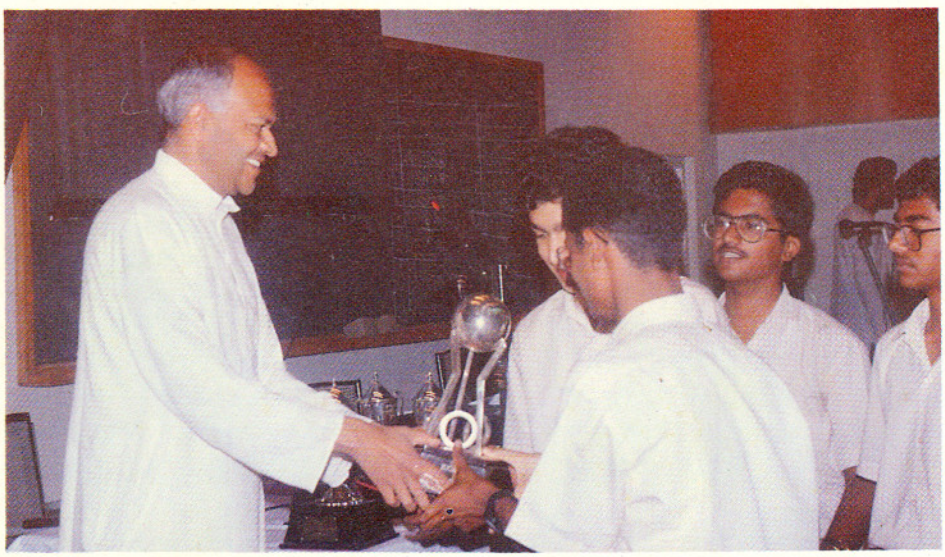
National Science Day

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 9:00 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 highlighted the recent developments in the study of the early universe and Ajit Kembhavi talked about 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 Lab. The students were introduced to the modern computing facilities, e-mail services, various graphics and numerical packages, the automated library services and so on. The students also enjoyed their visit to IUCAA's dome (depicting the overhead sky as on its First Foundation Day, December 29, 1988 at 8:00 p.m.) and the Foucault's pendulum. Tarun S. Ghosh, who was in charge of explaining the physics of the Foucault's 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 Madhavi Dinakaran. The cartoon and the painting contests



The Director distributed the prizes

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 the 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.

Observation of the sunspot

FEEDBACK

To,

The Editor, Khagol,

Khagol of January 93 has a neat little tale on youth and directors, page 8.

Here is a true -- and -- hopeful modern variation on that very theme.

Bart Bok, a well-known and disarmingly friendly elderly astronomer, now gone, who often referred to himself as "just an old telescope pusher", was long the Director of the Steward Observatory on Kitt Peak, part of the University of Arizona. There in early 1969 three young astronomers, one a theorist, one an electronics man, none familiar with that observatory, deliberately searched for and at once found the optical pulses of the Crab Nebula pulsar. It was justly a sensation.

Soon a meeting took place at which the valuable discovery was reported. Bart Bok was chairman of the session. He began by saying that the three men (Cocke, Disney, and Taylor) had received all the credit for this discovery, but that he wanted to emphasize the contribution of the Director as well. The audience grew uneasy, even embarassed; could this be the good.old Bart Bok, so anxious to claim some formal credit for himself? "Yes", he continued. "My contribution was absolutely necessary. You see, I was out of town at that time; if I had been there, I wouldn't have let such inexperienced observers near the telescope!"

So Director Bok played an essential role: being off station. More power to the young readers of Khagol; take chances! But old Bart Bok was no stuffy formalist, either. We ought to praise senior directors, who have flexibility and good humor; they're not so uncommon today.

A pleased if elderly reader,

Philip Morrison, Physics, MIT, Cambridge, MA 02139, USA.

PEP talks by Locals

22.01.93 D.J.Saikia on *Unification schemes*, 03.02.93 Arvind Paranjpye on *David Malin's astrophotographs*, 12.02.93 Patrick Das Gupta on *Spontaneous symmetry breaking*, 26.02.93 Dipak Munshi on *Aarseth's N-body code*, 12.03.93 Sanjeev Dhurandhar on *Gravitational waves*, 26.03.93 Pradeep Gothoskar on *Neural networks for fun.*

....and by Visitors

01.01.93 Donald Lynden-Bell (IOA) on *Straight lines in curved spacetime*, 03.01.93 Russel Cannon (AAO) on *Multi-object spectroscopy.*

Minischool on Photometry with Small Telescopes

A minischool on 'Photometry with Small Telescopes' was held at IUCAA during January 4-8, 1993. The school 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, Ashoke Sen and S.N. Tandon of IUCAA. The participants were also actively involved in the photometric observations of variable stars using IUCAA's Celestron 14" telescope. Ranjan Gupta was the coordinator of the school.

Participants of Minischool on Photometry with Small Telescopes

Miniworkshop on Techniques for Astronomical High Resolution Optical and IR Spectroscopy

An IUCAA 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 observatories. Lectures on various aspects of different high resolution spectrometers were delivered by N.K. Rao, IIA, Bangalore ; C. Debi Prasad, 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

Parsecstones in Astronomy - 2 — *J V Narlikar*

Does the Earth Move?

'E pur si muove' ('Yet, it does move') said Galileo in 1633 even after recanting and supporting the geocentric theory. Is the Earth fixed and the Sun goes round it or vice versa? The debate had been a long standing one. The relativist today may say: does it matter? Aren't the laws of physics the same, whichever frame of reference you find convenient to use? Indeed, in a purely two-body system the question of what goes round what is undecidable.

But astronomers have more than two bodies to deal with. Apart from the planets in our neighbourhood, there is the background of stars. With respect to that background the question of what goes round what does become meaningful. And it is in principle decidable. Aristarchus of Samos in Greece, back in the third century B.C. was the main proponent of the heliocentric theory. His idea was put to a test: at six month intervals the stars should appear to change their direction because of the change of the observer's vantage point as the Earth moves through space.

The idea was right but Aristarchus lost the debate for two reasons. First, his contemporaries had grossly underestimated the stellar distances and had expected appreciable angular changes of star directions, which were not found. Second, the astronomical techniques of his times were not accurate enough to measure the changes of the order of 0.1 arc second that were in fact there.

Even Galileo, despite his confidence in the heliocentric theory, did not have the correct test of his claim. His notion that the Earth's motion causes tides of oceans was wrong. The real tests of the hypothesis came in the 18th and 19th centuries. The parallax test proposed by Aristarchus was first used by Bessel for a reliable result in 1838 for the Star 61 Cygni, whose parallax is about 0.3 arc second. An earlier test of Earth's motion came in 1725 from aberration measurements by Bradley who measured the change in the direction of light coming from a star as perceived from the moving platform of the Earth.

conducted 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 coordinators of the workshop.

Seminars held during last three months

29.1.93 Sarbani Basu on *The spatial and temporal evolution of gas and heavy elements in the galaxy*, 9.2.93 Jai-Chan Hwang on On *cosmological perturbations*, 16.2.93 P.C. Vaidya on *Tachyon in an Einstein universe*, 23.2.93 Shiv K. Sethi on *On constructing viable extended inflation models*, 15.3.93 G.S. Lakhina on *Role of current sheets in astrophysical plasmas*.

Minischool on Pulsars

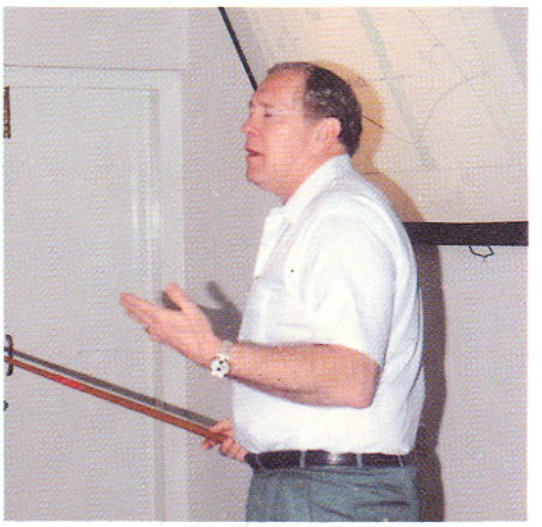
The minischool on Pulsars was held at IUCAA during February 15 -20, 1993. The minischool was originally to be held at Osmania University, Hyderabad, but due to unavoidable circumstances had to be shifted to IUCAA. The school was attended by research scholars and young research workers who are interested 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.

Hanbury Brown, during his visit to IUCAA

Colloquia held during last three months

27.1.93 David Schramm on *Shadows of creation: The origin of structure in the universe*, 8.2.93 Hanbury Brown on *The pursuit of high-angular resolution*, 15.2.93 Ramnath Cowsik on *Double beta decay tellurium nuclides*, 22.2.93 D.D. Gaur on *A new laparoscopic surgery*, 5.3.93 N.K. Notani on *Genetic transformation in bacteria, plants and man* and 29.3.93 C. V. Vishveshwara on *The cosmic picture book*.



David Schramm

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. It is hoped that the interest generated amongst young research workers will lead to their contributing to this field in the coming years.

National Amateur Astronomers' Meet

The third national meet of the Amateur Astronomers' was held this year at Vikram A. Sarabhai Community Science Centre, Ahmedabad during February 13-14, 1993. IUCAA contributed a lump sum amount towards meeting the expenses, particularly for participants from universities. About 70 outstation and 80 local participants attended the meet to give seminars and exchange ideas. An exhibition of the 110 Messier objects photographed by Ajay Talwar and his friends from Bombay was a notable feature of the meet. The Fourth National Meet will probably be held at Calcutta, hosted by the Mahindra Narayan Astronomical Trust, Calcutta. Asis Mukherjee (32G/1B, Haremohan Ghosh Lane, Calcutta 700085) may be contacted for further details .

LIMB DARKENING OF SUN

To unaided eye, Sun appears as a disk of uniform brightness. In fact, Sun is so bright that it is not possible to look at it for more than a fraction of a second, except at grave risk to the eyes, and any possible variations in intensity across its surface cannot be perceived. In order to have a close look at solar disk, you could use two or three layers of aluminised mylar to reduce its intensity. If you carefully look at Sun through these mylar layers, the regions near the edge would appear darker.

The relative darkness of solar limb is not due to lack of spherical symmetry, but it is caused due to the radial temperature gradient near the surface. Sun can be considered as a gaseous sphere at high temperature; the apparently well defined boundary is seen because the light can penetrate only a very tiny fraction of solar body, unlike in the case of a usual terrestrial flame which is penetrated deeply by light. If the light penetrates a distance λ then the light we receive from the centre of solar disk would have arisen from layers between radii r_0 and $(r_0 - \lambda)$, r_0 being the solar radius. On the other hand, if we look close to the limb, the light reaching us would have arisen from layers of radii between r_0 and $(r_0 - \lambda^2/2r_0)$ (see Fig. 1). As $\lambda << r_0$, it is clear that while looking near the limb, we are receiving light from relatively outer layers of solar atmosphere. As the temperature of the outer layers is lower, the light received from the limb has a lower intensity. This 'darkening' effect is shown in Fig. 2 for different wavelengths of light; it can be seen that the effect is larger for smaller wavelengths, being maximum for blue light in the visible region.

In order to make a measurement of limb darkening, you need a telescope and a light measuring device.

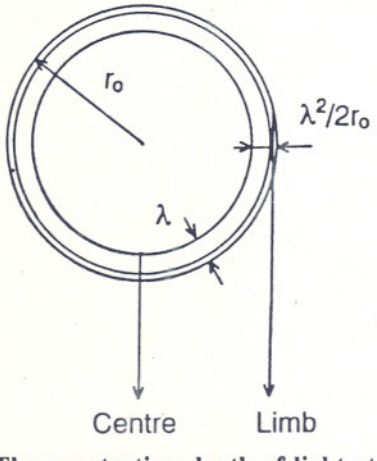


Fig.1: The penetration depth of light at the centre and at the edge is illustrated.

The box in page 6, contributed by Arvind Paranjpye, describes the fabrication and use of a small telescope. To get sharp images achromatic lenses are necessary -- ordinary single lenses have different focal lengths for different colours and therefore give rise to unsharp coloured images. For limb darkening observations, this defect can be reduced by placing a blue (red) plastic film in front of the telescope, and by reducing the opening of the objective lens through use of a cardboard cover with a 1 - 3 cm diameter hole in it. A photoresistor can be used as a sensor; the surface of the photoresistor should be in the shape of a rectangle (so that it can collect light from a small range of radii in the solar image) of width about one fiftieth and length upto one fifth of the diameter of solar image. A rectangular aperture of black paper can be used to cover the resistance in order to get the sensitive area in the desired shape. The readings of the resistance can be converted to relative intensity by using the equation $R^{-1} = R_0^{-1} + KI$, where R_0 is resistance in the dark, R is the measured resistance, I is the intensity, and K is a constant evaluated by measuring resistance at the centre of the image (assumed to have I = 1 unit). The measurements are made by keeping the resistance at different radii in the solar image, with the short side of the rectangular aperture along the radius, and noting the resistance. The darkening effect would be observed much more for the blue filter than for the red filter.

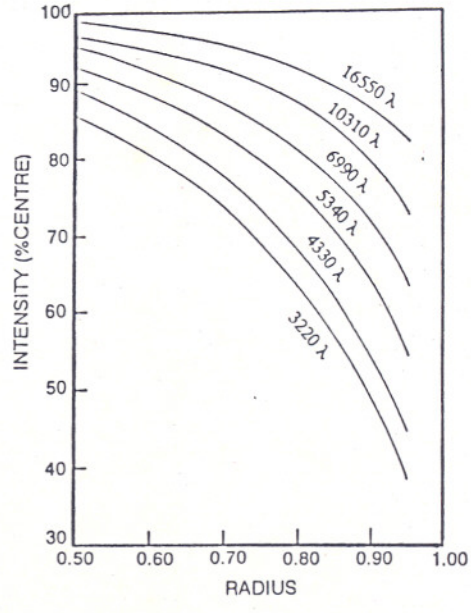


Fig.2: The intensity variation on solar disk is shown for several wavelengths; the ordinate shows intensity as percentage of its value at the centre and the abscissa is the radius. Each curve refers to the wavelength marked on it.

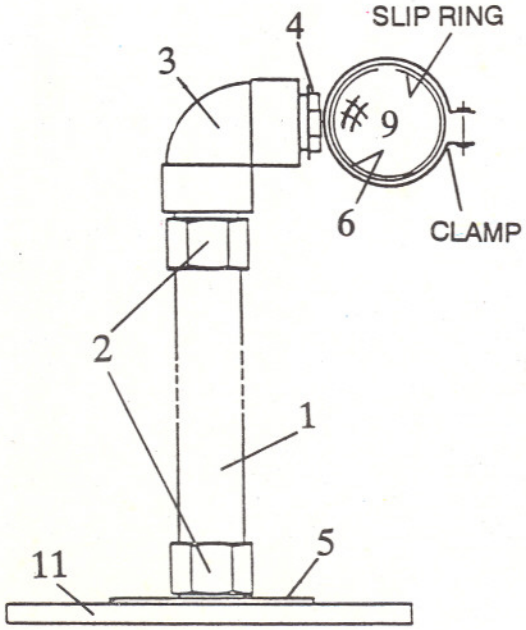
Construction of a simple telescope

All parts of the mount can be purchased from suppliers of irrigation equipments. The lenses can be purchased from the suppliers of scientific equipments, or as in our case, made to order from opticians making spectacles.

The list of items required are (number in square bracket indicates the part shown in the diagram):-

- 32mm OD plastic tube, 40 cm long [1] : one
- MTA(male threaded adapter) [2] : two .
- Elbow (threaded) [3] : one .
- End plug [4]: one .
- 4 inch flange (GI) [5]: one .
- 63mm OD tube 60 cm long [6]: one .
- 25 mm OD 5 cm long [7]: one .
- Reducers 63-50, 50-32, 32-25 [8]: one each.
- Lens objective 60mm dia., 50 cm fl [9]: one.
- Lens eye piece 20 mm dia., 5cm fl [10]: one.
- Wooden base 20 x 20 x 1 cm [11]: one.
- Aluminium strip 25 x 2 x.1cm [12] : one.
- Assorted screws, nuts and bolts.

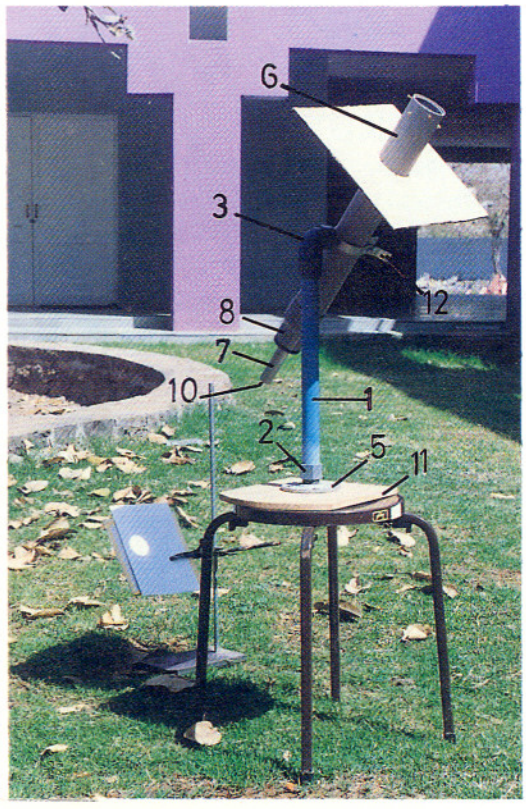
The assembly of the mount is self explanatory from the figure. The elbow moves parallel to the horizon and it is called azimuthal motion. The telescope tube which is attached to the other end of the elbow, is turned to change the altitude. This is called altazimuth mount. The lenses are supported inside the tubes by two slip rings. The slip rings are made by cutting two slices of 5mm width out of the tubes and from the two slices, cut off a piece of 5mm in length. This can be slipped ino the tube. The lenses are sandwiched between the rings and the rings are glued or held with screws. As shown, the aluminium strip is bent and fixed to the end plug to hold the tube. Before tightening the bolt to hold the tube, one should balance the tube properly. Approximate cost of this mount is Rs.80/.



You may project the Sun on a sheet of paper to see the sunspots. Cut a hole of diameter equal to the outer diameter of the tube, in stiff card board of 30 x 30 cm and insert the tube through it. This will block the sun light coming from outside the tube. The limb darkening effect can be demonstrated by placing a light dependent resistance [LDR] and measuring its resistance at various positions along the diameter of the Sun's image.

WARNING

Looking at the Sun directly through the telescope is injurious to the eyes.



A guide has been prepared on the following settings/observations with the 3" CSIO telsescope. Anybody interested in having this guide can contact Arvind Paranjpye, IUCAA.

1) Polar aligning a telescope. 2) Projection screen for 3" CSIO telescope. 3)Fixing reticule to eye piece. 4)Rotation period of the Sun. 5) Height of mountains on the moon. 6) Observations of variable stars - I.

ORION, THE HUNTER

Orion is one of the prominent constellations in the sky. In Greek mythology, Orion, the Hunter, was the son of Neptune and the Amazon Queen Euryale. Betelgeuse (α) [its Indian name is Kakshi] and Bellatrix (γ) make his shoulders and Rigel (β) [Indian name, Rajanya] and Saiph (κ) are his knees. The three stars Mintaka (δ), Alnilam (ε) and Alnitak (ζ) make his belt. Chain or cluster of stars to the south of the belt is the sword of the Hunter. In Indian mythology, it is Mriga, the Stag. It is very easy to understand the perception of the different figures for the same group of stars in different mythologies. From the places for which the latitude is more than 25^0N, Orion appears standing at the time of upper transit. For places closer to the equator, the constellation passes through or very close to Zenith. It is therefore seen as a horizontal figure rather than a vertical figure. The three stars of the belt of Orion are the marks of the point heads of trident thrown at it by Vyadh, the Killer. (Vyadh is the Dog Star Sirius).

In April-May, Orion can be seen on the western sky after the sunset. Betelgeuse, the brightest star in this constellation, is one of the largest stars known. This star has the largest apparent angular diameter of 0.049 sec. of arc [a 25 paise coin (with a diameter of about 1cm) subtends and angle of 1 sec. of arc at a distance of 2 km]. The surface of Betelgeuse was mapped by the technique of speckle interferometry and patches on the surface are as large as the orbit of the earth . Its radius is about 2.6×10^{11}m, which makes this star even larger than the orbit of Mars round the Sun. Distance to this star from the Earth, is about 650 light years (ly). Betelgeuse is an irregular variable star.

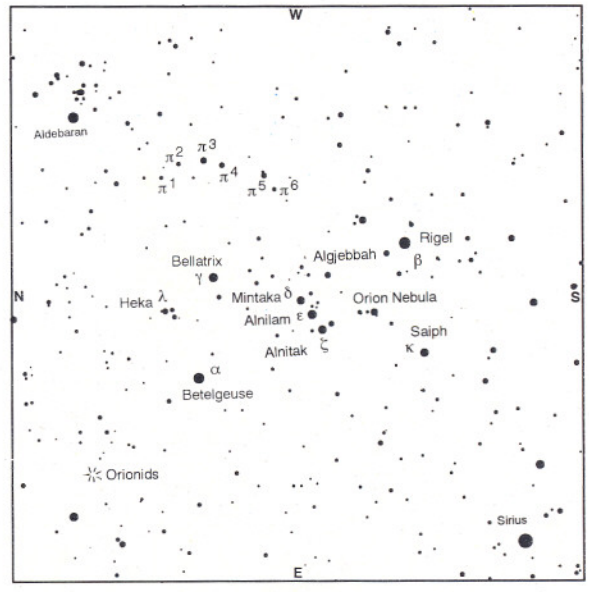
Rigel is one of the most luminous stars known. Its visual magnitude is 0.1. Absolute magnitude of this star is -7.1 and that of the Sun is 5.6, and thus Rigel is 57,000 times more luminous than the Sun.

Probably the only nebula which resembles so strikingly its name is the horse head nebula which is located at about a degree south of the star Alnitak. Horse head nebula is an absorption nebula visible to us only because it blocks light of a bright nebula behind it. It is an extremely difficult object to see. Many observers have failed to see it, even after using telescope as large as 40 " on clear sky.

The best observed nebulosity in the sky is the Great Orion Nebula. It is an wonderful sight through telescope of any aperture. Its angular size is about 85 x 60 minutes of arc, and it can be seen even by naked eye. It is about 1600 ly from us. This is an emission nebula. Its spectra show signatures mostly of hydrogen, some helium and small amounts of carbon, oxygen and nitrogen. Embedded in this nebula is a multiple star system, born out of the gas of the nebula. This system is called Trapezium. Hot stars of Trapezium give out large amount of ultra violet radiation to ionise the gas surrounding the nebula. This is hidden behind the dust cloud of the nebula.

You can try to take this simple astrophotograph of the Orion region. Load your camera with a colour slide film and expose it to Orion constellation for about 15 minutes. You will see reddish orange streak of Betelgeuse, whitish streak of Rigel and strong red streak of the Orion nebula. This red colour is due to the Hα emission from the nebula.

During the last fortnight of October, large number of meteors (about 75 per hour) can be seen coming from the direction 20^o NE of Betelgeuse. Such activity, called meteor shower, is due to the Earth's crossing of (or its proximity to) comet Halley's orbit. Meteors that we see are the debris of the comet, impinging the Earth's atmosphere at very high velocity and burning due to the friction . The peak activity of Orionid meteor shower takes place around October 24.



Preprint list

IUCAA preprints released during January 1 to March 31, 1993 are listed below. These can be obtained from the Librarian, IUCAA.

Beesham Aroonkumar, *Large Number Hypothesis and Withrow-Randall-Sciama Relation in Brans-Dicke Theory*, IUCAA-8/93; Dadhich Naresh and Patel L.K., *New Vacuum Cosmological Solutions*, IUCAA- 10/93; Das Gupta Patrick, *Magnetic Charges and Local Duality Symmetry - II*, IUCAA-4/93; Das Gupta Patrick, *Electric Charges from Spontaneous Breaking of Symmetry*, IUCAA-5/93; Das Gupta Patrick and Narlikar J.V., *Gravity Waves from Mini-Creation Events*, IUCAA-11/93; Jotania Kanti and Dhurandhar S.V., *Response of the Interferometric Antenna to the Gravitational Radiation from Pulsars*, IUCAA-9/93; Padmanabhan T., *Large Scale Structures in the Universe* , IUCAA-3/93; Padmanabhan T.,; *Path Integral for the Relativistic Particle and Harmonic Oscillators*, IUCAA-6/93; Patel L.K. and Dadhich Naresh, *Singularity Free Inhomogeneous Cosmological Stiff- Fluid Models*, IUCAA-1/93; Patel L.K. and Dadhich Naresh, *Singularity Free Inhomogeneous Models with Heat Flow*, IUCAA-2/93; V.R. Venugopal and K.S.V.S. Narasimhan, *Isolated Pairs of Spiral Galaxies - A Statistical Study of Far Infrared and Microwave characteristics.*

The Comet that Never Was

While some people are worried about Comet Swift-Tuttle's next visit, let us recall a previous occasion when the end of the world was predicted due to the arrival of a comet.

This was back in 1712 when the Rev. William Whiston forecast that a comet would arrive heralding the doomsday on Wednesday, October 14 at 5 a.m. Since the theologian had foreseen end by fire and his word carried great weight many Londoners took to the barges on the river Thames for safety. The Head of the Bank of England issued orders to all fire offices to be in a state of readiness. The Captain of a Dutch ship discharged all its powder in the river just to be on the safe side.

But more than that there was a wave of religion with the Bible and the Clergy much in demand. Many 'bachelors' married their mistresses. The stock market crashed . . . . But alas, the comet failed to appear and the world went on reverting to its sinful ways.

Source : Fireside Astronomy by Patrick Moore.

Congratulations

Hearty congratulation to Jayant V. Narlikar, Director, who has been elected fellow of the Third World Academy of Sciences.

VISITS ABROAD

G.C. Anupama attended the 2nd Haifa Conference on Cataclysmic Variables and Related Physics held at Eilat, Israel during January 11 - 14,1993, where she presented a poster on the Optical Spectrum of Nova Cygni 1992. From January 17 to February 24, 1993, she visited the Astronomisches Institut, Munster, FRG, where she collaborated with H.W. Duerbeck on their ongoing research work on novae and also gave seminars related to novae. From February 24 to 28, she visited the Landessternwarte, Heidelberg and also the Max Planck Institutes and ESO at Garching, FRG in connection with the Astronomical Data Centre at IUCAA.

S.N. Tandon visited Japan during January 11 - 22, 1993; the visit was supported principally by star-watching - programme organised by S.Isobe, Chairman of Asian Pacific Committee on Teaching of Astronomy. This star-watching-programme involved estimation of light pollution in several towns in the neighbourhood of Osaka, by the astronomers from many countries of Asian Pacific Region and the local population.

This opportunity was also used by S.N. Tandon to visit National Astronomical Observatory, Tokyo during March 19 - 22, 1993 and to get important inputs from the team working on Japanese National Large Telescope (8.2 m), on active optics and other techniques relevant for the proposed National Large Optical Telescope for India.

Farewell

We bid farewell to Jai-Chan Hwang, along with best wishes for the future. Jai-Chan Hwang was a Post-Doctoral Fellow in IUCAA.

How to communicate with IUCAA

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