KHAGOL खगोल

IUCAA

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No. 45

A Quarterly Bulletin of the
Inter-University Centre for Astronomy and Astrophysics
(An Autonomous Institution of the University Grants Commission)

January 2001

Twelfth Foundation Day Lecture of IUCAA

The twelfth Foundation Day lecture of IUCAA was delivered by the noted social activist Ms. Aruna Roy on the subject "Democracy and Right to Information". Ms. Aruna Roy is a member of Mazdoor Kisan Shakti Sangathan and is well-known for her dedicated work in rural Rajasthan for several social causes including the payment of minimum wages to the workers in the villages. This particular struggle emphasized the importance of right to information as a key to the empowerment - not only in sophisticated urban setting but also at the grass root levels in our country. She received the prestigious Magsaysay award in 2000 for her contributions.

Ms. Aruna Roy delivering the twelfth Foundation Day Lecture

In her talk Ms. Roy highlighted the importance of free availability of vital information to everyone in order to make meaningful and correct decisions which - in turn - is important for proper functioning of the participatory democracy. She explained in detail how the right to information was denied to people who were directly affected in a given situation - often in the flimsiest of grounds - thereby, depriving the people of a powerful weapon to fight back against social injustice. Ms. Roy also stressed the importance of effective legislation in this matter and why transparency and accountability can be meaningful only when the citizens can ask relevant questions and demand just answers. In her opinion, full blossoming of democracy can occur only when there is a continuous process of consultation and debate undercutting the interest of the coteries which rule. She felt that it was everybody's duty as citizens to translate such a concept into a working reality.

Welcome to ...

Tarun Souradeep, who has joined as a core faculty member. His research interests are cosmology, structure formation in the universe, cosmic microwave background, early universe and QFT in curved spacetimes.

Thierry Morel, who has joined as a post-doctoral fellow. His research interests are extragalactic astronomy, interstellar medium, variable stars and observational astronomy.

... Farewell to

Firoza Sutaria, who has joined the Department of Physics and Astronomy, The Open University, Milton Keynes, UK.

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Workshop on Automated Data Analysis in Astronomy

Participants of the workshop on Automated Data Analysis in Astronomy

A workshop on Automated Data Analysis in Astronomy was held at IUCAA during October 9-12, 2000. This was first of this kind of workshop organized in India in this field and it was attended by about 40 participants from India and abroad including representatives from USA, Germany, Russia, Argentina and Greece. Invited speakers were from these countries, institutes in India (IIA, PRL, UPSO, NCRA, BARC and IUCAA) and Indian Universities like Delhi, Osmania and Assam. The major topics included discussions/ talks on large astronomical data bases, data reduction techniques, artificial neural networks and astrophysical goals achievable from such data bases. The workshop was funded by IUCAA, ISRO, DST and CSIR. The coordinator of this workshop was Ranjan Gupta.

Workshop on Stellar Structure and Evolution

A workshop on Stellar Structure and Evolution, sponsored by IUCAA, was conducted at St. Berchmans' College, Changanacherry during October 3-6, 2000. Such workshops have been conducted by IUCAA in that region of Kerala about once every year for the past few years, and have greatly helped in spreading awareness about astronomy amongst students and teachers there. Topics covered by the workshop included solar physics, stellar photometry, stellar structure and evolution, binary stars and compact objects. The lecturers included Harish Bhatt and C. Sivaram from IIA, Bangalore, S.R. Prabhakaran Nayar from University of Kerala, Ajit Kembhavi, Yogesh Wadadekar and Arun Thampan from IUCAA and teachers from some of the surrounding colleges. The organization of the workshop was managed by O.S. Sebastian and George Varghese of St. Berchmans' College with the help of their colleagues. The coordinator from IUCAA was Ajit Kembhavi.

Colloquia

3.10.2000 Juergen Ehlers on General Relativity and its Empirical Foundations; 10.10.2000 Amitava Raychaudhuri on Neutrinos: Probing the Boundaries of Particle Physics; 23.10.2000 M.R. Das on Molecular Basis of Life and its Implications.

Workshop on Topics in General Relativity

About 20 active workers interested in field theoretic aspects of gravity got together at IUCAA for over a week (October 12-20, 2000) to discuss the current problems they were working on. The format of the workshop was very informal and helped free discussions. The topics discussed included both classical and quantum aspects.

It was started with an overview of classical GR and was followed by discussion on electrogravity duality, gravitational collapse, isolated horizons, naked singularity, Kalb-Rammond field and optical activity, 2+1 gravity, black hole entropy and entropy bounds, horizon states in AdS black holes, quantum creation of open universe, role of negative energy field in gravitational collapse and the Boomerang observations and their implications to cosmology. The informal nature of the workshop was very much appreciated by the participants and it was felt that this should continue as an yearly event. The speakers were N. Dadhich, G. Date, J. Ehlers, T. R. Govindarajan, P.S. Joshi, S. Kar, R. Kaul, P. Majumdar, S. Mukherjee, J. Narlikar and V. Sahni. The coordinator of this workshop was N. Dadhich.

Workshop on Solar Physics

A workshop on Solar Physics was organised at IUCAA during December 4 - 8, 2000. It brought together several people working on this area in India and lectures were pedagogical reviews of the respective fields of interest. There were lectures on Overview of Solar Physics, Instrumentation and Observational Techniques related to Solar Astrophysics, Solar Activity, Solar Magnetic Field, Solar Interior and Seismology, The Physics of Chromospheres and Coronae, Solar Chromosphere and Corona and Aspects of Solar Wind and the Radio Sun.

Participants of the workshop on Solar Physics

The lectures were delivered by S.M. Chitre (TIFR, Mumbai), Arvind Bhatnagar (USO, Udaipur), S.S. Hasan (IIA, Bangalore), P. Venkatakrishnan (USO, Udaipur), H.M. Antia (TIFR, Mumbai), A. Ambastha (USO, Udaipur), Peter Ulmschneider (University of Heidleberg, Germany), B.N. Dwivedi (BHU, Varanasi) and P.K. Manoharan (RAC, TIFR, Ooty). There were about 12 participants from universities besides the lecturers.

The workshop was organised by T. Padmanabhan, IUCAA in consultation with H.M. Antia, TIFR, and Arvind Bhatnagar, USO.

Introductory School on Astronomy and Astrophysics

The School of Physical Sciences (SPS), Swami Ramanand Teerth Marathwada University (SRTMU), Nanded organised an Introductory School on Astronomy and Astrophysics, sponsored by IUCAA, during November 16-20, 2000. S.N. Tandon, IUCAA, Pune and Suresh Chandra, SRTMU, Nanded were the conveners of the school. Thirty two students of graduate and post-graduate classes from various colleges in Maharashtra and Andhra Pradesh and twenty local students of the SPS participated in the school.

Lectures were delivered by J.V. Narlikar, S.N. Tandon, U.C. Joshi, V.B. Bhatia, M.L. Kurtadikar and the faculty members of the SPS, including Suresh Chandra, A.L. Choudhari, M.K. Patil and A.C. Kumbharkhane. The topics covered in the school were (i) Coordinates and tme, (ii) Photometric studies, (iii) Radio astronomy and molecules, (iv) Stellar structure and evolution, (v) Cosmology and (vi) Astronomy in India.

Besides the lectures, there were extensive programmes for night observations, with two 8" Meade telescopes. The night observations were supervised by J.V. Narlikar, S.N. Tandon, U.C. Joshi, V.B. Bhatia, Suresh Chandra, A.L. Choudhari, M.K. Patil and A.C. Kumbharkhane.

On November 17 evening, on the demand of the participants, a special question-answer session was organised, in which the questions were answered by J.V. Narlikar, S. N. Tandon, U.C. Joshi, Suresh Chandra and M.K. Patil.

IUCAA's first Donation of the new millennium

IUCAA has begun the new millennium with good news! Smt. Sunitabai Deshpande has agreed to give a donation of Rs. 25 lakhs to IUCAA for starting a "Muktangan Vidnyan Shodhika" (Muktangan Exploratorium) in the memory of Shri P.L. Deshpande. The money will be used to construct a building in the IUCAA Science Park area, to organize IUCAA's public outreach activities, especially for school children. The donation amount will be paid in 4-5 instalments. The first instalment given on January 1, 2001, is the first donation received by IUCAA in the new millennium.

Indo-French School on Star Bursts and the Structure and Evolution of Galaxies

Partcipants of the Indo-French School

An Indo-French school on Star Bursts and the Structure and Evolution of Galaxies was organized at IUCAA during December 12 - 20, 2000. The school was sponsored by the Indo-French Centre and was part of the activity to build collaborations between astronomers in the two countries. Senior scientists and research students from France and India participated in the workshop. There were a number of lectures on observational and theoretical aspects of the influence of star bursts on the formation and nature of galaxies. The school included lecture courses and seminars by senior French and Indian astronomers. There were a number of discussions and short presentations by research students. The school was successful in establishing closer contacts between astronomers from India and France. The coordinators of the school were Ajit Kembhavi from IUCAA and Bruno Guiderdoni from Institut d'Astrophysique, Paris.

HRD Workshop on Achieving Excellence

A Human Resources Development workshop on Achieving Excellence was conducted at Goa during September 30 - October 1, 2000 for the Adminstrative, and Scientific and Technical staff of IUCAA. The main objective of the workshop was to stimulate the work culture among the members to achieve excellence. Thirty members attended this workshop and eleven members gave talks on various topics, such as, Management of Centre of Excellence, Time Management, Accounts, How to Have Peace Always?, Managing Stress, Effective Purchase System, Personality Development, Income Tax and Investment Opportunities, How to Save Electricity?, 2.0 m. Telescope Project at Giravali, and Information Services in a Networked Environment in India. After each talk, enough time was alotted for discussions. Some of the members expressed the difficulties they face in their work. Everyone felt that the workshop was really beneficial to know about each other and their work and it was encouraging. V. Chellathurai and Rajesh Parmar were the coordinators of this workshop.

Seminars

4.10.2000 J. Maharana on Holography and String Cosmology; 20.10.2000 Nagesha N. Rao on Waves in Dusty Plasmas and the Concept of Fugacity ; 10.11.2000 K. N. Iyer on Radio Astronomical Studies Using IPS Array at Rajkot; 22.11.2000 Kaushik Bhattacharya on Particle Interactions in Magentic Fields; 30.11.2000 Sudip Bhattacharyya on General Relativistic Spectrum from Accretion Disk around Neutron Star; 6.12.2000 Ranjeev Misra on Timing Properties of X-Ray Binaries; 13.12.2000 G. Date on Isolated Horizons; 14.12.2000 Pankaj Jain on Neutrino-Induced Giant Air Showers in Large Extra Dimension Models; 18.12.2000 D.V. Ahluwalia on Spin One: Beyond the Textbook Wisdom.

Supernovae - Observation and Theory

1 Introduction

Supernovae are stellar explosions on the energy scale of $\simeq 10^{51}$ ergs of kinetic and electromagnetic energy, which occur at the end stages of stellar evolution. Depending on the Main Sequence mass of the star, it may result in the disruption of the entire star (for stars of mass $4 \lesssim M/M_\odot \lesssim 8$), or in the disruption of the outer layers of the star, leaving behind a dense remnant in the form of a neutron star (Main Sequence mass between 8 and $20 M_\odot$) or possibly even a black hole (for $M \gtrsim 20$ to 25 $M_\odot$). Only $\simeq 1\%$ of the explosion energy is emitted in the electromagnetic band, while the rest is carried away as kinetic energy of neutrinos emitted immediately before, during and after the explosion. However, because of the low interaction cross-section of neutrinos with matter ($\sim 10^{-44}$cm^2), the neutrino flux has been detected only in nearby supernova like SN1987A [7].

2 Observational Classification of Supernova.

Observationally, supernovae are classified into two main types (type I and II), depending on the presence or absence of hydrogen lines in the maximum light optical spectra of the supernovae. The type I supernovae are further subdivided into type Ia, type Ib and type Ic. The early spectrum of type Ia supernovae contains Si absorption features at $\lambda = 6150$ Å, while that of type Ib displays He features but no Si features. The spectra of type Ic has very weak or almost no He features and no 6150 Å features. Usually, the late time spectra often shows the same characteristics that are visible in the early spectra. However, there are often additional features visible in the supernova spectra $\simeq 6$ months after the explosion. Late time ($\simeq 6$ months) spectra of type Ia show Fe and Co emission features but no O lines, while the late time spectra of types Ib and Ic show O and Ca features in absorption with almost no evidence for Fe features. In the UV region, both type Ia and Ib show UV deficit, but have otherwise similar characteristics. Photometrically, the bolometric light curve of type Ib Supernovae is similar to that of type Ia but is fainter by 1-1.5 magnitudes. Examples of types Ia, Ib and Ic are SN1981B, SN1984L and SN1983V (see [6] and references therein). The ultrabright type Ic supernova SN1998bw, is quite unusual that it has been associated with a gamma ray burst GRB 980425 [3]. The type II supernovae are subdivided into classes type II-L and type II-P, depending on whether the bolometric light curve (or equivalently, the time evolution of the magnitude) falls off almost linearly in time (type II-L) or stays at a plateau for a period of few weeks before falling off. The optical spectra of type II-L and type II-P are similar, though type II-P spectra at maximum light show Hα emission features (common to both types) with some blue-shifted P Cygni absorption component. The maximum light UV spectra of both type II-P and type II-L are mainly Planckian with UV excess. Typical examples of type II-L are SN1979C, and SN1980K; an example of type II-P is SN1986I. It must be noted that these classifications are very broad and that anomolous examples are known to exist in all types.

3 Theoretical mechanisms for Supernovae

Theoretically, supernovae are classified according to the explosion mechanism. Type Ia Supernovae are attributed to explosive phenomenon in accreting white dwarfs in binary systems or to white dwarf mergers. Briefly, the explosion scenario leading to type Ia SN runs as follows [13]:

Stars of initial main sequence mass between 5 to 8 $M_\odot$ develop a C-He white dwarf cores with masses below the Chandrasekhar Mass, M_{Ch}, which are strongly or moderately degenerate (the electron Fermi-energy $E_F \gg kT$). These cores ultimately ignite by thermonuclear reaction involving Carbon. The Fermi energy of electrons at this stage is much higher than the thermal energy kT for degeneracy to be lifted by the energy released by the Carbon-burning reactions. This leads to a thermonuclear runway, which is believed to cause the supernova explosion. The explosion drives all of the white dwarf matter into the ISM, leaving behind no compact remnant – type Ia SNe are useful as standard candles in cosmology.

Stars having masses greater than $\simeq 8$ $M_\odot$ burn Carbon under non-degenerate conditions resulting in the formation of a O-Ne-Mg core. The stellar structure at this stage consists of a Hydrogen envelope surrounding a convective Helium shell (which may still be burning, albeit at a slower rate, the He fuel) surrounding a region where the "Carbon" fuel (essentially a mixture of ^{12}C and ^{16}O with traces of neutron rich nuclei like ^{21}Ne, ^{22}Ne, ^{25}Mg, ^{26}Mg) is "burnt" mainly by nuclear reactions like $^{12}C(^{12}C,\alpha)^{20}Ne$ and $^{12}C(^{12}C,p)^{23}Na$ [1]. Once the energy generation by nuclear reactions in the Carbon core becomes insufficient to support the star against gravity, the core contracts on Kelvin-Helmholtz time-scale until the central regions become sufficiently hot to ignite the O, Ne, etc. - residues of the Carbon burning stage. This cycle of Kelvin-Helmholtz contraction, heating up of the core to the point of igniting the next available nuclear fuel persists until the core abundance is dominated by nuclei which would undergo endothermic rather than exothermic nuclear fusion reactions. At this stage of stellar evolution, which corresponds to the end of Si-burning stage, the core density is $\sim 10^9$g/cm^3, and the temperature $\simeq 10^{10}$ K and the core radius is $\simeq 4\times10^3$km. The stellar structure can be described in terms of the "onion-skin" model of a massive star: The outer most layer of unburnt Hydrogen envelope, a Helium shell, a C-O shell, Ne-Mg shell, and finally a Si-burning core. The ashes of Si-burning consist primarily of neutron-rich Fe-group nuclei, having mass numbers in the region $A \simeq 60$. Since the core is no longer able to generate energy by means of nuclear fusion reactions, the star is supported against gravitational collapse by the Fermi pressure of the degenerate electrons present in the core. The core is thus a "white-dwarf" whose composition is dominated by "Fe-peak" elements. The Fermi energy of the electrons at this stage is $\sim$ 4MeV, which is large enough to allow heavy nuclei electron-capture transitions. Thus, the main energy loss at this stage is from the ν_e released from the electron-capture reactions taking place on the neutron rich nuclei present in the core, though photo-dissociation of heavy nuclei also facilitates the energy loss from the core. The electron capture reactions reduce the electron fraction Y_e (= electron density/baryon density) in the core. This means that the maximum core mass that can be supported against gravitational collapse, i.e., the Chandrasekhar mass of the core ($M_{Ch} = 5.6M_\odot(Y_e)^2$) decreases, leading to core collapse. The core continues to collapse; the contracting core has higher temperature, and a higher e$^-$-density, leading to higher Fermi energies, and an increased neutronisation rate. The homologously collapsing core continues its subsonic progress to higher densities until stellar matter is compressed beyond nuclear density (2.4×10^{14}gm/cm^3) at which point the collapse halts due to near incompressibility of nuclear matter and the core rebounds. Meanwhile, the matter overlying the core which was collapsing supersonically continues to fall on the rebounding core. A shock-wave forms at the boundary of the core as sound waves travel from the inner part of the core to the edge of the homologously collapsing core. The mechanism by which this shock wave propagates outwards and causes the disruption of the outer layers of the star is still under dispute. A sufficiently strong shock would be able to sustain the energy losses caused by photo dissociation of infalling matter and propagate to the surface. However, all numerical simulations to date find that this "prompt" shock stalls into an accretion shock at about a few hundred km, or $M \simeq 1.3M_\odot$. It has been suggested that the shock can be revived on time scales of 0.1 to 1 s by energy deposition from neutrinos which stream out from the newly formed neutron star (of radius $\sim$ 10 km) [2], [12].

Magnetohydrodynamical simulations which study the continued evolution of such "failed" core-collapse supernovae in massive stars with MS mass $M \simeq 35M_\odot$, where the iron core collapses directly to form a black hole suggests that these "collapsars" may be likely precursors for Gamma Ray Bursts [11].

The core collapse mechanism of supernovae has been used to explain type II events. Types Ib and Ic events are also most likely to be core-collapse events in stars which have lost most of their hydrogen envelope, perhaps through Roche lobe overflow to a binary companion.

4 Neutrino Emission From Supernovae

The ultimate source of the energy that is liberated in a core-collapse Supernova explosion is the gravitational binding energy of the collapsing core as it evolves from a "Fe"-composition "white dwarf" to a neutron star of radius 10 km and can be estimated as follows:

$$E_G = 3 \times 10^{53} \frac{(M_{\rm core}/M_\odot)^2}{(R/10 \text{ km})} \text{ ergs.}$$

From this, it is evident that observed energy released in the electromagnetic channel and the kinetic energy of the explosion (of the order of 10^{51} ergs) is only about 1% of the total available energy. Gravitational radiation can account for at most another 1% energy loss [8]. The rest of the energy released is carried away by neutrinos which are released during various phases of the explosion. The neutrino emission processes from a supernova are intimately related to the explosion mechanism and take place during the pre-supernova, collapse and post bounce stages.

The pre-supernova and core-collapse neutrinos are emitted mainly by electron captures on the neutron rich, mid-Fp shell nuclei which make most of the core abundance. As has been discussed in sec. 3, the Fermi energies ($\epsilon_F = 11.1(Y_e\rho/10^{10}\text{gcm}^{-3})^{1/3}$ MeV) at the end of the Si-burning stage are sufficiently high to cross the e^--capture thresholds for the heavy nuclei, which dominate the nuclear core configuration. Rapid neutronisation ensues, and the total energy that can be lost from the core in the form of neutrino at this stage (upto a density of 10^{12} g/cm^3 when neutrino interaction with matter becomes significant and the neutrinos are trapped) is $\simeq 10^{51}$ergs, which is relatively low as compared to the total energy carried off by the neutrinos in the explosion and post bounce phase. However, these pretrapping neutrinos have a special significance, because they escape from the overlying stellar matter without much interaction. Since the neutrino energy and the energy spectrum depend on the physical conditions (ϵ_F, Y_e, ρ, T, etc.) and on the nuclear configuration of the core (the nuclear abundances, the nuclear chemical potentials, the weak interaction rates, etc.) prevailing in the presupernova core, their detection and spectroscopy would yield important data relevant to the physics of the core.

The e^--capture neutrinos stream freely out of the star without any further interactions with the overlying matter until the neutrino optical depth is close to unity. At about 2×10^{11}g/cm^3 neutrinos start to interact with matter [5] by neutral current (n.c.) scattering off free nucleons and by coherent n.c. scattering off nuclei which dominate the neutrino-matter interactions [9], and the neutrino mean free path under these circumstances is given by:

$$\lambda_\nu = (1.0\times10^8\text{cm})\rho_{10}^{-1}(X_n + \frac{1}{12}X_h\overline{A})^{-1}\left(\frac{E_\nu}{10MeV}\right)^{-2} \quad (1)$$

where ρ_{10} is the density in 10^{10}g/cm^3 and E_ν is the neutrino energy. In deriving this equation the stellar nuclear configuration, which is an ensemble of heavy nuclei with a wide range of mass numbers around $A = 60$ and free nucleons is approximated by a single heavy nuclear species of mass number $\overline{A}$ and mass fraction X_h, immersed in a sea of free neutrons of mass fraction X_n and free protons of mass-fraction X_p. Since $X_p/X_n \sim 0.001$ at the trapping density, i.e., it is almost negligible, the scattering off free protons is not taken into account in eq. (1). The primary means by which neutrinos change their energy is by scattering with electrons. When the neutrinos have an overall optical depth greater than unity, scattering causes neutrinos to diffuse out of the core slowly, and the core surface at the "trapping radius" (for a given E_ν) can be treated as a radiating surface for ν_e of an approximately thermal spectrum. This concept of the neutrinosphere is analogous to that of the photosphere and for ν_e, which dominate the pre-supernova emission, it lies in the zone corresponding to a density of 5×10^{11} g/cm^3 [10].

While ν_e is the the main flavour of neutrinos emitted, at higher densities (near 10^{13}g/cm^3) the ν_μ and ν_τ (and $\overline{\nu}_\mu$, $\overline{\nu}_\tau$) production also takes place, leading to neutrino photospheres for each flavour, progressively closer to the center of the star.

The next phase of neutrino emission occurs for a period of few ms after the core rebounds and the shock propagates outwards. As has been noted in sec. 3, the collapsing "Fe" core consists of a subsonic and a supersonic infall region when collapsing; the subsonic part of the core reaches nuclear densities and rebounds, while the shock wave is generated at the boundary of the supersonic and subsonic infall zones soon after the bounce of the central part of the core. As the shock which is formed on the homologous core boundary propagates through the mantle, it reaches the neutrinosphere for ν_e mentioned earlier (which has a radius of $\sim$ 50 to 80 km and density $10^{11} < \rho < 10^{12}$g/cm^3), and causes a rapid burst of neutrinos, which together with the infall neutrinos is usually called the "prompt burst", lasting for $\sim$ 10ms. The neutrinos which are emitted in this phase are mainly ν_e and the total energy radiated, is upto 3×10^{51}ergs.

The core and the mantle together are the progenitors of the proto neutron star. The prompt burst is followed by neutrino emission from the cooling protoneutron star [4]. The propagation of shock through the mantle affects the matter in two ways: 1) it causes a rapid neutronisation of the matter, leading to energy loss through neutrino loss, and hence to collapse of the mantle to form the hot neutron star. The phase lasts for 500 ms to 1 s, and the energy released is $> 10^{53}$ergs. 2) While the emission is initially dominated by ν_e, the shock propagation and the mantle collapse causes heating up of matter so that $\overline{\nu}_e$, ν_μ and ν_τ are also generated by plasmon neutrino emission, thermal pair production and neutrino pair bremsstrahlung processes. Since the main source of neutrino opacity for ν_μ and ν_τ is by neutral current scattering, the neutrinosphere for these species lies deeper within the core at temperatures of $7 < T < 8$MeV. However, as the neutron star cools, diffusion from the innermost regions occurs to supplement the neutrino loss. The final stages of the supernova explosion are dominated by the emission ν_μ and ν_τ by the cooling neutron star and this cooling period can last for seconds.

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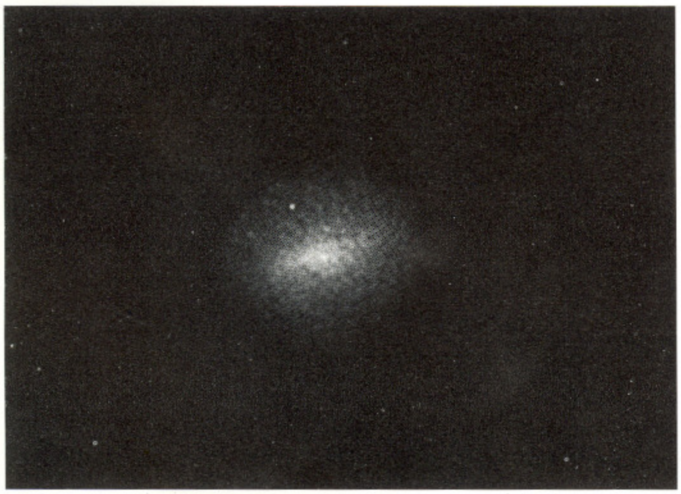
Observatory in memory of late Professor N.C. Rana of IUCAA

Night photograph of the exterior of the N.C. Rana Memorial Observatory located at the MGM Engineering College, Nanded. The lights of Gurudwara Sachkhandsahib are seen in the background.

Andromeda



Andromeda - taken with 14" IUCAA -Bhavnagar Automated Photoelectric Telescope (APT) by Umesh Dodia, (Exposure time 150 sec) at Cassegrain focus using SBIG ST4 CCD Camera. Raw image was processed using Paint Shop Pro to yield this photo.

Refresher Course in Astronomy and Astrophysics (May 14 - June 15, 2001)

IUCAA will conduct a Refresher Course in Astronomy and Astrophysics for teachers in universities and colleges. The topics will include observational and theoretical aspects of astronomy. In addition to lectures, the course will emphasize problem solving sessions and experiments; approximately two hours a day will be devoted to one of these two activities.

The number of participants for the course will be about 20. Interested persons should apply in plain paper, giving their curriculum vitae, and their experience of teaching and research in astronomy over the last five years. Applications should be forwarded through the Head of the Department, or Principal of the College/Institution, so as to reach **The Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, by February 28, 2001. The candidates will be informed of their selection for the course by March 14, 2001.

Observing with IUCAA Telescope

A workshop on "Observing with IUCAA telescope" was held in IUCAA during December 21-23, 2000. The main purpose of this workshop was to (1) discuss various observing programmes to be undertaken with IUCAA telescope, (2) introduce the details of Telescope/site/first light instrument/software for observing, etc., to the potential users from the university sector, (3) review the potential research problems that could be addressed with a 2m class telescope and (4) to plan for the next set of instruments. The workshop was attended by 30 participants from universities, research institutes and IUCAA. Visit to the instrumentation lab and IUCAA telescope site at Girawali were arranged as a part of this workshop.

Vacation Students' Programme 2001

IUCAA invites applications for the eleventh 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. 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 2001- 2002 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, 2001. The selected candidates will be informed by April 15, 2001 for the programme to be held during May 21 - July 6, 2001.

Community Health Care

Abhay Bang of Shodh Gram, Gadchiroli, gave an extra-mural talk on Community Health Care on October 4, 2000. The doctor couple Abhay and Rani have been engaged through their organization, SEARCH, in devising a model of community health for rural and tribal people of the Gadchiroli district of Maharashtra. Abhay told the fascinating story of their wonderful endeavour of over dozen years. It was a stimulating example of a couple and their organization carrying out immaculate and useful scientific research in the remote interior tribal region.

IUCAA Preprints

Listed below are the IUCAA preprints brought out during July-September 2000. These can be obtained from the Librarian, IUCAA (email: library@iucaa.ernet.in).

Archana Pai, Sanjeev Dhurandhar and Sukanta Bose, *A Data-analysis Strategy for Detecting Gravitational-wave Signals from Inspiraling Compact Binaries with a Network of Laser-interferometric Detector*, IUCAA-33/2000; Naresh Dadhich, *Negative Energy Condition and Black Hole on the Brane*, IUCAA-34/2000; Patrick Petitjean, R. Srianand and Cedric Ledoux *H_2 molecules and the Nature of Damped Lyman-α Systems*, IUCAA-35/2000; B.F. Roukema, *Observational Approaches to the Topology of the Universe*, IUCAA-36/2000; Janusz Gil and Dipanjan Mitra, *Vacuum Gaps in Pulsars and PSR J2144-3933*, IUCAA-37/2000; T. Padmanabhan and Shiv K. Sethi, *Constraints on Ω_B, Ω_M and h from MAXIMA and BOOMERANG*, IUCAA-38/2000; Varun Sahni, *Living with Lambda*, IUCAA-39/2000; Tapas K. Das, *Thermally Driven Outflows from Pair-plasma Pressure-mediated Shock Surfaces around Schwarzschild Black holes*, IUCAA-40/2000; Tapas K. Das, *On the Formation of Accretion-powered Galactic and Extra-galactic Jets*, IUCAA-41/2000; Tapas K. Das, *A Simultaneous Solution Scheme for Coupled Transonic Accretion-Wind Systems*, IUCAA-42/2000; S. Colombi, D. Pogosyan and T. Souradeep, *Tree Structure of the Percolating Universe*, IUCAA-43/2000; T. Padmanabhan and S. Shankaranarayanan, *Vanishing of Cosmological Constant in Nonfactorizable Geometry*, IUCAA-44/2000; Sanjeev V. Dhurandhar and Alberto Vecchio, *Searching for Continuous Gravitational Wave Sources in Binary Systems*, IUCAA-45/2000; Varun Sahni and Limin Wang, *A New Cosmological Model of Quintessence and Dark Matter*, IUCAA-46/2000; Naresh Dadhich and Narayan Banerjee, *Global Monopoles and Scalar Fields as the Electrogravity Dual of Schwarzschild Spacetime*, IUCAA-47/2000; S. G. Ghosh and Naresh Dadhich, *On Naked Singularities in Higher Dimensional Vaidya Spacetimes*, IUCAA-48/2000; D.K. Chakraborty and Parijat Thakur, *Projected Properties of Triaxial Modified Hubble Mass Models*, IUCAA-49/2000; R. Srianand, P. Petitjean and C. Ledoux, *The Cosmic Microwave Background Temperature at a Redshift of 2.33771*, IUCAA-50/2000; N. Dadhich and G. Date, *On a Peculiar Family of Static, Axisymmetric, Vacuum Solutions of the Einstein Equations*, IUCAA-51/2000; B.F. Roukema and G.A. Mamon, *Lifting Cosmic Degeneracy within a Single Quasar Survey*, IUCAA-52/2000; T. Roy Choudhury, R. Srianand and T. Padmanabhan, *Semi Analytic Approach to Understanding the Distribution of Neutral Hydrogen in the Universe: Comparison of Simulations with Observations*, IUCAA-53/2000.

Library Seminar

An one day seminar on The Information Age: Challenges and Opportunities for the Library Profession was organized at IUCAA on Tuesday, December 26, 2000. The seminar was inaugurated by J.V. Narlikar (IUCAA) and the concluding remarks were made by T. Sahay (IUCAA). The various topics covered were as follows: Library profession in the new millennium: Meeting the challenge (Maya Avasia, TTFR, Mumbai); Impact of the INTERNET on the organization and the services of Library and Information Centres (A. C. Tikekar, Mumbai); Impact of information technology and the changing roles of the library professions in the world of information in India (S. N. Singh, NIV, Pune); Future role of the IUCAA Library in web-based astronomy education (T. Padmanabhan, IUCAA); Libraries for the Universities: Help from the INTERNET (A. K. Kembhavi, IUCAA); Need for continuing professional / technology related education (M. B. Konnur, Pune). Around 50 librarians attended the seminar. The coordinator of this seminar was Nirupama Bawdekar.

A workshop on Celestial Mechanics and Dynamical Systems

A workshop on Celestial Mechanics and Dynamical Systems will be held at IUCAA, during October 8 - 10, 2001. The workshop will deal with various aspects of Celestial Mechanics and its applications. Further, the new ideas as developed in the area of nonlinear dynamical systems theory and its applications in the area of Celestial Mechanics will also be discussed. The workshop is specifically aimed for University and College teachers and also research students aiming to work/enter into some of the current problems in the area of Celestial Mechanics and Dynamical Systems theory. Resource persons will be drawn from existing workers from the country and abroad. Interested persons may contact L.M. Saha, Department of Mathematics, Zakir Hussain College, (University of Delhi), Jawaharlal Nehru Marg, New Delhi - 110 002; email: lms@ttdsvc.ernet.in, before February 28, 2001. Please note that the participation in the workshop is by invitation only.

Visitors

(October - December 2000)

J. Ehlers, R. Reddy, B.C. Paul, M. Sami, S. Mukherjee, A. Goyal, K.S. Sastry, S.N. Hasan, L. Prasad, G. Date, T.R. Govindarajan, A.C. Borah, A. Raychaudhuri, H.S. Das, V.O. Thomas, S. Chandra, A. Bhanumathi, A.K. Banerjee, A. Bhatnagar, R.P. Bambah, R.P. Gangurde, D.C. Reddy, N. Mukunda, M.R. Das, S. Barway, M.L. Kurtadikar, H.K. Jassal, A. Mahabal, S.N. Paul, K.K. Ghosh, L.K. Jha, N.N. Rao, S.N. Borah, K.N. Iyer, N.C. Wickramasinghe, N.R. Rao, K. Bhattacharya, J. Singh, A.C. Kumbharkhane, M.K. Patil, S.G. Ghosh, R. Dutta, R. Ramachandran, P.K. Suresh, D.B. Vaidya, C.D. Ravikumar, C.L. Gupta, T. Mukai, S. Bhattacharya, P. Joshi, R. Misra, A. Bawa, A.K. Sen, D.V. Ahluwalia, A. Toporensky, J. Anandan, M.M. Verma, and Aruna Roy.

Apart from the above, about 130 people visited IUCAA to attend the various workshops during the above period.

Visitors Expected

January 2001

S.K. Banerjee, Mody College of Engg. & Technology; Sisir Bhanja, Calcutta; J. Bagla, Mehta Research Institute; M. Boruah, Gauhati University, F. Ahmed, M.S. Khan, Naseer Iqbal Bhat, University of Kashmir; J. Rankin, University of Vermont; B. Varghese, M. Cherian, Mar Thoma College; M. Nair, J. Jose, S. John, St. Aloysius College; G. Burbidge, Centre for Astrophysics & Space Sciences, USA and H. Arp, Max Planck Institute, J. Einasto, Tartu Observatory, Estonia.

February 2001

F. Bouchet, Institut d'Astrophysique and J. Anosova, University of Texas at Austin, USA.

From the falling apple to the falling workman

The story of Newton and the falling apple roused Gauss' indignation. "Silly!" he exclaimed. "Believe the story if you like, but the truth of the matter is this. A stupid, officious man asked Newton how he discovered the law of gravitation. Seeing that he had to deal with a child in intellect, and wanting to get rid of the bore, Newton answered that an apple fell and hit him on the nose. The man went away fully satisfied and completely enlightened."

The apple story has its echo in our own times. When teased as to what led him to his theory of the gravitational field, Einstein replied that he asked a workman who had fallen off a building, to land unhurt on a pile of straw, whether he noticed the tug of the "force" of gravity on the way down. On being told that no force had tugged, Einstein immediately saw that "gravitation" in a sufficiently small region of space-time can be replaced by an acceleration of the observer's (the falling workman's) reference system. This story is as silly. What gave Einstein his idea was the hard labour he expended for several years mastering the tensor calculus of two Italian mathematicians, Ricci and Levi-Civita, themselves disciples of Riemann and Christoffel, both of whom in their turn had been inspired by the geometrical work of Gauss.

From : *The Men of Mathematics by Eric Temple Bell*

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

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