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IUCAA
ISSN 0972-7647

No. 58 / April 2004

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

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Welcome to...

Professor Donald Lynden-Bell, Institute of Astronomy, University of Cambridge, United Kingdom, has accepted the invitation to be an Honorary Fellow of IUCAA from February 20, 2004.

Professor Russell Cannon, Anglo-Australian Observatory, Australia, has joined the IUCAA faculty as a distinguished Visiting Honorary Professor.

Geetanjali Sarkar, who has joined as Post-doctoral Fellow. Her research interests are Observational Stellar Astronomy and AGB and Post-AGB Stars.

Congratulations

... to **Ujjaini Alam**, on receiving the Late Debleena Choudhury Award of Indian Physics Association, Pune Chapter, for best oral presentation by a Research Scholar.

... to **J.V. Narlikar**, the Emeritus Professor of IUCAA, on being the recipient of the prestigious ***Padmavibhushan Award*** by the President of India *and*

on being awarded The **Rammohan Puraskar 2004** by the Ram Mohan Mission, Kolkata.

National Science Day at IUCAA

The National Science Day was celebrated at IUCAA on February 28-29, 2004. On Saturday, 28, various competitions were held for the high school students. In the evening, night sky viewing through telescopes was arranged for the general public. On Sunday, February 29, the Centre was open to the general public with special displays, experiments and demonstrations, set up by the members of IUCAA.

Inter-School Competitions

The National Science Day 2004 celebrations started with essay, drawing and quiz competitions for the high school students. Schools were invited to send a team of five students to participate in the competitions. Eighty five schools participated in the competitions. One student from each school was asked to write an essay on one of the topics specified by a panel. The drawing competition was held in a similar manner. Like every year, the quiz contest was the key attraction during the school programme on the Science Day. A team of three students from each school participated in the qualifying round of the quiz competition. The first five qualifying teams were invited on the stage for the final quiz contest. The quiz had questions from different science fields with more emphasis on Physics and Astronomy.

Programmes for the general public:

The Open House for Public: In the afternoon of February 29, 2004, the enthusiasts and amateurs crowded in the Bhaskara lobby of IUCAA to view the poster display by the

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academic members of IUCAA. The posters elaborated on the research work at IUCAA and topics in the field of astronomy such as cosmology, evolution of stars etc. The students were happy to get their doubts and ideas regarding career prospects cleared at the career guidance cell. Students keenly interested in getting into the field of Astronomy as a career, attended the lectures and question-answer session by Ajit Kembhavi on this topic. In addition, there were lectures by A. N. Ramaprakash (*Large Astronomical Telescopes*), Tarun Souradeep (*Music of the Cosmic Drum*) and T. Padmanabhan (*Nobel Prize in Physics 2003*).

The library staff made a poster on the statues in the kund area and also on the work done by those eminent physicists-mathematicians. Dilip Sathe from Dadawala Jr. College, Pune, explained the Foucault's pendulum to the public. The demonstration of working of radio telescope, the spectrum of light and the Schlieren effect in optics, posters on virtual observatory, viewing of scientific video films and demonstration of do-it-yourself toys added flavour to the celebrations.

Visit to the Science Park : Visitors enjoyed the interactive outdoor exhibits in the IUCAA Science Park. Volunteering by students from Jnana Prabodhini Prashala to explain the exhibits, enabled the visitors to understand the scientific principle behind the exhibits.

Night Sky Show : Like every year, the night sky viewing session on February 28, 2004 seemed to be popular among the public. Around twelve hundred people enjoyed viewing through the telescope. People viewed Jupiter, Moon and Orion Nebula through the six inch Newtonian reflectors made by amateurs in the Public Outreach Programme laboratory of IUCAA. Viewing of Saturn through IUCAA's 14 inch telescope was also arranged. The members of SWAP and Akashmitra, the amateur astronomers' associations in Pune volunteered to arrange the sky show.

A great deal of planning and administration was necessary for the smooth execution of the celebrations of the National Science Day. The successful organization of these events was possible because of the active participation by all the members of IUCAA.

National Science Day Inter School Competitions

Essay Competition

English medium:

First Prize:	Ameya Ambardekar (Abhinav Vidyalaya, English Medium)
Second Prize:	Yash Deshpande (Vikhe Patil Memorial School)
Honourable Mention:	Srishti Mukherji (Kendriya Vidyalaya, Southern Command)

Marathi medium:

First Prize:	Janavi Jagadale (H.H.C.P. Hujurpaga High School)
Second Prize:	Shruti Hajirnis (Ahilyadevi High School for Girls)
Honourable Mention:	Ashish Kamalapurkar (Jnana Prabodhini Navnagar, Nigdi)

Drawing Competition

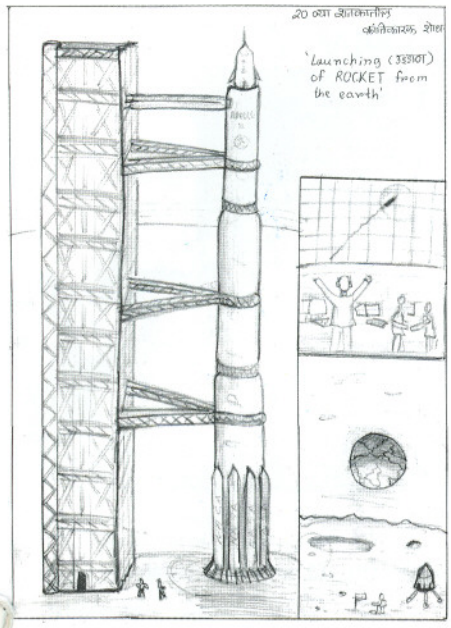
Second Prize:	Sourabh Laghate (Sou. Vimalabai Garaware High School) and jointly Amruta Garud (Abhinav Vidyalaya, Marathi Medium)
Third Prize:	Gayatri Sunandan Laghate (H.H.C.P. Hujurpaga High School) and jointly with Ashish Dilip Nade (Vidya Bhavan High School) and Sucheta Patil (The Army Public School)

Quiz Competition

First Prize:	Jnana Prabodhini Navanagar, Nigdi (Abhishek Dang, Aniket Inamdar, Kedar Sanjay Jumde)
Second Prize:	D.E.S. School (Sarang Kulkarni, Pushkar Pandit, Akshay Navgire)
Third Prize:	Vikhe Patil Memorial School (Hamsa Padmanabhan, Chaitanya Joshi, Nikhil Yelamanchili)

The N.C. Rana Memorial Trophy for the best all-rounder performance in the Inter-School Competitions went to Jnana Prabodhini Navanagar, Nigdi.

Prize-winning drawings of this year



Sourabh Laghate

Amruta Garud

The various themes for the drawing competition were: i) *The most remarkable scientific invention or discovery of 20th century;* ii) *Suppose mankind had evolved and lived in water;* iii) *Closer view of the night sky.*

Workshop on Introductory Astrophysics

A workshop on Introductory Astrophysics was held at the Physics Department, Utkal University, Bhubaneswar during January 26-29, 2004. It was the first workshop sponsored by IUCAA in the state of Orissa. The speakers and the topics of their talks were as follows:

Partcipants of the Workshop on Introductory Astrophysics

R. Nityananda (NCRA) on (i) *Cosmic Radio Telescopes* and (ii) *Giant Radio Telescopes*; A.K. Kembhavi (IUCAA) on *Binary Stars* (3 lectures); B.Paul (TIFR) on (i) *X-ray Universe* and (ii) *High Energy Astrophysics with Astrosat*; R. Srianand (IUCAA) on *Quasars*; R. Misra (IUCAA) on *Observational Evidence for Black Holes*; P. Subramanian (IUCAA) on *Solar Corona/flares and Solar Coronal Mass Ejections*; S. Bharadwaj (IIT/KGP) on *The Expanding Universe*; Sushan Konar (IIT/KGP) on *Astrophysical Compact Objects – A Physicists' Understanding*.

The workshop was attended by 60 postgraduate students, 6 research scholars and faculty members of the department and 30 other participants (8 teachers and 22 postgraduate students) from other colleges and universities of Orissa. The talks generated a lot of interest among the participants, who actively and enthusiastically took part in the discussions. The workshop was a great success considering the participants response and fulfilled IUCAA's aim of spreading Astronomy and Astrophysics among the University community. In addition A. K. Kembhavi also gave an evening popular talk on "*Black Holes: From Newton to Einstein*" in the auditorium of the Institute of Physics, which was attended by about 300 persons, including school/college students. The coordinators were Ranjeev Misra from IUCAA and Pushpa Khare from Utkal University.

Workshop on Galaxies: Structure & Dynamics

Workshop on Galaxies: Structure & Dynamics, a four-day workshop was organised at the Department of Astronomy, Osmania University, Hyderabad, during January 19 - 22, 2004. The coordinators were Ajit Kembhavi, S.K. Pandey and S.N. Hasan. Topics included, surface photometry in the optical bands, galaxy morphology, stellar and galaxy luminosity functions, interstellar medium, dynamics of galaxy interactions, collisions and mergers, N-body simulations and unification schemes based on radio observations. The speakers included Jayaram Chengalur (NCRA), Ajit Kembhavi and A.N. Ramaprakash (IUCAA), S.K. Pandey and D.K. Chakraborthy (Pt. Ravi Shankar Shukla University, Raipur), Somnath Bharadwaj (IIT, Kharagpur), P.M.S. Namboodiri (IIA), B.B. Sanwal (USO), Ashok Singal (PRL), K.S. Sastry, S.M. Alladin, G.M. Ballabh and S.N. Hasan (Osmania University). Evening sessions with practical demonstrations of techniques of surface photometry were also organised. The participants included 23 outstation researchers, as well as about 40 M.Sc. students of the department studying Astronomy and Astrophysics.

Participants of the Workshop on Galaxies: Structure and Dynamics

AKR Gravity Seminar II

On the dais are Romesh Kaul, J. Maharana, A.K. Raychaudhuri, Naresh Dadhich and Bhanu Das

The AKR Gravity Seminar series was started last year in honour of Professor A.K. Raychaudhuri for exposing the undergraduate students of the Kolkata colleges to the exciting frontiers of physics and astrophysics. The first seminar was held in the Presidency College, where Professor Raychaudhuri had taught and inspired several students who grew up to become leaders in their fields.The second seminar was held at St. Xavier's College on March 8, 2004 in which J. Maharana, Romesh Kaul, Bhanu Das and Naresh Dadhich gave lectures and it was attended by over 200 enthusiastic undergraduate students.

Workshop on Front-end Controls and Data Archival for Indian Telescopes

Participants of the Workshop on Front-end Controls and Data Archival for Indian Telescopes

A two-day workshop on Front-end Controls and Data archival for Indian Telescopes was held at IUCAA during January 29-30, 2004 with the purpose to bring together representatives of Indian optical and radio observatories for discussion on their currently used facilities, control systems, software/hardware issues, etc. Presentations were made by S.N. Tandon, A.K. Kembhavi, Ranjan Gupta, Sunu Engineer and Mahesh Burse from IUCAA on topics covering overview of the subject, virtual observatory, IUCAA telescope and its controls and data archival, etc. The other national observatories represented were: IIA Vainu Bappu Observatory by P. Anbazhagan; UPSO Telescope by B.B. Sanwal and P. Pant; PRL Telescope at GIRT by N.S. Jog; Osmania Observatory by P. Vivekanada Rao; RRI Radio Telescope at Mauritius by V.N. Pandey and GMRT by A. Adoni. The workshop concluded with a session on the action plans to be taken for bringing all the above observatories to a common platform, which can be easily upgraded in the future.

I. INTRODUCTION

I will discuss in this article the emerging concept of Virtual Observatories, the efforts being made in various countries to set up these structures, and describe work done under the Virtual Observatory - India project.

II. ASTRONOMICAL DATA

Astronomers carry out their observations using a variety of telescopes, based on the ground or on space platforms. They also use a variety of detectors like photographic plates, CCD cameras, radio receivers, X-ray detectors etc. The type and location of the telescopes and the kind of detectors used depend upon the region of the electromagnetic spectrum in which observations are to be made. There are two basic kinds of observing strategies which are followed :

- Observations of specific targets which are of interest to specific groups of astronomers.
- Observations which survey large portions of the sky and which can be used in a variety of scientific projects over the years.

Over the last two decades there has been great progress in telescope and detector technology. It has therefore been possible to build many large telescopes and increasingly sensitive detectors. The large installations are extremely expensive and the trend has been to build telescopes and detectors through collaborative efforts and to make them available to a wide community. Astronomers all over the world can therefore use the advanced facilities to which they may otherwise not have had access. The data obtained using these facilities is generally archived and made available to the entire community, regardless of who obtained it in the first place.

A. Data Volumes

Data volumes generated in ongoing and planned modern surveys can be as large as several hundreds of Gigabyte to a few tens of Terabytes. It is expected that some of the surveys which will be initiated over the next few years will generate several Terabytes of data per day. Storing, retrieving and scientifically using these vast databases is a formidable task, which requires the joint effort of astronomers and computer professionals to adopt existing hardware and software technology, and to develop new hardware and software to meet the challenge of making the data available to all potential users.

At the present time devices which can usefully store Terabytes of data are very expensive and it is expected that this situation will prevail for some time to come. It is therefore not practical to store all available data in many locations in the world for it to be locally available to astronomers everywhere. Moreover, maintaining mirror copies requires regular data transfers, not all of which can be done incrementally using the available bandwidth. Maintaining large data volumes also requires constant attention by computer professionals, and not all places would have access to such expertise. It is therefore necessary to selectively store data in strategic locations and to make it available using the internet as well as other means for data transfer. This of course brings forth the issue of providing engines and interfaces to enable users to obtain and combine data from a number of locations.

B. Data Variety

Data obtained in different parts of the electromagnetic spectrum requires vastly different kinds of processing before it is brought to a scientifically usable form. The data is also stored using quite different hardware and software systems, and technique have to be developed for bringing together the different structures. Even for data in the same region of the spectrum, different observers use different notations, conventions and units, and comparing data from different sources can be an exacting task. The difficulty here becomes more pronounced when much of the processing is to be carried out with computers avoiding human intervention, and the solution is to provide extensive universal standard descriptors for the data which makes automated analysis feasible.

III. VIRTUAL OBSERVATORY

A Virtual Observatory (VO) seeks to facilitate tasks mentioned above, which include storage and easy retrieval of large quantities of data in suitable format, provision for easy access to the data over the internet, and mechanisms which will enable the user to combine and compare data from different sources. But the VO has to go beyond simply making large amounts of data available: it has to provide query tools for the required data to be accessed from the vast store, for visualization of the data, and for data mining, which will enable new scientific discoveries to be made. The queries needed to generate the data for a user, and the subsequent analysis, can require computing facilities which may not be available at the user's establishment. A VO would seek to provide computing resources as well, either on its own site, or through a grid linking computers located at different sites.

Efforts in establishing such structures have been made, with moderate success, by different observatories and institutes from time to time. But the huge increase in the volumes of data now available, and the need to carry out research simultaneously in many different parts of the electromagnetic spectrum, has made it necessary to make collaborative efforts, much in the manner of joint effort undertaken to develop major new ground and space

TABLE I: **List of Virtual Observatories**

Virtual Observatory	Homepage
Astrophysical Virtual Observatory (AVO)	http://www.euro-vo.org/
AstroGrid	http://www.astrogrid.org/
Australian Virtual Observatory (Aus-VO)	http://www.aus-vo.org/
Canadian Virtual Observatory (CVO)	http://cadcwww.dao.nrc.ca/
Chinese Virtual Observatory (China VO)	http://www.china-vo.org/
German Astrophysical Virtual Observatory (GVO)	http://www.g-vo.org/
Hungarian Virtual Observatory (HVO)	http://www.h-vo.org/
Italian Data Grid for Astrophysical Research	http://wwwas.oat.ts.astro.it/draco/
Japanese Virtual Observatory (JVO)	http://jvo.nao.ac.jp/
Korean Virtual Observatory	http://kvo.kao.re.kr/
National Virtual Observatory (NVO)	http://www.us-vo.org/
OV France / France VO	http://www.france-vo.org/
Russian Virtual Observatory (RVO)	http://www.inasan.rssi.ru/eng/rvo/
Virtual Observatory - India (VO-i)	http://vo.iucaa.ernet.in/

based telescopes. The need is to make a comprehensive solution available to help astronomers, regardless of their geographic location, or their own area of expertise, to access data generated from different telescopes all over the world and in space. The task of easily and widely distributing data has now become very simple, because of the development of the internet and the World Wide Web. Using the internet even a remotely located user can access the facilities offered by a VO, and can use the data just as well as anyone else, which is a development of far reaching consequence.

A VO will seek to make the distributed data seamlessly available to astronomers. This will require the development of highly sophisticated data retrieval software which can federate data stored in many data fields. The data will be available in the form of catalogues, spectra and images. The VO will enable astronomers to use these different kinds of data simultaneously, irrespective of their location and basic nature, for a full multiwavelength analysis. The vast quantities of data will make it possible to look for very rare objects, patterns and relationships which remained totally inaccessible when only very limited data were available. Searching for these rare features will require the development of highly sophisticated data mining techniques for the search to be completed in finite time. The features found will have to be subject to analysis, and to be compared with the results of numerical simulations. The VO will seek to provide hardware and software platforms on which all these operations can be carried out.

A. VO Projects in the World

A Virtual Observatory, as the name implies, is a comprehensive concept which embodies computer hardware and software, data, and human expertise for providing services. A VO can occupy a small space in a single University department or an institution, or can be distributed over several locations. In fact all the VOs in the world can be considered to be parts of single VO, meshed together providing data and services to anyone who may need them.

There are several VO projects in operation in different countries in the world, and these are listed below, along with addresses of their websites. Some projects are large, and many people working on them, while others have just a small number of people engaged on very specific programs. The bigger projects include the National Virtual Observatory (NVO) of the USA, the Astrophysical Virtual Observatory (AVO) of the European Southern Observatory based in Germany, which brings together many European countries, some of which have their own individual VO projects, and Astrogrid, which is a VO project based in Britain. The smaller projects include those based in Australia, Canada, China, India, Japan, Korea and Russia. Links to various VO sites can be found on the VO-I homepage.

IV. THE INTERNATIONAL VIRTUAL OBSERVATORY ALLIANCE (IVOA)

As its name suggest, this is an alliance of VO projects based in various countries. It provides a forum at which astronomers, computer professionals and others who are engaged in VO activities in different countries can come together to share their experiences, set up collaborations, share resources and most importantly, develop common standards and infrastructure for the data exchange and interoperability. The VO concept involves sharing of data and resources, and the IVOA is most effective in bringing this about through continuous discussion and collaboration. The IVOA conducts interoperability meetings at which VO products developed by different projects are demonstrated. The meeting also provides a venue at which Science Working Groups from various projects can address astronomical requirements from the VO and demonstrate how the use of VO tools can lead to easier and more productive use of large datasets than was possible using traditional methods. Discussions between individuals and groups at interoperability meetings have

led to highly successful collaborations, like the development of a plotting and visualization tool by the VO-I project and Centre de Donnees astronomiques de Strasbourg (CDS), France.

The IVOA has defined (see Hanisch & Quinn 2003 on the IVOA website for a nice summary) six major programs which have to be undertaken to make progress towards building up of Virtual Observatories. These are

- *Registries*: These collect metadata about data resources and information services into a queryable database. The registry is distributed. A variety of industry standards are being investigated.
- *Data Models*: This initiative aims to define the common elements of astronomical data structures and to provide a framework to describe their relationships.
- *Uniform Content Descriptors*: These will provide the common language for metadata definitions for the VO.
- *Data Access Layer*: This provides a standardized access mechanisms to distributed data objects. Initial prototypes are a Cone Search Protocol and a simple image Access Protocol.
- *VO Query Language*: This will provide a standard query language, which will go beyond the limitations of SQL.
- *VOTable*: This is an XML mark-up standard for astronomical tables.

V. VIRTUAL OBSERVATORY - INDIA (VO-I)

This project is based in IUCAA, and its novel feature is that it is a collaboration between an astronomical institute and a major computer software company, Persistent Systems Pvt. Ltd. (PSPL), which has expertise in data management related products. The project, which is funded by the Ministry of Communications and Information technology, as well as by the two participating organizations, was begun in early 2002 for an initial period of three years. VO-I brings together astronomers from IUCAA, other institutions and University departments in India, and computer experts from PSPL. Apart from its expert help with in data base management and data mining, PSPL also provides project management expertise which is critical to the planning and and timely development of large software projects. The large pool of computer experts available with the company can be drawn on for the many different kinds and levels of expertise which various tasks require from time to time.

VO-I has successfully completed a series of projects the first of which was the development of a *C++ parser for VOTables*, which consists of a library of programs in the C++ language. Such libraries are required in the development of applications, which use data in the VOTable format, without having to carry out raw VOTable processing. VO-I has developed versions of the parser which act on data in the non-streaming as well as streaming format. The streaming parser is different from the non-streaming version, in that it does not create a tree-representation of the document in the memory. It reads the VOTable in chunks and can therefore be used for parsing real-time, streaming VOTables, as well as those VOTables which are too large to fit in the memory. Other VOs have developed such parsers using other programming languages.

A number of tools are now available to deal with data in the VOTable format. These very useful packages cannot be used with data in other formats, like ASCII or FITS, and therefore there is the need to convert such data to the VOTable format. There is also the need to convert data streams produced in non-VOTable format by various applications to the VOTable format. The *VOTable Java Streaming Writer* developed by VO-I acts on a data array in memory to convert it to the VOTable form, which is streamed row by row to a text area or output file. The writer thus does not create a tree structure in memory. The memory requirement is therefore substantially reduced and very large VOTables can be written. This version of the writer provides the VOTable data only in pure XML format and not in the VOTable fits and binary formats. A related package developed by VO-I is *conVOT*, which is a tool for converting ASCII or FITS tables to VOTable format. The tool supports ASCII files with column delimiters as well as those with fixed width columns and FITS ASCII and Binary tables. Large collections of FITS files can be conveniently browsed using the *FITS Manager*, which is a web-based tool developed by VO-I for viewing, creating and editing FITS files, and for converting FITS images to other image formats.

VO-I is developing a number of Graphical User Interfaces (GUI) for important data sets like the FIRST radio catalogue, the 2DF galaxy and quasar surveys etc. Such interfaces are usually provided by groups which create and maintain data bases, but the GUI being developed by VO-I will have additional features which will help the user to obtain derived quantities without having to go through complicated cosmological calculations, and will also provide tools for visualizing the data. The GUIs adhere to VO standards so that they can eventually become a part of the general VO repertoire.

A. VOPLOT

The VOPlot tool was developed as a major collaboration between VO-I and CDS, France, and is a menu and button driven tool for graphically visualizing data available in the form of catalogues. VOPLot can be used to draw histograms to examine the distribution of data val-

ues, like magnitude and redshift in a catalogue of quasars say, or to plot one set of data values against another and to obtained simple statistical information. However, VOPlot goes beyond being just another graphics package, because it adheres to emerging VO standards, like acting on data in the VOTable format, and because it provides for dynamical interaction with the data. The tool can be used to easily select a subset of data from a plot, and to obtain graphical representations. Once this is done, the user can graphically interact with the plots using the various buttons provided, and obtain a multidimensional visualization of the data through several simultaneous plots, and the selective highlighting of points in them. A very interesting capability of the tool is to pass from selected points on a plot to images of the corresponding sources in various sky atlases. All the manipulations are done through the use buttons provided in the tool, and no programming by the user is necessary. But users can dynamically provide simple mathematical formulae to obtain derived quantities like absolute magnitude from apparent magnitude and redshift.

VOPlot was originally conceived as a plotting tool to go with *Vizier*, which is the astronomical catalogue service provided by CDS. In this role it is available as a web based tool to be invoked from within Vizier, and is also integarted with the sky atlases provided by *Aladin*, so that a connection between individual data points and images of correspond sources can be made. VOPlot has also been integrated with several other catalogue services. VOPLot is also available as a stand alone version which can be installed on the user's machine. This version too uses catalogues in the VOTable format, which the user can provide by converting catalogues in other data formats to the VOTable format using tools for the purpose provided by VO-I. Information for obtaining and installing the stand alone version can be obtained from the VO-I website. A mirror of the Vizier catalogue service is available at IUCAA and can be easily accessed through the IUCAA website. VOPLot is under continuous development, and enhancements which provide 3-D plots, error bars etc are being made at the present. A sample VoPlot screen is shown in Figure 1.

VI. DATA MIRRORS

VO-I has obtained many large data catalogues, including Data Release 1 (DR1) of the Sloane Digital Sky Survey, which is about a Terabyte in size. The data is maintained on RAID systems. These consist of a series of disks on which the data is spread out in such a manner that any data lost in a disk crash is automatically reconstructed onto an extra disk which is provided for the purpose. The disk systems and servers used by VO-I are indicated in Figure 2.

VII. OPPORTUNITIES

The VO-I initiative seeks to undertake VO related developments for the Indian and International astronomical communities and has resources for setting up and developing collaborations, post-doctoral fellowships and visitors. Further details about these matters, and the opportunities available with VO-I for the community can be obtained from http://vo.iucaa.ernet.in/~voi/.

VIII. FURTHER READING

Due to the nature of this rapidly evolving field, the best resources for learning are the websites of the various VO projects listed above, the links that they provide, and the papers that are regularly posted on them. Many VO sites also provide forums for discussion and users can join specialized mailing lists.

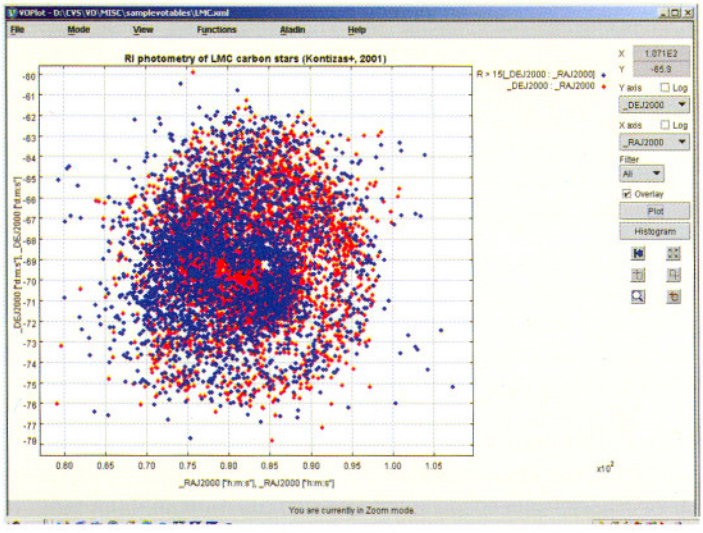


Fig. 1: A scatter diagram generated using VOPLOT. Buttons on the right of the pannel provide full control to the user.

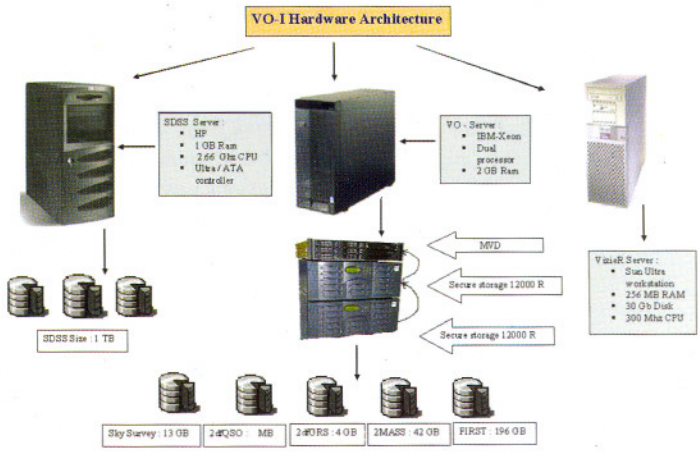


Fig. 2: The VO-I hardware setup at IUCAA. Only some of the main facilities and few databases have been indicated.

Mini-School on Introductory Astronomy and Astrophysics

IUCAA, and Department of Physics of IIPC, Kalyani Government Engineering College (KGEC) organized a Mini-School on Introductory Astronomy and Astrophysics during February 4-8, 2004. The lectures covered a wide view of the theoretical astronomy, cosmology, modern observational techniques and recent development in astrophysical processes. The details of the various topics covered by the lecturers and their names are as given below:

Ajit Kembhavi (IUCAA) on CCD Detectors and Image Processing in Astronomy; Ranjan Gupta (IUCAA) on Observational Astronomy; Sailoja Mukherjee (North Bengal University) on Cosmology I: Symmetries and Astroparticle Physics; Tarun Souradeep (IUCAA) on Cosmology II: Large Scale Structure of the Universe; Debi Prasod Duari (M.P. Birla Planetarium, Calcutta) on Evolution of Stars, Multi-wavelength Astronomy and Astrobiology; Amalendu Bandopadhyay, (Ex-Director of Positional Astronomy Centre, Calcutta) on Planetary Motion; Subhendu Joarder (GMRT, TIFR, Pune) on Techniques in Radio Astronomy and Experimentation; Somenath Chakraborty (Kalyani University) on An Overview of Neutron Star Properties.

The lectures were supplemented by Radio Astronomy Experiments conducted by S. Joardar, Sourav Chakraborty, Anup De, and Sisir K. Bose. The team has successfully recorded eight Jovian Bursts in the DAM range by using Dipole Antenna and 3 GHz Spectrum Analyzer. There was also a team of experts comprising of Nikhilesh Pal of Rohini Telescope; B.K. Mondal and B. Dasgupta of Positional Astronomy Centre, Calcutta; Indrajit Mukherjee and Sourav Chakraborty of KGEC assisting in night sky observation with optical telescopes. Participants observed Jupiter with its satellites, Saturn and its rings, Orion Nebulae and the new born stars at the Nebulae and taking video photographs of Saturn and Moon.

The school was attended by a large cross-section of students from different colleges and universities of West Bengal belonging to different disciplines. The participants also included college teachers, research scholars and scientists from different institutes.

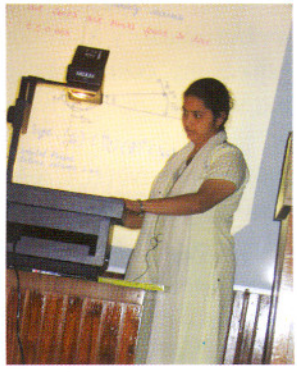
In parallel with the school was organised an exhibition under the title '*Cosmic Voyage*'. The exhibition was on the history of astronomy from its very inception at the stone age to the modern observational astronomy, the development of telescopes from Galilean to modern telescopes using adaptive optics, observation in other wavelength regions like UV, X-ray, g-ray, radio and microwave regions, cosmology and relativity theory, astrophysics, theory of big-bang, star birth, etc. Indian astronomical studies from 18th century, the age of '*Jantar Mantar*' to the present 21st century, the development of large array of radio telescopes at GMRT were also depicted at the exhibition.

The coordinator of the course was S. Mukherjee of North Bengal University.

Workshop on Brane and Loop Quantum Cosmology

Following the ICGC meeting at Kochi on January 5-10, 2004 a cosy and compact meeting was organised essentially to bring together active workers in brane and loop quantum cosmology for a relaxed interaction. Apart from a general discussion on motivation for brane world gravity from classical standpoint as well as gravity's strong linkage with thermodynamics, the discussion on the brane side concerned various models of dark energy and inclusion of Gauss-Bonnet and induced gravity terms. Recently, there have been some interesting developments in loop quantum cosmology, where the loop quantum effects radically alter the behaviour of energy density as the Planck scale is approached. It results in the avoidance of the big-bang singularity. This question is now being studied for the homogeneous Bianchi cosmology. The speakers were G. Amery, M. Bojowald, N. Dadhich, G. Date, G.M. Hossain, T. Padmanabhan, E. Papantonopoulos, M. Sami, Y. Shtanov, A. Toporensky and S. Tsujikawa. There was enough free time for informal interaction, which lent further a flavour of understanding and congeniality.

IUCAA-IIT Kharagpur Workshop on High-Energy Astrophysics



Harsha Raichur

Raka Dona Roy Mandal

Participants of the IUCAA-IIT Kharagpur Workshop and two shots of the presentations by Ph.D. students

As a part of the activity proposed under the MOU signed between IIT, Kharagpur and IUCAA, a Workshop on High Energy Astrophysics was organized during February 23- 25, 2004 at IIT, Kharagpur.

The aim of the workshop was to bring the experts in contact with the students (undergraduate and graduate) and the young researchers so that they could review the basic understandings and discuss the recent developments in this rapidly developing field of High-Energy Astrophysics. This aim has been amply fulfilled. The topics covered in this workshop included – a) compact objects, b) gamma-ray bursts, c) quasars/AGNs and d) cosmology.

A total of 58 participants attended this workshop of which 36 were from outside Kharagpur, coming from all parts of the country. This included a number of IUCAA associates too. There were ten invited speakers who reviewed several key areas and many contributed short talks mainly by PhD students and young post-doctoral fellows.

On the evening of February 24, Dipankar Bhattacharya, Dipanjan Mitra and Biswajit Paul had an informal discussion session with the students, telling them about possible research opportunities in astrophysics.

A panel discussion on Astronomy and Astrophysics research was scheduled as the concluding session of the workshop. Ramana Athreya, Somnath Bharadwaj, Pijush Bhattacharjee and Dipankar Bhattacharya acted as panelists. The issue that seemed to concern everyone is the still persisting lack of contact between the universities and the elite institutes.

Two other suggestions arose out of this panel discussion. The first one is to create a server of national workshops/schools/conferences on astronomy and astrophysics in the line of C-DAC. The second is to create a database of possible short-term projects (outside the standard summer projects) for undergraduate students. Scientists in the research institutes can advertise their projects in the web and the teachers in the respective universities can coordinate and recommend the names of suitable students. Several teachers (from colleges and universities) have shown interest in helping to create and maintain such a database.

Other details regarding the workshop is still available at the workshop webpage at http://www.cts.iitkgp.ernet.in/~heap04.

Seminars

12.1.2004 Parampreet Singh on *Some cosmological applications of loop quantum gravity*; 16.1.2004 Horton Newsom on *Impact craters on the Earth and Mars*; 16.1.2004 Ramesh Narayan on *Type I X-ray bursts*; 19.1.2004 Manoj Kaplinghat on *The supernova relic neutrino background*; 20.1.2004 Roy Kerr on *Discovering the Kerr solution*; 22.1.2004 Jasjeet Singh Bagla on *Cluster computing at HRI*; 23.1.2004 A. Klypin on *Dark matter in galaxies;* 16.2.2004 Russell Cannon on *The Universe at Z=0.5: A new spectroscopic survey of luminous red galaxies*; 9.3.2004 Chenzhou Cui on *Astronomy research environments in China and Chinese virtual observatory*; 18.3.2004 Dipankar Banerjee on *Dynamical fine structures in the solar atmosphere as seen by SOHO*; and 25.3.2004 Prasad Subramanian on *Solar noise storm continua: Power estimates for electron acceleration.*

Neem Seminars

The first informal seminar under the Neem tree in the IUCAA Kund was on February 10, 2004 by Kim Griest [University of California, San Diego, USA] on *Toward a possible solution to the cosmic coincidence problem and* the second one was on 23.3.2004 by Tabish Qureshi on *Quantum cryptography.*

Colloquium

29.1.2004 Samuel Lee Finn on *Gravitational wave observations of inspiraling binary systems in the local universe.*

IUCAA Preprints (January-March 2004)

Listed below are the IUCAA preprints released during January-April 2004. These can be obtained from the Librarian, IUCAA (library@iucaa.ernet.in).

Somnath Bharadwaj, *The size of the longest filaments in the universe*, IUCAA-50/03; Sergei F. Shandarin, Jatush V. Sheth and Varun Sahni, *Morphology of the supercluster-void network in LCDM cosmology*, IUCAA-51/03; H.K. Jassal, *Stabilization of branes in a cosmological setting*, IUCAA-52/03; Sunu Engineer, *Implementing an observatory control system-I. A Generic approach*, IUCAA-1/04; Hum Chand, Raghunathan Srianand, Patrick Petitjean and Bastien Aracil, *Probing the cosmological variation of the fine-structure constant: Results based on VLT-UVES sample*, IUCAA-2/04; R.K.S. Yadav & Ram Sagar, *U B V R I CCD photometric study of the open clusters Basel 4 and NGC 7067*, IUCAA-3/04, R. Srianand, H. Chand, P. Petitjean and B. Aracil, *Limits on the time variation of the electromagnetic fine-structure constant in the low energy limit from absorption lines in the spectra of distant quasars*, IUCAA-4/04; H.K. Das, Abhay Kohok and S.N. Tandon, *An implementation of transfer-pupil in a spectrograph on optical telescopes*, IUCAA-5/04; S.V. Dhurandhar, *Data analysis techniques for gravitational wave observations*, IUCAA-6/04; and R.K.S. Yadav and Ram Sagar, *A comprehensive CCD photometric study of the open cluster NGC 2421*, IUCAA-7/04.

Visitors Expected

April

Ninan Sajeeth Philip, St. Thomas College, Kozencherry; K.D. Patil, B.D. College of Engineering; S. Chatterjee, Indian Institute of Astrophysics, Bangalore; G. Ambika, Maharaja's College, Kochi; K.S. Sumesh, Maharaja's College, Kochi; Suresh Chandra, SRTM University, Nanded; G.P. Singh, Visvesvaraya National Institute of Technology, Nagpur; K. Shanthi; Academic Staff College, University of Mumbai; R.N. Ghosh, Govt. Polytechnic, Gaya; S. Sahijpal, Panjab University, Chandigarh; K.P. Harikrishnan, Cochin College, Kochi; K. Jotania, Gujarat College, Ahmedabad; D. Lohiya, Delhi University; and A.K. Mittal, Allahabad University.

May

A. Banerjee, Jadavpur University; S. Bhowmick, Barasat Govt. College; S. Chakaraborty, Jadavpur University; D. Chandra, SGTB Khalsa College, New Delhi; S. Chaudhuri, Gushkara Mahavidyalaya, Burdwan; U. Debnath, Jadavpur University; D. Jain, Deendayal Upadhyay College, Delhi; R.S. Kaushal, University of Delhi; M. Khan, Bengal Engineering College; A.C. Kumbharkhane, SRTM University, Nanded; N. Hasan, Osmania University, Hyderabad; Y. Mathur, University of Delhi; Sanjay Pandey, LBS PG College, D.C. University, Vallabh Vidyanagar; and A.A. Usmani, Aligarh Muslim University, Aligarh.

June

T. Chatterjee, Shibpur DB College, Kolkatta; A. Chattopadhyay, Calcutta University, Kolkatta; D.V. Gadre, Netaji Subhas Institute of Technology, Delhi; K.K. Mondal, Raja Peary Mohan College, Hooghly; B.C. Paul, North Bengal University, Siliguri; Lalan Prasad, M.B. Govt. PG College, Haldwani; N.K. Lohani, MB Govt. PG College, Haldwani;T.R. Seshadri, University of Delhi, Delhi; Nagendra Kumar, KGK PG College, Moradabad; H.Sikka, KGK PG College, Moradabad; and M. Yadav, KGK PG College, Moradabad.

Solution to *For The Younger Minds-7*

T. Padmanabhan

Consider a plane slicing the planet perpendicular to the axis of symmetry and at a distance s from the north pole. This plane cuts a circular disc of radius r of the planet. The gravitational force due to this disc on the north pole is along the axis of symmetry and has a magnitude $f = 2\pi\sigma(1 - \cos\theta)$, where σ is the surface density of the disc and $\tan\theta = (r/s)$. The total force exerted by the planet on the north pole can be obtained by writing $\sigma = \rho ds$ [where ρ is the mass density] and integrating over s from 0 to h, where h is the "diameter" of the planet along the symmetry axis. The total mass of the planet is an integral of $r^2 ds$ between the same two limits. To maximise the force, subject to the constraint of given mass, we need to introduce a Lagrange multiplier λ and extremise the integral:

$$F = 2\pi G\rho \int_0^h ds \left[\left(1 - \frac{s}{\sqrt{s^2 + r^2}}\right) + \lambda r^2\right]$$

The extremum condition gives $2\lambda r(dr/d\theta) = -\sin\theta$, which integrates to give the final result to be $r = \lambda^{-1/2}\sqrt{\cos\theta}$, which is the equation to the curve in polar coordinates. It is now easy to show that: (a) The radius R of a sphere with the same volume as our planet is given by $R = 5^{-1/3}h$. (b) The maximum force exerted by the planet on the north pole higher than that by a spherical planet, by the factor $(3h/5R) = (3/5)5^{1/3} \approx (39/38)$! It is surprising that the shape that exerts the maximum force at a point is neither a sphere nor a cone; in fact, (as far as I know), this shape has no special name.

For The Younger Minds – 8

While we are on the topic of gravitation, here is another surprising one: A result of some historical importance, due to Newton, states that a spherically symmetric density distribution produces an external gravitational field as though the total mass is concentrated at the centre. This raises the question: Suppose the gravitational field produced due to a finite distribution of matter in some region of space falls as $1/r^2$ outside the matter distribution [where the distance is measured from some point P inside the mass distribution] and is directed towards P. Any density distribution which is spherically symmetric about the point P will lead to such a force. Is this result unique? Can one have distribution of matter which is not spherically symmetric and yet produce the force indicated above?

Visitors during January to March 2004

M. Sami, A. Gupta, R. Sinha, Uday Chakravarty, Laxmikant Chaware, C.S. Shukre, M. Devasagayam, R. Chhetri, L.C. Padhy, P. Hasan, E. Papantonopoulos, B. Ahmedov, G. Amery, G.M. Hossain, S. Tsujikawa, S. Ray, J. Bagla, A.S. Reddy, P. Chingangbam, P.K. Suresh, B. Bambah, K.V.S. Shiv Chaitanya, G. Date, M. Bojowald, H. Newsom, V.L. Narasimhan, A. Klypin, R. Kerr, M. Kaplinghat, B. Schmidt, S. Barway, Lee Finn, A. Dirks, P. Vivekananda Rao, B.B. Sanwal, P. Anbazhagan, P. Pant, N.S. Jog, V.N. Pandey, A.V. Thampan, S. Tirupathi, S. Ramadurai, K. Griest, T.P. Prabhu, R. Cannon, S. Bhattacharya, S. Warrier, C. Chaturvedi, C. Pinto, P. Mitra, A. More, V. Suresh, P.V. Kokne, P. Janardhan, K. Pandey, U. Narain, A.N. Mitra, C. Cui, B.K. Sinha, S.K. Pandey, G. Ferland, G. Shaw, D. Banerjee, T. Qureshi, and F. Sutaria.

***Khagol* (the Celestial Sphere) is the quarterly bulletin of IUCAA.**

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