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

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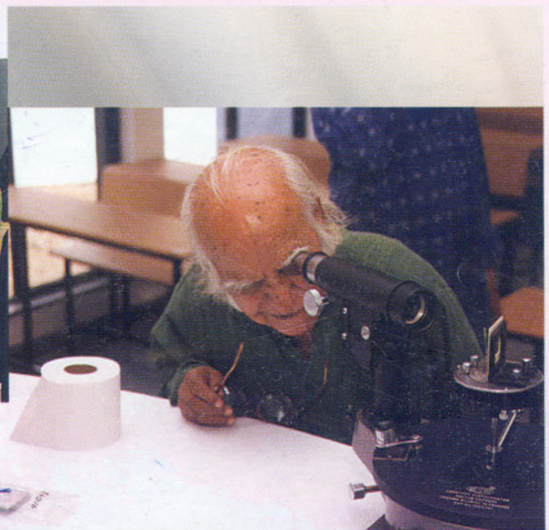
Muktangan Vidnyan Shodhika



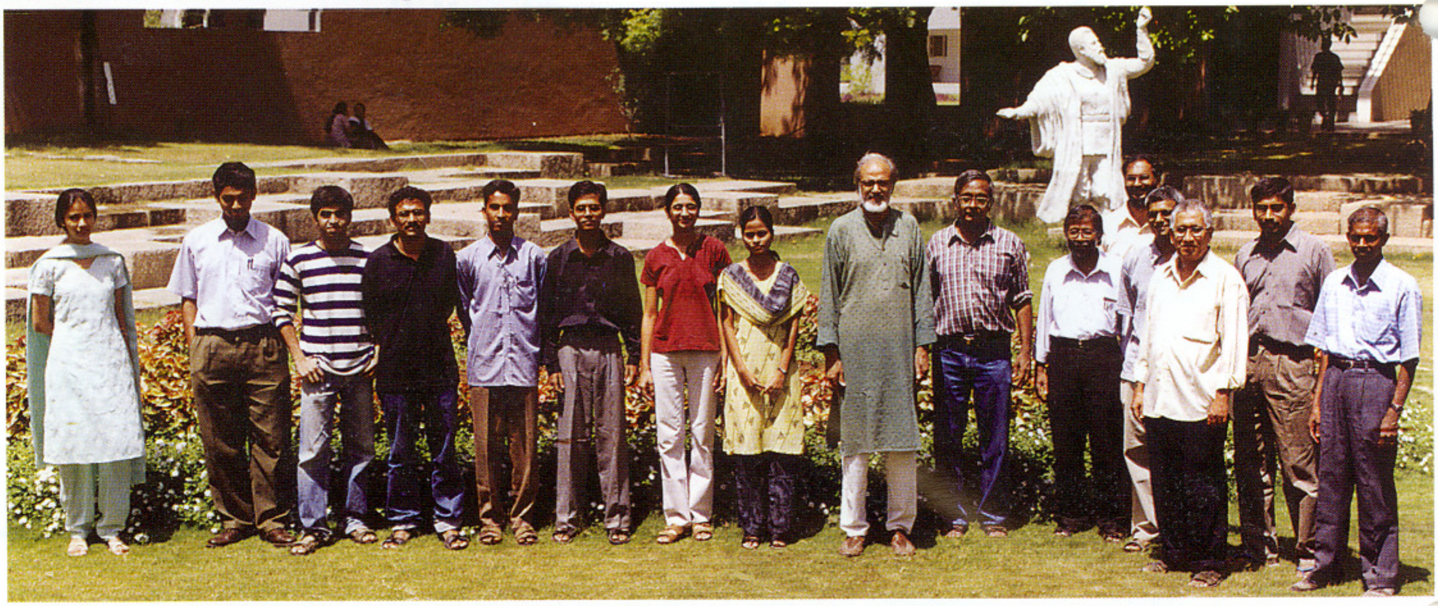
Here are some shots on the occasion of the inauguration of the IUCAA Muktangan Vidnyan Shodhika. For details see the report on page 2.

IUCAA Muktangan Vidnyan Shodhika

The IUCAA Muktangan Vidnyan Shodhika (MVS), the latest offering of IUCAA to the young minds curious about science, was inaugurated by Professor Yash Pal on June 12, 2004. The exploratorium is intended essentially for school children and will act as a focal point for them to have fun with science by actually doing experiments and investigating scientific principles. The exploratory was built from a handsome donation from Smt. Sunitabai Deshpande [wife of Pu.La. Deshpande] and partial funding support from the Marathi NRI organization in the USA called Maharashtra Foundation. The building has been named "Pulastya" (which is the name of one of the stars of the Saptarshi constellation), in memory of Pu-La.

The Exploratorium comprises of a small auditorium, where lectures, demonstration of experiments/slide shows, etc. can be held. It also has a Laboratory, Computer Centre, and a Library concentrating at present on Astronomy, Physics and Mathematics. On the day of the inauguration, there were lectures by Professor Yash Pal, as well as Professor Dinesh Thakur (University of Michigan) and Professor Milind Watve (Garware College, Pune) on the theme of "Fun of Doing Science".

Vacation Students' Programme



Participants and Lecturers of the Vacation Students' Programme

The Vacation Students' Programme (VSP) for students in their penultimate year of their M.Sc. (Physics) or Engineering degree course, was held during May 17-July 2, 2004. Eight students participated in this programme. The participants attended about 50 lectures dealing with wide variety of topics in Astronomy and Astrophysics, given by the members of NCRA and IUCAA. Each student also did a project with one of the faculty members of IUCAA during this period. The main purpose of this programme is to pre-select the eligible students to Ph.D. Programme. K. Subramanian was the faculty coordinator of this programme.

... Farewell to

Pavan Chakraborty, who has joined the Department of Physics, Assam University, as a Lecturer.

Harvinder Kaur Jassal, who has joined the Harish-Chandra Research Institute, Allahabad, as a Visiting Scientist.

Parampreet Singh, who has joined the Centre for Gravitational Physics and Geometry, Pennsylvania State University, as a Post-doctoral Fellow.

Ramakant Singh Yadav, who has joined the Dipartimento di Astronomia,University di Padova, as a Post-doctoral Fellow.

Introductory Summer School on Astronomy and Astrophysics

Participants and Lecturers of the Introductory Summer School on Astronomy and Astrophysics

The Department of Science and Technology sponsored Introductory Summer School on Astronomy and Astrophysics was held jointly by IUCAA and NCRA from May 17 to June 18, 2004. Thirty five students (final year bachelor and pre-final year masters) of science, engineering and mathematics streams from different colleges and universities spread across the country were selected for the school from an unusually large 350 applications. This year, the summer school also turned international with applications received from Bangladesh and USA. A masters student from Bangladesh University of Science and Technology also attended the school.

During the morning sessions of the school, there were several introductory courses covering topics in astronomy, astrophysics, gravitation, cosmology, etc. which were offered by faculty members of IUCAA and NCRA. The post-lunch sessions were set apart for talks on exciting areas of research and development in A&A. The speakers of these sessions were drawn from experts in the fields both from the local resource pool, as well as from other institutes in the country. Each school participant was also assigned an academic staff member of IUCAA/NCRA, with whom (s)he did a reading project. During the last week of the school, all the participants gave 20 minute presentations on their respective projects.

Facilities like library, internet access, xeroxing, etc. were provided to the students during their stay. A trip was also organized to visit the IUCAA Observatory and GMRT. Additionally, films on space research related subjects were screened during weekends.

The school was coordinated jointly by A.N. Ramaprakash (IUCAA) and D.J. Saikia (NCRA).

Proposals for holding Workshops/ Schools Outside IUCAA

Proposals to conduct workshops/schools in Astronomy and Astrophysics or related areas are invited from university departments/affiliated colleges and the same may be sent to the Chairman, Scientific Meetings Committee, IUCAA, by March 1, 2005 (for events to be conducted during August 2005–July 2006), so as to be included in the academic calendar for the next academic year.

The following details should be given while sending the proposals: (i) the title (topic) (ii) duration of the workshop/ school (iii) topics to be covered and number of lectures in each topic (iv) the level of audience and their number (v) the number of resource persons available locally and the number of resource persons expected from IUCAA and (vi) a description of the facilities available and the budget estimates (clearly stating the support offered by the host university/institute).

It is generally expected that infrastructural facilities and accommodation to the participants as well as the resource persons will be provided by the host institution. Other expenses will be borne by IUCAA. The proposers are encouraged to consult IUCAA faculty while framing the proposal.

Once the workshop/school is approved, IUCAA will nominate a coordinator from its faculty, who will interact with the organiser in relation to academic programme, budget, and identifying and approaching the resource persons.

Neem Seminars

13.5.2004 Parampreet Singh *Discussion on Triality between inflation, cyclic and phantom cosmologies*; 14.5.2004 Sandeep Sahijpal on *Some recent results in X-ray flaring and the origin of the solar system*; 27.5.2004 Ujjal Debnath on *Gravitational dust collapse with cosmological constant*; 28.5.2004 Subenoy Chakraborty on *The role of anisotropy and inhomogeneity in Lematire-Tolman-Bondi collapse*; 7.6.2004 Sanjay K. Pandey on *Probing LSS at high redshifts using HI emissions*; 8.6.2004 S.N. Hassan on *From Nbody1 to Nbody6 : The growth of an industry*; 15.6.2004 Naresh Dadhich on *Probing the universality of gravitation*; and 17.6.2004 Daksh Lohiya on *Softening Deuterium constraints in early universe cosmology;* and 23.6.2004 Lalan Prasad on *Nanoflares as a plausible coronal heating agent.*

School Students Summer Programme

Since 1993, IUCAA has been conducting summer programme for school students of Pune to give scientifically inclined students, a glimpse on doing science. The programme was conducted for six weeks for students of VIII and IX standards. Each week, a new batch of 30 students was invited to work on a project at IUCAA from Monday to Friday. Groups of four to six students were attached to individual guides. The programme has no set syllabus or course guidelines. The students and the guide work out their own schedule for the week. The students were given access to the IUCAA library. On the last day of the programme, that is on Friday, every student is asked to submit a report on the work carried out during the week.

This year's School Students Summer Programme was held from April 19 to May 28, 2004. The venue of the programme was the newly constructed Pulastya building of IUCAA Muktangan Vidnayan Shodhika (see the report of its inaugural programme in this issue of Khagol). We try to introduce a new element in this programme when possible. This year the students' presentation was carried out in the lecture hall of Pulastya. For the students, who gave the presentation, it was their first experience.

Students carried out various projects under the supervision of Amrit L. Ahuja, V. Chellathurai, N. K. Dadhich, Sanjeev Dhurandhar, Arvind Gupta, Ranjan Gupta, T. Padmanabhan, Arvind Paranjpye, A.N. Ramaprakash, Sanjit Mitra, Arvind C. Ranade, R. Srianand, Kandaswamy Subramanian, Prasad Subramanian and Arun V. Thampan.

During the week, they participated in various common activities. Arvind Gupta conducted a scientific toy making activity for them, Vinaya Kulkarni conducted guided tour of the Science Park and scientific movie appreciation, and Arvind Paranjpye carried out a general question answer session, observing spectrum using a spectroscope and coordinated the programme.

Seminars

1.4.2004 Firoza Sutaria on *The XMM-Newton FOV of M74 and associated SNe SN2002ap*; 13.4.2004 Badri Krishnan on *Dynamical horizons and their properties*; 15.4.2004 Badri Krishnan on *Searching for Gravitational waves from pulsars using the Hough transform*; 23.4.2004 Banibrata Mukhopadhyay on *Light-curve due to the hot-spot motion on the neutron star surface*; 3.6.2004 Dipankar Maitra on *XTE Observations of the 2003 outburst of the microquasar V4641 SQR*; 7.6.2004 Sandip Trivedi on *An inflationary model in string theory*; and 22.6.2004 Richard Henriksen on *What is the dynamic state of dark matter halos, both young and old*?

J.S. Bagla, Harish-Chandra Research Institute, Allahabad.

Cluster Computing in Astrophysics

Computing is an essential tool in almost all branches of science today, and astronomy and astrophysics are no exceptions. Indeed, astronomers and astrophysicists have been leaders in deployment of high performance computing for solving complex problems, e.g., see [39, 40], and in support of major observational efforts, e.g., [38]. In this resource summary, I will outline how commodity computers can be used as a platform for high performance computing.

Computing power has been increasing rapidly, the CPU performance typically doubles every 18 months. A typical desktop computer on sale today would have ranked amongst the top 100 in the first list (June 1993) of fastest supercomputers in the world [23].

The increasing computing power brings a larger range of problems within reach of normal desktop computers and many problems and analyses that could only be done on expensive workstations in the past can now be carried out on desktop computers. Easy availability of good quality software [1], operating system [2] and documentation [3] accelerated this all round development. As an example of the richness of tools and software available, we refer the reader to the *Linux Astronomy Howto* at [3].

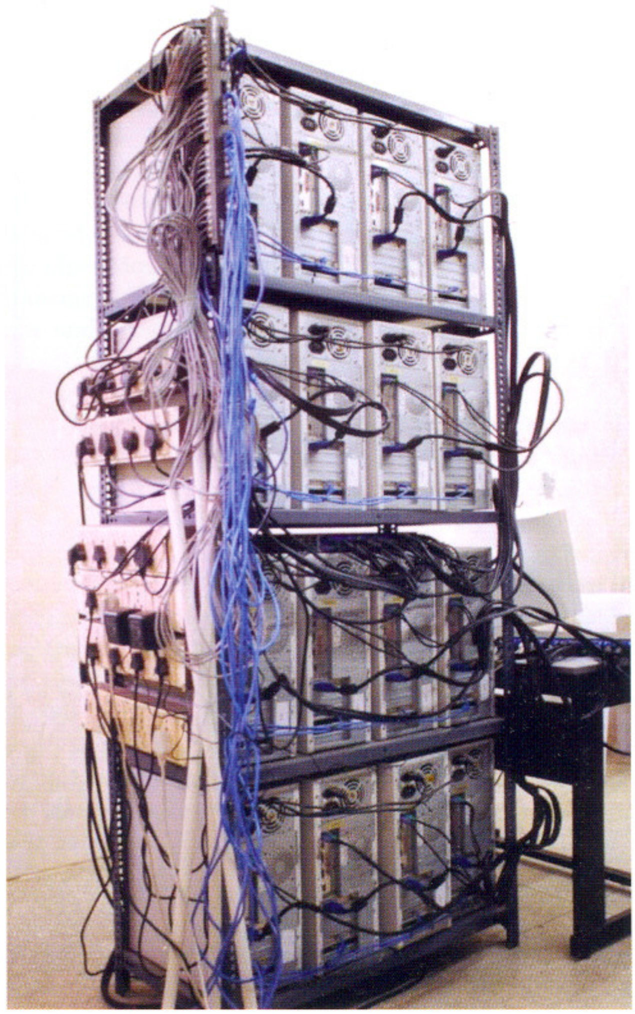


Figure 1: Picture of a 16 node cluster at the Harish-Chandra Research Institute, Allahabad. Note that there is just one monitor that is shared by all the computers in the cluster. Users access the cluster over the network and console access is not required except for system administration in case of network failure. See http://cluster.mri.ernet.in/ for details.

1 Cluster Computing

Computing power can be enhanced by using a large number of computers together. This not only allows us to run several programs at once, a group of computers in a network can also be used together to solve a single problem. A group of networked computers, often of identical configuration, meant to be used together for computing is called a cluster. The first cluster was designed and made by Donald Becker and Thomas Sterling in 1993 [7]. They showed that clusters made with inexpensive desktop computers can rival very costly supercomputers in terms of performance.

Before we proceed further, we would like to describe some often used terms. We have already mentioned that a cluster is a group of computers in a network. Clusters made out of commodity, off the shelf (COTS) computers are often also called Beowulf clusters – so called after the first cluster of its kind. If workstations with RISC[1] processors are used instead of COTS, then it becomes a cluster of workstations (COW). This is distinct from a typical network of workstations (NOW), which may be made of a variety of workstations and these may be used for interactive sessions as well. Workstations in a NOW may be used by a job management system when not in use for interactive sessions, thus, harvesting CPU cycles that would have been wasted otherwise. Clusters are typically made of identical computers as that makes parallel programming and load balancing simpler. In parallel programming, computational load for a single problem is distributed across many processors. If all the processors are not identical then it will be difficult to keep all the processors occupied by merely dividing the computational load equally, and an imbalance will result in at least some processors waiting while other processors finish the assigned tasks. Such imbalance leads to poor improvement in the time taken for solving the problem, thus, it is better to use identical computers and remove one potential reason for poor performance. Cluster nodes are not meant for interactive sessions on the console, as user interface and graphic applications can interfere with load balancing in a parallel programme. Figure 1 shows the picture of a 16 node cluster made using COTS computers.

Cluster computing is also called distributed parallel computing: parallel because instructions are processed concurrently by a number of processors, and as the total memory

[1] RISC: Reduced Instruction Set Computers. The idea is to break up complex instructions in terms of a small set of simple instructions and implement these optimally in the CPU.

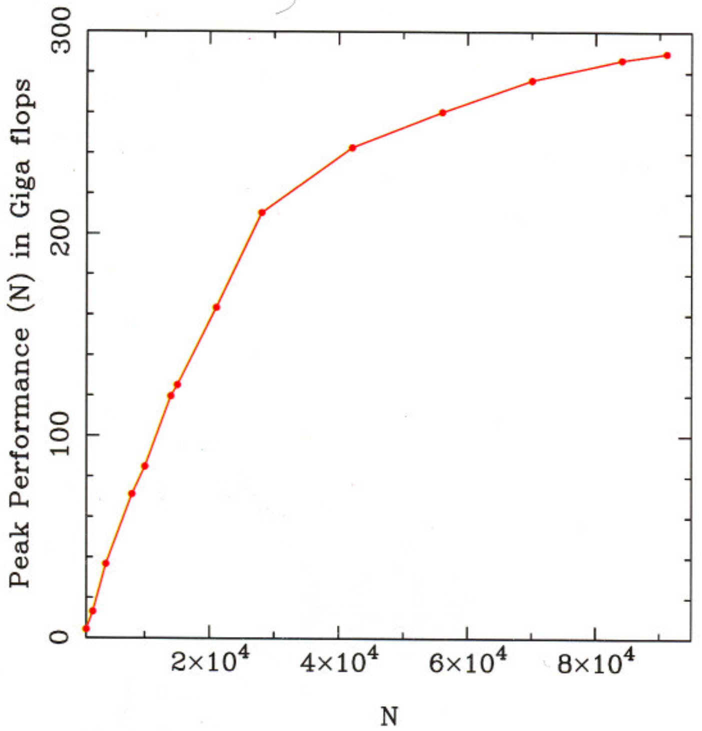


Figure 2: Performance of the Kabir cluster [25] is shown as a function of the problem size. This performance for the high performance linpack (HPL) [20] benchmark has been obtained using the Goto libraries [24]. Performance is better for larger problem sizes as the relative importance of communication overheads decreases when we run larger problems. Peak performance on this cluster is close to 290 Giga flops.

is distributed across different computers without a single addressing scheme, the name distributed parallel computing is appropriate. This is to be contrasted with shared memory parallel computing, where the entire memory has a single addressing scheme on a multi-processor computer, i.e., all the processors have a direct access to the entire memory. Number of processors on largest computers of either kind can be around 10^3. Cost of shared memory computers increases very rapidly with the number of processors, whereas the cost of clusters increases almost linearly with the number of processors. This gives clusters a distinct edge over multi-processor computers, as one can obtain very high computing performance for most applications at a low cost, e.g., it is possible to set up a cluster with a performance of 100 Giga flops[2] at a fraction of the cost of a multi processor RISC computer with the same performance. The low cost has made clusters the platform of choice for high performance computing. There are close to 300 clusters in the 500 fastest computing facilities [23] even though the idea of a cluster is just over ten years old.

In a cluster, processors communicate over a network and the performance of the network can be a serious bottleneck in distributed parallel computing. Clearly, inter-process communication is essential and we cannot avoid the network altogether. It is, however, important to ensure that the communication overheads are as small as possible, typically this means working with large problem sizes so that the computation time dominates over communications. Figure 2 shows the performance of the Kabir cluster [25] with the HPL benchmark [20] as a function of the problem size. We see that the performance increases rapidly as we increase the problem size before levelling off near 290 Giga flops. There is a range of problem sizes for which the cluster is a fast and efficient computing platform, using the same platform for very small problems is an inefficient use of resources. This is not a serious issue for shared memory computers.

Published performance evaluation can be used to decide the type of hardware to be procured [21], the most commonly used benchmark for this purpose is Linpack [20]. The list of 500 fastest supercomputers [23] is a useful resource for those planning to set up a major computing facility. Information can also be obtained from the pages maintained by the IEEE task force on cluster computing [4, 5, 6].

1.1 Management

Management of a cluster involves installation, system administration and allocation of resources to users. We are concerned here with installation of operating system and/or applications. Typically, each of the computers is set up with its own copy of the operating system and applications, and has its own host name and network address. Installation on a large number of computers can be a challenging task and there are several tools available to simplify this task [9], with some tools more specific for clusters [10, 11]. An interesting alternative is to use an operating system that treats the entire cluster as a single computer, e.g., see [8].

The standard for distributed parallel programming is the Message Passing Interface (MPI) [28]. MPI has been implemented on a variety of platforms, e.g., see [29, 30]. On shared memory computers, an alternative is available in the form of OpenMP [31]. It is worth mentioning that Parallel Virtual Machine (PVM) [32], has a very different approach to distributed parallel computing.

Installation of scientific applications is typically done by the friendly system administrator of the local facility. This requires close coordination between users and the administrators as high performance computing requires careful optimisation and tuning of applications. Users participate in the system administration process in most facilities, indeed many small and medium sized facilities are managed by users themselves. Benchmarking tools are essential for tuning and testing the computing facility. Programmes for testing nearly every aspect of computers are available [18, 20, 19, 22].

Most operating systems provide easy to use packages for maintaining user accounts on a large network. These tools set up configuration files for network services such as the Network Information Service (NIS) and the Network File Sys-

[2] 1 Giga flop = 10^9 floating point operations per second. 1 Tera flop = 10^3 Giga flops.

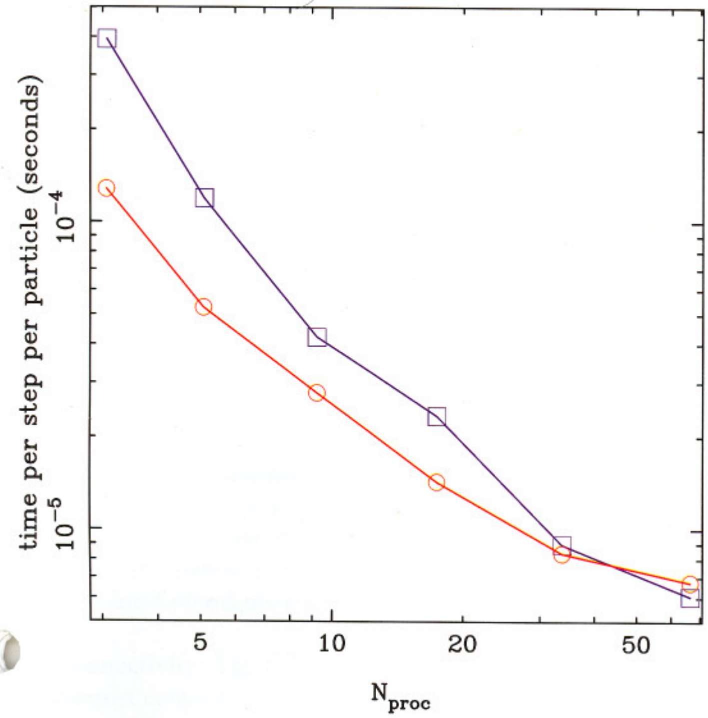


Figure 3: This graph shows the performance of the parallel TreePM code [41]. We have plotted the time taken per particle per time step as a function of number of processors used. The red curve is for a simulation with 2 million particles and the blue curve is for a simulation with 16 million particles. Programmes that require larger computing resources are more efficient when run over a large number of CPUs, this is why the larger simulation continues to scale well up to the largest number of processors used.

tem (NFS) [3]. Managing user accounts on a large number of computers without these network services is an extremely tedious task. Cluster command and control (C3) tools [12] are a useful alternative in such situations. Rationale for not using network services is to reduce non-computational load on the network, this makes sense if the same network is used for computation related communications. Many clusters use high performance networks for computation related communications in addition to an ethernet network for all other communications, and tools such as C3 are not essential for such clusters.

1.2 Job Schedulers and Load Balancing

Clusters and other high performance computing facilities that are used by multiple users require job scheduling systems or other mechanisms for balancing computational load across the available CPUs. Such mechanisms are not needed for facilities that are dedicated for a single application or user.

Job schedulers [14, 13] are used to schedule jobs with different requirements in terms of number of CPUs, memory, CPU time, etc. using a simple algorithm to ensure equitable distribution of resources amongst different users and jobs, while maximising utilisation of computing resources. A large number of schedulers with a variety of scheduling algorithms have been implemented.

Load balancing on a cluster is a more complex task, in that it requires migration of jobs from one computer to another in a seamless manner. The most challenging aspect of this is the transfer of Input/Output and communications related to a program from one computer to another. Load balancers are more convenient than job schedulers for a situation, where most of the jobs are sequential in nature. Mosix [16], OpenMosix [15] and Condor [13] are examples of load balancing softwares. These also have many other useful features and are often used instead of job schedulers on small clusters. Recently, an OpenMosix cluster has been set up in IUCAA.

A concept called the grid has been proposed to harness the available computing power. A large number of computing facilities accessible on the Internet can, by mutual agreement, allow requests for resources to be made available to the set of all the users. Thus, jobs will get scheduled at whichever facility is underused at the given moment. Software implementations of the grid [17] must incorporate features for secure transactions between different computing facilities that may be of a completely different type and located on different continents. This idea and the software being written for the purpose can also be used to efficiently manage sites with multiple computing facilities, where the grid software serves as a coherent job management system.

2 Astronomy and Astrophysics

Computations of interest in astronomy are similar to those required in physics and chemistry. Efficient subroutines for most computational requirements can be found on many repositories, e.g., see [34]. Parallel versions of these subroutines can be used to enhance performance of programmes without making significant changes to the sequential programs [35, 36, 37]. A comprehensive list of software packages and subroutine libraries of interest to astrophysicists is maintained at the astrophysics source code library (ASCL) [33].

Astrophysics applications of many diverse types have been parallelised. Several parallel algorithms for N-Body simulations have been proposed and implemented, e.g., see [41, 42, 43, 44, 45]. Figure 3 shows the performance of the Parallel-TreePM code as an example of how the performance of an N-Body code scales on a cluster. Some of the codes mentioned above also solve for gas dynamical effects. Mesh based codes for MHD have also been parallelised, e.g., see [46, 47]. CMBfast [48] is a popular software package for computing the temperature anisotropy power spectrum for the cosmic microwave background radiation. Many familiar packages have been rewritten to incorporate support for MPI, e.g., [49]. The number of astrophysics applications that have been parallelised is very large and we refer the reader to ASCL [33] and other web resources for a more exhaustive listing.

3 Discussion

Large scale computations of complex nature are the main reason why high performance computing facilities are needed by astrophysicists. High performance computing is also relevant, whenever large amounts of data is to be processed, e.g., the Sloan Digital Sky Survey [38]. Cluster computing being the least expensive option, is the most popular one as well. Computers that form part of a cluster can serve as desktop computers for several years after they cease to be useful as part of a high performance computing platform.

Several clusters with performance up to 1 Tera flop have been set up at less than Rs.25,000 per Giga flop [25, 26, 27]. Multi-processor RISC workstations cost at least 4 times, this can still be worth the cost if a large number of applications are sequential. But in such a case, it is important to ensure that each processor in the RISC workstation is much faster than commodity processors.

There are only a few high performance computing facilities available to academic users in India, though the number is increasing rapidly. A list of such facilities is maintained at http://cluster.mri.ernet.in, please refer to this with caution as participation is voluntary and sometimes it is difficult to get the relevant details.

Setting up a small cluster with a target performance of 50 Gflops is well within the scope of individual departments and can be set up and managed by one or two dedicated users. Happy (cluster) computing.

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UGC-Infonet

Ajit Kembhavi

The UGC-Infonet is a major initiative undertaken by the University Grants Commission (UGC) to bring the benefits of Information and Communication Technology (ICT) to all the Universities and Colleges in India. The initiative was formally launched at the beginning of the golden jubilee celebrations of the UGC on December 28, 2002, and has made rapid progress since then. More than a hundred universities have now been provided moderate to high bandwidth internet connectivity, and are able to use it to access invaluable knowledge resources over the World Wide Web. The Infonet is enabling the university sector and college community to actively participate in the process of learning and teaching, regardless of their geographical location, the other resources available on their campus, and the level of their participation in such activity in the past. There are four main divisions to the tasks undertaken by Infonet:

Connectivity: The first task of the programme was to provide Internet connectivity to the universities. This was done with the help of ERNET, which is the pioneering Internet Service Provider (ISP) for the academic community in India. By the end of June 2004, 113 universities all over the country have been connected to the Internet using terrestrial lines, where these are available, and satellite connectivity in the more remote areas. The bandwidth provided ranges from 128 kbps to 2 Mbps depending on the perceived needs of the specific university and the infrastructure available for the connectivity. The number of connected universities will increase to 150 in just a few months and will keep increasing at steady rate. The capital costs for the connectivity have been entirely borne by the UGC, which will also pay 90% of the rental for the lease lines. The bandwidth provided to the universities will soon be increased to a minimum of 500 kbps. State-of-the-art monitoring devices and software are being used for tracking the level of usage and the performance of the network. A programme has also been started to provide connectivity to colleges at a very reasonable cost, and it is hoped that the academic community over the whole country will benefit from the programme in a year or so.

E-Subscription: The library resources available to the university community have been dwindling at an alarming rate over the last two decades or so, because of the steeply increasing costs and the decrease in resources available to any one university. The community has, therefore, been deprived of research journals, reviews, and access to databases which are critical for research and developmental work. One of the primary aims of the Infonet has been to address this issue by providing electronic access to the literature. An increasing number of publishers now offer electronic access delinked from print subscription, and this facility can become extremely cost effective when user institutions come together in the form of a consortium. Using this route, over the last six months, about 50 universities have been provided with access to more than two thousand journals from prestigious international publishers, and access to eight major databases. The literature covers essentially all fields of learning, including social sciences, humanities, physical, chemical and biological sciences, mathematics, etc. The scheme will be extended to another 50 or so universities in the next several months, and the entire system will be covered in the next two years. A scheme is also being drawn up for students and faculty from undergraduate and postgraduate colleges, so that the community everywhere in the country can reach the best literature. This project has brought the universities on par with the best research and teaching institutions in the country. The E-subscriptions are administered and managed by INFLIBNET (Information and Library Network, Ahmedabad). The consequent single-point interaction with publishers has made it possible to expand rapidly the scope of the literature provided and the number of universities covered. It is hoped that it will be a model for other developing countries.

Training: Training in various aspects of ICT is critical for effective use of the facilities offered by the Infonet. The training has to be imparted to Library and IT professionals, who will be the resource persons on every campus, as well as to faculty and students who are the ultimate users. Training in various aspects of the Infonet is being provided by courses conducted by ERNET and by INFLIBNET on their own campuses, as well as by INFLIBNET on individual University campuses all over the country.

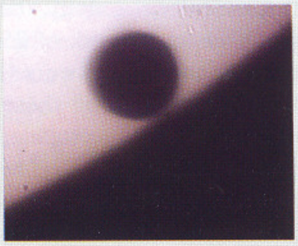
The UGC has Academic Staff Colleges (ASC) on 51 university campuses for conducting refresher courses, and orientation and other similar programmes. As a part of the Infonet activity, the ASC have been provided with a state-of-the-art network of 25 computers along with peripherals and useful softwares. Specialised courses in ICT will be conducted using these networks, with the help of university faculty as well as computer professionals from the industry. The aim of these courses is to keep the user community abreast of the developments and to prepare it for making their own contributions, and developing adequate courses for regular teaching in these subjects. It has also been decided that a portion of every refresher and orientation course would be devoted to the application of ICT to the specific field of the course, so that many experts become available for bringing thousands of colleges in the country to the Infonet.

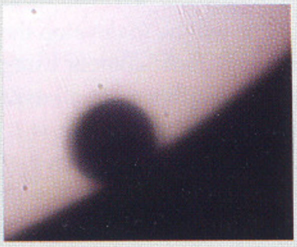
E-Content Development: The most important, and the most difficult part of the entire Infonet exercise will be to develop the infrastructure for the development of educational content using electronic multi-media techniques, and to distribute this all over the country using the internet connectivity. The idea here is to combine the domain expertise in every field of knowledges, that is available amongst university faculty, with the ICT expertise of proven international standards available with the Indian software industry. Here again a twin-track approach will be followed: (a) The UGC has drawn up a scheme through which university faculty can undertake projects for development of electronic content. Grants will be provided through the project for acquiring appropriate software packages and for software developments. Expert help for casting the content in multi media format will be made available . (b) Systematic development of content will be undertaken through active collaboration between large IT companies and the University system. The multi-media content developed will be distributed using the internet, both in streaming formats at a fixed schedule, as well as in web-based form. The content will be supplemented by problems and exercises, interaction with teachers through the web, and test and examinations. This system will enable content developed by the best teachers and experts to reach the most remote corners of the country, and to be available to every teacher and student who may want it. It is expected that this development will complement traditional learning and teaching, which will always continue to remain the most important medium for imparting knowledge. E-content development will be coordinated by CEC (Centre for Educational Comunication, New Delhi) which will help to carry out much of the development through the Educational and Media Research Centres (EMRCs) and Audio Visual Research Centres (AVRCs) located on different university campuses.

The Infonet has progressed rapidly, since its inception just about 18 months ago, in coverage across the country and in the facilities that it provides. The work involved has been done by INFLIBNET, ERNET and CEC, under the advice of a small number of expert committees set up by Professor Arun Nigavekar, Chairman, UGC, who has provided the overall vision and thrust, and with the active cooperation and help of Commission members and staff of the UGC.

Transit of Venus 2004


The Venus has entered the solar disc


The Venus is totally on the solar disc but, it seems to be connected to the edge by a small bridge. The effect is called 'Black-Drop'


The Venus, now seen on the solar disc

The rare event of the transit of Venus took place on June 8, 2004. The last transit of Venus from the earth was seen in 1882, nearly 122 years ago. Thus, this rare planetary alignment grabbed the attention of members of scientific community, public as well as media. IUCAA's 14 inch, 9 inch and a 6 inch telescopes were tracing the Venus, seen as a small black dot on the disc of the Sun. Moving with an angular speed of 3.2 arc minutes per hour, the Venus took about 6.2 hours to cross the disc of the Sun. The disc of the Venus made the first contact with the solar disc at 10:43:29 hrs and it left the solar disc totally at 16:55:59 hrs. Vinaya Kulkarni, Madhura Gokhale, Abhra Ray, Hrishikesh Kulkarni, and Nilesh Puntambekar recorded a movie of the ingress, black drop effect, transit and egress using a web camera attached to the 14 inch telescope.

ZEE News, Star News, Aaj-Tak, and Sahara television channels interviewed A.N. Ramaprakash, Varun Sahni, S.K. Pandey, Ajit Kembhavi, Vinaya Kulkarni, Abhra Ray (M.Sc. Space Science student, Pune University), and Nilesh Puntambekar (Sky Watchers' Association, Pune) on the various aspects of the transit phenomenon. The Zee News was giving live telecast of the views of IUCAA members and the preparations of the transit viewing at IUCAA for two days prior to the event and also on the day of the transit. The Star News gave live telecasts of members of IUCAA on the details of the rare phenomenon of the transit on the day of the event.

Arrangements were made at IUCAA Science Park area to show the transit of Venus to the members of public. The solar image through telescope was projected on a screen. Around 1500 people visited IUCAA to view the transit.


At IUCAA, people had queued up to view the transit of Venus

IUCAA Preprints (April-June 2004)

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

Ranjan Gupta, Harinder P. Singh, K. Volk, and S. Kwok, *Automated classification of 2000 bright IRAS sources*, IUCAA-8/04; Francisco Valdes, Ranjan Gupta, James A. Rose, Harinder P. Singh, and David J. Bell, *The Indo-U.S. library of Coude feed stellar spectra*, IUCAA-9/04; Prasad Subramanian, B.S. Pujari, and Peter A. Becker, *Angular momentum transport in quasi-Keplerian accretion disks*, IUCAA-10/04; Suresh Chandra, *Search for an interstellar Si_2C molecule: A theoretical prediction*, IUCAA-11/04; R.S. Kaushal, *Model independent studies of cosmological dynamics of phantom field*, IUCAA-12/04; Manuel Malheiro, Subharthi Ray, Herman J. Mosquera Cuesta, and Jishnu Dey, *General relativistic effects of strong magnetic fields on the gravitational force: A driving engine for gamma-ray bursts in SGRS?*, IUCAA-13/04; Sanjit Mitra, Anand S. Sengupta, and Tarun Souradeep, *CMB power spectrum estimation using non-circular beam*, IUCAA-14/04; Patrick Petitjean, A. Ivanchik, Raghunathan Srianand, et.al *Time dependence of the proton-to-electron mass ratio*, IUCAA-15/04; A.R. Prasanna, and Subharthi Ray, *Self lensing effects for compact stars and their mass-radius relation*, IUCAA-16/04; Ramesh Tikekar, and Kanti Jotania, *Relativistic superdense star models of pseudo spheroidal space-time*, IUCAA-17/04; Varun Sahni, *Dark matter and dark energy*, IUCAA-18/2004; Amir Hajian, and Tarun Souradeep, *Statistical isotropy of the WMAP data : A bipolar power spectrum analysis*, IUCAA-19/04; N.K. Lohani, and Lalan Prasad, *Heating of solar coronal loops by phase-mixing*, IUCAA-20/04; Suresh Chandra, and S.A. Shinde, *Suggestions for an interstellar C_5H_2 search*, IUCAA-21/04; and Ujjaini Alam, Varun Sahni, and A.A. Starobinsky, *The case for dynamical dark energy revisited*, IUCAA-22/04.

Erratum

"Somnath Bharadwaj, Suketu P. Bhavsar, and Jatush V. Sheth, *The size of the longest filaments in the universe*, IUCAA-50/03".

The above preprint was issued during the period January-March 2004. However, the names of Suketu P. Bhavsar and Jatush V. Sheth were inadvetently missed out. The error is regretted.

Visitors during April to June 2004

M. Sami, Arvind Gupta, Gopika Krishnan, Lakshmi Vijayan, F.K. Sutaria, Anupreeta More, Vandana Suresh, Sandeep Warrier, Cheryl Pinto, Chetan Chaturvedi, Piyali Mitra, Ninan Sajeeth Philip, G. Jacob, A.P. Jayalekshmi, Anu Abraham, Sumy Thomas, Bini Samuel, Lince Thomas, G.C. Anupama, Suresh Chandra, Priya Hasan, Badri Krishnan, K.Shanthi, C. Mukku, Pramod Musrif, R.N. Ghosh, K.S. Umesh, G. Mohanty, G. Ambika, Ujjal Das, A. Paranjape, H.P. Singh, B. Mukhopadhyay, S. Sahijpal, V.B. Bhatia, K.P. Harikrishnan, G.P. Singh, Malay Maiti, K. Jotania, R.S. Kaushal, D. Lohiya, R. Tikekar, A.C. Kumbharkhane, Subenoy Chakraborty, Ujjal Debnath, U. Dodia, A. Mohan, D.C. Srivastava, T.P. Prabhu, Snigdha Das, S.R. Choudhury, Rajendra Shelke, Sanjay Pandey, A. Banerjee, S.K. Pandey, A.A. Usmani, Yogesh Mathur, S.N. Hasan, P. Hasan, J. Maharana, C.D. Ravikumar, P.K. Suresh, Lalan Prasad, N.K. Lohani, Nagendra Kumar, Himanshu Sikka, Meenakshi Yadav, V.C. Kuriakose, P. Udayashankar, D. Maitra, Tanuka Chatterjee, Asis Kumar Chattopadhyay, S.Mukherjee, S. Trivedi, Russell Cannon, Rabin Chhetri, Yash Pal, Dinesh Thakur, M. Watve, T.R. Seshadri, S. Konar, N. Banerjee, K.K. Mondal, G.D. Sharma, S. Banerji, Pankaj Joshi, C.V. Vishveshwara, D.V. Gadre, Aalok Pandya, Tarun Sanghi, M. Trivedi, Jaswant Kumar, S. Unnikrishnan, P.K. Srivastava, S.G. Ghosh, D. Deshkar, S.B. Sarwe; K.Y. Singh.

Apart from these, 29 students attended the summer school and 8 students attended the Vacation Students' Programme.

Visitors Expected

July

Laxmikant Chawre, Pt. Ravishankar Shukla University, Raipur; Yashar Akrami, Sharif University of Technology, Iran; Ehsan Kourkochi, Sharif University of Technology; P.N. Pandita, NEHU; A. Pradhan, Hindu P.G. College, Zamania; Bhim Prasad Sarmah, Tezpur University; Somak Raychaudhury, University of Birmingham; Indranil Chattopadhyay, Centre for Plasma Astrophysics, Belgium; Aliakbar Dariush, Shiraz University, Iran; Arnab Kumar Ray, HRI, Allahabad; L. Sriramkumar, HRI, Allahabad; Arno Dirks, United World College; and M.H. Dehgani, Shiraz University, Iran.

August

Bobomurat Ahmedov,Tashkent Institute of Nuclear Physics; Valeria Kagramanova, Tashkent Institute of

Continued on page 12...

For The Younger Minds – 9

Anyone who has tried walking with a bowl of soup in one's hand would have noticed the oscillations set up in the soup. The basic mode of oscillations is what is known as "sloshing mode" in which the fluid just sloshes back and forth. Estimate the frequency of oscillation of this sloshing mode.

Solution to *For The Younger Minds-8*

T. Padmanabhan

It is possible to have several (very complicated) density distributions, which will all produce a *strict* $(1/r^2)$ force outside the distribution. The simplest way to generate such solutions is to use the following fact. Let $\phi[\mathbf{x};\rho(\mathbf{x})]$ be the gravitational potential at a point $\mathbf{x}$ due to a density distribution $\rho(\mathbf{x})$. Consider a new density distribution $\rho'(\mathbf{x}) = (a/x)^5\rho(a^2\mathbf{x}/x^2)$ with $x = |\mathbf{x}|$. It can be easily shown that the gravitational potential due to $\rho'(\mathbf{x})$ is $\phi'(\mathbf{x}) = (a/x)\phi(a^2\mathbf{x}/x^2)$.

Let us now consider a distribution of matter in a finite region $\mathcal{R}$ of the space which produces constant gravitational potential in some compact region $\mathcal{C}$ within $\mathcal{R}$, say. [See, for example, problem 1 of "For the Younger Minds - 2"; superposition of different solutions discussed there will lead to constant potential in an empty cavity inside a matter distribution.] Let $\mathcal{S}$ be an imaginary spherical surface of radius a with centre inside the compact region $\mathcal{C}$ and encompassing $\mathcal{R}$. If we now "invert" the space with respect to $\mathcal{S}$ by mapping each point $\mathbf{x}$ to $(a^2\mathbf{x}/x^2)$, the region $\mathcal{C}$ will get mapped to a non compact region outside the matter distribution. From the result quoted above, the potential in the outside region will now vary as $1/r$ since, the original potential inside $\mathcal{C}$ was constant. This provides an explicit construction of an asymmetric density distribution producing $1/r$ potential outside.

A well-known example of this occurs in the electrostatic problem of a point charge and a conducting sphere. This problem is usually solved by the method of images, in which induced charge on the surface of the sphere is replaced by an image *point* charge. This, in turn, means that the effect of the charge density induced on the surface of the conductor is equivalent to that of a point charge. Of course, the gravitational situation is different in the sense that no negative mass is allowed but this can be easily taken care of by superposing solutions.

[For further reading: "Cosmology and Astrophysics *through* Problems" by T. Padmanabhan, Cambridge University Press (1996), Problem 1.11]

Visitors expected contd...

Nuclear Physics; Lau Loi so, Taiwan; Kailash Sahu, StSci, Baltimore; and Khalid Saifullah, Quid-e-Azam University, Pakistan.

September

About 100 participants from abroad and 40 from India are expected to attend the Interoperability meeting of International Virtual Observatory Alliance, during September 27 to October 1, 2004.

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

We welcome your responses at the following address:

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