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Fourteenth Foundation Day Lecture of IUCAA

The fourteenth Foundation Day lecture of IUCAA was delivered by Mr. N.R. Narayana Murthy, Chairman of the Board and Chief Mentor of Infosys Technologies Limited, Bangalore. He chose a theme which is close to the hearts of several academics: "***A Framework for Excellence in Higher Education.***" The key points were delivered with a surgeon like precision and Mr. Murthy was categorical in what can and cannot be accepted in the field of higher education. He pointed out that India needs an efficient innovation system of industry and universities to create new knowledge and technology. Further, higher education drives innovation and innovation drives progress. In this context, India has one of the largest higher education systems in the world. Nevertheless, total enrollment in higher education is only 6% of relevant population (17-23 year olds). Similar problems exist at every level, as illustrated by Mr. Murthy in his talk with specific examples. He suggested the importance of depoliticising higher education, bringing it into the domain of market economy, so that competition can drive the quest for excellence and emphasized the need for courageous decisions. He further added that, "In a democracy like India, voice of the majority prevails, but this majority is average and mediocre, opposing every change, good or bad. Only competition from across the world will improve our universities."

Mr. Narayana Murthy delivering the lecture

Mr. Narayana Murthy planting a tree

Contents...

The modelof the building of the IUCAA Muktangan Vidnyan Shodhika is being looked at by Shri Pu. Bhagwat, J. V. Narlikar and others

IUCAA Muktangan Vidnyan Shodhika Foundation Stone Unveiled

Foundation stone of "IUCAA Muktangan Vidnyan Shodhika" (IMVS), the Science Exploratorium, was unveiled by the well known Marathi literary doyen Shri. Pu. Bhagawat on December 27, 2002. The Exploratorium will be a building with two floors located on the southern part of IUCAA Science Park. It will house a laboratory having facilities for doing science experiments (including the facility for making amateur telescopes), a library, an open air amphitheater and sky observing facilities consisting of a large telescope and a few binoculars.The IMVS is being built out of a generous benefaction from Smt. Sunitabai Deshpande as well as a grant from the Maharashtra Foundation, USA.

Creating aptitude for science and encouraging curiosity about nature have been considered important parts of education. IUCAA is one of the few scientific institutions that actively participate in this exercise. Appreciating IUCAA's contributions in this field, and to encourage this activity further, Smt. Sunitabai Deshpande has made a handsome donation of Rs. 25 lakhs to the Centre for creating 'Muktangan Vidnyan Shodhika'.The intention to make this donation had in fact been expressed by the multifaceted Marathi humourist *late* Shri P. L. Deshpande, known as 'Pu La' and Smt. Sunitabai Deshpande while Pu La was alive. This has now been fulfilled by Sunitabai.

Workshop on Gravity and Astrophysics

The inauguration of the workshop at Mar Thoma College

A three days workshop on Gravity and Astrophysics, sponsored by IUCAA, Pune, was held at Mar Thoma College Tiruvalla, Kerala, during October 7 - 9, 2002.

The workshop was inaugurated by the Manager of the College and the Metropolitan of Mar Thoma Church, His Grace The Most Rev. Dr. Philipose Mar Chrysostom Metropolitan. The lectures were delivered by G. Date (Einstein's Equations and Solar System tests); A. Kembhavi (Stellar Structure and Evolution); Ranjeev Misra (Radiation and Accretion Disks); and J. V. Narlikar (Elements of Tensor Analysis in General Relativity). About 100 postgraduate students in Physics, 20 B.Sc. students and 30 research students and teachers from different colleges and universities in Kerala participated in the workshop.

In addition, there were popular talks in the college auditorium by K. Indulekha of the Mahatma Gandhi University, Kottayam on "Tensor Analysis" (in Malayalam) and by J. V. Narlikar on "Cosmic Illusions". The popular talks were well received. About 400 people including class XI, XII students from various schools, general public and students from other disciplines attended the talks with great enthusiasm. A number of students participated in the 'question time' and prizes were awarded for the best question of the day. The coordinators of the workshop were Fr. A. Abraham and A. K. Kembhavi.

Congratulations

... to **Naresh Dadhich**
on being invited to be an honorary Research Professor at the University of Natal, South Africa.

BASHES COME HOME

IUCAA finally managed to win the Annual Bashes Cricket match against the combined might of GMRT and NCRA. IUCAA won the toss and elected to bat. Thanks to some aggressive batting by Santosh and Vijay. IUCAA put up a score of 119 for the loss of 9 wickets. This proved too much for the opposition, who managed to reach (Nelson) 111 for 7 in the stipulated 20 overs. It was a well fought game and the return of the Bashes has brought new confidence to the IUCAA Team. Congratulations!

Workshop on Gravitation and Astrophysics

J.V. Narlikar delivering a lecture

An IUCAA sponsored workshop on Gravitation and Astrophysics was held at Science College, Congress Nagar, Nagpur, during October 27-30, 2002. About 65 selected delegates attended the four-days workshop, out of which about 15 were from outside the region.

The main aim of the workshop was to provide an opportunity to students, research scholars and teachers in the region to get an exposure of the exciting field of gravitation, cosmology and astrophysics, and make them aware of the recent developments in the field. Those who are already initiated in research got a good opportunity for interaction with the experts. J. V. Narlikar and K. Subramanium delivered a series of lectures on cosmology, Banibrata Mukhopadhyay spoke on accretion disks, Sajith Philips discussed neural networks and their applications, N. Dadhich gave a course on basics of general relativity and A. Kembhavi talked about radiative processes in astrophysics, in addition to delivering a public lecture on "Super massive Black Holes - Are there Billions of Them?" The public lecture was at a level appropriate for school students and even laymen.

Besides lectures, there were interactive discussion and presentation sessions as well. This gave a rare chance to participants from the region to interact with these experts. Sushant Ghosh from the Mathematics Department of the college, who is a visiting associate of IUCAA, was the local coordinator of the workshop.

Introductory School on Astronomy and Astrophysics

An Introductory School on Astronomy and Astrophysics was held at N. E. S. Science College, Nanded, during December 18-21, 2002. Colleges under Nanded Education Board run undergradute programmes in A & A. The participants were predominantly undergraduate (about 60) and postgradute (about 20) students along with physics teachers from nearby colleges and universities (about 20).

Six topics were covered during the school: Introduction to Astronomy (A. N. Ramaprakash), Our Solar System (A. Paranjpye), Compact Objects, Accretion Disks and Their Properties (B. Mukhopadhyay) Special Theory of Relativity in Astronomy (H. K. Jassal), Our Sun (P. Subramanian) and Gravitational Waves and their Detection (S. K. Sahay). A public lecture given by A. Paranjpye on 'The Centre of the Universe' in Marathi at the Nanded Science College Auditorium was well attended and appreciated.

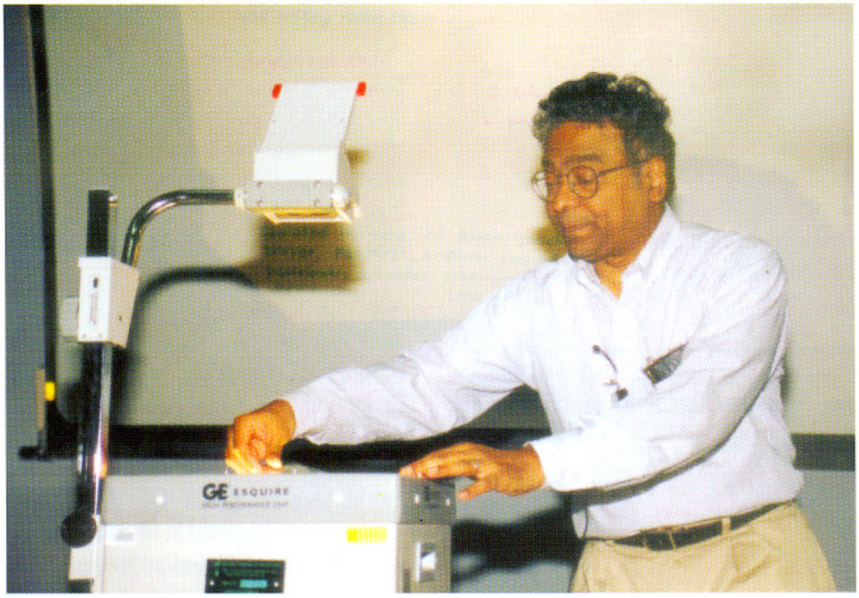
In order to encourage follow up activities after the school, the student participants were asked to write an essay on any one of the six topics covered during the lectures. Authors of the best among these essays will be invited to IUCAA and given oppurtunity to interact with the resource personnel. A. N. Ramaprakash and M.J. Nimkar were the coordinators of the workshop.

The Introductory Workshop on Astronomy and Astrophysics

The Introductory workshop on Astronomy and Astrophysics for college students was held at Fergusson College, Pune, during November 26 -28, 2002, co-sponsord by Fergusson College and IUCAA. The aim of the workshop was to convey the excitement of modern Astronomy and Astrophysics to postgraduate and senior graduate students, studying science in different colleges in Pune. There was enthusiastic participation in the workshop with about 100 students participating in the programme. Lectures were given by N.K. Dadhich, A.K. Kembhavi, J.V. Narlikar, T. Padmanabhan, R. Srianand (from IUCAA), R. Nityananda (from NCRA) and Raka Dabhade (of Fergusson College).

On the last day of the workshop, a discussion session on "Careers in Astronomy" was organised at IUCAA. The panel consisting of N. Dadhich, J.V. Narlikar, R. Nityananda and V.K. Wagh answered a wide variety of questions raised by the students regarding the career progress in Astronomy and Astrophysics. Once again the response was very enthusiastic with several students actively participating in the discussions and expressing their opinion. After the discussion session, the students visited different scientific exhibits in IUCAA and participated in the Night Sky Watching Programme organised by Arvind Paranjapye. It is hoped that similar activities can be held every year catering to the students in Pune colleges. The coordinators of the workshop were Raka Dabhade from Fergusson College and T. Padmanabhan from IUCAA.

The 22nd Meeting of the Indian Assocaition for General Relativity and Gravitation



Abhay Ashtekar delivering a lecture

IUCAA hosted the 22nd meeting of the Indian Association for General Relativity and Gravitation (IAGRG) during December 11-14, 2002. The IAGRG meetings are held roughly once in 18 months. This meeting, with around 100 participants, was considerably larger than its recent predecessors. Apart from a broad representation from the Indian GR community, the meeting had about a dozen foreign participants.The scientific programme had 7 review talks and 18 invited talks on topics of current interest ranging from classical GR, quantum gravity, gravitational radiation, astrophysics and cosmology. It also featured 18 short oral research presentations and an equal number of poster presentations. There was a conscious effort to provide opportunity to younger researchers to deliver the invited talks. A highlight of the meeting was the Vaidya-Raychoudhury endowment award lecture, delivered by Rajaram Nityananda, Centre Director, NCRA. His lecture titled "Gravity and light" covered different aspects of propagation of light in general relativity. Besides IUCAA, the meeting was co-sponsored by grants from the Council for Industrial Research (CSIR), New Delhi and Institute of Mathematical Sciences, Chennai. The scientific programme, abstract book and list of participants can be obtained online at http://www.iucaa.ernet.in/~iagrg02.

Workshop on Early Universe, Large Scale Structure and the CMBR

The IUCAA - Delhi University Workshop on Early Universe, Large Scale Structure and the CMBR was held during November 16 - 21, 2002 at the IUCAA Reference Centre, Department of Physics, University of Delhi. The inaugural talk was given by N. Panchapakesan on "Cosmology: Facts and Fiction". There were 11 pedagogical talks on the follwing topics: T. R. Seshadri (Univ. of Delhi) on FRW Universes (2 talks); Jasjeet Bagla (HRI, Allahabad) on Structure Formation (3 talks); K. Subramanian (IUCAA, Pune) on CMBR Anisotropy and Polarization (2 talks); D. Narasimha (TIFR, Mumbai) on Gravitational Lensing and Large-scale Structures (2 talks); T.Padmanabhan (IUCAA, Pune) on Cosmological Constant and Dark Energy (2 talks). In addition, there were a number of seminars by participants. T. R. Seshadri was the coordinator of the workshop.

Participants of the workshop

Coronal Mass Ejections from the Sun: Energetics

Coronal Mass Ejections (CMEs) from the sun are spontaneous expulsions of $\sim 10^6$K blobs of coronal plasma weighing $\sim (10^{14} - 10^{15})$ g, ejected at speeds ranging from a few hundred km/s to as much as 2000 km/s. Carrying kinetic energies of the order of $(10^{29} - 10^{30})$ ergs, CMEs have now been recognized as the most important phenomena affecting the sun-earth environment apart from energetic solar flares.

1 Transient phenomena in the corona

Energetic flares and CMEs are the most commonly discussed transient phenomena in the solar corona. While flares are intense, abrupt releases of energy visible across the electromagnetic spectrum, CMEs are bodily ejections of blobs of coronal plasma. The relationship between flares and CMEs is a subject of considerable debate (see, for e.g., [1]; [2]; [3]). While most of this work focused on a cause-effect relationship between flares and CMEs, it is now becoming clear that they are different, albeit strongly coupled manifestations of the same basic processes in the corona (e.g., [4]). The solar surface exhibits differential rotation (the equator rotates faster than the poles). Magnetic fields in the corona, which have their feet rooted below the photosphere, are continually twisted due to this differential rotation. The magnetic fields are thus stressed, and are far from their minimum potential energy configuration. These stressed fields undergo a catastrophic loss of equilibrium and consequent rearrangement to the minimum potential energy configuration via magnetic reconnection in response to stimuli such as emerging or cancelling magnetic flux. Some of the free energy stored in the stressed magnetic fields is spent in accelerating particles and heating the coronal plasma (and consequently converted into radiation) while some of it is expended in lifting and accelerating the CME against the gravitational potential of the sun. This is a unified picture that explains both flares as well as CMEs (e.g., [5]). It must be pointed out, however, that only relatively large flares and fast CMEs seem to be associated with each other. There are several instances of CMEs occuring without flares and vice-versa.

2 CMEs: Evolution and terrestrial effects

In general, the conditions in the source regions of CMEs are rather complex, and the initiation mechanism of CMEs is a subject of intense ongoing research (e.g., [6], [7]). Specifically, it is not clear what precisely constitutes a CME in the lower corona. Observationally, CMEs are outward propagating density enhancements seen in white light in the field of view of a coronograph (Figure 1).

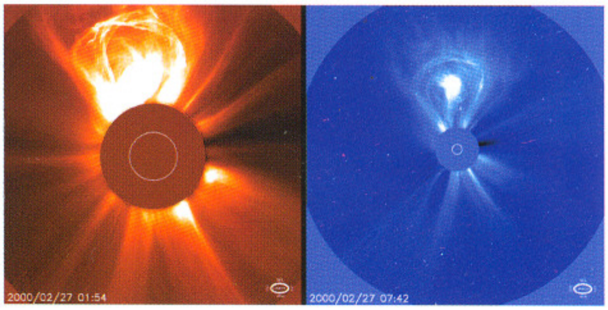


Figure 1: Images of a CME on 27 February 2002 from the LASCO instrument aboard SOHO. The left panel is an image from the C2 coronograph, which has a field of view (2.2 – 6.0) $R_\odot$. The right panel is from the C3 coronograph, which has a field of view (3.7 – 30) $R_\odot$. In both images, the inner white circle represents the sun, while the outer disk shows the extent of the occulter.

There are some instances of dimmings and mass losses in the lower corona that probably constitute the onset phase of CMEs in the lower corona ([8]; [9]; [10]). However, the evolution of CMEs in the lower corona, beneath the occulting disks of coronographs (i.e., below $\sim$ 1–2 $R_\odot$) remains poorly understood. We will focus on a relatively better defined problem in this article; the evolution and energetics of CMEs from $\sim$ (2.2 - 30) $R_\odot$. Such studies ([11]; [12]) have been made possible only recently, because of the availability of high quality coronograph data from the Large Angle Spectrocopic Coronograph (LASCO, [13]) aboard the Solar and Heliospheric Observatory (SOHO, [14]).

Before embarking upon a discussion of the energetics of CMEs in the inner heliosphere (from $\sim$ 2 – 30 $R_\odot$), we pause to briefly re-emphasize some of the overall motivations for studying CMEs from the sun. CMEs directed towards the earth have an important bearing on the solar-terrestial environment. They are often accompanied by energetic particles (associated with the accompanying flares) which affect satellite electronics, astronaut safety and even have implications for radiation experienced by airline passengers. Earth-directed CMEs can impact and damage satellites. Furthermore, they often cause geomagnetic storms when they impinge on the earth's magnetosphere. Geomagnetic storms, in turn, cause spectacular auroras at high latitudes and induce large currents in power grids, and oil and gas carrying pipelines. Such storms also induce ionospheric currents, thereby affecting radio communications. This apart, an understanding of dynamic transients in the solar corona will have important implications for understanding more distant solar-like stars with coronae. Interestingly, however, coronal transients like flares and CMEs have negligible effects/consequences on the overall energy budget of the sun. There are some indications, however, that the magnetic fields (and the associated magnetic helicity in particular) carried off by CMEs might have a bearing on the poorly understood solar magnetic cycle (e.g., [15]; [16]).

3 CMEs: White light coronograph observations

CMEs have traditionally been defined as eruptions of matter visible in white light coronographs. Early observations of CMEs with the Skylab and Solar Maximum Missions have been well summarized in [1], [17], [18] among others. Since then, the LASCO coronographs aboard the SOHO mission have provided a steady stream of high quality white light images of the solar corona (see http://lasco-www.nrl.navy.mil). An example of a CME observed with the LASCO C2 and C3 coronographs is shown in Figure 1. The inner white circle represents the sun and the outer disk is the occulting disk of the coronograph. The occulting disk creates an artificial eclipse, blocking photospheric light and allowing one to see the faint corona of the sun. The C2 coronograph has a field of view of (2.2 - 6.0) $R_{\odot}$ while the C3 coronograph has a field of view of (3.7 - 30) $R_{\odot}$. Such coronographs detect the photospheric light Thomson-scattered by coronal electrons and therefore, provide a means to measure coronal density. Transient phenomena such as CMEs appear as intensity enhancements in these images. Due to the intrinsic angular dependence of the Thomson scattering process, features in the plane of the sky are emphasized (as compared to those out of the plane of the sky) in such images.

4 Morphology of CMEs

The general morphology of CMEs is varied and complex. The so-called 'classic' CME has a bright front, a dark cavity following it, with a bright core embedded in it, much like that in the C3 image in Figure 1. However, CMEs in general have a variety of shapes and sizes. The orientation of a CME with respect to the plane of the sky determines its appearance in a coronograph image to a considerable extent. For instance, the appearance of the CME shown in Figure 1 changes considerably between the C2 and C3 fields of view. In this article, we concentrate on CMEs that have a 'flux rope' like morphology. Such CMEs are envisaged to contain magnetic fields of the form of a helical rope, much like a telephone cord. Since the coronal plasma is highly conducting, it is well confined along the magnetic lines of force, and the intensity enhancements evident in a white light coronograph are taken to be tracers of the magnetic field. Helical magnetic fields are often observed to confine solar prominences, and the theoretical basis for flux-rope like configurations in erupting CMEs is well established (e.g., [19]). A cartoon of a magnetic flux rope is shown in Figure 2. The flux rope has its feet embedded in the

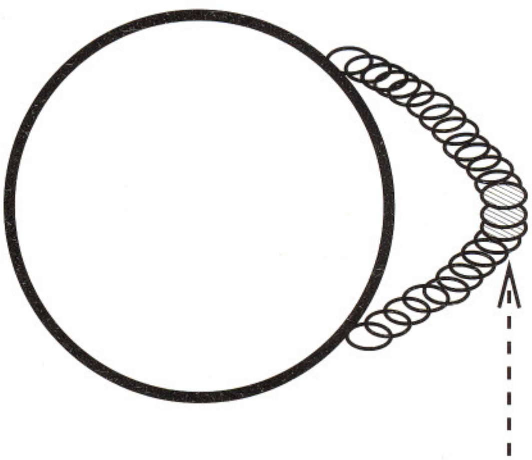


Figure 2: A cartoon of a flux rope with its ends rooted on the solar surface. The arrow indicates the viewing direction. From this direction, a superposition of the shaded cross-sections will be visible.

corona, and a projection of its cross section will be visible in coronograph images. The cross-sections of the flux rope visible from the indicated viewing direction are shaded in Figure 2. A superposition of these cross-sections are visible in the coronograph data of Figure 3, where the viewing direction is perpendicular to the plane of the paper. As the flux rope erupts, it expands; this is reflected in the larger flux rope cross section in the right panel of Figure 3 as compared to the left panel. In other words, the flux rope has expanded as it has progressed outwards through the corona.

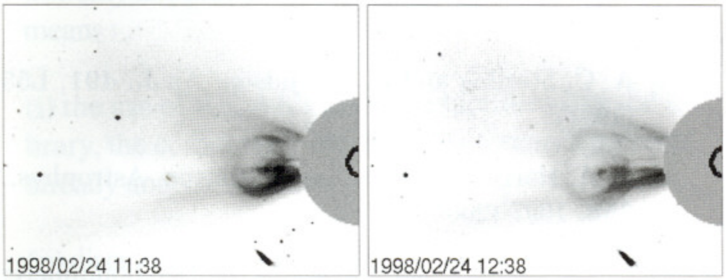


Figure 3: Adapted from [11]. This is the mass image of a typical flux rope CME. Such a mass image is derived from intensity images such as figure 1. We are viewing the cross section of a flux rope (see Figure 2). The viewing direction here is perpendicular to the plane of the paper, so we observe a superposition of the cross-sections shown as shaded ellipses in figure 2. By delineating the extent of the flux rope cross section in successive mass images, we can follow the evolution of the center of mass, kinetic and potential energies of the CME.

5 Mass and energy of CMEs

The intensity of Thomson scattered light from a density enhancement depends upon the density and the orientation of the enhancement with respect to the plane of the sky. Structures that are closer to the plane of the sky (paper) are visible more clearly than structures that are out of the plane of the sky. Since we select events that have clearly defined flux rope-like morphologies in the coronograph images, we assume that the CME is not displaced by more than 20 degrees from the plane of the sky as it propagates outward. Using this assumption, we backtrack through the basic Thomson scattering calculation to obtain a 'mass image', in which the brightness of each pixel gives the excess column density in that pixel over a suitable background. Figure 3 is such a mass image of a CME with a suitable pre-CME background subtracted off. By simply circumscribing the extent of the flux rope via visual inspection, one can obtain the total mass contained in such a CME at a given time. By following the evolution of such a CME through several frames and outlining the extent of the CME in each frame, one can follow the evolution of the center of mass, kinetic and potential energies of the CME. The magnetic energy contained in these CMEs cannot be measured directly. A rough estimate of the magnetic energy is made by estimating the average magnetic flux contained in magnetic clouds near the earth, and assuming that the magnetic flux is frozen in with the CME as it travels outwards. These calculations were first done for a sample of 11 flux rope CMEs in [11]. A similar study on a larger sample of around 50 such CMEs has been carried out in [12]. Figure 4 shows the results for a typical flux rope CME. The re-

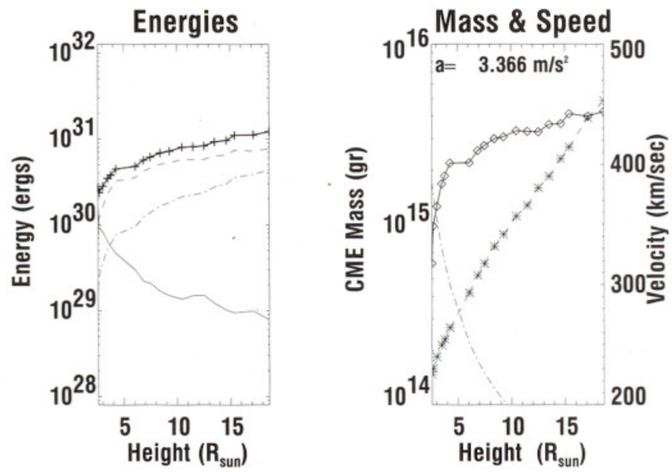


Figure 4: LASCO measurements of a flux rope CME on 17 Nov 2000. The horizontal axis denotes heliocentric height in $R_{\odot}$. *Left Panel*: Evolution of potential (dashed lines), kinetic (dash-dotted lines), magnetic (solid lines) and total (solid lines with plus signs) CME energies. The total energy is the sum of potential, kinetic and magnetic energies. *Right Panel*: Evolution of mass (solid lines with diamonds) and the center of mass speed (dashed lines with asterisks). The derived accelerations are also shown. The dash-dotted line is the escape speed from the sun as a function of height.

sults from the study of [11] indicate that for relatively slower CMEs that are eventually advected with the solar wind, the magnetic energy advected by the flux rope is given up to the potential and kinetic energies, keeping the total energy roughly constant. This indicates that beyond $\sim 2R_{\odot}$, these CMEs are essentially closed systems, and are magnetically driven, although the details of the manner in which magnetic energy is converted to mechanical energy are not clear. Fast CMEs, on the other hand, are ballistic, and their kinetic energies exceed their magnetic and potential energies, especially in the outer corona, beyond $\sim 15\ R_{\odot}$. The study of [12] has a larger share of such fast events, and is expected to shed some more light on them. It is also expected to reveal the solar cycle dependence of CME energetics and on the manner in which the CMEs expand in the heliosphere.

6 Summary

There are several outstanding unresolved issues related to the initiation and propagation of CMEs. The total energy budget involved in the initiation phase of the flare-CME phenomenon is still far from clear. The initiation mechanism apart, the development of CMEs in the lower corona, below the occulting disk of coronographs, is not very well understood. There are a handful of observations pointing to dimmings/mass evacuations in various wavebands ([8]; [9]; [10]) but this is an area that clearly merits further study. While, there seems to be reasonable progress made in understanding the energetics of CMEs beyond $\sim 2R_{\odot}$ ([11], [12]), the manner in which CMEs interact with the overlying streamers on their way out into the heliosphere is still not very clear ([20]). Finally, the initiation mechanism of CMEs continues to be a subject of intense research. While there is progress in understanding the basic magnetic topologies that might result in solar eruptions (e.g., [5]; [21]) it is clear that the source regions of CMEs in general have rather varied characteristics (e.g., [6]).

A majority of SOHO data is available via the SOHO website (http://sohowww.nascom.nasa.gov). The issues raised in this article deal primarily with data from the LASCO, Extreme Ultraviolet Imaging Telescope (EIT) and Michelson Doppler Imager (MDI) instruments. Most of such data analysis uses the Interactive Data Language (IDL) along with a suite of routines written in IDL, called the Solarsoft suite. The Solarsoft routines can be downloaded free of cost from http://www.lmsal.com/solarsoft.

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Associateship Programme

One important component of IUCAA's academic activities is the Associateship Programme, under which a faculty member of an Indian university or a postgraduate department in a college can visit IUCAA for periods of short and long durations over a span of three years to develop his/her interest and expertise in astronomy and astrophysics through any of the following means :

(i) the use of IUCAA's in-house facilities like the library, the computers, etc. towards research projects already undertaken,

(ii) discussion with IUCAA's core academic staff, postdoctoral fellows and visiting experts regarding teaching and research assignments as well as joint projects,

(iii) participation in observational programmes in national and international astronomical facilities, and data reduction,

(iv) carrying out R & D activities in astronomical instrumentation and

(v) joint research projects with members of other universities/postgraduate colleges.

The Associateship Programme has been designed to promote mobility and to this end, the travel and local living expenses of an associate for these visits will be borne by IUCAA as per its rules. The associate will continue to carry out the existing commitments at his/her parent organization. However, since IUCAA has been created by the UGC as a field station for these activities, it is expected that those visiting IUCAA under this scheme will be treated as on duty by their respective organization.

Applications, in plain paper, are invited for the fourteenth batch of associates for the tenure starting from July 1, 2003 to June 30, 2006. The applicants should forward their applications through the heads of their departments/institutions, along with their biodata, list of publications and a brief write-up on the work they intend to carry out as Associates of IUCAA, to **The Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, so as to reach before **April 30, 2003**. In addition, each applicant should arrange for two experts in the field to send their confidential assessment directly to the above address. Those who had applied last year are requested to update their application. The selected candidates will be informed by June 15, 2003.

Welcome to . . .

Pavan Chakraborty, who has joined as a Post-doctoral Fellow to work on the instrumentation related to the IUCAA 2 m. telescope. His research interests are Instrumentation, Cometary Dusts, Stellar Disk, and Extra Solar Planets and their relevance to the origin of the Solar System.

. . . Farewell to

Sushan Konar, who has joined the Indian Institute of Technology, Kharagpur, as a Faculty Member.

S. Shankaranarayanan, who has joined the University of Azores, Portugal, as a Post-doctoral Fellow.

Vacation Students' Programme 2003

IUCAA invites applications for the thirteenth 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. The programme will conclude with seminar presentations of the projects by the participants, and an interview. 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 2003- 2004 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, 2003. The selected candidates will be informed by April 15, 2003 for the programme to be held during May 19 - July 4, 2003.

Refresher Course in Astronomy and Astrophysics (May 19 - June 20, 2003)

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 limited to 20. Interested persons should apply on 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 March 10, 2003. The candidates will be informed of their selection for the course by March 20, 2003.

Seminars

03.10.2002 Sanjit Mitra on *Quantum gravity at small distances*; 16.10.2002 T. R. Govindarajan on *Non-commutative spacetime and quantum gravity*; 17.10.2002 T.P. Singh on *Classical and quantum aspects of gravitational collapse*; 15.11.2002 W. C. Saslaw on *Galaxy clustering and statistical mechanics*; 29.11.2002 Sergei Shandarin on *Quantitative morphology for large scale structure and the cosmic microwave background*; 5.12.2002 Tulsi Dass on *Probability-dynamics unification, noncommutative geometry and autonomous formalism for quantum mechanics*; 23.12.2002 Uriel Frisch on *Reconstructing the initial conditions of our Universe by optimal mass transportation* and 26.12.2002 Anvar Shukurov on *Simulations of the multi-phase interstellar medium.*

Colloquium

17.12.2002 Varun Sahni on *The riddle of dark energy*

Telescope Making Workshop at Margao

A telescope making workshop was conducted at Godavari Naik Hall, M & N English High School, Margao by Association of Friends of Astronomy (Goa) from October 28 to November 17, 2002, jointly with Marathi Vidnyan Patrishad, Goa and under technical guidance and supervision of IUCAA. There were 23 participants from six colleges. Six 6 inch reflecting telescopes were made at the workshop by six teams of school and college students, each accompanied by one teacher. The workshop was made possible due to the financial support received from the Department of Science and Technology, Government of Goa and the active interest taken in the project by its Director, N. P. S. Varde. Most of the students who participated were from the Higher Secondary Schools and Junior Colleges from towns in Goa. Some students travelled as much as 100 km every day to attend the workshop. Expert guidance in all aspects of telescope making was given by Arvind Paranjpye and Vinaya Kulkarni and they personally supervised making of the telescopes.

IUCAA Preprints

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

K. Rajesh Nayak, A. Pai, S. V. Dhurandhar and J.Y. Vinet, *Improving the sensitivity of LISA*, IUCAA-43/02; K. Subramanian and John D. Barrow, *Small-scale microwave background anisotropies arising from tangled primordial magnetic fields*, IUCAA-44/02; K. Subramanian, *Magnetic helicity in galactic dynamos*, IUCAA-45/02; Bikash Chandra Paul, *Inflation in Bianchi models and the cosmic no hair theorem in brane world*, IUCAA-46/02; Varun Sahni and Yuri Shtanov, *New vistas in braneworld cosmology*, IUCAA-47/02; Varun Sahni, *Theoretical models of dark energy*, IUCAA-48/02; Varun Sahni and Yuri Shtanov, *Braneworld models of dark energy*, IUCAA-49/02; Varun Sahni, Tarun Deep Saini, A.A. Starobinsky and Ujjaini Alam, *Statefinder - a new geometrical diagnostic of dark energy*, IUCAA-50/02; Jatush V. Sheth, Varun Sahni, Sergei F. Shandarin and B.S. Sathyaprakash, *Measuring the geometry and topology of large scale structure using SURFGEN: Methodology and preliminary results*, IUCAA-51/02; Joydeep Bagchi, *Discovery of giant 'radio arcs' in cluster Abell 3376: Evidence for shock acceleration in a violent cluster merger?*, IUCAA-52/02; Banibrata Mukhopadhyay, *Stability of accretion disk around rotating black holes: A pseudo-general-relativistic fluid dynamical study*, IUCAA-53/02; J.S. Bagla, H.K. Jassal and T. Padmanabhan, *Cosmology with tachyon field as dark energy*, IUCAA-54/02; S.G. Ghosh and A. Banerjee, *Non-marginally bound inhomogeneous dust collapse in higher dimensional space-time*, IUCAA-55/02; D. V. Ahluwalia, *Evidence for Majorana neutrinos: Dawn of a new era in spacetime structure*, IUCAA-56/2002 and T. Padmanabhan, *Cosmological constant - The weight of the vacuum*, IUCAA-57/2002.

Erratum

The January 2002 issue of Khagol carried a report on Mini School on Astronomy and Astrophysics held at H.N.B. Garhwal University. We regret that Professor N. Panchapakesan's name was inadvertently missed out from the list of lecturers and speakers.

Visitors during October - December 2002

M. Sami, S. Barway, D. Malquori, D.V. Ahluwalia, D. Rosario, S. Barway, C.D. Ravikumar, P.K. Srivastava, A. Pramanik, S. Bhattacharya, K.S.V.S. Narasimhan, A. Zdziarski, M. Safonova, A.Nigavekar, R. Ramakrishna Reddy, S. Mukherjee, M. Whittle, K.S. Sastry, S. Konar, A. Rai Choudhuri, A. Pradhan, T.R. Govindarajan, P.S. Joarder, T.P. Singh, Asoke Sen, P. Shawhan, P. Kumar, A. Khugaev, S.N. Paul, S. Kar, T.A.V. Murthy, B.C. Paul, M.N. Prasad, S.G. Ghosh, G.S. Khadekar, K. Shanti, P.Gopakumar, F. Ahmad, W. Saslaw, Tulsi Dass, F. Ochsenbien, P.N. Pandita, S. Shandarin, U. Debnath, R. Tikekar, Ng. Ibohal, D.C. Srivastava, Saibal Ray, Sanjay Pandey, Deepti Kumar, S. Sahayanathan, K.C. Wali, J. Anandan, P. Prakash, U. Frisch, A. Shukurov, S. Sahijpal, Abhinav Gupta, U. Narain, B.P. Sarmah, S.P. Bhagwat, M. Anagadi, V. Sivakumar, R.P. Bambah, Ved Prakash, Narayana Murthy, A. Toporensky, N. Kumar, N. Panchapakesan

About 70 out station participants attended the IAGRG meeting during December 11-14, 2002.

Visitors Expected January to March 2003

January:
Apoorva Patel, IISc., Bangalore; Arun Mangalam, IIA, Bangalore; J. Babu; A. Starobinsky; Gary Ferland, University of Kentucky; Y. Michel, France; K.P. Harikrishnan, The Cochin College, Kochi; Manzoor Ahmad Malik; G.Burbidge, University of California, San Diego; Bruno Guiderdoni, IAP, France; Irina Radinschi, GH. Asachi Technical University, Romania; R. Ramakrishna Reddy, Sri Krishnadevaraya University, Anantapur; J. Dey, Maulana Azad College, Kolkata; M. Sinha, Presidency College, Kolkata; M. Bagchi, Presidency College, Kolkata; K. Indulekha, M.G. University, Kottayam; Nagendra Kumar, K.G.K. (PG) College, Moradabad; H. Sikka, K.G.K. (PG) College, Moradabad; Rajendra Shelke, College of Engineering, Badnera; Robin Chhetri, Sikkim Govt. College, Sikkim; N. Sajeeth Philip, St. Thomas College, Kozencherry.

February:
Ken Chambers, Bob Joseph, Nick Kaiser, John Tonry, Brent Tully, Harald Ebelling, Institute for Astronomy, Hawaii; A. Brandenberg, Nordita, Denmark.

March:
W. Hutter, Netherlands Science Foundation.

For the Younger Minds - 3

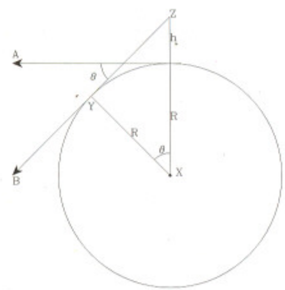
T. Padmanabhan

(1) Why do the hands in a clock rotate clockwise? [People have constructed mechanical clocks which run anti-clockwise but these are mostly curiosities. One simple answer to the question is "by definition"; one can do better than that!]

(2) A black, isolated, spherical body contains a heat source inside. When the heat generated by the source is balanced by radiation from the surface, it's surface temperature is T. A thin spherical shell, with radius slightly bigger than the radius of the body, is kept around the body in order to provide thermal shielding. The shield is black on both sides and is attached to the body by a few insulating rods. What will be the new surface temperature of the thermally shielded body?

Answers to the questions which appeared in Khagol - October 2002

(1) The gravitational force at any point $\mathbf{x}$ inside a constant density (ρ) sphere is $\mathbf{F} = -(4/3)\pi G\rho\mathbf{x}$. Consider now a sphere of radius R and constant density ρ centered at the origin, with a spherical cavity of radius L, with its centre located at $\mathbf{l}$. The force at any point inside the spherical cavity can be found from superposition principle and is given by $F = -(4\pi/3)G\rho\mathbf{l}$. Thus the field inside a spherical cavity, located off-centre within a larger (constant density) sphere is constant. This provides one solution to the problem. Given such a solution, one can construct several others by superposition.



(2) The figure above illustrates the geometry relevant to this problem. The person lying on the beach will see the sunset along the direction A and the person who is standing up will see it along the direction B. Since $h \ll R$, elementary geometry gives $\theta \simeq (2h/R)^{1/2}$. [Incidentally this shows that the distance to the horizon, visible from a height h, is about $\sqrt{2hR}$]. Taking $h \simeq 1.65m$, $R \simeq 6 \times 10^6 m$ we find that $\theta \simeq 10^{-3}$rad. Since the Sun covers π radians in (12×3600) seconds it will take about 12 seconds to cover 10^{-3} rad. Most people find this to be surprisingly large. In fact, by measuring this time difference one can estimate the radius of the Earth. [For a more challenging question, estimate the systematic errors in such an observation.]

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

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

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