



IIA Newsletter

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First IHY Asia-Pacific School

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IIA organized the First Asia-Pacific School on International Heliophysical Year at the Kodaikanal Observatory during December 10 - 22, 2007. The school was co-sponsored by National Aeronautics and Space Administration, USA and the Asian Office for Aerospace Research and Development, Japan. International Heliophysical Year (IHY) is an international programme of scientific collaboration launched in 2007, on the fiftieth anniversary of the International Geophysical Year (IGY), extending through 2008. To address IHY's focus on providing unique opportunities for the global community to increase the visibility and accessibility of the heliophysics outreach programme, the International Steering Committee of IHY mooted the idea of having IHY Schools to educate students about Universal Processes and to provide them with an opportunity to view their own interests in a new context. By enhancing the scope, impact and outreach of the existing space physics programmes at various host locations, the IHY schools enable student cultural exchanges with the goal of establishing innovative new models for graduate education and training in heliophysics.

The overall aim of the IHY school in Kodaikanal was to teach the students how the Sun influences a sphere of 100 AU radius around it through its electromagnetic and mass emissions and the physical processes that are involved. The purpose was to provide an introduction to heliophysics for students who do not have an opportunity to take such a course at their home institution. The school was attended by about 35 students from India and abroad. The participants were mainly pre- and post-doctoral research students. As a special case, a few final year M.Sc. (Physics) students, with an interest in Solar Physics and who want to pursue it further, were also selected.

The school covered a broad spectrum of physical processes in the heliospace: Sun in the Universe, Solar interior, Solar atmosphere and the heliosphere, Solar eruptions and heliospheric consequences, Shocks, flows and obstacles, Dynamo processes, Reconnection processes in Sun and heliosphere, Sun-Climate, Turbulence in the heliospace, Planetary atmospheres, ionospheres and magnetospheres, Radio emission

processes, Energetic particles in the heliosphere, Elemental abundances in the heliosphere, Space platforms for heliophysical studies, Space weather, Cosmic rays and climate.

Speakers were drawn from both India and abroad and there were 45 lectures in total. There were also laboratory exercises for the students to get experience in observations and data analysis. Further details of the school are posted in <http://www.iiap.res.in/ihy/school/>.

— R. Ramesh

Fluorine in R Coronae Borealis Stars

R Coronae Borealis (RCB) stars comprise a sequence of hydrogen-deficient supergiants with effective temperatures from about 3500 K, as represented by Z UMi and DY Per, to about 19,500 K, as represented by DY Cen. They share the characteristic of H-deficiency with H-deficient cool carbon (HdC) stars at low temperatures and with the extreme helium (EHe) stars at high temperatures. The sequence HdC - RCB - EHe in the (T_{eff} , log g) plane reflects a close evolutionary connection.

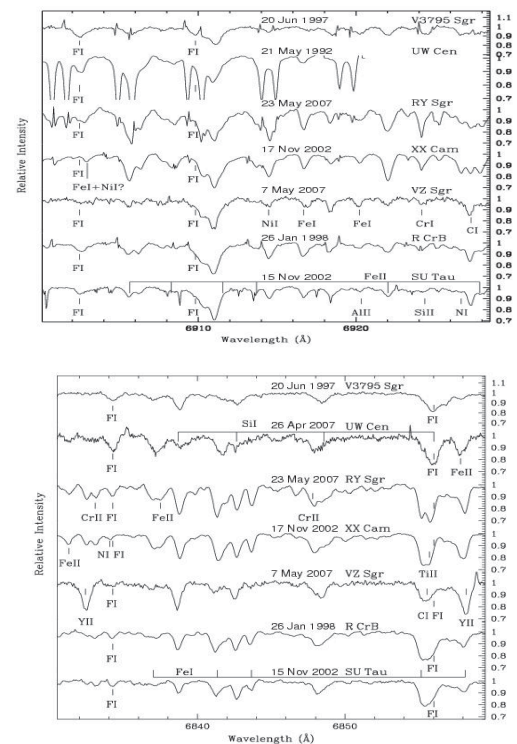
If HdC, RCB, and EHe stars share a common heritage, the expectation is that their atmospheric compositions should show some common features (Pandey et al 2004, Rao 2005). Just 5 HdC, about 40 RCB (Zaniewski et al 2005), and 21 EHe stars are known in the Galaxy. It is through a study of their compositions that one hopes to test theoretical ideas about the origins of these extremely rare stars.

Currently, two scenarios remain in contention to account for these high luminosity hydrogen-poor stars. According to the first, a final He-shell flash in a post-AGB star on the white dwarf cooling track creates a H-poor luminous star. This is dubbed the 'final flash' (FF) scenario. In the second scenario, an H-poor star is formed from a merger of a He white dwarf with a C-O white dwarf. In a close binary system, accretion of the He white dwarf on the C-O white dwarf may lead to a H-poor supergiant with the C-O white dwarf as its core. This is called the 'double degenerate' (DD) scenario.

A determination of which scenario provided which star rests in large part on the observed chemical composition of a star's atmosphere and theoretical predictions about the FF and DD products. Evidence from elemental abundances, especially the H, C, N, and O abundances, suggests that the RCB and EHe stars evolved via the DD rather than the FF route (Pandey et al 2001, Saio & Jeffery 2002, Pandey et al 2006). The convincing and essentially incontrovertible evidence, that the DD scenario led to the HdCs and some cool RCBs was presented by Clayton et al (2007) with their discovery that the ^{18}O was very abundant in their atmospheres.

Presence of this isotope of oxygen was attributed to nucleosynthesis occurring during and following accretion of the He-rich material onto the C-O white dwarf.

Determination of the oxygen isotopic ratios requires a cool star with the CO vibration-rotation bands in its spectrum. The majority of RCBs and all of the EHe stars are too hot for CO to contribute to their spectra (Tenenbaum et al 2005). An alternative tracer of nucleosynthesis during a merger may be provided by the fluorine abundance. Considerable enrichment of EHe stars with fluorine was discovered by Pandey (2006) from detection and analysis of about a dozen F I lines in the optical spectra of cool EHe stars. Calculations by Clayton et al (2007) suggest that F synthesis is possible in the DD scenario. Here, we report on a search for F I lines in spectra of RCBs.



Spectra of RCBs showing F I lines

High-resolution optical spectra of RCBs at maximum light obtained at the Vainu Bappu Observatory and at the W. J. McDonald Observatory in Texas, USA were examined for the suitability of this project. F I lines were identified and analysed for the first time in the spectra of RCB stars. Sakurai's object, a final He-shell flash product, shows no detectable F I lines.

The abundance of fluorine in RCB and EHe stars is about 1000 times the solar abundance. The present challenge is to show that the DD scenario includes the possibility of robustly increasing the F abundance to the observed level of 1000 times the solar abundance. This work has been done in collaboration with David Lambert and N Kameswara Rao and has been

published in The Astrophysical Journal of February 20, 2008.

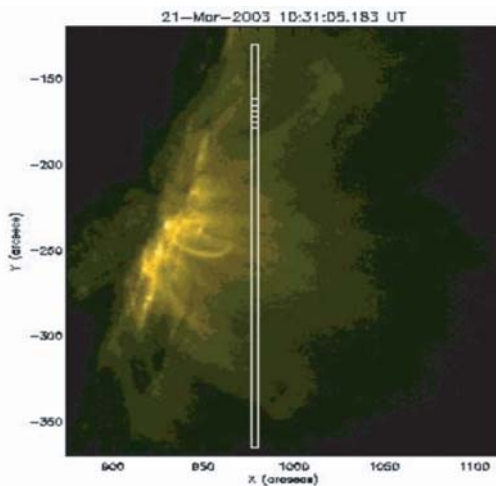
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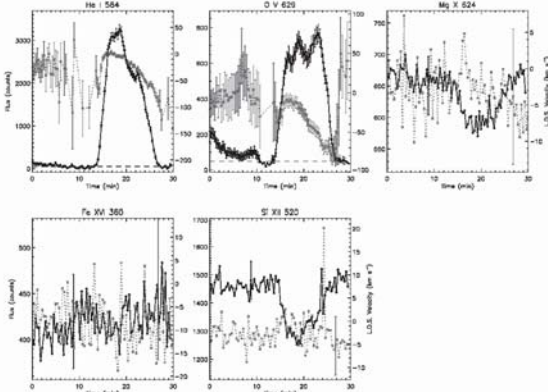
- Gajendra Pandey

Plasma Condensation in Coronal Loops

Using temporal series data from the Coronal Diagnostic Spectrometer (CDS) on SOHO, we have detected plasma condensation within coronal loops through the use of spectroscopic analysis.

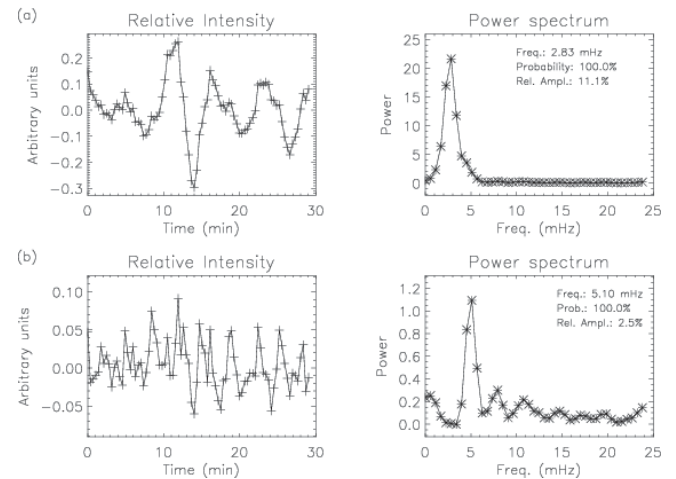


The location of the slit, overlaid on the TRACE image taken at the beginning of the time series observation. The white boxes mark the location of the pixel where we find evidence of evacuation of plasma material.



Variation with time of intensity (black lines) and velocity (grey lines) corresponding to pixel 57 of dataset s27152r01, which shows intensity enhancements in cooler lines and reduction in hotter lines.

We find that, for the cooler lines of He I 584 Å and O V 629 Å there are sharp increases in intensity, accompanied by large blue-shifted velocities. In the case of O V (a transition region line) there is a substantial rebound to red-shifted velocities when the strong brightening fades. The sharp increase in intensity and blue-shifted velocity in the cooler lines is accompanied by a corresponding decrease in the intensity of the coronal lines (Mg X 624 Å, Fe XVI 360 Å, Si XII 520 Å) but with no corresponding change in their velocity values implying an evacuation of plasma. From Fourier analysis, evidence is found for possible 1st and 2nd harmonics in the He I and O V lines, indicative of standing waves in loops.



(a) Time series of the relative intensity in He I (Left panel) and the resulting power spectrum (right panel). (b) Pre-whitened time series and the resulting power spectrum. Note that a frequency of 2.83 mHz is found, together with what appears to be its harmonic at 5.10 mHz. Both frequencies are above the statistically significant 95% probability.

We conclude that we are seeing the first spectroscopic evidence of plasma condensation taking place in coronal loops. This work was done in collaboration with E. O'Shea and J. G. Doyle of Armagh Observatory. It has been published in A&A, 475, L25, 2007.

- D. Banerjee

Conference on Observational Evidence for Black Holes

Following the great success of the First Conference in Calcutta in January 1998 on the 'Observational Evidence for Black Holes in the Universe' (OEBH), a second conference on the same topic was held in the same city during February 10 – 15, 2008. The main aim of the conference was to update the current knowledge and understanding of the existence of black holes in the observational context and to describe the progress in the theoretical aspects of their studies from quantum scale to quasars.

The conference attracted a large number of astrophysicists from India and abroad. About a

hundred observers and theorists attended the meeting, with their research interests ranging from primordial black holes, through stellar mass and intermediate mass black holes to the supermassive black holes in the centres of galaxies. Conference talks were partitioned into seven sessions: AGN/Quasars; Galactic Centre and other massive black holes; Low-mass black holes/LMXBs; Primordial black holes; Black hole accretion — theoretical considerations; Jets and outflows; GRBs, neutron stars and black holes. Each session opened with review talks given by the invited speakers, which included world renowned experts in the field like G. S. Bisnovatyi-Kogan, Felix Mirabel, R. Antonucci, A. Goldwurm, A. Wandel, T. Belloni, W. D. Arnett, L. G. Titarchuk and R. P. Kerr. The conference began with the main convenor, Sandip Chakrabarti (SNBNCBS), giving an overview of the activities which were to unfold during the week.

The observational evidence of the black holes in AGNs was presented by Amri Wandel (Racah Institute, Jerusalem) and that of the black hole in our Galactic Centre by Stefan Gillessen (MPE IR/mm Group). Felix Mirabel (ESO) summarised the observational status of microquasars. An attempt to unify the evolution of black-hole binaries was presented by Tomaso Belloni (INAF, Merate, Italy). Lev Titarchuk (NASA/GSFC) demonstrated a new method to determine the mass of a black hole in Galactic X-ray binaries by using the scaling of the spectral index and QPO frequency correlation. Archan Majumdar (SNBNCBS) argued how primordial black holes could survive as candidates of dark matter and certain possible observational signatures were pointed out. Accretion disk models were contrasted with observations by Bisnovatyi-Kogan (IKI, Moscow). As a special treat, Roy Kerr (Canterbury, New Zealand) presented his own account on obtaining the “Kerr” solution. There was a poster session with each of about 15 posters presented as a 5-minute talk.

From IIA, the conference was attended by Firoza Sutaria, Margarita Safonova and Veeresh Singh. Firoza Sutaria presented the current understanding of the nature of compact objects in quiescent LMXBs and Margarita Safonova gave a talk on the possibility of detecting the intermediate-mass black holes by microlensing. Veeresh Singh, presented a poster on X-ray emission from Seyfert galaxies. The conference concluded with a whole-day trip to the Sundarbans on two boats, where the closing speeches were given by Sandip Chakrabarti and Felix Mirabel, and where active discussions continued.

The OEBH conference was followed by a two-day Satellite Meeting (February 16 – 17, 2008) on Black Holes, Neutron Stars and Gamma Ray Bursts, intended mostly for the younger scholars working in Relativistic Astrophysics of Compact Objects, and it concentrated on an in-depth analysis of the nature of these objects.



The Satellite Meeting was inaugurated on the boat, but continued through presentations and discussions at the S. N. Bose National Centre till the evening of February 17, 2008. Both the meetings were jointly organised by the S. N. Bose National Centre for Basic Sciences (SNBNCBS), Calcutta, ICTP, Trieste and the International Centre for Relativistic Astrophysics (ICRANET), Pescara, Italy. Proceedings of the Second OEBH meeting will be published under the title “The Observational Evidence for Black Holes in the Universe”.

- Margarita Safonova

Science Extension Programme in schools

The Indian Institute of Astrophysics initiated its science extension programme in the Government High School, Madivala on February 4, 2008 for students of the 8th, 9th and 10th standards of the school. This inauguration took place after about six months interaction between IIA and the school. The aim of the programme is to infuse scientific curiosity into students at a young age.

The students are encouraged to perform experiments and report their findings based on their observations. IIA plans to augment this programme when the International Year of Astronomy 2009 (IYA) commences next year. At the inauguration, Professor S. S. Hasan explained the importance of IIA’s public outreach programme in the context of IYA 2009 and the new research programmes that IIA has planned. He said that IIA is exploring the possibility of designing a small modern telescope of approximately 2-inch aperture similar to what Galileo had used 400 years ago, to distribute it to schools throughout Karnataka.

Ms Jayasree, a teacher from the school, gave an excellent summary of Galileo’s landmark contributions, while some of the students demonstrated Galileo’s experiments to the audience. Ms Jayashree spoke on Galileo’s discovery of the laws of pendulum, the first ever use of the telescope to view astronomical objects and the various discoveries which emanated from these observations, the discovery of laws of floatation, observation that falling bodies experience the same acceleration due to gravity, irrespective of their mass.



She also emphasised that it was Galileo, who first started the practice of writing science in the local language as opposed to the earlier practice of writing in Latin, which kept scientific knowledge confined to an elite section of the population. She specially mentioned the relentless struggle that Galileo had to wage against the Church to establish Copernicus's heliocentric model of the solar system.

The three experiments set up as a part of this programme are based on Galileo's findings with the pendulum and the optics of telescopes. The idea is that the students should discover these laws themselves. IIA scientists plan to conduct laboratory classes in the school once a week.

– S. Chatterjee

National Science Day

February 28, the National Science Day, was celebrated as an Open Day in IIA. Nearly 500 school and college students from Bangalore participated in the festivities on that day. From 9.30 in the morning to 8.30 in the evening IIA had a steady stream of enthusiastic visitors. The Ministry of Science & Technology, Govt. of India, chose 'Understanding Planet Earth' as the theme for this year's Science Day. Consequently, an exhibition of posters on Water, Air, Ice, Ocean and Space was put up for the visitors. Models of our premier telescopes in Kavalur and Hanle were displayed. A special attraction was a desk-top model of the TAUVEK payload and posters describing its science objectives. Children were keen on knowing about weather patterns, global warming, and the phenomenon of La Niña. The scientist-volunteers were kept on their toes throughout



the day responding to the eager queries of the youngsters.

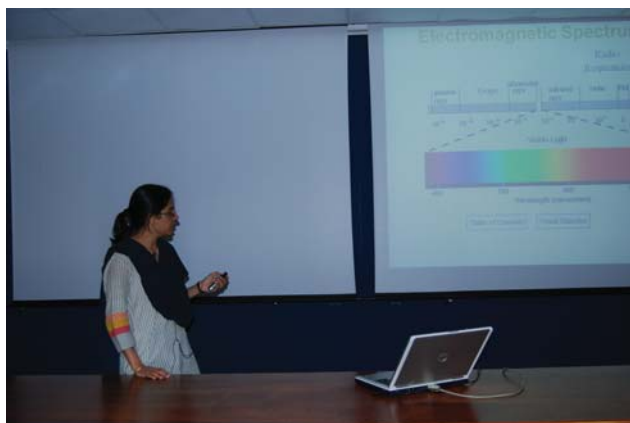
In the lawns, a coelostat arrangement was put up tracking the Sun in the sky. A large image of the Sun was focussed on a white board kept inside a tent for visitors to see. A quiz programme on Sunspots was conducted. Unfortunately, the current period being near the solar minimum, sunspots were hard to come by. The box spectroscope designed by the IIA scientists for easy viewing of the solar spectrum was made available to the children who had a gala time looking through it at the continuous spectrum as well as the Fraunhofer lines. The two-element radio interferometer was also set up and the signal from it was displayed in an adjoining room where a team of radio astronomers explained the instrument and the radio studies of the Sun. Students from the engineering colleges were excited about this particular experiment and asked many questions.



Four popular talks were scheduled, three in the morning for the school children and one in the afternoon for the college students. The main auditorium on the first floor and the large seminar room on the ground floor were overflowing with people in the morning, when Dipankar Banerjee and Nimisha Kantharia spoke respectively on the Sun-Earth Connection and Galaxies. They had to speak twice, once at each venue and even then some schools had to miss, as there was just not enough place in the two rooms for children to even stand. The morning programme was brought to a close with a wonderful show organised by Edwin Ebenezer of pictures of telescopes and the Sun, especially three-dimensional images of the Sun obtained with STEREO. Ebenezer



took trouble to make special plastic viewers to see the 3-D effects of the images and distributed them to the audience at the beginning of the session. The children were thrilled.



In the afternoon, Prajval Shastri gave a talk titled 'Harnessing gravity – shining black holes and growing galaxies'. It was a richly illustrated powerpoint presentation covering some of the latest observations and theoretical speculations on a theme of immense current interest.



Later in the evening, the sky-watch programme got under way on the terrace of the Main Laboratory Annexe. A 14-inch Meade Telescope was set up for viewing the night sky. Although the skies had a light haze, Saturn, Mars and the Great Nebula in Orion could easily be seen in their splendour. About 70 people lined up for the direct viewing. The Science Day festivities were brought to a close around 10 PM.

Public Outreach Programmes

The Madhya Pradesh Council of Science & Technology sent a large group of students aged between 12 and 16 years to Bangalore end of January, under their Mission Excellence programme. IIA was one among the few major institutions they visited. On February 1, more than 500 children of MPCST came in two batches and a programme of talks and a few hands-on experiments were organized for them. Dr Jayant Murthy spoke in the morning on 'Science from Space: 50 years of space flight'. This richly illustrated talk excited the imagination of the children and motivated them to ask many

questions. The handful of scientists who were present were literally mobbed by the teenagers who wished to know everything about everything under the Sun.



Out in the lawns a 4-inch refractor was set up to produce a medium-size image of the Sun on a white board. Features of the Sun were explained to the children and a quiz on sunspots organised by Dr K B Ramesh was contested by them. The box spectroscope was also available and students were shown the spectrum of the Sun. Due to constraints of time, other planned activities could not be carried out.



In the afternoon, Dr Arun Mangalam spoke on a different topic and one that is of enormous current interest. His talk was titled 'Brighter than a trillion suns — quasars and black holes'. Although the subject was complex, some of the children were up to the challenge of comprehending the essential physics of the rich extragalactic phenomena that Arun was describing. Dr R. S. Bharadwaj, Scientist-in-charge of M.P Mission Excellence and Dr N. P. Shukla, Project Director, MPCST, accompanied the children.

About 30 students of Aurora's Degree and Post Graduate College accompanied by their teachers, Ms Meera Joshi and Mr K Satyanarayanan, visited IIA on February 29 for a half-day interaction on the role of mathematics in research in astronomy and astrophysics. A programme of 4 talks was arranged for them. Dr A Satya Narayanan gave the first talk, starting with the basics of differential equations and

then going on to partial differential equations which often defy analytical solutions. He set up the equations of magnetohydrodynamics and showed a few special cases where solutions are obtainable. The second talk was given by Dr K. N. Nagendra on Radiative Transfer. Dr Nagendra explained the physics of spectrum formation and absorption and emission processes. He set up the transfer equation in plane parallel geometry and gave its integro-differential form and its formal solution. Dr S. Chatterjee spoke on gravitational settling of stars on the plane of the Galaxy. Outside in the foyer, he had shown a piece of metal which floated in water when he had dropped it on the pond below. He described the Archimedes Principle and the law of floatation. In the auditorium, he had balloons filled with hydrogen that floated in air, and a balloon filled with air that sank to the ground. Following these live demonstrations which also included settling of sand particles in a jar filled with water, he formulated the Boltzmann-Poisson equations that describe the gravitational equilibrium of stars in Galaxy's gravitational field. Dr Chatterjee showed the solution in the simplest approximation worked out in 1942 by Lyman Spitzer, Jr.

The last talk in the series was delivered by Dr Arun Mangalam on Geometry of Space-time. Starting with Euclidean Geometry and its five basic postulates, Dr Mangalam discussed the relevance of the fifth postulate and its rather restrictive nature and showed how other geometries can be formulated keeping the first four of Euclid's postulates intact but discarding the fifth. Then he showed how Gauss calculated the distances between four points on a surface and gave the idea of the metric and introduced curvature. He brought in physics through Eötvös's experiment of the equality of gravitational and inertial masses which prepared the ground for Einstein's General Theory of Relativity. Finally, he introduced concepts of Riemannian Geometry and how Einstein used them in his physical theory. He ended with a description of the Robertson-Walker metric and the Friedmann Universe. The students of mathematics were left with no doubt about the importance and relevance of their subject to research in astronomy and astrophysics.

From the Archives

National Workshop on Preserving our Scientific Heritage

The Indian Institute of Astrophysics, the Indian Institute of Science and the Tata Institute of Fundamental Research jointly organised a National Workshop on the topic 'Preserving Our Scientific Heritage' in IIA, Bangalore on January 21-22, 2008. This workshop was deemed timely as there has been a surge of interest in discovering and collecting historical material on science and scientists in India. Members of the organising committee were drawn from the three premier institutes. The scientific programme was carefully planned. It included various aspects of preservation and conservation techniques used in preserving the scientific

contents buried in many of our organisations. The aim of preventive conservation is to create a favourable condition, minimizing decay, and to avoid unnecessary remedial treatments, and thus prolonging the life span of rare materials. Since the topic of preservation is seldom talked about in our country, the workshop was organised to sensitise our policy makers and the custodians of our heritage (many of whom participated in the workshop), the importance of initiating the process of safeguarding our archival material immediately.

Diverse areas like collection policies, preservation and conservation issues, case studies of established archives in India and perspectives of the users, were addressed in the scientific programme. Participants came from government scientific organisations, the corporate world and universities and academic institutions. The speakers were experts in their respective fields. The keynote address was delivered by Ross Bassette, an historian and a recognised expert on history of science and technology, from the North Carolina State University in Raleigh. In his address, Professor Bassett expressed his concern at the lack of attention paid to creating archives in general and spoke on issues related to setting them up in India and the importance of safeguarding India's history.



Dr. Ross Bassett, delivering the keynote address during the workshop

Presentations on the first day focused on the current collection policies formulated by the existing archives in the country. It turns out that this varies from one individual archive to the other. Hence it was emphasized that a collection policy should be drawn out at the initial stage of setting up any archive and that it should be in line with a comprehensive planning policy. It is also necessary to make the policy visible to the users of the archives both within and outside the organisations. In the afternoon, there were presentations of seven case studies of science archives in the country. As many of these archives belong to organisations which have completed important milestones over the past two centuries, it was interesting to note that the potential to create the awareness in preserving the heritage exists in the country and the great variety of scientific contents which need immediate attention for posterity.



Session on Collection Policy – panel of speakers

In the evening, a special talk was delivered by Professor P. Balaram, Director of the Indian Institute of Science, on the topic 'Private philanthropy and public good – the early history of the Indian Institute of Science'. This session was organised in the Indian Institute of Science Faculty Hall. It attracted a huge audience. Professor Balaram traced the main events that led to the birth of IISc, starting from the 1890's. He highlighted the role of a few individuals like Swami Vivekananda and Shri Burjoji Padshah who were instrumental in realizing Shri J. N. Tata's dream of building the institute.



Group photograph of the workshop participants

On the second day, the workshop had presentations on issues of preservation and conservation. They focused on many problems and described possible solutions involving both natural materials and technology. The broad spectrum of points from simple handling of archival material with care to the actual planning for disaster preparedness was well received by the participants. The need for professional training on par with international standards was also emphasised. The different media, format of the archival materials and the disaster management issues were discussed with reference to the topography and the climate of the location where the archives are situated.

The afternoon session was devoted to user's perspective on archives. The presentations in this session helped as a kind of feedback to gauge the quality of the archives in terms of their contents and the use of those contents for scientific research in the country. The view was expressed that proper finding tools and indexing of the archival contents would aid in better usage of archives in the country.

The last session was a panel discussion which was moderated by Professor Roddam Narasimha, FRS (JNCASR), who made brief remarks on four main issues namely, Copyright compliance, Developing archives, Identifying standards and the Need for National Science Archives in India. Though the discussion was geared to include opinions and views on these four points, it was not limited to only these issues. Many participants expressed the opinion that a workshop of this kind could be made into a series, organised biennially. They also endorsed the view of initiating a forum of archivists to carry out many of the recommendations of the workshop. Coincident with the National Workshop, IIA archives got a face-lift with more contents and better display with suitable lighting and controlled temperature. Care was taken to maintain the chronological sequence of scientific contents from the inception of the Institute. The astronomical instruments used in the observatories at Madras and Kodaikanal for different purposes are displayed in the archives. An exclusive panel depicting the pictures on Solar Eclipses from 1868 to 2006 is added as a part of the display in the archives.



IIA Archives

– C. Birdie

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