SPECIAL SCIENTIFIC SESSION

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SPS

Astronomy for Developing Countries

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Special Session: Astronomy for Developing Countries

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Abstract. A Special Session was held during the XXIV General Assembly on the topic "Astronomy for Developing Countries". During two-and-a-half days, thirty-eight oral papers were presented and a similar number of poster papers were displayed. Edited summaries of the oral papers are presented here. Full texts of those papers and abstracts of the posters appear in a separate volume published in 2001 by the ASP.

1. Survey papers

1.1. Astronomy for developing countries

A.H. Batten (Dominion Astrophysical Observatory, Canada,) began by posing the question commonly asked of those working to promote astronomy in developing countries: why should such countries be concerned with astronomy? The question at least implies that such countries have much more pressing needs. Probably, everyone who has thought about the matter has devised his or her own answer. Those who are taking part in this meeting, while they recognize the many needs of developing countries, believe that there is a case for encouraging the study of astronomy in at least some of them. The questions we have to ask concern what it is realistic for the astronomers in those countries to expect and how we in developed countries can help them best.

Comparison of what many countries spend on astronomy, averaged over several years, with their *per capita* Gross National Product (GNP), shows that the total annual public spending on astronomy is usually an amount of the same order as the *per capita* GNP multiplied by the number of astronomers in the country. While this statement is subject to several qualifications and uncertainties, it does give some idea of the amount of public money likely to be available for the support of astronomy in any given country. It can immediately be seen that astronomers in developing countries suffer from a double disadvantage. Their *per capita* GNP is much lower than in developed countries and the proportion of astronomers to their total population is also much lower. Probably, in many developing countries, even that proposed level of expenditure is not reached although, in some of the most populous, the large populations to some extent make up for the low *per capita* GNP, and expenditure on astronomy may well be greater than would be expected from the above rough guide. In general, however, astronomers in developing countries must look to help from international consortia in their own profession or from private foundations. Consider, for example, an imaginary (but not unrealistic) country with a per capita GNP of $200 employing five astronomers. The annual budget for astronomy can be expected to be only a few thousand dollars –and all equipment, books or journals and travel must be paid from that amount.

Astronomers in developing countries are often isolated. Computers may be cheap in absolute terms, but the above example shows that even they can be a major purchase. Power supplies and telecommunications links are often unreliable in just those countries. While e-mail has undoubtedly become more widespread in the last few years, an e-mail address does not necessarily imply that its owner is always accessible, still less that he or she has access to on-line catalogues like SIMBAD or the software needed for modern data analysis.

The most important thing that astronomers in wealthy countries can do is to work to break down this isolation. Meetings like this one are a beginning, as are other activities of the IAU and the UN/ESA Workshops on Basic Space Science. There is a need, however, for individual collaborative agreements between institutes in developed and developing countries, so that astronomers in the latter can participate in advanced research that they could never undertake on their own, perhaps sometimes travelling to the host institute at its expense. Such contacts would be a great help for isolated colleagues and would make them more effective scientists and teachers in their home countries. They could be achieved by a very small expenditure on the part of developed countries. The benefits to both astronomical research and the further development of the country in question could well be out of proportion to the small sacrifices required of individual astronomers in wealthy countries.

1.2. Critical factors for a successful astronomical research program in a developing country

J.B. Hearnshaw (University of Canterbury, New Zealand) discussed the critical conditions for undertaking a successful research program in a developing country. There are many important factors, all or most of which have to be satisfied: funding, library holdings, computing access, Internet access (email, WWW, ftp, telnet), collaboration with astronomers in developed countries, provision of proper offices for staff, supply of graduate students, access to travel for conferences, ability to publish in international journals, critical mass of researchers, access to a telescope (for observational astronomers), support from and interaction with national electronics, optics and precision engineering industries, a scientific culture backed by a national scientific academy, and lack of inter-institutional rivalry. Hearnshaw listed 15 key factors and ranked them in order of importance, and discussed the use of an astronomical research index (ARI) suitable for measuring the research potential of a given country or institution.

He also discussed whether astronomers in developing countries in principle fare better in a university or in the environment of a government national observatory or research institution, and topics such as the effect of the cost of page charges and journal subscriptions on developing countries. Finally he presented some statistics on astronomy in developing countries, relating the numbers of astronomers to the size of the economy and population in each country.

2. Astronomy education: The situation

2.1. Astronomy education: The current status in Zambia

G. Munyeme and P. Kalebwe (University of Zambia, Zambia) described the current sitaution in Zambia, where many interlocking factors determine the introduction of astronomy into education. Infusing such a new subject into an education system so centralized as that of Zambia is extremely complex. At school level the process is more complex than at university level, as all syllabuses are developed by a central body, Curriculum Development Centre (CDC), whose priorities are determined by the perceived social and economic needs of the country. The prevailing notion in Zambia is that astronomy has no direct bearing on future employment needs. It is therefore not surprising that astronomy is at the bottom of the priority list among school subjects. Universities have more freedom to set up their curricula, but the low level of funding and the problems of finding high-level academic personnel create difficulties for the introduction of new subjects and courses. A recent upsurge of interest in astronomy at the University of Zambia has opened up the background necessary for developing astronomy in both school and university curricula. The University of Zambia has recently formed the Astronomical Society of Zambia and the Working Group on Space Science in Zambia (affiliated to the Working Group on Space Sciences in Africa). Coupled to this are exchange visits and collaborative work between the Physics Department of the University of Zambia and the South African Astronomical Observatory. Zambia has no experience of astronomy education and is dependent on the establishment of strong links with institutions and individuals in other countries. Such a link has been established between the Physics Department of the University and the South African Astronomical Observatory (SAAO). Visits to SAAO and a visit to Zambia by Dr Peter Martinez have already proved very useful. The authors hope that the University will be able to influence school curricula and train a small number of school-teachers as well as to arrange public lectures and to increase the contacts with the SAAO and other foreign institutes.

2.2. A renewal of astronomy education in Vietnam

D.G. Wentzel (University of Maryland, U.S.A.) described how Vietnam had been scientifically completely isolated for almost 30 years, during which time an entire generation of scientists has been trained without participating in the process of science, without a sense of exploring nature, of measuring things, of interpreting data. Astronomy almost disappeared during this time. With French help, several lecture courses have introduced modern astrophysics to Vietnamese physicists, and four students are studying abroad. The IAU program "Teaching for Astronomy Development" (TAD) has concentrated on modernizing the on-going astronomy course for students in the third year of the pedagogical universities. Three 1-2-week "Teachers' Workshops" have served to introduce selected up-to-date astronomical topics and a few modern teaching methods. The TAD program has also provided appropriate journals, books, a PC, and educational software. A new text "Astrophysics", in Vietnamese and English on facing pages with color pictures – apparently a first for any textbook in Vietnam – will first be used starting September 2000. Part of these activities were supported by ICSU.

Wentzel also described some of the planned future activities: collaboration on planning a newly approved astronomy course in the 12th grade of the natural science branch of secondary schools; collaboration so that the 41-cm telescope and astronomers in Hanoi can produce simple quality science; helping the only planetarium in Vietnam to acquire a wider range of offerings; helping to create a set of B.Sc.-level astrophysics courses for three universities, and supporting the Vietnamese Astronomical Society in effective public outreach.

2.3. The Central American master's program

M.C. Pineda de Carias (Central American Observatory of Suryapa and the National Autonomous University of Honduras) described the new Master's Program in Astronomy and Astrophysics for Central America which is part of a project at the National Autonomous University of Honduras to contribute to the establishment of Astronomy and Astrophysics as academic fields within the six Spanish-speaking countries of Central America and is also part of an IAU TAD program. In 1997, the same year that the Central American Astronomical Observatory of Suyapa (OACS) was officially inaugurated (within the frame of the VII UN/ESA Workshop or Basic Space Science), degree courses in Astronomy and Astrophysics at graduate level were approved. In 1998 the program was formally opened for Central American graduate students in physics, mathematics or engineering. In the year 2000, the first group of students is expected to finish their courses. She presented the main features of the Master's Program: the syllabus, resources, organization. She also discussed the results achieved and future plans, and made some recommendations about how the international community may contribute to enhance this type of effort, and on how this model may be useful for the benefit of developing countries. There is a continuing need for visiting professors and for opportunities for the successful graduates of the Master's Program to continue their studies elsewhere, providing they eventually return to their homelands.

2.4. Astronomy development in Morocco: A challenge for science and education

K. Chamcham (Université Hassan II, Morocco) described his experience in Morocco, with reference to European institutions which he visits regularly. He discussed the difficulties one can face in trying to set up projects in a country where astronomy is a forgotten science: everything has to be built from scratch and, at the same time, one tries to keep up the pace at the international level. The situation can be complicated in a system where individual initiatives are not welcomed and are considered as a threat to the established system.

These probems, added to isolation from the international community, turn the achievement of even a simple project (such as setting up a small telescope) into a psychological challenge. It takes years to achieve what could be done in a few months in developed countries. On the other hand, one is encouraged by the strong demand from students and the public. Not only do they try to find out information on astronomical phenomena for themselves, but they ask for the development of facilities and the organisation of scientific activities. This is encouraging, because in the circumstances described, even professional astronomy cannot survive without feedback from the public and long-term investment in students.

At the University of Casablanca, more than a decade ago, Chamcham began by organising seminars and workshops, gathering students and colleagues from all fields, showing them that astronomy is a science which needs all the other disciplines in order to make sense of observations or to build theoretical models. He became aware of a strong demand from a group of undergraduate students and colleagues for the inclusion of astronomy in the physics curriculum. There was, however, a difficulty in that changes to the curriculum have to be made by decree.

The breakthough came from the IAU, when IAU officials visited Morocco and expressed the support of the international community for astronomy development in Morocco. This helped to change the official attitude, especially when students showed how their level of achievement was improved and their personalities were strengthened by taking advantage of the facilities offered by the IAU-TAD programme. Support from established western institutions also played a significant role. In the Moroccan academic system, research is not a criterion for career advancement and many lecturers have lost their motivation. Astronomy has proved to be a great stimulus to the students and also to some of the lecturers.

3. Astronomy Education: What can we do?

3.1. The Vatican Observatory summer schools in astronomy and astrophysics.

C.J. Corbally (Vatican Observatory, University of Arizona, U.S.A.) described how two seemingly incongruous components come together about every two years: the serene terraces of the Pope's summer residence at Castel Gandolfo, and the noisy exuberance of 25 beginning-level graduate students. Add in a small faculty of first-rate professors and a resourceful local support team, and one has the ingredients for the month-long Vatican Observatory Summer Schools (VOSS). The eighth School is scheduled for the summer of 2001, and its goals are the same as when the series started in 1986: to encourage and motivate a mix of young people from industrialized and developing countries who are at critical moments of their research careers, and to make a small, but significant contribution to the progress of developing countries by exposing some of their most talented young citizens to people involved in high quality research in astrophysics.

The nature of each VOSS is simple. Two 75-minute lectures are given each weekday morning on the School's topic. (Two principal faculty persons carry most of the lectures, but one or two other faculty are invited for a week or so to give a boost to the academic program.) Student presentations or a guest lecture will end the morning's work. Lunch is offered for all on one of the Castel's terraces, and the students are free in the afternoon to siesta, to recreate, and to study. There may be an informal gathering in the evening for discussion, sampling of a country's cuisine prepared by some students, or visual observing. On the academic side, it is learning for learning's sake; on the cultural and recreational side, the building of (international) relationships is emphasized. Thus Castel Gandolfo becomes a second home to both faculty and students.

At the end of the month, in the preparations for departure, the first element of the all-important follow-up is forged, continuing (e-)mail contact between the VOSS alumni(ae). Other elements of follow-up are the subsequent placing of students in stimulating graduate schools or institutes for part of their training, the reunion of alumni at scientific meetings, and the establishment of post-doctoral fellowships.

The impact of the VOSS may be measured by the statistics: so far we have held seven schools, involving 173 students from 48 nations, and 57% of the students have been from developing nations. All but 10 of the alumni(ae) are continuing in astronomical research and about half of those from developing nations have spent at least two years in an institute of an industrialized country. Perhaps the best way to reckon success is in the quality of the professional friendships forged during the Schools. These have persisted and give the best hope for promoting astronomy in developing countries – and indeed everywhere.

Further information can be found on the website:

`http://clavius.as.arizona.edu/vo/voss.html`

and from the article by Joson and Aguirre in Sky and Telescope, May 2000.

3.2. Exchange of experiences in teaching astronomy

R.M. Ros (Technological University of Catalonia, Spain) described the European Association for Astronomy Education which brings together European teachers and lecturers interested in astronomy. A Working Group of the Association is responsible for training teachers and organises an annual Summer School for teachers under expert guidance. For a week the teachers participating can exchange experiences, increase their knowledge and discuss different ideas and perspectives. The teachers have opportunities to learn about new teaching materials and methods and about recent research.

In general, the instructors are professional astronomers, professors and teachers from different countries. The papers presented offer very practical activities, paying special attention to didactic aspects. There are general lectures to all 40 participants and workshops for smaller groups of 20 participants. There are also day-time and night-time observations, made without expensive equipment or complicated procedures, so that they are easy to set up. The observational exercises are based on topics that are related to what is taught in the classroom.

The Summer Schools promote scientific astronomical education at all levels of astronomy teaching, reinforce the link between professional astronomers and teachers with experience of teaching astronomy, allow debates among the participants on pedagogical activities that they have already carried out in their own classrooms and help teachers to organise activities outside the classroom.

Astronomy teachers need special training, access to specific research, to new educational materials and methods and the opportunity to exchange experiences. All these things are provided by the Summer School. New schools are already planned for 2001 and 2002.

3.3. Variable-star measurement and analysis: Tools to develop astronomical research and education

J.A. Mattei (AAVSO, U.S.A.) and J.R. Percy (University of Toronto, Canada) described how astronomers and students can contribute to research – even if they have few resources – by measuring and analyzing variable stars, which yield important information about stellar nature and evolution. Practical activities can be an important part of scientific education in any part of the world. Useful measurements of variable stars can be made by eye, binoculars, or small telescopes, then sent to databases, such as that of the American Association of Variable Star Observers (AAVSO), for use by scientists and educators worldwide. Data and software for analysis are readily available on the World Wide Web e.g. at the AAVSO web site www.aavso.org. Variable-star measurement and analysis is inherently simple; the data can be obtained and analyzed by professional or amateur astronomers – and by students, who can thus do real science, while developing and integrating a wide range of scientific and mathematical skills. The AAVSO recently developed *Hands-On Astrophysics* (HOA) – which includes more than 500,000 measurements, software, charts, and instructional material including videos, together with a comprehensive teachers' and students' manual. Communication and support can be found through the AAVSO web site. HOA can be ordered through the site, or from AAVSO, 25 Birch Street, Cambridge MA 02138, USA. HOA is already being used in several astronomically-developing countries to promote research, and research-based education. HOA brings the excitement of astrophysical research and discovery to the students in science, mathematics and computer classes and helps to develop an understanding of basic astronomy concepts. HOA is a stepping-stone to more advanced work such as CCD photometry, and a model for using the processes and data developed and obtained by amateur astronomy to do useful science at low cost.

3.4. Distance education and self-study

B.W. Jones (Open University, U.K.) spoke about three problems in relation to teaching science in general, and astronomy in particular, that can be acute in developing countries

- a shortage of science teachers

- a shortage of non-human resources

- difficulties that students face in attending a campus.

Distance education has the potential to alleviate all three problems, and self-study the first two.

Distance education allows a student to study at home or in the work place, full-time or part-time. Course materials are delivered to the student by mail, and perhaps some electronically. Though self-study is central to distance education, the student must be supported, and a tutor is an essential component of that support. Face-to-face contact with the tutor will be limited, perhaps absent, but contact by mail, telephone, or e-mail are all very effective. Tutors of courses which contain astronomy can be senior school science teachers with no previous knowledge of astronomy, provided that they first receive subject tuition. All tutors require training in distance tuition.

Self-study materials must be suitable for that purpose – many standard textbooks are unsuitable – and the student must receive a clear specification of the knowledge and skills they are expected to bring to a course.

Through distance education, a course team containing only a few astronomers can prepare astronomy courses, or science courses containing astronomy, for large numbers of students. Course materials can include written materials, kits for practical work, and TV programmes; if the students have access to the required equipment, these can also include video, CD-ROMs, and internet resources. Distance education around the world has its focus in universities, and is targeted at students 18 years of age and older. However, the courses need not be at degree level. An important target group is science school-teachers, who can thereby learn astronomy that can be introduced into school science courses to good effect.

Overall, if a course can reach several hundred students, then the cost of producing a graduate through distance education can be roughly half that by traditional campus methods.

The increasing availability of the internet has led to the concept of the e-university, where a substantial part (but not all) of course delivery and teaching takes place over the internet. Consequently, there is the potential for distance education courses developed in one country to be available to any student in any country, provided that the student has access to the internet, and provided that appropriate invigilation for any examinations can be provided.

On campus, self-study can relieve teachers of much of the task of delivering the core curriculum, thus liberating time for higher quality contact with students, such as tutorials and problem classes, even when there is a shortage of astronomy teachers. Distance education materials, being designed for self-study, can thus have an important role on-campus too.

3.5. Using television for astronomy teaching

J. Fierro (UNAM, Mexico) stated that the full potential of television for education has not been used in developing nations. It is relatively inexpensive to produce astronomy programs that can be broadcast by taking advantage of satellite transmission.

She suggested that these programs should have the following elements in order to be efficient:

1 Be in the local language.

2 Be short enough so that the teacher has a chance to comment on them during a one hour lecture.

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3 Show experiments specially if they are meant for schools that do not have laboratory facilities.

4 Be produced for several educational levels, including programs aimed for teacher training.

Inexpensive books should be edited in the local language that will serve as an educational complement to the television series.

3.6. Principles for tertiary-level astronomy courses

D. McNally (University of Hertfordshire, U.K.) discussing tertiary-level courses said that any worthwhile tertiary level course of study should as its highest priority reflect the discipline it represents as it is contemporaneously practised. Were it not to do so, students would be intellectually underprovided. Astronomy is at once one of the purest sciences, apparently having little connection with day-to-day life, and yet is very much an applied science, drawing together chemistry, physics and biology and drawing heavily on engineering skills and, of course, mathematics. Thus astronomy is a marvellous vehicle for extending horizons and generating awareness of the interconnectedness of scientific endeavour. He identified three pathways in which astronomy is used at the tertiary level of education:

i science for those not studying a physical-science discipline;

ii courses with another degree such as physics or mathematics;

iii degree courses specializing in astronomy.

McNally's primary concern was with the third pathway and he set out general principles governing what a first-degree-level course of study in astronomy should aim to provide for its students. He did not attempt to set out specific syllabi, but rather to outline ranges of topics and their level of treatment. Courses can concentrate on astrophysics, combine astrometry with astrophysics, be directed towards detector systems, or these elements can be mixed according to the tastes of the instructors. He emphasized the continuing importance of positional astronomy and celestial mechanics, especially in this post-HIPPARCOS era. There is a small, but persistent, group of undergraduates who are passionately devoted to these topics and who find astrophysics tedious. He also discussed the prerequisites for entry into such a course, particularly the need for a sound understanding of mathematics and physics, including the opportunity for experience in the laboratory. He emphasized that while all students taking such courses should have as professional an experience as possible, it should be recognised that students taking tertiary astronomy courses may not become professional astronomers and that such courses will necessarily have to have the flexibility to meet local circumstances.

3.7. Highlights of initiatives in astronomy education in South Africa

C. Rijsdijk (South African Astronomical Observatory, South Africa) began by pointing out that the exclusion of large sections of South Africa's people from formal education by the apartheid government has had long-term effects, effects that the present government has to deal with and find solutions to.

The problem is more than just a lack of resources and facilities, it is also an abundance of under- or un-qualified and de-motivated science teachers and a youth that has neither a culture of learning nor of science. In addition the education system is changing from a traditional to an Outcomes Based Education (OBE) system, known as Curriculum 2005 (C2005). There are long-term benefits, but short-term implementation problems which will be alleviated when the revised and more accessible curriculum for the 21st century, C21, comes on line. For the new system to succeed requires major up-grading and re-training for all science teachers. This in turn means that it is difficult to get teachers to attend additional workshops on astronomy, there just isn't enough time.

The lack of a proper infrastructure has meant the development of resources that are cheap, readily available and easily reproducible. These are then used in workshop situations with teachers and students to convey some basic astronomical concepts. As more schools get access to electricity and telephones, ideas on how to use modern technology, television and the Internet, will be sought and implemented wherever possible. Research has shown that these will be able to make significant contributions to alleviating these problems but care must be exercised as there are many misconceptions about astronomy: flat earths and geocentric universes are not unusual.

Because it is expensive and difficult for rural teachers and students to visit observatories, the SAAO has developed the Starbus project. This is a brightly decorated mini-bus equipped with a wide range of workshop materials that visits rural schools. Other non-governmental educational organizations use similar procedures to bring science to masses of students, running practicals for up 1000 students at a time – far from ideal, but better than nothing.

The government is busy trying to find solutions to these problems and many strategies have been, and are being, developed at school level: these will make significant contributions to scientific literacy in the coming years.

There are several universities that offer astronomy at post-graduate level: the normal route would be physics at undergraduate level with some astronomy component. Postgraduate students would then usually register at a university and do their observational work at one of the national facilities. Numbers of students are small and as they reach higher levels they become progressively more capable of holding their own with their peers in other countries.

The construction of the Southern African Large Telescope, SALT, will become an icon to inspire the country's youth: its Collateral Benefits Plan aims to make substantial contributions to science and technology education. An international collaboration synergizing the educational outreach of the world's large telescopes is planned, enhancing this icon.

3.8. Astronomy education in Chinese universities

C. Fang and Y. Tang (Nanjing University, China P.R.) remarked that after rapid development in China in the early 1990s, more than twenty universities now have education and research programs in astronomy. In four key universities, complete series of educational programs of undergraduate, master's, doctoral and post-doctoral levels have been established. These universities have instruments of their own for teaching but even undergraduate students are expected to spend two or three weeks at one of the country's major observatories working under the direction of a research astronomer. After four years of study at the undergraduate stage, more than one third of the students have been enrolled in courses for the master's degree. Three years later, one third of them begin their three-year Ph.D. education. Only a few students enter into post-doctoral programs. There are also systems of study for the master's and doctor's degrees in the Chinese Academy of Science. There is strong competition for university entrance and each year about 50 students are admitted to the astronomy departments. Students must obtain 150 credits in four years to earn their first degree. The first two years are mainly mathematics and physics; in the following two years they take courses in general astronomy, theoretical astrophysics, practical astrophysics, celestial mechanics and astrometry. Courses (some of them optional) are also required for the master's degree but the student is also expected to have published at least one paper and to write and to defend a thesis. After an examination and oral test, a master's student may be admitted to the Ph.D. program which includes course work, but the student is expected to engage in research, to publish up to three papers and to write and defend a comprehensive thesis. In recent years, astronomy education in China has been much improved, but some students, after receiving their master's degrees choose to study for their Ph.D. abroad; they cannot always find jobs in astronomy afterwards.

4. Astronomy research: The situation

4.1. Revitalizing astronomy in the Philippines

C. Celebre and B.M. Soriano (PAGASA, The Philippines), concerned about the possibility that astronomy in the Philippines will remain as lethargic as it has been for 100 years if drastic positive changes are not made, planned various revitalizing activities in 1997. Some have already been implemented for the purpose of reactivating astronomy in the country. These activities include the declaration of the third week of February of every year as National Astronomy Week and the attendance of the Chief of the Atmospheric, Geophysical and Space Sciences Branch (AGSSB) of the Philippines Atmospherical, Geophysical and Astronomical Services Administration (PAGASA) at IAF, IAU and UN OOSA conferences and symposia, which paved the way towards increased interest in space science and astronomy in the Philippines.

A project proposal for the donation of a 45-cm telescope by the Japanese Government to the Philippines was also prepared. The project is aimed at upgrading the capability of the country's astronomical observatory to observe astronomical phenomena as well as of its staff to conduct astronomical researches in the future. The donor government approved the telescope donation by the end of March 2000. Several project proposals, for the purpose of acquiring sundry astronomical equipment, were also prepared and submitted to the Department of Science and Technology (DOST) for possible funding through its Grant-in-Aid Program. Four 10-inch and one 7-inch Meade telescopes were procured in

1999 under one of the DOST-GIA projects. Also, a mobile planetarium was purchased in the same year through the equipment outlay of PAGASA.

Applications to various training courses in astronomy are also included among the revitalization activities, which will augment the training needs of the personnel of the Astronomy Research and Development Section (AsRDS) of AGSSB. These fellowships include the Monbusho Fellowship, Training in Astronomy in Gunma Astronomical Observatory of Japan and the International School for Young Astronomers. The Officer in Charge of the AsRDS is scheduled to undertake a 6-month research training at the Gunma Astronomical Observatory, beginning in September 2001.

Astronomy was also promoted throughout the country through the celebration of the centennial of astronomy in the Philippines in 1997. Awards of Recognition were given to five Filipinos who have made great contributions in this field. An Astro Olympiad, a contest in astronomy for high school and college students, was also conducted which became an annual activity. Seminars/Workshops on Basic Astronomy for Science Teachers were also conducted throughout the country. The agency also issued, on a monthly basis, the "Astronomical Diary" which gives information on some significant astronomical events.

Lastly, the agency applied for associate membership to the IAU, because it believes that the Union can assist in its new mission of revitalizing astronomy in the country and allow the AsRDS personnel to participate actively in regional and global cooperative activities in astronomy, particularly in the Southeast Asian region. The membership application was endorsed by the IAU Executive Committee and was approved at the IAU General Assembly held in Manchester, U.K., in August 2000.

4.2. Work at Bosscha Observatory

M. Raharto (Bosscha Observatory, Indonesia), recalling the location of the Observatory, near Lembang (–6° 49′ south, 107° 30′ east, and 1300m above sea level), explained that it operates under the Bandung Institute of technology (ITB), Department of Education and Culture of Republic of Indonesia. In general ITB has three missions in higher education, concerned with developing and transmitting science and technology. Within these missions, work at Bosscha Observatory concentrates on contributing to the development of astronomy, and providing a facility for astronomy education. The observatory is also open as indirect facility for education in science and technology in general. It serves the public in what he called a program of astronomy for non-astronomers, the main task of which is to explain astronomy in popular ways adapted to the educational and background experiences of visitors. More than 10,000 people visit the Observatory every year, which provides good opportunities for direct interaction between astronomers and the public.

The principal instruments of the Observatory are a double refractor of 60-cm aperture and focal length 10.78 m (at visual, 0.55μm) and 10.72 m (at photographic, 0.43μm), a Schmidt telescope (51/71/27 cm), a GTO Cassegrain (45 cm), the Bamberg 37-cm refractor with focal length 7 m and a Unitron refractor 10.2 cm with focal length of 1.5 m. Recent work at Bosscha Observatory includes observation of visual double stars, a survey of M stars and Galactic structure, observations of bright novae, such as V382 Velorum, and proper motions of sunspots. Undergraduates from the ITB Department of Astronomy have helped with public observing campaigns for lunar and solar eclipses as well as of the Leonid shower and bright comets. Some staff from the ITB Department of Astronomy contribute to the administrative work of the Bosscha Observatory, as well as to the astronomical research.

Economic and political crises in Indonesia began in 1997. The short and direct impact of the crises were a psychological shock for the younger generation. Many companies collapsed and life became harder. Naturally many people thought first about survival and forgot the development of science. Some people think long-term survival will be helped by improvement in the quality of education in science and technology. It seems a temporary condition, but the crises make it difficult to find bright members of the younger generation to develop astronomy in Indonesia. The uncontrolled prices and depreciation of the currency make life harder. Now the currency is becoming stable at the fallen value of about one-third its former value; that is, prices are three times higher than before the crises. Nobody thought about the impact of the economic and political crises for the development of astronomy. There will be direct impacts in the form of higher maintenance costs and government spending cuts. Most of the government's budget is given to a large effort to help students with scholarships so that they may continue their studies. Fortunately for the Bosscha Observatory, a new supporting unit consisting of a 10-PC computer network for the Internet and a CCD camera were donated by a well known company, Schlumberger, in 1999. The continuation of support from the LKBF foundation for astronomical journals keeps the library up to date and the Internet connection runs well. A general problem is that there is no budget for research and development, Perhaps, in the future, a wealthy man or company will come to help to solve the problem. Visitors to the Observatory's "astronomy for non-astronomers" programmes provide another chance that the country will contribute directly to the Bosscha Observatory. The Observatory staff is optimistic about the survival and development of astronomy in Indonesia during the next century. International cooperation and help for the young staff who continue their study in astronomy and astrophysics could be another important source for astronomical development in Indonesia.

4.3. Astronomy research in China

J. Wang (National Astronomical Observatories, Beijing, China, P.R.) spoke of the dreams of Chinese astronomers over recent generations to lay their own foundations for astronomical observation. Decades of efforts by Chinese astronomers have established some basic facilities, such as the 2.16-m optical telescope, the solar magnetic-field telescope, the 13.7-m millimeter-wave radio-telescope, the 25-m VLBI radio telescope etc. Most of these instruments are operated by the observatories in the Chinese Academy of Sciences (CAS). They are accessible to researchers from both CAS and universities.

One mega-science project, the Large-Sky-Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), intended for astronomical and astrophysical observations requiring wide fields and large samples, has been initiated and funded. LAMOST is a 4-meter reflecting Schmidt telescope. It is under active development and will come into operation at the end of 2004. The telescope, when complete, will have the highest spectrum-acquiring rate of any in the world.

To concentrate the efforts on mega-science projects, to operate and open national astronomical facilities in a more effective way, and to foster the best astronomers and research groups, the National Astronomical Observatories (NAOs) has been coordinated and organized by the Chinese Academy of Sciences. Four research centers jointly sponsored by observatories of the Chinese Academy of Sciences and universities have been established.

Current astronomy research in China covers a diversity of areas, such as the deep survey of large red-shift galaxies, supernovae and supernova remnants, dark matter and gravitational lensing, galaxy interaction and star-burst galaxies, active galactic nuclei, γ-ray bursts, molecular clouds and star formation, stellar convection and pulsation, stellar evolution, solar magnetism and magnetic activity, astro-geodynamics, dynamics of celestial bodies and artificial bodies, astronomical optics, modern studies of ancient Chinese astronomy literature, and so on.

Based on an analysis of the general trend of astronomy research in the coming new century and the *status quo* of astronomy research in China, nine research fields have been given priority for support in NAOs. In the frontier research area, the large-scale structure of the universe, formation and evolution of galaxies, high-energy and cataclysmic processes in astrophysics, formation and evolution of stars, solar-magnetic activity and helio-geo space environment receive enhanced support. In applied astronomy studies, astrogeodynamics, dynamics of celestial bodies in the Solar System and artificial bodies are selected as principal fields. In technology studies, space observation and exploration, and new astronomical techniques and methods are given top priority.

4.4. The Egyptian 1.88-m telescope

A.M.I. Osman (NRIAG-Helwan, Egypt) recalled that astronomy is an old science in Egypt but the first reasonable-sized telescope was an 0.9-m reflector at Helwan Observatory, south of Cairo, installed in 1905. Nearly 2000 nebulae were discovered with this instrument, which was also used for observations of comets, planets and their satellites. In 1962, the Kottamia 1.88-m reflecting telescope was erected 70 km east of Cairo and became the largest telescope in the Middle East and North Africa. The telescope can be used at the Newtonian, Cassegrain and coudé foci. The telescope has been used by Egyptian and foreign astronomers. Recently, an extensive upgrading programme has been undertaken to increase the telescope's efficiency. A new zerodur optical system has been delivered by Zeiss, Germany, and a new CCD system including an acquisition camera, Tek 1024 x 1024 pix with pixel size 24 x 24 μm, liquid-nitrogen cooling, and an offset guiding camera, Kodak 1280 x 1024 pix with pixel size 16 x 16 μm with thermoelectric cooling. This CCD system has been attached to the Newtonian focus for direct imaging with scale 22.5 arcsec mm^{-1}. There are still some problems with the support system of the primary mirror.

The aluminizing plant has also been refurbished by Balzer, the new pumping system can reach 0.1 Pascal inside the chamber which can accommodate mirrors up to 2m. The unit is supplied with a microprocessor, which controls and checks all recoating steps and closes all valves to stop the operation in any emergency.

A Cassegrain spectrograph (a donation from Okayama Astrophysical Observatory, Japan) will be attached to the telescope after modification for use with a CCD camera instead of the image-intensifier. This spectrograph will be used to obtain medium-to-low dispersion spectra of faint stars and galaxies down to 15 magnitude.

Once the mirror-support problems are solved, the telescope will be available to all astronomers from North Africa and the Middle East.

4.5. Astronomy in Algeria: Past and present developments

A. Irbah, presenting a paper by himself, T. Abdelatif and H. Sadasoud (all three from CRAAG, Algeria) spoke of the development of the study of astronomy in Algeria since 1890 when the Algiers Observatory was built. Several instruments were soon installed on the site and have contributed to many scientific projects, such as the international sky-map program (*Carte du Ciel*). However, the observatory's activities were suddenly interrupted in 1962 with the departure of all French astronomers. Although, as in any Moslem country, astronomy has practical importance, since religious fasts and festivals are linked to the first visibility of the new Moon, the subject is taught neither in schools nor universities. During the solar eclipse of August 11th, 1999, (partial in Algeria) many people were afraid of this natural phenomenon and stayed at home. Young people, however, have an interest in the subject and several amateur clubs have been formed.

The Algiers Observatory was built at Bouzaréah especially for the *Carte du Ciel* and Astrographic Catalogue projects. The principal instrument, a coudé refractor, was designed for that work. Twenty years were needed, after the French departure, before new astronomy programs were developed at the Observatory which is now a part of the *Centre de Recherche en Astronomie et Géophysique* (CRAAG). The new programs are principally based on imaging through atmospheric turbulence, solar physics and pulsating variable-star studies. Only one experiment is at present developed; a solar experiment within an international program for surveying the radius of the Sun. Diameter measurements show apparent variations in the Sun's diameter, opposite in phase to the sunspot cycle. The experiment will be continued at the CRAAG observatory in southern Algeria (Tamanrasset). Similar measurements will be made from Picard, a microsatellite to be launched in 2002.

There are plans to install an automatic observing station in Algeria, which will be devoted primarily to the observation of pulsating stars and the study of stellar instability. There is also a team working on solar-terrestrial relations and their applications to telecommunications.

Algerian astronomers now form a relatively significant team, since more than twelve researchers have a permanent status. This is a good start, taking into account that astronomy is not taught in Algerian universities. The astronomers are keenly interested in international collaboration and several collaborative projects already exist. Most important are the projects undertaken with French astronomers, but there is also collaboration with astronomers in Spain and Britain.

4.6. Astronomy in Venezuela

P. Rosenzweig (Universidad de Los Andes, Venezuela) spoke of the steady development of astronomy in Venezuela since the installation of the Observatorio Cagigal in Caracas. During the last few decades there has been great progress in the development of astronomy in her country; both theoretical and observational astronomy are flourishing. The creation of a research group in astronomy and astrophysics at the Universidad de Los Andes (ULA) in Merida, called Grupo de Astrofisica (GA), became necessary because of the construction of the Observatorio Nacional de Llano del Hato on university land, also in Merida, operated by the Centro de Investigaciones en Astronomia (CIDA). The GA started with few members but nowadays has increased in numbers and has been undergoing many transformations, promoting the creation of the Grupo de Astrofisica Teorica (GAT), the Grupo de Astronomia, the Centro de Astrofisica Teorica (CAT), and with other collaborators initiated the creation of a graduate-study program (that offers master's and doctor's degrees) within the Postgrado de Fisica Fundamental of ULA.

With the financial support of some domestic Science Foundations such as CONICIT, CDCHT, Fundacite, and individual and collective grants, many research projects have been started and many others are being developed. Also, Venezuelan astronomy has benefitted from the interest of researchers in other countries. Open doors have provided agreements resulting in a good scientific output and an upgrade of the instrumentation of the Observatory.

With significant collaboration from national and foreign institutions, astronomy in Venezuela is set to become one of the strongest scientific disciplines in the country during the next decade.

5. Astronomy Research: What can we do?

5.1. What can be done with small telescopes?

B. Soonthornthum (Chiang Mai University, Thailand) spoke of the rapid development of modern astronomy over the last few decades. Large telescopes, several metres in size, have been constructed and installed in many sites around the world. They are intended for high-quality research work at the frontiers of astronomy.

In many parts of the world, only small telescopes can be provided, because of budgetary limitations and the stage of development of science in many countries. Much effort has, however, been put into trying to use these small telescopes to the best of their capabilities. A small telescope with modern detectors can produce useful astronomical research. Because of their convenience in operation, with suitable site selection, small telescopes can also be widely used for social and public services. Many astronomical activities carried out with small telescopes may have large social impacts on the people in the surrounding region.

Sirindhorn Observatory, Chiang Mai University, is the only observatory in northern Thailand which plays active roles in educational programs and social public services. The major instrument is a 40-cm Cassegrain reflecting telescope with photoelectric photometers operating in the standard wide and intermediate bands, CCD photometers and a CCD spectrograph. Each year, this observatory serves a large number of people in Thailand by teaching, research and public services. Graduate and undergraduate courses in astronomy are offered at the Faculty of Science, Chiang Mai University. National and international collaboration in astronomical research works have been established. Moreover, this telescope is also used for social and public services, especially for school pupils from all over the country,

Soonthornthum also spoke of the importance of regular maintenance of even a small telescope, especially in the hot and humid climates encountered in many developing countries.

A larger telescope is being developed for more efficient operation which will be able to serve the future development in astronomical activities in Thailand.

5.2. Astronomical research and education in Tajikistan

P.B. Babadzhanov (Institute of Astrophysics, Tajikistan) reported that there is an ancient tradition of astronomical research in Tajikistan but modern research is carried out by the Institute of Astrophysics, Tajik Academy of Sciences. Modern astronomy began in Tajikistan in the 1930s, when the favourable geographic and climatic conditions for observing were recognized. The Institute has three observational stations: the Gissar observatory (at an altitude 730 m above sea-level) with photographic fireball and meteor patrols, a 70-cm reflector, a 40-cm Zeiss astrograph, a high-precision astronomical telescope (D=1 m, F=0.75 m), etc.; the Sanglokh observatory (at an altitude 2300 m above sea-level) with a Ritchey-Chrétien 1-m telescope and 0.6-m reflector from Carl Zeiss; the Pamir observatory (at an altitude 4350 m above sea-level) with a 70-cm reflector. The main scientific fields of investigation are physics and dynamics of asteroids, comets and meteors, variable stars and astrometric observations of artificial Earth satellites. The work of the Institute was badly affected by the disintegration of the Soviet Union. Social and political instability in the period 1991-7 resulted in serious damage to some of the buildings of the Institute. Several of the staff have left Tajikistan or sought employment in areas other than astronomy. It has been necessary, therefore, to take measures to restore the staff of the Institute to its full strength. In 1999 the Department of Astronomy was reinstated in the Tajik State National University and the first students were admitted to study astronomy. Twenty have completed the first year. It is proposed to offer complete programs up to the doctoral level. The Institute and its observatories welcome scientific collaboration with astronomers from other countries.

5.3. The choice of small telescopes

D.L. Crawford (GNAT, Tucson, U.S.A.) pointed out that small telescopes equipped with modern CCD imaging detectors and which take full advantage of computer control and communication networking can be powerful tools for astronomical research and education. Many are being used by both professional and amateur astronomers to do important, even frontier, research. An automated network of small telescopes can provide more hours of quality observing worldwide more cheaply than the much larger instruments.

In all countries there are good people with good ideas. Small telescopes have the potential to complement very well the research being done with large telescopes and space instruments. Just as the operator of a fleet of trucks needs vehicles of all sizes, so astronomers need telescopes of different sizes. Each country is different, however, and this must be taken into account in planning. There are three ways to obtain access to the tools of an astronomer: developing and operating an observatory within a country; becoming involved in the operation of a remote observatory elsewhere; accessing existing data bases. Wherever telescopes are involved there are some considerations in common. What type of telescope is needed, what size, what mounting and what instrumentation? Crawford restricted his discussion to telescopes in the range 0.5-m to 1-m aperture. This size range is of relatively low cost and is suitable for high-quality research. Imaging and photometry will be the main roles for such a telescope. The primary focal ratio should be in the range 1.5 to 2.0, the secondary in the range 6 to 9. The field of view should be designed to handle a 2000 square CCD chip, although smaller ones can be used. One should aim for an image quality of 0.6 to 0.8 arcsec at full-width-half-maximum. It is important to keep operating costs low, as well as the capital cost, but the telescope must be reliable.

Although the design of a remote observatory needs careful thought, even a site in one's own country is remote for most of the users. GNAT is now operating an 0.5-m telescope, fully automatically, near Tucson, every clear night. This can serve as a prototype of a class of telescopes that could be installed in almost any country in the world. There is a real need for a network of such remote telescopes.

5.4. Is astronomical research appropriate for Third-World countries?

M. Snowden (Lanka Astronomical Institute, Sri Lanka) described the situation of the unproductive 45-cm astronomical telescope, donated by JICA in Japan to Sri Lanka, which raises questions as to the fundamental reasons for what he sees as the unproductive nature of pure science in developing countries in general. Before the installation of the telescope, attention was given to site location, maintenance, and scientific objectives, and the facility was subsequently launched with an international conference organised by the UN Office for Outer Space Affairs. Unfortunately, no research or significant education has resulted after four years of operation.

The telescope operates at an annual cost of U.S. $13,000 per year, which includes salary for one trainee, maintenance, and a modest promotional programme. A comparison with a similar installation at the University of Auckland suggests that a lack of funding and technical competence are not at fault for the failure in Sri Lanka. The small facility in New Zealand, located on the roof-top of Auckland University's Physics Department, operates with a slightly smaller annual budget than the one in Sri Lanka and has resulted in a modest but productive programme of research and teaching.

Lack of financial backing and expertise are often blamed for weak science in developing countries, but on careful examination, one sees that most of these countries have people with adequate skills, and plenty of resources for religion and military. A general lack of motivation for science appears to be the principal reason.

This failure in motivation is one of several traits common to unproductive countries. Besides highly inefficient bureaucracies, they mostly lack the cultural and philosophical base of the European Renaissance, which is necessary for the tolerance, motives, and discipline for pursuing an activity that violates human preferences. By contrast, excellent facilities, such as ESO, SAAO, Cerro Tololo, and GONG, are seen in these same countries, but only when they are administered from the West.

5.5. Simple radio-astronomy equipment

N.Q. Rieu (Observatoire de Paris, DENIRM, France) spoke of the major role that radio astronomy has in the study of the universe. The spiral structure of our Galaxy and the cosmic background radiation were first detected, and the dense component of interstellar gas is studied, at radio wavelengths. COBE revealed very weak temperature fluctuations in the microwave background, considered to be the seeds of galaxies and clusters of galaxies. Most electromagnetic radiation from outer space is absorbed or reflected by the Earth's atmosphere, except in two narrow spectral windows: the visible-near-infrared and the radio, which are nearly transparent. Centimetre and longer radio waves propagate almost freely in space; observations of them are practically independent of weather. Turbulence in our atmosphere does not distort the wavefront, simplifying the building of radio telescopes, since no devices are needed to correct for it. Observations at these wavelengths can be made in high atmospheric humidity, or where the sky is not clear enough for optical telescopes.

Simple instruments operating at radio wavelengths can be built at low cost in tropical countries, to teach students and to familiarize them with radio astronomy. He described a two-antenna radio interferometer and a single-dish radio telescope operating at centimetre wavelengths. The Sun and strong synchrotron radio sources, like Cassiopeia A and Cygnus A, are potential targets.

6. Providing continuing support

6.1. Internet resources for astronomers worldwide

G. Helou (Caltech, U.S.A.) pointed out that today's Internet, provided abundant resources for astronomical research, which are available from wherever a connection can be made. These resources are mostly in the form of freely accessible databases or archives, and range from literature services to space-mission archives. They offer instant access to the latest published data and papers, and offer unique opportunities for archival and creative research. He offered a sampling of such services and discussed accessibility from far-flung points on the planet.

6.2. Astronomy research via the Internet

K.U. Ratnatunga (Carnegie Mellon University, U.S.A.) also spoke on the uses of the Internet for astronomers in small developing countries who may not have a dark site with good seeing for an astronomical observatory or be able to afford the financial commitment to set up and support such a facility. Much astronomical research today is based on remote observations, made from telescopes in space or obtained by service observers at large facilities on the ground.

The astronomical research environment has also changed over last five years in many significant ways. The price of computers needed for data analysis and the cost of on-line data storage has dropped tenfold. The amount of astronomical data available in on-line archives from both ground-based and space-based observations is growing exponentially. Submission of papers to most leading journals is done on-line. Practically all leading astronomy journals back to volume 1 are now archived at the Astrophysics Data System (ADS) at `http://adsabs.harvard.edu` with mirror sites around the world. The latest preprints are also archived at astro-ph (`http://xxx.lanl.gov`) and updated daily.

An on-site local telescope is now not needed to start active research and education in astronomy. Cutting-edge astronomical research can now be done on low-cost computers with a good Internet connection to get on-line access to astronomical observations, journals and the most recent preprints. For example, Hubble Space Telescope observations are released after one year and images taken in parallel mode are made freely available on the Internet a day after the observations are taken. Everyone on the Internet has equal opportunity to make and publish discoveries from them. The first gravitational lens to be discovered by the Hubble Space telescope was found as a part of the Medium Deep Survey (MDS) on archival data, after the observations were released to the public one year after they were taken.

Ratnatunga observed that Internet bandwidth is what is most lacking in his home country of Sri Lanka. The academic bandwidth into the whole country is less than what would be considered acceptable for a small university in the U.S. One does need to be able to have response during working hours for remote interactive log-in and to have the ability to transfer of the order of 100MB or more on demand – without unreasonable time delays. E-mail allows fast easy collaboration between research scientists around the world. An international program with some short-term collaborative visits, could mine data from the available astronomical observations for a fraction of the capital investment and running costs of a small local observatory. Students who have been trained in the use of computers and software in such a program would also be more employable in the current job market.

The set-up of computer facilities and Internet connectivity is also common to many fields of scientific research. This is a very important consideration for any proposal to start fundamental scientific research, including astronomy, in developing countries where everything must be related to the practical needs of the country. The Internet can reach you whereever you like to be and give you direct access to whatever you need for astronomical research.

6.3. Experience in developing an astronomy program in Paraguay

A. Troche-Boggino (Universidad Nacional de Asunción, Paraguay) urged the audience not to confuse Paraguay with its neighbor country Uruguay. Paraguay is a land-locked country between Argentina, Brazil and Bolivia. Its population is over five million inhabitants. Asunción is its capital at latitude $-25^\circ\ 18'$ and longitude $57^\circ\ 35'$ W.

Troche-Boggino became active in astronomy education 26 years ago, when there was little astronomy teaching in Paraguay. He found opportunities for

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training high-school teachers. A new program for secondary schools was in a trial stage at that time. Basic astronomy topics were requested as a part of three high-school courses of Natural Science and as a part of the course of Mathematics in the last year. Also, an elective astronomy course for junior students of physics was scheduled at the National University of Asunción.

So, he used such opportunities to practise astronomy teaching as a university instructor and later he started to train high-school teachers in topics related to our science. He still does that and has some former students in the same job at the Instituto Superior de Educación of the Ministry of Education and Culture.

International Schools for Young Astronomers (IAU-ISYA) held in Argentina in 1974 and later in Brazil in 1977 and 1995 were encouraging and led to contacts with IAU Commission 46 which helped the speaker to know how to set up supporting framework for astronomy in Paraguay. Expressing his gratitutde to Dr. Cecylia Iwaniszewska for her continuous kind assistance, he quoted her motto: "In order to reach each new generation with basic Astronomy, we need to show them its most outstanding facts, as well as to build a supporting frame".

What is the supporting frame's relevance? First, the frame means: good reading materials, practical work, well-trained teachers, an astronomical observatory, planetarium etc. Second, with a poor framework it may happen that students learn poorly but believe that they are experts. This means: instruction will become sketchy and few real experts will get good job positions.

Among important visitors from the IAU astronomers were J. Sahade and R.M. West. These visits led to a Visiting Lecturers' Program (VLP) for Paraguay, which began in 1988 and ran until 1994. Troche-Boggino worked as local coordinator of six excellent astronomical courses by astronomers from Argentina, Mexico and Italy. In particular, D.G. Wentzel's readiness to help, providing supporting material and visiting, improved the VLP. Among the results of the IAU-VLP, two students went abroad for further study and practical work in astronomy. Another two attended an ISYA in Brazil in 1995. Two former VLP students are doing doctoral work in physics abroad. Other former students are university and high school instructors.

6.4. Opportunities for collaboration in astronomy among East-Asian countries

N. Kaifu (National Astronomical Observatory, Japan) reported on the astronomical activities in Asian countries, especially those in East Asia. These efforts started in 1990 from a small-size China-Korea-Japan meeting on star-forming regions. Aware of the importance of cooperation among those neighbouring countries, participants agreed to hold "East-Asian Meetings" on observational astronomy sequentially. The 1992 meeting was on "Millimeter-Wave Astronomy" in Daejon, the 1995 meeting was on "Ground-based Astronomy in Asia" in Tokyo, and the 1999 meeting on "Observational Astrophysics in Asia and its Future" held in Kunming and Lijiang achieved high activity with 100-200 participants from more than ten Asian countries. An important product of those meetings was active exchange between young astronomers including graduate students. Also among those efforts was an East-Asian co-experiment to search for good sites for a possible future Asian observatory. The primary aims of these meetings and activities are to widen the contact area among Asian astronomers especially among the younger ones, as well as to promote small but realistic cooperation in the field of instrumentation. This close cooperation between Japan, China (both mainland and Taiwan) and Korea in millimeter and sub-millimeter wave-technology is one of the good examples of real scientific products and the building up of new instrumentation groups in those countries.

6.5. Catalogues in modern theory and observation

O.Yu. Malkov presented a paper by himself and A.V. Tutukov (both from the Insititute of Astronomy, Moscow, Russia) on the role of astronomical catalogues as powerful tools for carrying out modern theoretical and observational studies. There are about 1000 modern astronomical catalogues that provide accumulated information in accessible form for many classes of astronomical objects, e.g. stars, galaxies, even, now, extrasolar planets. Analysis of the data in these catalogues provides important information without the need for modern expensive observational techniques. Any stellar catalogue can be considered as the product of the history of star formation, the consequent stellar evolution and the effects of observational selection.

For example, data for about 1000 spectroscopic binaries and 3000 visual binaries can be used to derive the birth function of binary stars. Analysis of the distribution by orbital angular momentum makes it possible to estimate the number of planetary systems in the Galaxy.

There are many large catalogues, containing astrometric and photometric information for millions of objects, that are now widely used by the astronomical community, such as the Guide Star Catalog and the USNO Catalog of Astrometric Standards. Because of the large size of these catalogues and their sometimes complicated formats, extracting the data is not always easy. User-friendly programs have been created to allow one to look directly at the data in a large catalogue, either as a sky map, in a graphical plot, or in tabular form.

Modern data can thus be made available to any astronomer with access to the Internet, including those in developing countries. These data can be used for carrying out modern theoretical studies, without involving large telescopes. The statistical properties of astronomical objects provide us with the most common properties of their families which can then be made the base of further study.

6.6. Third-world networking

J.V. Narlikar (IUCAA, India) introduced TWAN, a projected Third-World Astronomy Network. He proposed the idea of linking a few key institutions in Third-World countries in an international network to help them promote the growth of astronomy and astrophysics (A & A), in their local regions and countries.

Emphasizing the need for such a network, Narlikar stressed three main problems faced by the Third World nations that TWAN was proposed to solve:

1 Isolation from the mainstream developments in A & A which leads to research in not very relevant areas and teaching with outdated curricula.

2 The priorities for public funding in these countries naturally being for creating basic amenities, basic research in fields like A & A suffers from lack

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of adequate support, resulting in shortage of facilities like a good library, computer power and labs for instrumentation, as well as very few opportunities for attending international conferences and pedagogical activities.

3 Lack of access to good observing facilities and instruments for collecting and processing data, results in scientists turning away from observations towards abstract theories where they may not achieve international standards.

Fortunately, thanks to the IT-revolution currently underway, it is possible for the Third-World nations to come together and build up on their intrinsic strength with some assistance internationally. A beginning has already been made by networking libraries so as to share one another's database. Referring to the Indian experience, Narlikar described how libraries from eight research institutions and observatories have come together in a group called FORSA (Forum for Resource Sharing in Astronomy). Networking helps in sharing limited resources and speedy inter-library borrowings can be arranged. Special rates have been offered by publishers of journals when sharing of hard copy as well as the electronic versions of journals is involved. He also briefly related the astronomical data centre at IUCAA which now has a mirror site for the Strasbourg Data Centre. The International Centre for Theoretical Physics (ICTP) in Trieste has also shown how a central facility can be used by academics from the Third-World nations under an associateship programme. This has been copied and used successfully by IUCAA for Indian universities. The ICTP has also set a tradition of hosting and sponsoring workshops and schools at different levels for such academics and their students.

He also described the recent experiment tried at IUCAA where students and amateurs could remotely log in onto a small automated telescope at Mount Wilson. The 12.5 hours time difference meant users in Pune could use the telescope in daytime. The discussions currently underway for a National Virtual Observatory in the U.S,A. point to new exciting ways of tapping the huge databases being created in astronomy, a venture which surely would benefit scientists from the Third World also.

With these examples in view he proposed the setting up of a Third World Astronomy Network (TWAN) with some token support from the IAU, a recurring grant from the UNESCO, and contributions from the National Academies including those which are the adhering organizations for ICSU. He suggested identifying a few institutions in selected Third-World nations to act as nodes for the network. Thus any benefits of TWAN would be passed on to the institutions linked to the respective nodes in their national networks.

The TWAN could organize or serve as a catalyst in organizing the following type of activities for the academics in A & A in the Third World:

a An annual calendar of pedagogical activities which may range from introductory to advanced level workshops for students, refresher courses for teachers, and activities of interest to amateurs.

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b Mirror sites of astronomical data centres at the nodal institutions with facilities for data processing including the latest astronomically useful software.

c Facilitating usage of good observing facilities which are mostly in the First World, through forging observing collaborations with First World scientists and also through assistance with writing their own independent observing proposals.

d Creating a corpus for supporting travel of needy scientists to attend pedagogical activities, collaborative ventures or observing runs.

Narlikar ended by suggesting that the IAU through its Commission 46 on Teaching of Astronomy may create an international steering committee to work out a detailed modus operandi for TWAN and its budgetary needs.

6.7. Libraries in developing countries

P. D. Hingley (Royal Astronomical Society, U.K.) drew on his considerable experience of the laborious process of shipping unwanted books and journals to various parts of the world. He described the difficulties (and satisfactions!) of this process and suggested ways in which it might be facilitated. He also discussed the inevitable imbalance in funding and staffing between libraries in different countries; the status of librarians in the international astronomical community; the role of the librarian as the keeper of the "corporate memory and lore" of the institution; the value of the LISA meetings (I, II and III) in fostering friendship, help and cooperation; whether the growth of digital archives and resources online remove the need to ship paper copies, especially of journals; and "when to give up and throw it away".

6.8. African collaboration: The potentials of SALT

P. Martinez (South African Astronomical Observatory, South Africa) remarked that since the early 1970s, the major facility for optical/infrared astronomy in sub-Saharan Africa has been the South African Astronomical Observatory in Sutherland, the largest instrument being the 1.9-m Radcliffe telescope. In the early 1990s a case was made for the construction of a 3.5-m telescope, similar to ESO's New-Technology Telescope. At the same time, large political changes were taking place in South Africa and, after the transition to a democratically elected majority government, an audit of the country's capabilities in science and technology was made, as a result of which, it was recognized that South Africa should not confine itself to scientific research with a purely utilitarian return. At the same time, an American-German consortium was constructing the 10-m Hobby-Eberly Telescope (HET) in Texas and approached South African astronomers as possible partners in the building of a southern-hemisphere twin. These factors came together and, on 1 June 1998, the South African Minister of Arts, Culture, Science and Technology announced in Parliament that the South African Cabinet had approved the construction of the Southern African Large

Telescope (SALT) and would fund 50% of the cost, the balance to be found by international partners.

Over the next five years, South Africa and its international partners will construct SALT, a 10-m optical/near-infrared spectroscopic survey telescope. SALT will enable South African astronomers to remain internationally competitive in astronomy but it has an importance to South Africa (and to all Africa) far beyond its mission in astronomical research. The construction is being planned in such a way as to maximize collaboration between South African and foreign companies, thus enabling South Africans to gain valuable experience by working with foreign companies. Amongst the greatest educational challenges facing South Africa now is the broadening of education in science and technology. The SALT project will specifically involve student participation and will provide educational opportunities for astronomers, physicists, computer scientists and engineers during both the construction (five-year) and operational (25+year) phases. There is also a carefully designed programme of public educational outreach in connection with the project.

SALT will be significant for other African countries since there are, at present, few large-scale facilities in Africa and African astronomers are forced to develop their careers elsewhere. The existence of SALT will encourage African astronomers to remain in their own region. Note that SALT was intentionally named Southern African Large Telescope and has been envisaged as a regional facility from the beginning. The Working Group on Space Sciences in Africa and the South African Astronomical Observatory are currently planning a pilot project which could form the basis of an African Network for Education and Research in astronomy which will strengthen the entire African community and prepare it to make the greatest possible use of SALT.

6.9. Security of equipment

L.I. Onuora (University of Sussex, U.K. and formerly of Nigeria) spoke about providing adequate security for equipment. This is probably a problem in all parts of the world, but it needs special consideration in developing countries. Social and economic conditions are very different so that implementation of advice sought from experts who are unfamiliar with local conditions can lead to disasters. For example, it is important when choosing a site for even a small telescope in a developing country to be sure that a constant power supply will be available. Power cuts in a developing country may not be just for an hour or two, but can last for days, or even weeks.

The need for adequate security must be taken into account when considering factors such as type of equipment, the site for the equipment, budgetary provisions, personnel etc. If no-one lives near an observatory the telescope is isolated and becomes a target for pilferers. It may be better to have such a telescope on a university campus, even though that situation may not be scientifically ideal. Security guards may be needed and must be provided for in the budget, which inevitably reduces the money available for scientific staff. Since in many developing countries there is no equivalent of the granting councils found in developed countries, it is important to be sure that the money needed for security is actually available. Of course there is a danger that too heavy security will discourage the legitimate users of a telescope, and the great benefit of public

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education might then be lost. It is important, however, for all concerned to be aware of this issue and for visitors and would-be benefactors to pay attention to the views of the local scientists who will be working with the instrument.

6.10. Overcoming the English-language barrier

T.J. Mahoney (IAC, La Laguna, Spain) stressed that the English language has attained an overwhelming hegemony since the Second World War and is now firmly established as the *lingua franca* of science. Scientists who fail to publish in English run the risk of lack of international recognition of their work with occasionally catastrophic consequences (e.g., Osawa and the prediction of the existence of the C_{60} molecule). The membership list of the IAU reveals that $\sim$ 60% of working astronomers are non-anglophone, yet all peer-reviewed articles must conform to high standards of written English. Some even claim that there is an "Anglo-Saxon bias" towards work produced by non-anglophone workers, especially by those from countries with small astronomical communities.

How to surmount this language barrier?

The scientific community can help by subsuming all questions relating to language usage into the editorial process, thereby leaving referees free to concentrate solely on scientific concerns. Publishers can contribute by providing clear instructions to authors and explaining what happens in the publishing process. Research centres need to foster a keen awareness of the language problem by offering courses in communication techniques. Where economically feasible, they could set up in-house editorial services to vet articles for grammar, spelling, adherence to journal styles, etc.; where this is too expensive, such services might be set up by pooling limited resources on a regional, national, or even international basis.

Above all, non-anglophone authors can help themselves by learning to regard English as an essential working tool, rather than as an objectionable hurdle to be cleared with the minimum effort. They should ensure that their writing possesses a clear logical structure, write with a target journal in mind, *read the journal instructions carefully*, run a spell-checker (with caution!) through their work, learn all they can about editing and publishing and acquire a minimum set of up-to-date standard reference works (dictionaries, etc.). See the SPS poster by Mahoney ("Making the most of publishing software").

A Scientific Editorial Service (SES) has been in operation at the Instituto de Astrofísica de Canarias (IAC) since 1996. About half the total published output of the IAC – from main journal articles to proceedings contributions – is pre-edited by the Service; to date over 200 articles and many proceedings contributions have been processed by the SES. IAC authors who use the SES find that many of the usual language problems with referees tend to arise much less frequently or not at all.

6.11. The preservation of library materials in developing countries

E. Lastovica (South African Astronomical Observatory, South Africa) pointed out that the acquisition of books and journals for a scientific library is costly. To ensure that this is a cost-effective process, consideration must be given to the arrangement, care and preservation of this material so that the library resources can be fully utilized. An area somewhere in the organization needs to be designated as the library. There are many threats to library collections: the inherent chemical instability of acidic paper, poor environmental conditions in the library (too much heat, humidity, dryness or light), careless handling, birds, mice, rats, moulds and fungi. While professional library conservation is beyond the budget of many institutions, even non-specialists can take some simple preventive measures.

It is pointless to apply preservation measures to a jumble of books and documents. Items have to be acquired by purchase or donation, a catalogue must be compiled of all publications in the collection, and a loan record kept. Besides regular library routines, attention must be given to the environmental protection of the collection. Factors that contribute to the deterioration of books and other library items are temperature and humidity, air pollution, dust, light and pests. Unchecked they may cause serious damage to library materials at a very fast rate. If they are controlled, deterioration is greatly reduced. Ideally the library should be weatherproof and free of biological infestations. There is no ideal level of temperature or relative humidity for all types of library material but, rather, a range of values that vary according to the medium of the object being stored. Generally, high temperatures combined with very dry air are harmful, but a constantly damp environment is also bad. Too much (ultraviolet) sunlight will cause irreversible fading.

It is important that the users of books and other library materials treat them with respect. There are many very simple rules that, if observed, can help to lengthen the life of a book. Regular cleaning of the library is important. There should be a free circulation of air in the library. In some places, plans should be made for natural disasters (floods, hurricanes, earthquakes). Lastovica concluded with a list of sources of information on preservation, especially with reference to South-East Asia.

6.12. Astronomy education in Africa during the 2001 and 2002 eclipse expeditions

J.M. Pasachoff (Williams College, U.S.A.) pointed out that total solar eclipses bring widespread attention to astronomy and that two will cross southern Africa on June 21, 2001, and on December 4, 2002. Most of Africa will see partial phases. There is much confusion, in both the developing and developed world, about how hazardous solar eclipses are and how to view them. There is, therefore, much scope for public education in astronomy on these occasions. Even the difference between partial and total phases is often not understood by those in the eclipse path, while some mistakenly believe that the Sun emits extra rays during an eclipse, that make the spectacle hazardous to watch.

The total phase of the 2001 eclipse will be visible from parts of Angola, Zambia, Zimbabwe, Mozambique, and Madagascar. The total phase of the 2002 eclipse will be visible from parts of Angola, Zambia, Botswana, Zimbabwe, South Africa, and Mozambique. Public education must be undertaken to tell the people how to look at the eclipse safely. We can take advantage of having the attention of the people and of news media to teach not only about eclipses but also about the rest of astronomy. Pasachoff is Chair of the "Public Education at Eclipses" Programme Group of IAU Commission 46, which is able to advise educators and others about materials, procedures, and information releases.

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References

Batten, A.H. (ed.) 2001, Astronomy for Developing Countries, Special Session of the 24th General Assembly of the IAU, ASP

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