

NEWSLETTER

IAU COMMISSION 46: THE TEACHING OF ASTRONOMY

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MESSAGE FROM THE PRESIDENT

Dear Commission Members and Newsletter Readers:

The important time of the General Assembly is almost here, with several major events concerning our Commission. Commission 46 members will meet twice: on August 19 at 2 pm, and August 23 at 2 pm. The agenda of these business sessions is being sent to Commission 46 members along with this Newsletter.

The keystone of this General Assembly, however, will be our Joint Discussion #4, entitled "Current Developments in Astronomy Education", which will take place on August 18. Exciting lectures, as well as posters, are scheduled and we expect stimulating discussions.

The organization of our traditional Schoolteachers Meeting is going ahead nicely, thanks to the efficiency of Professor Henny Lamers. It is planned to take place on August 26, a date when a larger number of Dutch high school teachers can attend. Though it will be held partly in Dutch, and partly in English, all members of Commission 46 are invited (and expected!) to attend, and participate in informal discussions with the local schoolteachers. The teaching of astronomy is not widely developed in schools in the Netherlands, and there is much that we can do.

I wish you a fruitful General Assembly, and I look forward to meeting you this summer in The Hague.

Lucienne Gouguenheim

PLEASE CIRCULATE THIS NEWSLETTER TO YOUR COLLEAGUES

REPORT ON THE 20TH INTERNATIONAL SCHOOL FOR YOUNG ASTRONOMERS

D. G. Wentzel, University of Maryland; Secretary of the ISYA

This ISYA met at Inter-University Center for Astronomy and Astrophysics (IUCAA), Pune, India from January 3 to 21, 1994. Travel support was provided by IAU, UNESCO and ICSU. IUCAA provided local hospitality and meeting facilities in its modern complex. The ISYA was advertised in the IAU Bulletin, through national representatives of IAU Commission 46 in relevant countries, and through the journal *Khagol*, published by IUCAA, which reaches all relevant institutions in India. The most effective advertising was provided by the participants of the 1992 ISYA in China.

The director of the school, Dr. J. Narlikar, asked seven faculty members to join the school:

P. Eggleton (U.K., stellar interiors and evolution, with emphasis on evolutionary manifestations in binaries),
 M. Gerbaldi (France, stellar spectroscopy, derivation of stellar parameters),
 S. Isobe (Japan, observational techniques),
 D. Wentzel (USA, solar physics and MHD),

and, from Pune:

T. Padmanabhan (a masterful introduction to cosmology),
 A. K. Khembavi (high-energy astrophysics), and
 D. J. Saikia (who substituted on short notice for Chanda Jog, interstellar matter and galaxies).

However, Khembavi and Saikia discussed almost exclusively active galaxies and quasars.

There were 35 participants, including 11 women: 10 participants (including 1 woman) were from India; the other participants came from Argentina, Bulgaria, Canada, Iran, Ireland, Korea, Nepal, Russia, Sri Lanka, Vietnam, Turkey and Ukraine. Three participants, from Canada, India, and Sri Lanka, respectively, are studying in the USA; one participant from India is studying in France. Among the foreign participants, 15 (including 8 women) received travel support; 9 of these needed to have their travel expenses refunded in US dollars cash while they were still in Pune. Ten foreign participants and one faculty member found their own travel support.

The initial selection of foreign participants for travel support emphasized reaching graduate (post-baccalaureate) students from a maximum number of different institutions. When two grants from other sources saved us money, two people with recent doctoral degrees (both from Russia) were added. It is important to offer the ISYA to beginning graduate students, since they most need to see the breadth of astronomy, but it is also important to have more experienced participants who become the scientific leaders of the school and ask questions in lectures. The questions not only demonstrate the broad range of interests among participants but also stimulate subsequent discussions. The large range in participants' backgrounds makes it difficult to give lectures appropriate for everybody. Ideally, each lecturer starts at an introductory level and yet reaches considerable depth. To do this effectively, the lecturer must be involved in the life of the group. It is disadvantageous if local faculty appear almost only for their lectures or if foreign faculty miss the beginning of the ISYA. Two of the lecturers, having started at a suitably low

introductory level, stayed at that level so that the advanced students dispersed to their individual interests. Inevitably, lectures from faculty who did reach adequate depth served mostly to provide the "flavor" of the topic for the beginners. The participants were encouraged to seek individual discussions with the faculty members, and several participants sought out particularly the Indian faculty members and J. Narlikar. One participant also had contact with engineers for very practical problems concerning CCD photometry.

Since many participants came from institutions with no or very limited astronomy research journals, they made extensive use of the excellent library. The computer center was widely used, and accounts on Sun SparcStations were opened for interested students.

The language of the school was English. Since most foreign participants had little experience with spoken English, it was necessary to speak quite slowly and display the crucial words, names and phrases on overhead transparencies for visual recognition. The overheads were copied for all participants. The Indian faculty tried very hard to speak slowly and evenly, but several participants still found them very hard to understand, particularly since they placed relatively little text on overheads. The participants from the various countries integrated well already during the first week. However, it took until the third week for them to discuss science with each other without being selfconscious of the English. This was also the experience at the ISYA in China in 1992. It is probably the best reason for the ISYA lasting as long as three weeks. (The more formal aspects of the school become rather exhausting after two weeks.)

There were 38 lectures of 1 to 1.5 hours, plus seminars by J. Narlikar and J. Ostriker and a presentation on the Giant Meterwave Radio Telescope (GMRT) and its astrophysical challenge by G. Swarup. Some practical exercises, including sky observing with two Celestron telescopes, were also organized. A visit to the GMRT took place one afternoon. Talks by 10 participants were given about their research; 12 participants presented brief talks concerning their observatory or university; 2 faculty gave talks to the amateur astronomical society of Pune. Several social and sightseeing events were organized as well as a weekend excursion to the painted caves and rock-cut temples of Ajanta and Ellora. (Since several foreign participants could bring no money and the trip was expensive by Indian students' standards, this excursion was possible only by the IAU supporting the entire group's travel.)

Only 2 faculty and about 2/3 of the participants could stay the entire three weeks, particularly because the Moscow-Bombay flight by Aeroflot was not even quite weekly. Thus particular emphasis was placed on integrating the participants rapidly, for instance by having participants from different countries share rooms.

The local details of the school were organized efficiently by Mrs. S. (Lata) Shankar and Dr. N. Dadhich. E-mail was essential, especially for solving visa and travel problems and for optimum use of available travel support. The few participants without e-mail could at least be reached by fax. M. Gerbaldi (assistant secretary for ISYA) provided much valuable advice both in planning and during the ISYA.

NEWSLETTER # 3; APRIL 1994

IAU WORKING GROUP FOR THE WORLDWIDE DEVELOPMENT OF ASTRONOMY

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Although I said last year that I would not send out a *Newsletter* this year, it seems the best way, in fact, to spread news of the meeting of the Group arranged for the morning of Saturday, August 20th, during the forthcoming IAU General Assembly. I do not yet have precise information about time and place. That will be in the final programme that those of you who come to The Hague will receive on registration. We do have the whole morning for the meeting -- i.e. about three hours.

Poster Papers. My call for poster papers produced nine abstracts. One was not concerned with the work of the Group and had to be rejected. If you sent me an abstract and have not received from me an explicit letter of rejection, you may assume that your poster was accepted and begin to prepare it. The abstracts have now all been sent to the Local Organizers. Most of the abstracts were lightly edited, either to reduce them to about 200 words, or to make the English more idiomatic. I am asked by the local organizers to make clear that the standard size of the poster boards is 120 cm high by 100 cm wide. These figures were given correctly on p. 46 of IAU Information Bulletin No. 71, but incorrectly on blue p. 12 of Bulletin No. 72. At present, I do not know when you can exhibit your poster; it may be only for a day or two before our Group's session.

Oral Presentation. The following speakers are confirmed for the session (there may be some others):

The Chairman: Introductory Remarks.

H.J. Haubold: UN Activities in the Promotion of Space Science.

L.I. Onuora: Astronomy in Nigeria.

R. Sadat: Astronomy in Algeria.

A.M.I. Osman: The Kottamia Observatory and other Aspects of Astronomy in Egypt.

M.B. Al-Malki: Problems of Astronomy in Saudi Arabia.

B. Warner: The Role Of South Africa.

The titles are, for the most part, of my choosing, and I am prepared to allow the speakers some freedom in what they talk about. Two speakers are also giving poster papers: I ask them to emphasize different points in their two presentations. Speakers can count on a minimum of ten minutes each; it *may* be possible to increase that to fifteen. I do want to encourage discussion from the floor, and the more concise you are, the more discussion we can have.

Other Activities. This has been a very busy year for the Chairman. I have visited astronomers in seven countries on three continents, and travelled around the world. The Indian teachers' workshop was successful and I believe that my visit to Viet Nam was helpful to the local astronomers. At least it gave me a great appreciation of the difficulties they face in the country. I am grateful to all of you who offered me hospitality during my travels. I hope to see many of you in The Hague.

ASTRONOMICAL RADIO MINI-PROGRAMS

Julieta Fierro
Instituto de Astronomia, UNAM

For over a year we have been producing weekly five minute radio programs on astronomy.

The staff from one of the National University's radio stations calls us at home and we record two or three programs at a time. This procedure is very convenient for the astronomer, who needs only a watch to make sure his timing is right and can have all the notes he needs at hand (he can even walk around as he talks). The static and rather poor quality of the transmission is no problem in such short programs due to the fact that it makes them sound "more alive".

The programs we have produced have been about: the subjects presented at the weekly colloquium held at the Institute of Astronomy of our National University; astronomical news based on articles from magazines such as *Sky and Telescope*, *Astronomy* or *Science News*; general Mexican astronomical related subjects: awards given to our local researchers, new instrument development, etc; book reviews; and special events such as eclipses or the spring equinox. Once in a while we talk about general astronomical subjects according to radio-listeners' requests: extraterrestrial intelligence, how to become an astronomer, impacts, or the meaning of the constellations names.

As far as we can tell the programs have been very successful; they have been broadcast in prime time, that is to say during the morning news which is mostly listened to by people who are driving their cars to work. We try to keep the transmission informal and lively, like telling a story to the listeners, so they feel comfortable and are not specially distracted from driving in Mexico's City's traffic during one of the rush hours.

The astronomical radio miniprograms are re-transmitted in nineteen other cities in Mexico where local universities have radio facilities.

We feel that this is a very simple and inexpensive way of talking about astronomy to a great diversity of people. Similar mini-programs could be useful for countries that have few astronomers and need to recruit students.

MORE ASTRONOMY IN SPANISH CURRICULA

Ros R.M. ¹

Universitat Politècnica de Catalunya, Spain

The second National Teaching Astronomy Conference was held in Spain last summer. The "Círculo Astronómico Mediterráneo" and University of Alicante organized the "II Jornadas Nacionales de Astronomía en la Enseñanza" from 13th to 17th September 1993, in Alicante. About 300 teachers of different teaching levels attended the conference, the majority of them coming from secondary schools.

Since 1987, when the "I Jornadas Nacionales de Astronomía en la Enseñanza" were held in Cadiz, with 250 participants from all the country, we have organized different regional or international conferences. However we have not held other national meetings, and now was the moment to do it, because there are some changes in astronomy in Spain.

The new reformed curriculum for high schools contains a compulsory subject about astronomy in the field of natural sciences, and there is also an optional astronomy workshop. So, it was necessary for Spanish teachers to have a meeting to present different experiences and to discuss about this new period when astronomy, in secondary schools, seems better situated than some years ago.

Various activities took place including sixteen talks, two open discussion meetings, six posters. Seven general lectures were given by Prof. Eduard Salvador from University of Barcelona, Profs. Antonio Ten and Victor Reglero from University of Valencia, Profs. Jose Perez-Mercader and Mariano Moles from "Consejo Superior de Investigaciones Científicas", Prof. Nicoletta Lanciano from "La Sapienza" University of Roma, and Prof. Gonzalo Vicino from "Consejo de Enseñanza Secundaria" from Uruguay. In addition, there were various exhibitions of didactic materials and telescopes during the conference.

Thanks to good organization and the high standard of all the participants, the conference was a great success. This success invites Spanish teachers to prepare a next meeting in 1995.

If you wish to receive the Proceedings of "II Jornadas Nacionales de Astronomía en la Enseñanza", please write to Guillem Bernabeu, Dept. de Ingeniería de Computadores, Automática y Fundamentos Físicos de las Técnicas, Universidad de Alicante, Ap. Correos 99, E-03080 Alicante, Spain, or to Juan Vicente Perez, Círculo Astronómico Mediterráneo, Ap. Correos 616, E-03001 Alicante, Spain.

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TRIENNIAL NATIONAL REPORTS

ASTRONOMY EDUCATION IN PARAGUAY

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Some steps have improved our Astronomy education. These are the following:

i) Dr. Donat G. Wenzel, our present VLP Coordinator, visited Paraguay soon after the last IAU General Assembly at Buenos Aires, in August 1991. He stayed for two weeks and gave four interesting lectures on Solar Astronomy for our VLP students and other interested students and staff at the Department of Physics, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Asunción. These talks were related to topics of Dr. Wenzel's book "The Restless Sun". He delivered a talk to interested public and amateurs, too. He had interviews with high school students and the press.

ii) A PC for our VLP has been bought thanks to funds from IAU. At present this is fully used by VLP students at the Department of Physics.

iii) One of our Physics instructors, Ing. Tomás Rolón, received a grant to spend a month at "Instituto Argentino de Radioastronomía" at La Plata, Argentina. He has been trained and built parts for a small radiotelescope, during March 1992.

iv) The fifth VLP instructor, Dr. Armando Arellano Ferro, from UNAM (MEXICO) delivered an excellent course "Optics and Instrumentation in Astronomy" during spring 1992. More appropriately, this was about Observational Astronomy and emphasized photometry and spectroscopy, with practical work observing Variable Stars. It also contained a good introduction to Variable Stars, and Stellar Evolution. Twelve students have attended this course to the end (more at Newsletter No. 36).

v) Dr. John Percy sent as a loan the peripheral parts of the IAU Travelling Telescope (a photometer, a spectroscope and a well equipped photographic camera). These were used for practical work at Dr. Arellano Ferro's course and were used with a C-8 telescope at Sr. Eduardo Parini's observatory at Caacupé-mí (14 km from UNA'S campus). These instruments are still used by some students to make Variable Star observations. Also, Dr. Percy has provided us with the appropriate software for photometry.

vi) Two of our VLP students have received grants and travel by February 1993. So Norma Caballero is now working in research in radio astronomy at IAR (with former VLP instructors) in Argentina. Furthermore she is taking courses for Licenciature in

Astronomy. Nancy Nuñez went to Mexico and spent three months working on Variable Star research with Dr. Arellano Ferro. She is back observing variable stars.

vii) The sixth VLP course is expected in April 1994. Thanks to the support from CLAF (Centro Latino - americano de Fisica) and UNESCO to cover the expenses of all VLP instructors and the "Società Dante Alighierei" provided an apartment to most to stay in downtown, Asunción. We are expecting to have Dr. Michele Bossi, from Observatorio Astronomico di Brera, Italy, by next April 1994.

viii) There are two regular Astronomy courses at Universidad Nacional de Asunción: one elective for junior physics students at the mentioned Physics Department and another for the Facultad de Ingenieria (oriented toward geodesics).

It is worth mentioning that much effort has been done by two amateur clubs from Paraguay. "Club de Astrofisica del Paraguay" and "Centro de Estudios Astronómicos". They publish bulletins, "Astrocosas" and "Antares" respectively. They provide activities like lectures, summer courses and star parties.

At the secondary level, some Astronomy has been taught through courses of Natural Sciences and Senior Math. There remains still "Cosmography" in some high schools. We wish this doesn't disappear but gets improved. Regularly, two courses in Astronomy to train high school teachers are given at the Instituto Superior De Educacion which depends from "Ministerio de Educación y Culto".

Astronomy is a popular subject but teaching of science is most needed in countries like my own, because every year less students are involved at university level in math and science. The preferences are for the commercial and easy-to-get-jobs professions. It is certainly a challenge for any involved educator to improve it. Young students should learn some Astronomy to open their mind and interest toward science and technology. Now, nature helps us from time to time, so; a Total Eclipse is expected in November 3, this year. It will go diagonally through the middle of this country. Although weather prospects are better toward north and particularly toward Peru and Bolivia, some conditions are better in Paraguay. It will happen closer to the middle of the morning. It is easier to find roads and towns in the totality path. It is safer and has enjoyable tropical countryside. Really, this eclipse is expected to provide a good opportunity to turn people's interest toward our science. We are look forward to welcoming astronomers and amateurs from all over. But also we would like to hear what you think is best to continue improving Astronomy in Paraguay.

TRIENNIAL NATIONAL REPORTS

ROMANIA

Elvira Botez

Astronomical Observatory, Str. Ciresilor 19, 3400 Cluj-Napoca

During this triennial interval, the teaching of astronomy in Romania came up against serious difficulties inherent to the transition period. However there remains a hope that the conjugated efforts of professional and amateur astronomers will lead to an increase of the importance of astronomical teaching, as well as to corresponding results.

Elementary schools. Primary notions are introduced during the 3rd year (orientation based on heaven's aspect, in the framework of general notions about nature). Planetariums play an essential part during these stage. The geography program during the 5th year introduces some information concerning the solar system.

Secondary schools. More detailed information about the solar system is provided for the 9th year also in the framework of the geography program. As an independent discipline, astronomy is introduced in the 12th year (only for special classes of mathematics and physics) by teachers of mathematics, physics, sometimes geography (unfortunately, teaching of astronomy performed by professional astronomers is very rare). Astronomy constitutes an optional discipline for obtaining the "baccalaureat" degree at the end of secondary school; it is to be emphasized that many pupils choose astronomy for this purpose.

University Education. Astronomy is present in courses (compulsory, optional, facultative, experimental) at universities (faculties of mathematics, physics, geography, philosophy, chemistry), as well as at technical and military high schools. It is to be emphasized that there is collaboration between professors and researchers in performing such courses. Every year there are students (in mathematics and physics) who graduated from their university education with a master's degree thesis in astronomy. There also are teachers who prepare their post-graduate work in astronomy (ending with a "1st degree" thesis). Lastly, researchers and teachers obtain the PhD with theses on astronomical topics.

Public Education. Public astronomy education is done in planetariums and public observatories, by radio and TV programs, lectures at popular universities, popular journals and magazines, amateur astronomical societies. There are three planetariums belonging to the universities of Bucharest, Iasi and Timisoara (for students only), and four public planetariums in Bacau, Baia Mare, Constanta and Suceava. The most important public observatory is "Admiral Vasile Urseanu" Observatory in Bucharest. Four small public observatories belong to the last four above mentioned planetariums. Public observatories are located at the Palace of Children in Bucharest, and Natural Science Museum in Slatina, too. Many papers of astronomical information appear in various popular journals and magazines. The Bucharest "Astroclub" (see below) edits the popular astronomical journal "Orion". There are several amateur astronomical societies among which we mention : the Romanian Astronomical Foundation (including professional astronomers, too), the Bucharest "Astroclub", Galaxis" (Arad), "Universzum" (Odorheiu Secuiesc) and those belonging to the Palace of Children in Bucharest of Natural Science Museum in Sibiu.

NEWS NOTES

Efemerides 1994

One of the projects of the Seminario de Astronomia y Astrofisica, Facultad de Ciencias Fisicas, Universidad Nacional Mayor de San Marcos (Peru) is "Efemerides 1994", by Jorge Meléndez, María Luisa Aguilar, and Rocío Meigarejo. This publication contains predictions, information, and a useful glossary.

Distance Education (UK)

The Open University (UK) announces the availability of the book "Images of the Cosmos", co-published with Hodder and Stoughton (London).

The book is a component of the Open University undergraduate astronomy course S281 *Astronomy & planetary science*. The course enrolls 1200 students per year, and in addition to "Images", which comprises the colour images for S281, there are many other course materials. Many of these will be available at the end of 1994 from Open University Educational Enterprises, 12 Cofferridge Close, Stony Stratford, Milton Keynes MK11 1BY.

Distance Education (France)

The CNED (Centre National d'Enseignement a Distance) has produced in 1993, for the first time in collaboration with the Universite de Paris Sud a yearly correspondence course in Astronomy. This course is offered for academic credit "Diplome d'Universite". The background of the students is that of the level of a scientific baccalaureat. This year nearly 800 students have enrolled in this course and 400 will go for the examination (which is not compulsory). This course consists of a printed text (about 550 pages), a videocassette of 55 minutes, a set of 60 slides, a set of 41 black and white photos, a leaflet of exercises (with answers) including some home experiments. Three written problems are proposed : They are individually corrected. Moreover a direct link with a tutor is available through the French e-mail system "Minitel". It is also proposed to participate twice in a full day meeting in a French observatory. Students study exclusively in their own homes, in their own time, and progress at their own rates. They can test their progress by answering the questions spread all along the written course and by using the set of multiple-choice questions available through the Minitel.

Symposium on Astronomy Education

The Astronomical Society of the Pacific plans to hold a two-day symposium on astronomy education as part of its 1995 summer meeting at the University of Maryland. Don Wentzel is chair of the LOC, and John Percy is chair of the SOC. The emphasis of the meeting will be on recent developments in astronomy in North America, but participants from other countries are cordially invited. The format of the meeting will be review lectures, discussion, and poster papers. For ... more information, contact John Percy at the address on the cover of this Newsletter.

Presented at a joint meeting of the Astronomical Society of Australia, and the Royal Astronomical Society of New Zealand; reprinted from Southern Stars, vol. 35, Numbers 6, 7, 8, June 1994.

EDUCATION IN ASTRONOMY: AN INTERNATIONAL PERSPECTIVE

John R. Percy¹

Abstract

The health of astronomy is profoundly affected by the quality and quantity of astronomy education, in the schools and universities, and among the general public. Education plays a direct role in attracting and training the next generation of astronomers. It contributes to the awareness, understanding and appreciation of astronomy among the taxpayers who support us. This review focuses on three topics: the educational activities of the International Astronomical Union (IAU), some notable astronomy education projects and programs worldwide, and some actions which you and your colleagues could take to promote more and better astronomy education in your city, your country, and the world. For a comprehensive view of astronomy education worldwide, see Pasachoff and Percy [1], and the triennial national reports in the Newsletter of IAU Commission 46 (The Teaching of Astronomy).

1 The IAU and its Education Activities

The IAU is a non-governmental scientific union founded in 1922 to "promote and safeguard astronomy, and to develop it through international cooperation". The IAU also acts as a liaison by representing astronomy on about 20 other unions and commissions. There are currently 65 countries adhering to the IAU - up from 51 three years ago, primarily due to political events in Europe. Individual membership is by nomination, and is free (so there are no economic barriers); it is based on qualifications - usually a PhD and some years of experience. There are 7301 members (10.5% women); the number doubles about every 12 years. IAU headquarters is based in Paris, and is administratively "lean". Most of the IAU's funds (which come from formula funding from the adhering countries, as with the UN), support meetings, including General Assemblies, Regional Meetings, Symposia and Colloquia, held in geographically-diverse locations, and the participation of young and/or needy astronomers. The IAU is governed by an Executive Committee, composed of a President, six Vice-Presidents, a General Secretary, and an Assistant General Secretary. The membership is organized into

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40 commissions or interest groups, of which only one is concerned with education. The last few issues of the IAU's semi-annual Information Bulletin have contained some interesting statistics about IAU membership, and some controversial proposals to restructure the commissions.

2 IAU Commission 46 (The Teaching of Astronomy)

This commission serves "to further the development and improvement of astronomical education at all levels throughout the world". It has about a hundred members, including representatives from each country adhering to the IAU, consultants from countries not yet part of the IAU, and other interested persons. It is governed by a President (currently Lucienne Gouguenheim, France), a Vice-President (currently me), and an Organizing Committee of individuals responsible for specific projects and programs. These include: liaison with other unions; a Newsletter, with triennial national reports; meetings associated with IAU General Assemblies and Regional Meetings, including a one-day workshop for local teachers at each General Assembly; IAU Colloquium #105 (The Teaching of Astronomy", held in Williamstown USA in 1988 [1], the Visiting Lecturers' Program, which sends experienced astronomer-educators into "target" countries (currently Paraguay and Peru) for up to several months to give courses and develop collaborations; the International Schools for Young Astronomers (co-sponsored by UNESCO) - intensive three-week schools held every year or two for advanced students and young astronomers and teachers in different parts of the developing world (currently India in early 1994); the Travelling Telescope, a Celestron-8 telescope and research-grade instruments to be used in countries (currently Paraguay) where astronomical research is in a developing stage. The national representatives play an important role in coordinating astronomy education in their countries, and in providing a two-way communication channel with the IAU.

Note that most (but not all) of these activities are designed for developing countries. The IAU also has a Working Group on the Development of Astronomy, and Commission 38 (Exchange of Astronomers), which also promote and facilitate the development of astronomy.

3 Astronomy Education Worldwide: An Overview

Readers should realize that there are two main systems of education, typified by the "European" system in which, through a national curriculum and standard exams, a subset of students are specially selected and prepared

shown that women astronomers in North America still work in a "chilly climate". It is interesting to look at IAU statistics on the percentage of women astronomers in different countries, and in different fields of astronomy. New Zealand is lowest, with 0% women among its IAU members; Australia is not far ahead. In the "romance language" countries like France, Italy, Spain and Latin America, the fraction of women is much higher - typically 30%.

Among the general public there is considerable interest in astronomy though, as research shows, the level of understanding is limited. In North America (and now in the former Soviet Union), there are the additional "problems" of creationism and pseudoscience. These may herald a general backlash against traditional science. Planetaria and the media play an important role in public awareness of astronomy, as do amateur astronomers, who number at least a million in North America. These "volunteer astronomers" make important contributions to education and research, as well as by providing public support for astronomy. But there is concern (perhaps unjustified) about the "dumbing" of amateur astronomy as these individuals flock to computerized telescopes and software akin to video games.

4 Astronomy Education Worldwide: From A to Z

The following representative items have been culled from the 1990-93 National Reports which have been received as of 1993 November (the deadline was July!). These are only a tiny fraction of the programs and projects in astronomy education worldwide.

- Argentina: In Esquel, astronomers are developing an astronomy centre in a town square, with both educational (e.g. a sundial) and recreational (e.g. an earth-moon carousel) components.
- Australia: One state has developed a pre-matriculation "distinction" course in cosmology, to challenge the most talented students in the system.
- Belgium has experienced an increase in public interest in astronomy as a result of the first flight of a Belgian astronaut, and programs offered by planetaria, the Euro Space Camp, and public "schools for astronomy".
- Brazil: Since 1971, over 18,000 people have taken 370 public education courses at the Sao Paulo Planetarium and School of Astrophysics.
- Bulgaria now has a separate astronomy course in grade 11 high school.
- Canada: Toronto is home of the Youth Science Academy, in which high school students organize seminars and field trips on science, and the Univer-

for university studies while the rest are provided with more job-oriented training; and the "North American" systems in which curricula are local (but comparable) and most students can - for better or worse - gain access to tertiary education. For a more eloquent and less simplistic account see Wentzel's introductory paper in [1].

Basic topics in astronomy are usually taught in elementary school but, as much research has shown, not understood. This is partly because the topics are usually boring and taught by rote, and partly because elementary school teachers seldom receive much training in science in general, and astronomy in particular. The challenge is to develop an interesting curriculum (which should not be difficult, given the students' interest in astronomy), to teach it in a "hands-on" way, and to provide teachers with support through in-service workshops and other resources. It is in senior elementary school that students (especially girls) are "turned on" or "turned off" by science, so this level is critical.

In secondary schools, astronomy can be taught as a science, and many science teachers are interested in and knowledgeable about astronomy. In Europe, most physics teachers have received some training in astronomy. In North America, science teachers are more likely to teach astronomy because they enjoy it as a hobby. In the USA, a new generation of astronomy programs and materials are being developed, thanks to the education division of the National Science Foundation. In Canada, there is no compulsory astronomy in the secondary schools of some provinces; if optional, it is often by-passed in a very overcrowded curriculum.

At the university level in North America, hundreds of thousands of non-science students take astronomy as a "science requirement" annually. Textbooks, teachers' guides, and resource material (slides, videos, computer software, lab exercises) are readily available. These courses provide an excellent way of reaching the influential as well as "the masses", since there is a good chance that any influential person will have taken an astronomy course! Astronomy courses for science students are much less common but, again thanks to the NSF education budget, they have increasing access to telescopes, CCDs, photometers, computers and other teaching and research tools.

It is from this pool that future astronomers come. Unfortunately, the pool is shrinking in North America (and elsewhere) because science is seen as difficult, impractical and unlikely to be financially rewarding. One way in which the pool can be expanded (and equity achieved) is to attract more women and minorities to science. Despite these efforts recent surveys have

- sity of Toronto Mentorship Program, which enables outstanding senior high school students to work on research projects with faculty such as me.
- China, in 1992, hosted both an International School for Young Astronomers, and a conference on Teaching Astronomy in the Asian-Pacific Region.
 - Colombia experienced an increased interest in astronomy as a result of the 1991 July solar eclipse; geographical accidents can leave a positive legacy!
 - Finland: University astronomy enrollment has risen as a result of Finland's more active role in space research.
 - France: The long-standing Comité de Liaison Enseignants et Astronomes (CLIEA) organizes very successful summer schools for teachers, and a journal *Les Cahiers Clairaut*.
 - Hungary: As elsewhere in eastern Europe, the education system is in a state of flux, with the creation of new private schools and universities.
 - Japan reports growing public interest in astronomy, but there is concern about light pollution in this densely-populated country.
 - Malaysia: The "lone astronomer" has been responsible for a new planetarium complex in Kuala Lumpur, in addition to her many other duties.
 - Mexico: The institute of astronomy of the national university has an active outreach program to schools and the public, through books, newspaper articles, and even "science in the subway stations".
 - New Zealand, as part of the 1993 RASNZ AGM, held a one-day workshop for school-teachers - an event which should be part of every scientific meeting!
 - Nigeria is developing a national space policy, and this may have a positive effect on astronomy education, and may stimulate the development of collaborative astronomical research.
 - Norway has a planetarium which specializes in the projection of Northern Lights in a wide screen movie format.
 - Peru: the Boletín Informativo SAA (Seminario de Astronomia y Astrofísica) for 1993 list an impressive array of activities and accomplishments.
 - Poland has hosted two recent science education conferences with an astronomical flavour: *Cosmos: An Educational Challenge*, and *Frames of Reference*.
 - Portugal: Much effort has gone into the development of a high-quality graduate program in astronomy at the University of Porto.

- Russia: Positive advances in astronomy education have been compromised by political and economic factors, and by the growth of pseudoscience - "the backside of non-intelligent human rights".
 - South Africa: Within the turmoil of political events, astronomy is seen as an inexpensive way to "turn on" a multiracial population to the cultural and economic benefits of science.
 - Spain: "Permanent Seminars" for teaching astronomy have been established in several locations, and have produced effective astronomy activities for school classes.
 - Sweden has brought astronomy to the attention of students and the public through an essay contest, sponsored by the European Southern Observatory, in which the prize is a night of observing time on an ESO telescope!
 - Switzerland is home to the Saas-Fee courses, given each year by three lecturers to about a hundred European doctoral and post-doctoral students; the lecture notes are published by Springer-Verlag.
 - United Kingdom: the Open University, which specializes in distance education, has developed an astronomy course which will enrol more students than all other astronomy courses in the UK!
 - United States: Of the many astronomy education projects funded by the NSF, the largest is Project STAR: Science Teaching through its Astronomical Roots, which includes a textbook, teachers' manual, inexpensive apparatus, and a well-researched approach.
 - Yugoslavia: The Youth Research Station in Petnica organizes a variety of courses and project work for students interested in astronomy.
 - Zimbabwe: Astronomy is alive and well at Prince Edward School - a government school in Harare; it has an observatory and is headquarters for the local astronomy club.
- ## 5 The Developing Countries
- Of what value is astronomy to developing countries? Perhaps the most obvious is its educational value. With its appeal to young people it can attract students to the sciences and engineering, rather than to law and politics. It is deeply rooted in the culture of almost all societies, so it can also raise the general level of scientific literacy. To paraphrase the words of Mazlan Othman (Malaysia): "Astronomy is the stuff of dreams and youthful fascination. This is true for us in the developing countries as much as in countries

like the USA. Our youth are interested in astronomy and space as much as youth elsewhere. And when you in the developed countries achieve your dreams, we hope not to be too far behind you." A common phenomenon in the developing countries is "the lone astronomer" - one individual who facilitates astronomy at the university, school, amateur and public level. Their achievements are remarkable. What are their needs? One is to visit and be visited, and many of the IAU's programs are designed with this in mind. If you have the opportunity to spend a few days in such a country, please do so. I can put you in touch with the appropriate person. Another need is for books and journals, and several organizations (such as the Canadian Astronomical Society) have programs of this kind. It is necessary to identify a "target person" in the country concerned, and to set up a channel for communication and delivery; again, I can provide advice. There is a need for equipment and observing facilities; the Travelling Telescope is a modest step in this direction.

6 How You Can Improve Astronomy Education

It would be unreasonable to expect every astronomer to devote a large fraction of their time to education (although some of us do). A better approach is to stress organization, coordination and communication. Several concrete steps to improve astronomy education are outlined below.

Make education a part of your organization (RASNZ, ASA). Establish an active education committee, with an active chair/coordinator, which will (i) provide a regular education column in your journal, (ii) organize an education session, public lecture and teachers' workshop at your AGM, (iii) maintain a network of information about education topics for your members and (iv) work with education authorities and other groups in your country to promote astronomy education.

Be aware of developments in astronomy education, as well as education in general, using channels such as those mentioned above. Is the science curriculum changing? Make sure astronomy is not left out! Looking for new teaching material? Be aware of what exists; don't re-invent the wheel! Convene a meeting on astronomy education every few years, inviting people from the educational authorities, teachers' associations and the media. Lobby for more funding for science education: the annual education budget of the NSF (USA) is half a billion dollars!

Help get more and better astronomy in: day and night schools (teaching a general-interest course in the evening is fun!); museums, science centres and planetaria; parks and conservation areas ("star parties"); radio, TV

and print media. Lobby for, and help develop a new planetarium, science centre or public observatory.

Support astronomy in the developing countries. Broaden your perspective by learning about astronomy worldwide, and about the specific needs of the developing world. Find out about programs to send surplus books and journals there; support and use these. Locate and communicate with "the lone astronomer"; find out how you can help. If you visit a developing country (or any country), consider meeting with astronomers, teachers and students there; make arrangements ahead of time by consulting with IAU Commission 46. Support the IAU and its activities.

Do your bit for education. Pass on your knowledge and enthusiasm for astronomy; students especially must be shown that scientific careers are exciting! Give the occasional public lecture or school visit, and write the occasional article for a magazine or newspaper. Encourage interested students, especially under-represented groups such as young women. Publicize astronomy, and its practical and cultural value.

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