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INTERNATIONAL ASTRONOMICAL UNION

COMMISSION 46 — TEACHING OF ASTRONOMY

NEWSLETTER

Number 21; January 1987

Editorial

Greetings and Happy New Year! We are now half way through through the triennial cycle of Commission 46 activities. We can soon look forward to the preparation and publication of the National Reports and the Astronomy Education Material - always interesting reading.

This issue contains some very special news. The Executive Committee of the IAU has approved our proposal for a Colloquium on the Teaching of Astronomy. More information on this colloquium is contained on pages 21 to 24. As Chairman of the Organizing Committee, I would be glad to have your suggestions about the organization of the colloquium. I would also appreciate contributions of oral or poster papers.

I had a very pleasant visit with Dr. Derek McNally at the University of London Observatory at Christmas. There is much to be learned by discussing astronomy teaching with colleagues from afar! I am sure that there will be much of this at IAU Colloquium 105.

I thank all the contributors to this rather long issue, and Mrs. Jane Collett for typing it. The next issue will be prepared in May 1987. Please send your contributions before then.

John R. Percy

IN THIS ISSUE

TELESCOPES FOR STUDENTS

An astronomy class typically is composed of twenty or more students, one instructor, and one telescope. For observing sessions, these numbers mean that at any one moment most of the students are standing, slowly freezing in the dark, waiting their turn at the eyepiece. Moreover, when they do have their 20-second peek, moist breath, a bump by the last observer, or unfamiliarity with the instrument often mean that the object will look hazy, be out of focus, or even out of view. A couple of sessions under these circumstances can dampen the interest even of keen students. Also, the instructor may be reluctant to let individual students have unsupervised access to the one, expensive, fragile telescope.

Ideally each student would have a telescope during supervised observing sessions. Each telescope should be easy-to-use, rugged, equipped with setting circles, and mechanically and optically designed so as to minimize conceptual barriers between its operation and the geometry of the sky. As a step toward this goal, for the introductory astronomy course at Acadia University we have designed and constructed a set of six telescopes. Each telescope is a modest wide-field, equatorially-mounted refractor.

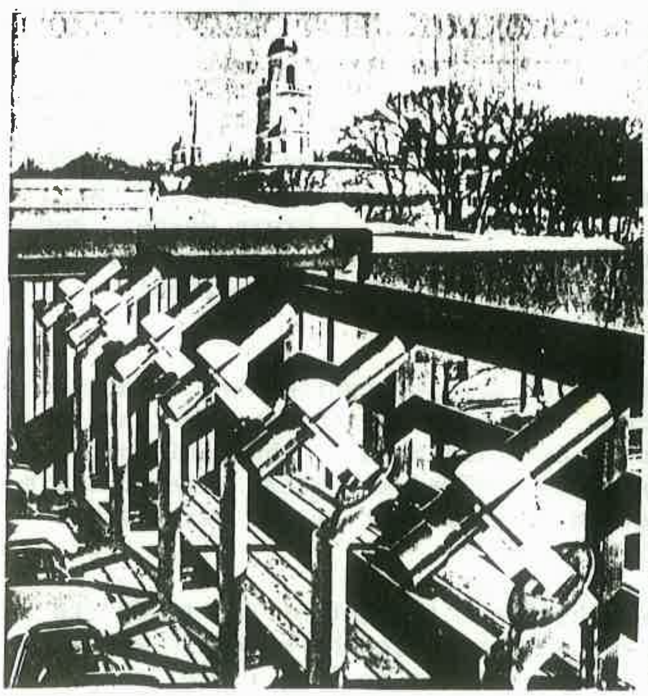
The objective lens of each telescope is a 78-mm diameter (74-mm clear aperture), f/5 achromat (from the Jaegers firm of Lynbrook, N.Y., catalogue No. S851). The eyepiece is of the erfle type. It has a focal length of 16.3 mm and an apparent field of 69°, providing a magnification of 23x, an actual field of 3°, and an exit pupil of about 3 mm. Thus the magnification is low, but higher than the "RFT" range. The optical components are mounted in an aluminum tube (wall thickness 6 mm), with a rack-and-pinion focuser for the eyepiece. The focuser is modified so that neither the eyepiece nor the rack can fall out.

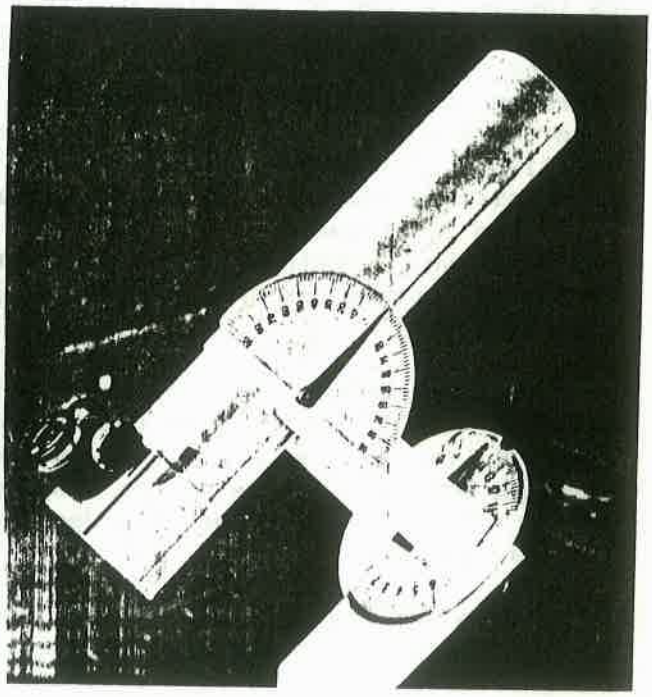
The 3° field of view is sufficiently large that a "finder" telescope is not required. It is sufficient to sight along the side of the telescope tube to aim the instrument at an object visible to the unaided eye. Moreover the field is large enough (and the aperture sufficient) to provide striking views of several objects that cannot be encompassed by the narrower fields of larger telescopes (e.g. the Pleiades, the Praesepe cluster in Cancer, the entire Perseus double cluster, the North American Nebula, the entire sword of Orion with the Great Nebula, the Andromeda Galaxy together with its two companions NGC 205 and 221, the quartet of galaxies: M 81, M 82, NGC 2976 and 3077).

At a magnification of 23x, angles as small as 10" can be resolved, and atmospheric turbulence is not a problem (higher magnification would be required to approach the diffraction limit for a telescope of this aperture, although an f/5 achromat does not perform well at this limit). The 23x magnification brings the disk of Jupiter, the rings of Saturn, the double star Mizar, and the Trapezium in the Orion Nebula into view. Thus, in addition to providing unique wide-angle views, the telescopes provide an introduction to sights that are displayed to better advantage in larger instruments. Even for some objects that are generally considered to require larger instruments, these telescopes provide pleasing views (*e.g.* the Triangulum galaxy, M33, appears as a glowing cloud set in a broad, dark field of stars. Even the Crab Nebula is an obvious small blob of light in a star-peppered field).

The neck-saving, 90° bend in the optical path is provided by an Amici (roof) prism. Since there are *two* reflections, the view is not only upright, but is correct left-for-right. Thus the view through the telescope has the same orientation as the view seen with the unaided eye when the observer raises his head, and the telescopic view may be compared directly to star charts. This eliminates a source of confusion for students, and, even for experienced observers, is a convenience that must be experienced to be fully appreciated.

Each telescope is mounted on a three-legged stand constructed of welded iron pipe. The main column has a diameter of 73 mm. This provides a very stable support that is not easily upset (total mass ~ 15 kg). If the telescope is jarred, vibrations die away within one second. A handle on the main column near the centre of mass facilitates carrying the entire instrument with one hand. The height above the ground of the centre of the declination axis is 97 cm which allows comfortable observing while seated on a small stool. For polar alignment, the stand may be set in a predetermined location; *or*, a bubble level located near the base may be used to determine when the polar axis is at the correct angle, and the observer, knowing the sidereal time and having aligned the telescope with the setting circles, may then turn the stand in azimuth to reveal any bright star (not near the zenith) of known right ascension and declination.





As is apparent from the figure, the equatorial mount is of the fork type. There are no clamps or slow motion drives. Motion about both axes is controlled by friction, which can be adjusted. There is a short, fixed pointer at the upper edge of the right ascension dial. This acts as the meridian marker and, when the right ascension dial is properly set (it can be rotated independently of the telescope or stand), the dial reading indicated by this fixed pointer is, of course, the sidereal time. Thus the right ascension dial can be set either by knowing the sidereal time, or by first aiming the telescope at an object of known right ascension and setting the dial using the pointer attached to the base of the fork. Once set, for a period of a few minutes other objects can be found by use of the dials. (Even near declination 0°, objects take 6 minutes to drift from the centre of the field to the edge).

Note that the pointers on the declination and right ascension dials point in the same direction as does the telescope. Consequently, the calibration marks on both dials, extended radially, coincide with the imaginary grid of right ascension and declination on the sky. In this spirit of didactic simplicity, the declination scale is calibrated to 90° S, even though the telescope physically cannot be swung southward in the plane of the meridian to point much below the horizontal (which for the latitude of Acadia University corresponds to declination 45° S).

Except for the optical components and the focusers, the telescopes were manufactured in the Interdepartmental Workshop at Acadia University. I am particularly indebted to Mr. Oscar Morehouse who refined several details of the design during construction.

The declination dials (calibrated at 2° intervals) and right ascension dials (calibrated at 10 min. intervals) are 15 cm in diameter. These were drafted with India ink, photocopied, attached to aluminum disks with glue, and covered with self-adhesive transparent vinyl. The objective lens is secured 5 cm inside the end of the aluminum tube with two bronze snap rings and O-rings. The fork base and tines are made of 1/4 inch steel plate. The declination bearing consists of two, hard-brass studs anchored in the sides of the telescope tube with self-locking nuts. Each tine has a cut across the bearing hole and a screw to squeeze the two sides against the studs to adjust the friction. Teflon washers position the telescope tube between the tines. The polar axis is made of 1/2 inch diameter drill rods, is welded to the fork base, and is threaded at the lower end to take two nuts, a brass washer, and a teflon washer. Another teflon washer under the fork base serves the dual role of thrust bearing for the polar axis plus radial bearing for the right ascension dial.

Although many aspects of the construction are straightforward, some are critical to the operation of the telescope; *e.g.* the optical and declination axes must be fixed in place with the polar axis inclined to the horizontal at an angle equal to the latitude; the fixed pointer and the polar axis must lie in the same vertical plane; the declination pointer must be set parallel to the optical axis.

Plans for these telescopes are available from the author for $2.00 (to cover copying and postage). Note however, that because the specific eyepiece and prism used in the Acadia instruments appear to be no longer available, a few of the dimensions and details would need to be altered to accommodate eyepieces and Amici prisms of other dimensions. Also, the reader will, no doubt, have already thought of improvements to the design described here.

Aside from providing more time at the eyepiece for students, these telescopes provide experience that is missing at observing sessions involving one, larger motor-driven telescope which necessarily has been pre-aligned on objects of interest. When they sit down beside one of these basic instruments, students are literally cast adrift among the stars: they *have* to study the star patterns, think about coordinates, and allow for the turning of the planet beneath their feet. This experience will probably stay with them long after other details learned in class have been forgotten.

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Editor's Note: This article was reprinted from the *Journal of the Royal Astronomical Society of Canada 80, 211 (1986)* with the permission of the author and the editor.

JOURNALS FOR THE DEVELOPING COUNTRIES

According to a letter to the editor of Physics Today, May 1986, there is a program for sending surplus journals to libraries in the developing countries. It is managed by the International Centre of Theoretical Physics, Miramare 34100, Trieste, Italy, and is at present handled there by H. Dalafi. Those wishing to donate journals, or those wishing to receive them, might wish to contact the Centre, or the editor of this Newsletter.

WHEN I HEARD THE LEARN'D ASTRONOMER

When I heard the learn'd astronomer,
When the proofs, the figures, were ranged in columns before me,
When I was shown the charts and diagrams, to add, divide, and measure them,
When I sitting heard the astronomer where he lectured with much applause
 in the lecture-room,
How soon unaccountable I became tired and sick,
Till rising and gliding out I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.

Walt Whitman

PUPPETS AND ASTRONOMY

Every year, thousands of students from primary, secondary and university institutions come to the University of La Plata Astronomical Observatory (where the Faculty of Astronomical and Geophysical Sciences is located). Their aim is to visit its building; to get in touch, in most of the cases, for the first time, with the telescopes and to listen to a talk on Astronomy. For such purposes, the above-mentioned Faculty has a team of professionals who not only do research work but also take care of the public visiting the Observatory.

For some years, students attending the first years of primary school, i.e. from the first to the fifth grade which corresponds to students 6 to 10 years old, and also disabled students, have been encouaraged to visit the Observatory. The lectures for each level of attendance were prepared in different appropriate ways, and the educational elements used in each case varied strongly.

As members of this team of professionals concentrating on children, we imagined astronomy classes given by the astronomers who had established the foundation of our science. Thus we made puppets that not only played the role of Galileo, Copernicus, Kepler, Halley and Newton, but also were in charge of teaching the concepts of the cosmos which their "human" ancestors had once brought out.

In the very beginning, the didactic shows were given at the dome, within the puppeteer theatre built by the Faculty. These "astro-puppets" became the first beings who gave lectures at the University of La Plata, and their success spread rapidly..

Children are entranced by their speeches, and have an affectionate dialogue with the puppets, through which they express their doubts about the universe. This is something that not even the professionals themselves could always achieve.

The material that comes out of these classes is ample and vast, so that the teacher accompanying the group of students can re-elaborate it at school. Then, using the most frequent questions asked by the visiting children plus nearly a hundred questions collected at other schools, we came to produce, jointly with the professionals in charge of the Design section in the Faculty of Fine Arts, an educational audiovisual.

With this audiovisual and the astro-puppets, we have prepared an eduational astronomy show, addressed not only to children, but also to the general public, entitled "Science + Fantasy = Astronomy". The show is sponsored by the National University of La Plata and the Scientific Research Committee of the Province of Buenos Ares (CICPBA).

The pageant was presented for the first time in 1986 at the National Childrens' Festival, which takes place annually in the city of Necochea, Buenos Aires Province. It had an excellent acceptance. In five performances, we recorded an audience of more than four thousand people, half of them under the age of ten. Grown-ups and teenagers made up the rest, all being equally enthusiastic about the performance.

"Science + Fantasy = Astronomy" has grown a lot since that beginning. It has helped us to narrate the story of the geocentric-heliocentric dichotomy, and to explain and provide information about Comet Halley. Consequently and obviously, the number of puppets increased much as science itself does.

We do not think we should attribute the evident success of this non-traditional method of teaching and scientific popularization upon the purely esthetic contents of the show (staging, coloring, etc.), but upon the blending of two wonderful aspects: astronomy and puppets. Astronomy has a natural charm, a touch of mystery, and it provides a continuous stimulus to wonder about the origin and future of worlds. The puppets have a rich power of expression through which they can break down the boundaries between reality and fantasy. In this way, they can elaborate easy concepts in an interesting way, yet they are as convincing as those given by books or by teachers in the classrooms.

Horacio L. Tignanelli
Observatorio Astronomico
(1900) La Plata, Argentina

GIREP

GIREP, which when translated into English means "International Research Group on Physics Teaching", is a group which has much in common with IAU Commission 46. Sga. Silvia Pugliese Oona, via San Nazario 22, ID015 Ivrae (Torino), Italy, is the Secretary of GIREP, and Editor of the GIREP Newsletter. As well as sending me a report on GIREP '86, she has also sent me a letter which reads in part:

> " I take the opportunity to ask you to kindly send me any information which might interest teachers of physics and astronomy (or teachers of astronomy in physics), for our Newsletter. I'm interested, amongst others, in announcements of forthcoming meetings and conferences.
>
> As Ms. Iwaniszewska very effectively put it in Elsinore, astronomers and physicists should join hands in the endeaavor to improve the education of young people and their understanding of the world they live in. "

GIREP CONFERENCE 1986 - COSMOS, AN EDUCATIONAL CHALLENGE

"Life is nothing but stardust...."
"Good planets are hard to find...."
are two remarks quoted from the GIREP Conference we would like to use to introduce this report.

GENERAL CONFERENCE OUTLINE

Some 125 participants must have had a good time in the beautifully situated and excellently equipped LO-Skolen conference centre in Helsingor, Denmark from August 17-23, 1986. The conference programme consisted primarily of plenary lectures in the fields of astronomy and astrophysics, with some references to education. Parallel sessions and workshops concentrated more on education: the teaching of astronomy at the various levels, visual aids, astronomical experiments and observations in schools, students' concepts of astronomical phenomena, etc. It was difficult to choose among them. Moreover, this part of the conference only took two afternoons: maybe not enough to deal with "the educational challenge".

CONTENT: WHAT TO TEACH AND WHY?

Astronomy and astrophysics cover a wide range of phenomena, so educational boundary conditions such as a limited amount of teaching time and the difficulty of some concepts/topics force some choices on teachers and curriculum developers. An answer to the question "why teach astronomy/ astrophysics" would be very useful to help make this sort of decision. This question occasionally emerged in the plenary lectures, but was treated in a rather casual way. "Answers" from different speakers varied:

i) Teaching astronomy/astrophysics extends the repertoire of realistic and useful problems (an answer from the viewpoint of physics education itself).

ii) Teaching astronomy/astrophysics is necessary to develop the capability of the general public (tax-payers!) to assess the desirability of space research programmes (an answer from the viewpoint of society as a whole and space research institutions in particular: see the plenary lectures on the American, Soviet and European space programmes on the first day of the conference).

iii) Astronomy/astrophysics can deal with and try to answer questions students (are supposed to) ask: "What is the universe we live in?", "How did life get there?" and "Are we alone?" It seems, however, that if astronomy is being taught at all in schools, it is often restricted to the solar system, and the approach is historical and/or descriptive/qualitative. Aspects such as birth and evolution get little or no attention, so one might wonder if astronomy teaching does answer the questions we suppose the students have.

iv) The discussion of rival theories (Copernicus vs. Ptolemy, different cosmological models) can lead pupils to see that, in spite of the popular image of science as a sort of Delphian oracle, the interpretation of natural phenomena is not fixed, and controversies are quite common.

v) Archie E. Roy's highly enjoyable astronomical/archeological detective story "The lamps of Atlantis" suggested more reasons for teaching astronomy: an historical approach can enlighten the interaction between science and general education; science is not a cold, calculating pursuit, but involves passionate disputes, aesthetic judgements, religious convictions, economic needs...

Other reasons for teaching astronomy are also found in some parallel session and workshop contributions.

i) The possibility of starting from direct observation. The everyday astronomical events can be observed with the unaided eye and the happenings are the same now as in the time of the ancients. The sky is a large laboratory anybody can use at no cost.

ii) The majestic display of celestial events powerfully stimulates the imagination and the curiosity of students (both boys and girls!).

iii) The ingenious thinking which mankind has done to explain the events in the sky possess the characteristic traits of all scientific work: the making and testing of theories, the roles of assumption and of experiment, of models and of mathematics.

TEACHING AIDS

Perhaps the most important (and most often neglected) teaching aid in an astronomy course is the observation of the day and night time sky with naked eye, simple binoculars or camera: but these activities seem to be difficult to incorporate in the day-to-day teaching practice. They are mostly replaced by visiting planetaria, looking at photographs or other materials, among which videodiscs and computer software are the most recent developments. Here is a list of student activities apart from direct observation.

i) Making measurements on videodisc images (but most videodiscs now available were not developed with some kind of educational aim in mind, so students' activities based on videodisc information are limited in number).

ii) "Playing" with computer software, *e.g.* getting familiar with the motion of heavenly bodies or developing a star model.

iii) Looking for differences between experiments shown in Skylab film strips and the same experiments under Earth-bound conditions.

iv) Making measurements on original astronomical photographic materials, such as those provided by the Royal Observatory in Edinburgh (Southern Sky Survey).

v) Performing experiments (see those drawn up in the workshop on "experiments and observations in schools").

vi) Reading and commenting on science fiction stories. (The use of science fiction in astronomy teaching rather surprisingly became a topic of interest, thanks to a plenary lecture by Curt Roslund and some parallel session contributions).

vii) Watching and discussing films meant either for the school or for the general public. We saw "The history of the future", a very interesting TV-program broadcast by the British BBC.

Teaching astronomy can be much more than teachers' talk and/or students' reading. Activities should help students learn about what science is, how scientists work, how science develops; not so much about final results or the latest achievements.

How can we choose worthwhile activities for our students? (This brings us back to the question of why astronomy should be taught).

STUDENTS' CONCEPTS

The other point to be considered when planning school activities is the students' view. J. Nussbaum and a number of other contributors reported on the results of research into students' understanding of phenomena in the solar system/cosmos. The target population for this kind of research was 12-15 year old students. Here is a summary of findings.

i) On the nature of heavenly bodies (including the Earth): the Earth is perceived as a flat disk or half-sphere; no distinction is made between planets and stars; the Sun is thought to be a solid or a combination of solid, liquid and/or gaseous material, and not as a star.

ii) On gravity: a planet's gravity is related to its rotational speed, its distance to the Sun and to its surface temperature; a uniform gravitational field is thought to be present, but only in a limited area (the planet's atmosphere).

iii) On the motion of heavenly bodies: pre- and post-Copernican ideas are mixed up.

iv) On energy transformation in the stars: the Sun is a ball of burning fuel.

Besides these ideas on specific astronomical topics, the teaching of astronomy must also consider students' understanding of mechanical and optical phenomena.

Some basic difficulties in astronomy teaching are that children are supposed to see and think in 3 dimensions but are offered 2-dimensional visual information. Furthermore, they are often requested to abandon their familiar reference system. Implications for teaching seem to be the use of 3-dimensional models and the thorough development of the concepts of frames of reference and relative motion, preferably from the students' own observations and not only on the authority of the textbook or teacher. Besides, it seems that a more thorough development of the concept of gravity might be necessary.

Koos Kortland
Luisa Viglietta

GIREP 1986: A PERSONAL VIEW

"Oh, this looks just like my backyard!" These words remained as my most vivid recollection of one of the sessions of the Danish GIREP conference which I attended in August 1986. These words were uttered by a boy of 8 when he saw the well-known slide of dust and stones on the Martian surface. And they bring forth the purpose of teaching solar system astronomy at the elementary school level - to show the pattern of the solar system, the similarities and the differences between our nearest neighbours in space: to create a new awareness of the Earth. All of this was presented at one of the parallel sessions by Mrs. Varda Bar of Jerusalem.

About 130 scientists (85 percent physicists and 15 percent astronomers), schoolteachers and university professors, planetarium lecturers and education professors, science museum staff and space programme members, coming from Europe, North America, Asia and Australia, all of them spent together a laborious week at the modern educational centre LO Skolen on the outskirts of Elsinore, 45 kms north of Copenhagen. Such meetings are organized by the GIREP (Groupe international de recherche sur l'enseignement de la physique) every second year, and are dedicated to the teaching problems of one aspect of physics each time. This year the conference title was "Cosmos - an Educational Challenge".

The programme consisted of plenary sessions with general invited papers; parallel sessions on teaching at various levels of education; workshops oriented towards practical experiments and teaching materials; posters relating experiences and tests, new school programmes, etc. Let me mention some examples.

The Photographic Teaching Packages of Mary Brück from Edinburgh have been advertised in this Newsletter. Some of these 25 x 25 cm film copies, bought and explained by Suzan Tritton, have provided for many teachers the first contact with original research material. The information contained on these photographs may be used for many more advanced exercises.

Some ideas about planning practical work in astronomy for university students were proposed by David Clark of Glasgow. The Glasgow artificial stellar teaching laboratory provides simulated experiments for large groups of students.

Jens Marten Knudsen of Copenhagen gave a very interesting talk on meteorites, showing how their study brings us to a better understanding of the evolution of life in the universe.

The evolution of the universe is taught in Hungarian schools, but children are not overburdened with a collection of names, numbers, and biographies, as is often customary. This was mentioned by George Marx of Budapest who, introducing the relations of Man and Cosmos, stated that astronomy served as an intellectual foundation of civilization and now it is still needed for our survival and further progress.

As was shown in many papers, progress in the classroom is demonstrated through a wide stock of exercises prepared for the use of microcomputers, as well as video disks used instead of slide presentations.

Some papers discussed students' concepts of physical and astronomical phenomena; some suggested the use of science fiction to get more interest in older students.

Many papers told of special teaching programmes, of special teaching experiments carried out with groups of small children (France, Italy) in order to get them acquainted with the concepts of time and space. But neither good programmes nor sophisticated modern devices can take the place of the most important factor in the educational process - a skilled and talented teacher. And - as I remember having met in Elsinore with so many people truly deserving this title - I am looking into the future of astronomy teaching with more hope.

Cecylia Iwaniszewska
President: Commission 46

IAU COLLOQUIUM 98

IAU Colloquium 98, scheduled for June 20-24, 1987, is entitled "The Contribution of Amateur Astronomers to Astronomy", and should be of particular interest to readers of this Newsletter. Further information and an invitation to participate can be obtained from Dr. P. Simon, Société Astronomique de France, 3 rue Beethoven, 75016, France.

A QUOTATION

"Astronomy is useful because it raises us above ourselves. It is useful because it is grand. It shows us how small is man's body, how great his mind. His intelligence can embrace the whole of this dazzling immensity, in which his body is only an obscure point, and enjoy its silent harmony. Thus we attain self-insight, something which cannot cost too dear, since this insight makes us great."

Henri Poincaré

ALTERNATIVE FRAMEWORKS AND THE TEACHING OF ASTRONOMY

INTRODUCTION

When students embark on a new subject or concept, they frequently bring with them their own preconceptions relating to the subject matter in hand. Nussbaum (1) draws attention to the fact that in most cases adults, teachers and parents are unaware of the gap between the child's concept and the generally accepted view. The Children Learning in Science Project (C.L.I.S.P.) has shown that these incorrect, untutored ideas, or "alternative frameworks" have an influence on future learning. "When students are presented with ideas in science lessons they may fit them into their intuitive ideas, and the result may be a mix of taught science and intuitive science." (2) Astronomy has yet to achieve a place in the mainstream of British secondary science curricula; therefore, most pupils' astronomy education takes place through informal teaching, (television, films, comics, etc.) Doubtless this informal learning is mixed with the child's own intuitive ideas, resulting in a range of alternative frameworks on basic astronomical events.

SURVEY TO IDENTIFY PUPILS' ALTERNATIVE FRAMEWORKS

Against this background a survey by questionnaire and open-ended interview was carried out in order to identify commonly held misconceptions on the easily observed astronomical events. The population comprised sixty pupils aged between twelve and sixteen years of mixed ability, from Court Fields Comprehensive School, Somerset, and St. Mary's Comprehensive School, Newcastle-upon-Tyne. The questions were designed to discover alternative frameworks on the following concepts: Day and Night; Gravity and Planet Earth in Space; Tides; Sun, Time, and Shadows; Phases of the Moon. An alternative framework was rated as commonly held if it appeared in more than ten per cent of the population.

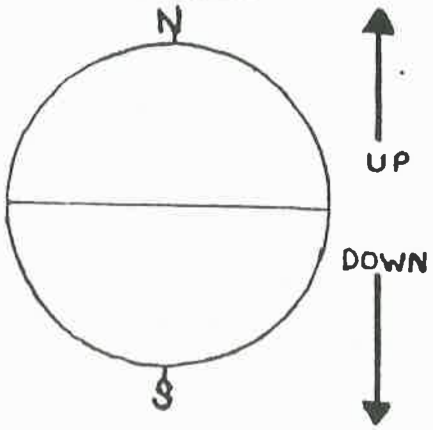
DAY AND NIGHT

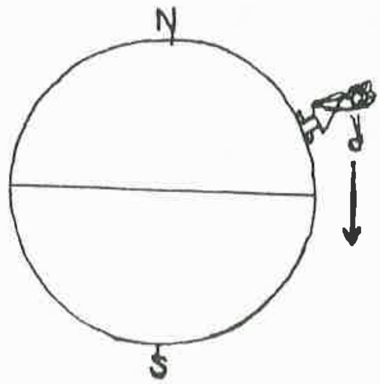
The most common misconception was that of Planet Earth orbiting the Sun to give day and night.

A number of pupils visualised the day/night division falling along the equator. On interviewing these pupils it became apparent that they pictured Australia as being underneath Great Britain and had learnt that when it is night in one place it is daytime in the other. Of the seven per cent labeled by the schools as less able, three per cent visualise the Moon as being the cause of night by covering the Sun during the hours of darkness.

GRAVITY AND PLANET EARTH IN SPACE

The questions on gravity were based on diagrams used by Nussbaum and Novak (3). A majority of pupils visualised Planet Earth in a naive way, similar to the early cultures of Greece and India, with Planet Earth having an upward and downward direction as shown in the figure. Pupils were presented with the diagram and asked to predict the stone's direction of fall when the person gently lets it go. Seventy-four per cent of the population pointed the arrow in the direction shown on the diagram. Pupils were presented with a diagram of an astronaut, holding a spanner, on the surface of the Moon, and asked to predict the direction of fall when the spaceman gently lets the spanner go. A majority of pupils thought that it would float away into space. When asked why the spaceman did not float away, all of the pupils thought that weights in his boots held him down. If a drawing of Planet Earth was made on the same page as the diagram, most of the pupils thought the spanner would fall '<u>down</u>' to Planet Earth.





TIDES

The alternative frameworks given for the cause of tides gave an insight into the way pupils piece their everyday observations together to form concepts about their environment. Peter, an average thirteen year old, stated that he had visited the beach many times, and on each occasion the position of the tide and the weather were different. He had pieced these two observations together when forming his idea on the cause of tides and arrived at an explanation which worked for him, as he was never placed in the situation where the idea was challenged. A majority of pupils thought changes in the weather were responsible for changes in tides. These pupils had observed that it is often windy by the seaside and that the television news frequently shows high tides, gales and flooding as being closely associated.

SUN AND TIME

All pupils questioned were aware of the Sun's apparent motion throughout the day; however, fifty-four per cent considered the Sun to be moving around Planet Earth. The direction of sunrise and sunset was not always known, and pupils' predictions regarding changes throughout the day of a shadow cast by a post suggests that they are often unaware of the Sun's change in altitude during the day. Few pupils interviewed could relate the Sun's position to time or could give a reason for time zones.

PHASES OF THE MOON

All pupils in the survey were aware that the Moon changes shape, but almost one-third failed to relate the period of time between successive new moons, with the period of one month. A majority explained the Moon's phases in terms of the Earth's shadow being cast onto its surface and considered full moon to be synonymous with new moon. A number of the less able pupils thought that clouds are responsible for the Moon's phases.

RESULTS

A number of pupils exhibited ideas which were unique, but many of the misconceptions occurred frequently in the population. The most recurrent alternative frameworks are the ones which were mentioned above.

HEADS OF SCIENCE SURVEY

A survey of four hundred schools, selected at random from England, Wales and Northern Ireland, shows that heads of science (H.O.D.'s) are aware of this dearth in their pupils' astronomical knowledge. However, none could envisage astronomy, as a subject in its own right, being given a place on the already overcrowded science timetable.

Sixty-four per cent of the H.O.D.'s surveyed showed a positive interest in teaching units which use topics from astronomy as support material for the three main sciences. The remaining thirty-six per cent did not anticipate astronomy featuring in the science curriculum because of pressure from high priority subjects for time on the timetable, lack of finance, the need for in-service training and a lack of suitable daytime practicals.

CONCLUSIONS

These surveys, and subsequent discussions with astronomers who were experienced in teaching young people, suggest that many pupils entering secondary school have their own explanations for the easily-observed astronomical events. Astronomers' closeness to their subject often results in them becoming distanced from the ordinary person's concept of the universe. Those astronomers involved in the education of young people need to be aware of this gap and take into consideration the pupils' early intuitive ideas.

A teaching strategy which encourages pupils to test their own ideas by using the scientific process is being advocated by a number of curriculum researchers (4). The findings of the two surveys discussed above suggest that astronomy education in Great Britain would be best served by the production of support material based on a process approach, whereby pupils can test their own ideas and explanations. In this way, pupils will be less likely to cling to old notions and frames of reference should they not hold good when tested, and astronomy can be presented as a branch of science which follows the same problem-solving process as the other sciences. Perhaps then, some of the basic astronomical ignorance, which appears to exist, will be challenged and our pupils be more aware of their place in the cosmos.

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ASTRONOMICAL INSTRUMENTS AT SENIOR HIGH SCHOOLS AND PLANETARIUMS IN JAPAN (SUMMARY)

Recent rapid developments in astronomy have led to many exciting discoveries such as proto-stars, neutron stars, quasars, pulsars, and so on. Public interest in astronomy is now at a very high level, thanks to mass-communication through scientific journals and radio and television programs, and new results from Japanese mm-wave radio telescopes and astronomical satellites. At this stage, it will be useful for the future reformation of the educational system to study what kinds of observational instruments are available for each level of education at senior high schools and planetariums.

We distributed questionnaires relating to astronomical instruments to each of 3315 senior high schools and of 215 planetariums in Japan, and received 907 and 85 answers, respectively. Those data were statistically analysed, and the results were presented at GIREP Conference '86.

Our impression after looking at the results is the following. Student interest in astronomy, as demonstrated by membership in astronomy clubs in schools, is high. As expected, many senior high schools have at least one small telescope, usually an equatorially-mounted refractor, but there are few schools and planetariums which retain teachers and staff who have studied astronomy at university. The present state of astronomy, on the basis of astronomical instruments at senior high schools and planetariums in Japan, is at a high level, but the "soft-ware" including teaching staff should be developed at the next stage.

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TEACHING OF ASTRONOMY AT UNIVERSITY LEVEL IN PORTUGAL

This is a short account of the status of teaching of astronomy in Portugal, at the University level. It is a summary of the report presented at the GIREP 86 Conference (August 18-23, Elsinore, Denmark). The full report will appear in the Conference Proceedings.

Before 1984 astronomy was but an option for students of Mathematics and Physics and a compulsory subject for students of Surveying Engineering (always in small numbers). Therefore the courses were mainly on Spherical and Positional Astronomy. This is still the situation at the (few) Portuguese Universities where there are some astronomy courses, except for a small number of local (and inconsequent) initiatives. Such an example is the optional course on Stellar Structure offered since 1980 to the students of Applied Mathematics at Porto University.

1984 might be considered as a landmark for the teaching of astronomy, because it marked the beginning of the first degree in astronomy in a Portuguese University. It was jointly set up by the Physics and Applied Mathematics Departments at the Faculty of Sciences of the University of Porto. The astronomy degree is interdisciplinary, and has an annual intake of 15 students. Its structure is in course units and comprises: 1st year: 45 to 50% mathematics, 28 to 30% physics, 11 to 12% applied mathematics, 11 to 12% astronomy; 2nd year: 49 to 50% physics, 24 to 26% mathematics, 26% applied mathematics; 3rd year: 63% physics, 25% astronomy, 12% mathematics; 4th year: 75% astronomy, 25% physics, mathematics, chemistry or geology.

As shown above most of the initial three years (out of four) provide a basic training in mathematics and physics. However, in the first year, and aiming at keeping alive the student's enthusiasm, an initial course in astronomy was introduced. It is intended as an overview of modern astronomy. It is structured on a basis of 13 to 15 weeks, with 3 theoretical lectures (50 minutes each) and 2 practical lectures (80 minutes each), weekly. The theoretical lectures make wide use of transparencies and slides and allow plenty of time for interaction with the students. Problems and examples that will complete and/or clarify the topics, are presented in the practicals. Microcomputers are regularly used. The course is not too descriptive and makes large use of mathematics and physics. When necessary, approximations adequate to the students' ability are used, but always aiming at the astronomical aspects of the subjects under discussion.

The first group of students enrolled (October 1984) was made up of very good students. In a census involving all degrees associated with physics, the astronomy degree ranked first in the whole country as far as the marks of the applicants were concerned (Gazeta de Fisica, 1985). The same happened again with the second group of students (October 1985).

The number of astronomers in Portugal is very small and the number of active astronomers (either at observatories or universities) is even (much) smaller. The existing three observatories in the country (at Porto, Coimbra and Lisboa) are almost empty or partially filled with people inadequately prepared for modern astronomy. Therefore, there is a real need for adquately trained people, with an interdisciplinary education in physics and mathematics. The astronomy degree aims primarily at the education of this new generation of astronomers. It is however accepted, and it may be of great importance in the long run, that some of the students may compete, after graduation, with other physics or applied mathematics graduates, either in industry or high school teaching. The course is gradually being implemented, as the students progress. Therefore the 3rd year will come into activity in October 1986.

As mentioned above, apart from the introductory course in the first year, the specific topics in astronomy are concentrated in the 3rd and 4th years. As mentioned, the small number of active astronomers in Portugal constitutes a drawback towards an ideal spread in the areas to be covered.

We are fully aware of the difficulties in this initial phase but it also seems to us that this is the only possible way to change the astronomy situation in Portugal. We believe that the initial difficulties might be overcome through collaboration with foreign astronomers. A Fulbright Scholarship has already been granted for 1987. Similar support from other sources is also being sought. Therefore, all collaboration will be most welcome.

Our future plans also include the provision for postgraduate training for a few students, by placing them at selected foreign Institutes until a "critical mass" of well trained astronomers is reached. Here again we count on international collaboration and a much needed change of attitude of the Portuguese Research Authorities and Universities towards the research and teaching of astronomy.

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XV IAU-UNESCO INTERNATIONAL SCHOOL FOR YOUNG ASTRONOMERS

The XV IAU-UNESCO International School for Young Astronomers was held from 15 to 27 September, 1986, in Espinho, a summer resort 15 Km from Porto, Portugal. The School was organized by the Portuguese National Committee on Astronomy (Seccao Portuguesa das Unioes Internacionais Astronomica e Geodesica e Geofisica - S.P.U.I.A.G.G.), under the direction of Prof. J. Pereira Osorio (Faculty of Sciences, University of Porto), with the cooperation of his assistants Isabel Maria Couto and Ana Leite da Cunha.

The School was announced in the IAU Bulletin well in advance. Moreover, individual contacts with institutions in Mediterranean and most other African countries and their embassies in Lisbon were made to publicize the School as much as possible. The number of young astronomers was 30, from 7 different countries: Angola, Czechoslovakia, Greece, Guinea, Portugal, Spain and Turkey.

The lectures were conducted in English. The main subjects were the following: Cosmic Electrodynamics (Prof. H.M. Schmidt, Max Planck Institut, FRG); Interstellar Matter (Dr. B. Somerville, University College London); Auxiliary Instrumentation and Detectors for Medium-Sized Telescopes (Dr. J. Meaburn, Manchester University); Solar System and Binary Stars (Prof. Z. Kopal, Manchester University); Structure and Evolution of the Universe (Prof. J. Kleczek, Ondrejov Observatory, Czechoslovakia). A great part of lecture notes were photocopied and distributed to the students. Therefore, they could concentrate more on the lectures themselves than on writing notes.

Besides the lectures, an important part of the School activity was devoted to seminars, with the participation of the students. Therefore, all became acquainted with the scientific work of the others, as well as with the research and modern astronomical equipment of their Institutes.

Several scientific movies were shown during the lectures or in the evening, after the lectures. The high scientific level of most of them was a great contribution for the School. Visits to places of historical importance (in Porto, Coimbra and Conimbriga) and the folklore festivals in Espinho were a good contribution to the participants' cultural education.

All the participants, lecturers and students, were accommodated, took their meals, and followed the School activities in the same building. Therefore, the young astronomers were able to get advice from and discuss their scientific problems in full with the lecturers, seeking orientation for their future scientific research.

ASTRONOMY INFORMATION FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

The Astronomical Society of the Pacific continues to provide information and teaching aids which are of great interest to teachers and the public. The best way to find out about these is by writing to request their 1987 Catalog; their address is 1290 24th Avenue, San Francisco CA 94122, USA.

The Universe in the Classroom, the ASP astronomy newsletter for teachers, has been a great success: it is mailed to well over 10,000 teachers on a regular basis. To receive the quarterly newsletter, teachers or librarians should write on school stationery to the ASP (address given above) and state what grade levels they teach.

Several new slide sets have been produced: Radio Universe (40 slides), Voyager at Uranus (15 slides), Telescopes (50 slides), Halley's Comet Revealed (17 slides) and Portraits of the Solar System (20 slides). Since the postage cost is a complicated function of the total price of the order and the country to which it is sent, I can only suggest that potential buyers write for a catalog, or for specific information about individual slide sets.

The ASP also sells information packets on astronomy as a hobby, selecting a telescope, quasars, black holes, astrology, computer software, pseudoscience and interdisciplinary approaches to astronomy. Also available is The Universe at your Fingertips, a 96-page compendium of resource material prepared under the auspices of IAU Commission 46. The price is $11.95 (US) postpaid.

Finally, the ASP warns the public to beware of groups selling star names (a phenomenon, in the affluent world, connected with the eternal search for an appropriate gift for "someone who has everything"). By international agreement, the naming of atronomical bodies is done by the IAU, and no fee is ever charged by anyone involved in its decisions. No astronomer or reference work would recognize a name which was not approved by the IAU.

IAU COLLOQUIUM 105!

I am happy to tell you that the IAU Executive Committee has approved our proposal for an IAU Colloquium on the Teaching of Astronomy: Present and Future. As explained in the following article, it will be held at Williams College in Massachusetts USA. Professor Jay Pasachoff has graciously offered to serve as host and as Chairman of the Local Organizing Committee. The formal conference se ssions will be held July 27-30, 1988, with a welcoming reception on the evening preceding the conference (and opportunities for sightseeing and excursions before that). Arrangements will be made to transport participants to the IAU General Assembly in Baltimore on July 31, in time for the traditional one-day meeting with local teachers on August 1.

This is the first IAU Symposium or Colloquium devoted entirely to the teaching of Astronomy. A conference on this topic is certainly well-justified, and long overdue. The program will cover most topics related to the teaching of astronomy around the world. The format of the conference will include several invited reviews, some contributed oral papers and many contributed poster papers, as well as adequate time for viewing of the posters and for general discussion. The poster paper format is particularly well-suited to the presentation of course outlines, practical exercises, computer programs, apparatus and the like. We also plan to have exhibits of commercial books and equipment, and facilities for demonstrating computer software, laserdiscs and other electronic and audio-visual material. Anyone who has suggestions about the program of the conference, or who wishes to contribute a paper, should write to me.

A limited number of travel grants to this conference will be available, thanks to a contribution from the IAU. The IAU will also be awarding travel grants to the 1988 IAU GA, and participants in IAU Colloquium 105 may be able to take advantage of these. However, I strongly urge participants to look for sources of travel grants within their own country first, perhaps from their national scientific and educational associations. I would be happy to help in this respect by providing an official letter of invitation to the conference. If you need such a letter, please write to me explaining your need, and your proposed contribution to the program of the conference. If you are a national representative to IAU Commission 46, please indicate this. Note that non-members of the IAU normally need a letter of invitation (in this case from me) in order to participate in an IAU meeting.

I look forward to meeting many of you at IAU Colloquium 105 in Williamstown!

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IAU COLLOQUIUM 105: LOCAL ARRANGEMENTS

Jay M. Pasachoff, U.S. Representative to Commission 46 and Director of the Hopkins Observatory at Williams College, invites you to Williams for Colloquium 105, "The Teaching of Astronomy: Present and Future".

We look forward to having Colloquium 105 at Williams College as part of the 150th birthday celebration of our Hopkins Observatory, the oldest extant astronomical observatory in the United States. Founded in 1838, its old building on campus now serves as a planetarium and museum.

Williams College is located in a resort area in one of the prettiest parts of the United States. It is in the Berkshire mountains, 265 km due north of New York City and 240 km due west of Boston. Its nearest airport is Albany, New York. On your map, look for Williamstown in the extreme northwest corner of Massachusetts, close to the state lines for Vermont and for New York State.

Academically, Williams was ranked first this year among all American colleges (that is, institutions providing 4 years of instruction leading to a B.A. degree but not graduate study).

Lodging will be provided in both Williams College dormitories and in local hotels. The dormitory accommodations will include both singles and doubles, all with shared bathrooms, and a few family suites. The hotel rooms, which will be more expensive, will have private bathrooms. The hotel is about the same distance from the meeting rooms as are the dormitories.

Albany, NY, airport (airport code ALB) is about 80 km from campus, and we will be arranging pickup. Albany is served by full-size airplanes (727, etc.) by several airlines, with nonstop service from Washington, Chicago, and Newark. Connecting services on 30-passenger airplanes from JFK in New York are also available. We anticipate chartering buses to take conference participants directly to the IAU General Assembly in Baltimore at the end of the Williamstown Colloquium.

The Travel Store, Inc., 105 Spring Street, Williamstown, Massachusetts 01267, will serve as official travel agent for the Colloquium. Their telephone number is (413) 458-5786; inside the United States, their toll-free number is (800) 221-3701. Ms. Diane McAndrews is their group travel coordinator. They will be glad to arrange any or all of your itinerary.

We do not yet know whether international fare will allow flights to Albany, NY, and returns from Baltimore, MD. Some people might find it most convenient to fly directly to and from Baltimore, MD., or Washington, D.C.. They would take one airline flight from Washington to Albany before the colloquium, and return to Baltimore by bus with the group.

In the summertime, Williamstown is a mountain resort that is surrounded by theatre and music festivals. The Boston Symphony Orchestra's summer residence at Tanglewood is only 45 minutes to the south, and we are planning an excursion there. A high-quality theatre festival, with Broadway/movie/ television actors and actresses takes place in Williamstown itself. The Clark

Art Institute is widely known for its collection of impressionist paintings, including over two dozen Renoir oils, and the Williams College Museum of Art has recently expanded to become a major museum of modern art.

We hope to welcome as many as possible of you here in 1988. I would appreciate some very preliminary replies to aid in our planning. Replies are not binding, of course.

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Please send this form, a copy of this form, or the information requested on the form, to: Professor Jay M. Pasachoff, Hopkins Observatory, Williams College, Williamstown MA 01267 USA.

Name:...

With regard to IAU Colloquium 105, my present plans are:

..... almost certainly to attend

..... probably to attend

..... possibly to attend

I would attend alone .... or with .... family members, some of whom

would be children, ages ....

I would plan to stay in the dormitories .... or the hotel ....

Address:..

....

....

Telephone or Telex: ....

General comments or questions (if any):