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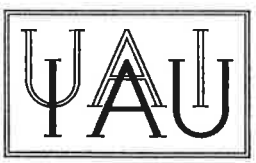

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46. COMMISSION POUR L'ENSEIGNEMENT DE L'ASTRONOMIE

Report of Meetings

PRESIDENT: E.L. Schatzman.
VICE-PRESIDENT: Miss E.A. Müller.
TEMPORARY SECRETARY: T.L. Page.

First Meeting, 23 August 1967

The President in chair.

Concerning the Draft Report M. Minnaert objected to the statement on p. lxxxix which said that Commission 46 should not be concerned with secondary school education. E. Schatzman explained that this was the result of a questionnaire sent to members of the IAU, but agreed that this paragraph in the Draft Report should be altered. A discussion followed which ended with the general agreement that (1) astronomy should be taught well in secondary schools, (2) professional astronomers had neglected this in the past, (3) secondary school teachers need help in preparing courses (like ESCP in the United States), (4) the mathematics teachers might be encouraged to include astronomy in their courses, (5) the Commission 46 must promote the teaching of astronomy in schools, integrating astronomy with other sciences such as in USA ('Earth Sciences') and Australia ('Integration of Science').

The Commission's President proposed that the organizing committee should remain small, but that each member nation of the IAU designates one member interested in the teaching of astronomy to join the Commission as a member in order to enable the Commission to keep in touch with the educational programs in all countries. It was agreed that each member nation of the IAU be invited to designate one member of Commission 46 who is to be selected according to his capabilities and his interest in promoting the teaching of astronomy in his own country. The President will inform the Executive Committee that some of the member nations may not have a suitable person and that Commission 46 may ask for 2 or 3 persons from some other nations when that seems desirable. The total membership of Commission 46 should be kept below 45.

The President announced his decision to retire as president of Commission 46, and proposed that the Commission's Vice-president, Miss Professor E.A. Müller, should succeed him and that Dr J. Kleczek should become Vice-president. The President's propositions were accepted by the Commission. J. Kleczek had been acting as Secretary of the 'Summer Schools for Young Astronomers' sponsored by UNESCO, and he will continue doing so during the period he will be holding the Vice-presidency of Commission 46. It is planned to appoint an Assistant Secretary to the Secretary of the UNESCO Summer Schools who will in turn become secretary of these schools and Vice-president of Commission 46 when the Vice-president takes over the presidency upon retirement of the current president.

After a lengthy discussion the following members were proposed to form the organizing Committee of Commission 46: G.O. Abell, B.J. Bok, E.K. Haradze, V. Kourganoff, M.G.J. Minnaert, T.L. Page, E.L. Schatzman.

The President discussed the report of new mathematics teaching in Belgium and the pamphlet 'Observatories of the World' published by the Smithsonian Astrophysical Observatory, Cambridge, Mass., U.S.A., which should be kept up to date for the use of astronomers wishing to study or observe elsewhere.

J. Kleczek reported on the 6½-week 'Summer School in Astronomy for Young Astronomers' at Manchester University, England. He explained that students of poor preparation gained more at the Summer School but that they could not reach the level of the better prepared students. Miss E.A. Müller pointed out the advantages of having a few well prepared students join these Summer Schools for the benefit of the other students.

With a vote of appreciation to E. Schatzman for his services as President of the Commission the meeting adjourned until August 28.

Second Meeting, 28 August 1967

The Vice-president in chair.

Because the retiring President was unable to be present, the Vice-president took over the chair for the second and third meeting of the Commission. She pointed out that the following two main topics should be discussed during the two planned sessions of the Commission: I. The teaching of integrated sciences and of astronomy at all levels [i.e. (a) elementary school, (b) secondary school, (c) university—undergraduate level, (d) university—graduate level, (e) general public], and II. the aims and goals and the future programs of Commission 46. In order to start and stimulate these discussions, she read the following address of the retiring President, *E. Schatzman*, to the Commission and interested participants:

'I would like to express my views on the general problem of the teaching of astronomy and astronomical education. After three years of activity as President of Commission 46 on the Teaching of Astronomy, I have reached a certain number of conclusions.

(1) The problems concerning the teaching of astronomy differ very much when we consider the elementary school, the high school, the university (undergraduate), and the formation of research workers.

I shall insist several times in this speech on the following point: at the elementary level, from the elementary school to undergraduate students, astronomy has not to be taught as a separate subject; astronomy should be integrated with the other sciences, and I shall later give several examples, in order to explain more clearly what I mean by integration.

On the other hand, at the graduate level the essential problem is to teach basic methods and to suggest ideas in order to promote what will be original work five years from now. It may appear a fantastic ambition to teach today what is yet unknown. However, I see no other way than the paradox to express what I think is the basic nature of graduate education.

(2) Let us consider first the elementary level, when knowledge is essentially qualitative and descriptive.

The sciences of the earth, geography, geology, are taught at a very elementary level. To place the earth in the solar system, and the solar system in the universe, to explain gravitational attraction, and let the child understand that people of Prague are not upside down with respect to the people of Mount Stromlo, are fundamental aspects of our knowledge, and one part of the education in geography. I shall leave to the representatives of the IAU at the meeting of the Inter-Union Committee on Scientific Education, in Varna in 1968, the task of writing in great detail the possible program of an integration of astronomy, geography and geology into a unique program of earth sciences for the junior high school.

I would like to draw attention to the work of the mathematicians. For more than fifty years the union of mathematics has studied with great care the problems of the teaching of mathematics in the secondary school. As it is well known, this care comes purely to a research carried into the field of the logics of mathematics, and to the idea that the young child is very logical and does not understand what is not logical. Mathematicians think that the difficulty of many children in understanding mathematics is not due to the difficulty of the concepts which are introduced, but to the fact that many of them are introduced in a quite irrational manner, and at a pace which does not follow the development of the mind.

Physicists are just beginning to worry about the pedagogy of physics, but we have the good luck that astronomy, in fact, begins much before physics. Are we unable to imitate the efforts of the physicists, and shall we ignore the longlasting work of the mathematicians? The difficulty is not so much a difficulty of choosing a program, but a difficulty of choosing a method for teaching the basic concepts of space, time, motion, matter. Measuring the classroom with a rod, and mapping it, is a simple and exciting task at the age of 8 or 9. Shall we immediately conclude that it is just as easy to

understand how the shape and size of the earth have been determined, and how the distance to the sun has been measured?

(3) A second level begins with the introduction of the quantitative sciences, physics and chemistry.

The USA, with the American Institute of Physics, and the Australians have published the results of a very interesting work. The USA now has a textbook for the teaching of the earth sciences; the Australians have a textbook for the teaching of sciences.

These attempts are quite interesting for the astronomer and for the scientist. The astronomer finds for the first time books in which astronomy has a very large place, about one-third of the space in the American book on the earth sciences, about one-fifth of the space in the Australian book. From the point of view of the scientist, this is a remarkable effort to present the unity of the world to children.

This, however, cannot have a world-wide utilization. Even at the level of the last three years of high school, these books avoid almost entirely the use of mathematics, and remain qualitative and descriptive. As far as the IAU is concerned, I believe that a very interesting task is ahead of us, with the discussions which shall begin with the representatives of the other unions.

However, this does not avoid the task that has to be undertaken in each country, if not in each university; in the present situation, it seems impossible to incorporate in the curriculum 60 hours of astronomy, as Minnaert suggested several years ago; but it seems possible to incorporate astronomy in physics, mechanics, geography, natural history (especially geology). However, I shall repeat that the task is not simply to determine which subjects have to be taught, but to find the proper pedagogical methods.

Physicists have begun to worry about the way in which physical concepts are understood and acquired, and I would like to stress, in this connection, the importance of the work of Bachelard in '*La formation de l'esprit scientifique* (4ème Edition, Paris, Vrin, 1960). The book of Bachelard is known among philosophers rather than among scientists. It is interesting to see how the basic concepts of force and mass are related to the experiments that people have made with their bodies since the time they were babies and children. Deeply rooted in the unconscious part of the mind is the emotional knowledge of weight and inertia.

The problem of the teaching of science is not simply to have the most gifted to understand mass and force, but to have all children understand these concepts. I believe that it is only by the connection of rational concepts with unconscious knowledge that it will be possible to overcome the difficulty.

Similarly, astronomers may wonder how to teach the basic concepts of space, time, matter and evolution, and how to include these questions in education. The immensity of space, the unity of space and time are yet difficult to grasp, even for people having a good education. The teaching of physics is traditionally related to instruments and machinery and not turned towards the basic laws of physics. The program of integration naturally emphasizes the basic laws of physics.

(4) It is probably in the university, at the undergraduate level, that the most interesting task can be undertaken. The Feynman lectures in physics, in which a certain amount of astronomy and astrophysics is included, are a good example of what can be done. However, it may not be an easy task to discuss with a physicist whether the Rutherford formula is more or less important than the laws of the Keplerian motion. The best solution would be to have astronomers or astrophysicists undertaking the task of teaching an elementary course in physics and including in such a course the basic knowledge of the universe.

(5) I shall not develop the question of the teaching of astronomy at the graduate level. This is already a research problem and each astronomer, each institution, should have the freedom of deciding its own research program and of recruiting with its own goals.

The Vice-president then opened the discussion on the topics of the agenda.

T. Page spoke on integrated science courses used in the United States for secondary school and college students not specializing in science. He described the Earth Sciences Curriculum Project, which cost about $5000000.—, and which brought over 50 scientists and teachers together to write a new text book called "Investigating the Earth". This book has been tested in more than 100 US

high schools for an eight-month course, of which 20% is astronomy and the rest is geology, meteorology and oceanography. The astronomy writers were C.M. Huffer, J.A. Hynek, T.L. Page and A. Slettebak. Although the high school students were very interested in astronomy (including solar physics, stellar interiors, origin of the solar system, galactic structure and cosmology), the teachers did not like to teach it, because they knew very little about the subject. Integrated science courses for university students at Chicago, Wesleyan and Yale Universities also used astronomy to capture student interest. T. Page described one he gave at Yale for 220 students which developed three broad topics: (1) *Theories of motion*, a historical treatment from Ptolemy through Kepler, Galileo, Newton and planetary orbits to relativity theory; (2) *Matter and energy*, leading to the theory of stellar evolution through thermodynamics, nuclear physics, and stellar interiors; (3) *The origin of life*, including geology, the formation of the solar system, early conditions on earth and the formation of organic compounds. A student poll showed that about 75% found this course very interesting, but 5% found it confusing and dull.

In answer to questions from Reeves, Abell and Minnaert, Page said that these courses are so called 'problem oriented', intended to show students the current research problems in astronomy and other sciences, and to show how much previous work led up to these problems. The laboratory work required of the students was concentrated in two-week projects. Each student spent two weeks following up some problem of his choice (such as Flying Saucers, Pairs of Galaxies, the Law of Redshifts, Sizes of Lunar Craters etc.).

Miss V. Reade commented that, in general, students do not like the historical approach because they consider it requires them to learn 'out-dated, wrong facts'. Minnaert, Page and others replied that this misconception should be eliminated; the historical development of such concepts as gravitation or the galaxy or stellar structure is characteristic of science, and provides basic understanding of advanced astronomical problems.

M. Minnaert spoke on laboratory exercises used in first-year Dutch university courses. He stressed the fact that secondaryschool preparation in astronomy varies widely, so that experience in elementary, fundamental observations must be given in the university. Most of the exercises are carried out by pairs of students working together for one or two nights, all students working on the same exercise at the same time. Calculations are performed with slide rules. About 20 small telescopes (4-inch, *f*/12) with hour-angle and declination circles were built in the University Observatory shop. About 15 small microdensitometers were also built for student use; the purchase price of parts totalled about $ 100.– each. These student instruments were used in exercises on variable stars, spectral line profiles, count of stars in globular clusters etc.

Valuable laboratory manuals mentioned by M. Minnaert include those by Stetson, Dussheimer, Jaschek, the Utrecht manual (soon to be published in English) and Atanasijevic (for advanced courses). It was agreed by the commission that a list of these manuals and other teaching aids should be compiled by a working group.

E. Kononovič stressed the need for astronomy textbooks that proceed rapidly to the modern research problems, and described the new Soviet textbook *General Astronomy* by Bakulin, Moroz and Kononovič (Moscow, 1967). The first few chapters cover coordinates and positional astronomy, and the remainder is devoted to the sun, planets, stars, galaxies and cosmogony. The Vorontsov-Velyaminov exercise book can be used with this text.

The Vice-president in chair then adjourned the second session and proposed the discussions to be continued at the scheduled hour of the following day.

Third Meeting, 29 August 1967

The Vice-president in chair.

The Vice-president reminded the members of the Organizing Committee who were able to be present, and the audience consisting of about 80 people, that during this last session of Commission 46 the future programs of the Commission were to be discussed.

Referring to the teaching methods *M. Lavagnino* spoke in favor of the historical method of integrated science courses. He recommended Pannekoek's textbook which he found most useful for his courses in La Plata, Argentina. *Miss B. Middlehurst* commented that introductory courses should always start with observational facts familiar to the students.

P. Routly spoke about the American Astronomical Society's Committee on Education and its efforts to improve the general public understanding of astronomy and astronomical research. He described two color motion pictures with sound made by the American Astronomical Society. The first shows how a radio astronomer (M.S. Roberts) works. This film, called 'Radio View of the Universe' was shown at the Twelfth IAU. General Assembly in Hamburg in 1964. The second film, 'Exploring the Milky Way', shows how an optical astrophysicist (G.W. Preston) works at Lick Observatory. Both films are now ready for distribution through Modern Learning Aide, New York City. Teachers may contact P. Routly at Princeton University Observatory, Princeton, New Jersey, U.S.A. for further information.

In this connection the Vice-president mentioned several excellent French films on various astronomical subjects. Other films were mentioned such as the Canadian 'Universe' by D. McRea, and the Australian on Radio Astronomy by T. Gold. It was agreed that such educational films should also be listed by the Commission.

P. Moore spoke about popular books on astronomy written for the general public with serious interest in astronomical developments. Many young people are attracted to professional astronomy by reading these books. Several comments were made agreeing that such books are needed so that the general public will become more familiar with current astronomical research goals. *G. Hawkins* mentioned the need for simpler books for very young readers, several of which have recently been published in the United States.

The Vice-president then proposed three continuing programs for Commission 46. She described them in the following way and asked for comments:

(1) Summer School for Young Astronomers, supported by UNESCO, to be continued by J. Kleczek and his Working Group, as decided in the first meeting of the Commission.

(2) Cooperation with Commission 38 on Exchange of Astronomers which should include the possibility of

(a) sending some of the good students of the UNESCO Summer Schools to work at some larger observatory or institution; and

(b) arranging for visiting professors to smaller observatories or institutes who will give lecture courses and advise the students on research programs with the available telescopes. The Vice-president stressed the importance of these visiting professorships and how greatly the smaller observatories and institutes may benefit from them.

(3) Improvement of the teaching of astronomy at all levels by

(a) compiling lists of educational material (books, motion pictures, photographic plates, lab exercises etc.);

(b) exchanging data on courses, exam questions at various levels, and student performances;

(c) exchanging data on teacher preparation.

Many comments and suggestions followed the presentation of the proposed programs. In particular, the formation of working groups was discussed, and the availability of educational material at various observatories was commented. It was agreed that the detailed planning of the future programs of Commission 46 was to be made by the Organizing Committee, and that it was up to the Organizing Committee to form working groups once the detailed programs have been established.

Asking the audience, the Vice-president learned that 12 countries were represented at the third meeting of Commission 46. One member of each of these countries agreed to help the Commission by establishing a list of educational material etc. in his own country.

Thanking the audience for the many comments and suggestions and calling the members of the Organizing Committee for a special session the Vice-president adjourned the meeting.

Meeting of the Organizing Committee, 30 August 1967

The following members of the Organizing Committee attended the special meeting: Miss E. A. Müller, Vice-president, G. O. Abell, E. V. Kononovič (replacing E. K. Haradze who was unable to attend), M. G. J. Minnaert and T. L. Page. They decided to collect data for the list of Educational Materials by a letter (drafted by T. L. Page) to the 12 persons who had offered their collaboration during the third meeting of the Commission, and to other persons interested in the teaching of astronomy. A draft list will be collected by Miss E. A. Müller, the new president, and sent in mimeographed form to the Commission members, to all national representatives, and to the persons who submit items for the list. This will be done by about March 15, 1968. The national representatives will be asked to make corrections and additions, so that a final list can be published by the I.A.U. in September 1968.

After this list is prepared, the Organizing Committee plans to establish 2 or 3 working groups to arrange further exchange of data under point (3) of Miss E. A. Müller's programs for Commission 46.

ADDENDUM TO THE REPORT OF COMMISSION 46

(1) The following Institutions have answered to the questionnaire after completion of the report:
Observatory and Astronomical Institute, Jena
Commission pour l'Enseignement de l'Astronomie (Comité National Belge d'Astronomie).

Le Comité Belge s'est particulièrement intéressé aux incidences de la réforme de l'enseignement des mathématiques dans l'enseignement moyen. Ce problème présente un intérêt suffisant pour donner ici un bref rapport sur les travaux de la Commission Belge.

Réforme de l'Enseignement des Mathématiques dans le secondaire en Belgique

Parallèlement à son travail d'enquête générale concernant l'enseignement de l'Astronomie en Belgique à tous les dégrés, la Commission ad-hoc créée par le Comité National Belge d'Astronomie s'est vivement préoccupée du projet de réforme de l'enseignement des mathématiques dans le secondaire. Elle a émis deux voeux; insistant particulièrement sur *l'applicabilité* des notions enseignées pour les sciences d'observation et a entretenu une correspondance suivie avec les Ministres de l'Education Nationale ayant la réforme de l'enseignement des mathématiques dans leurs attributions. Ces voeux ont été transmis pour information, aux commissions universitaires chargées d'élaborer la liste des désidérata des facultés des sciences et des sciences appliquées qui a été portée devant la Commission Ministérielle pour l'Enseignement des Mathématiques.

Le projet de réforme repose sur les bases suivantes:

(*a*) Donner aux grandes structures mathématiques toute l'importance qu'elles méritent. Ceci suppose un enseignement basé sur des notions modernes coordonnées.

(*b*) Eviter à tout prix un enseignement qui ne serait pas basé sur des réalités naturelles. En particulier, insister sur la nécessité d'une maîtrise complète des techniques du calcul (calcul algébrique, matriciel, différentiel, intégral). Réduire aussi la brêche séparant la géométrie de l'algèbre. Donner aussi la possibilité de mathématiser une situation.

Il est hors de propos de décrire ici le programme proposé, celui-ci devant être approuvé et amendé encore par la Commission du Programme. Un accord a été obtenu dès à présent au sein des Universités belges sur la base du document fourni par les Facultés des Sciences et des Sciences Appliquées de l'Université de Bruxelles.

La Commission Belge a dressé un tableau complet des enseignements d'Astronomie dans les universités belges mais sans indication de recrutement.

Princeton University Observatory has given the titles of the courses, the number of students attending the courses and the number of B.A. and Ph.D. awarded every year: 4 and 2.

(2) A list of observatories where training of astronomers could be undertaken has been obtained by Dr Page. A limited distribution to the members of the organizing committee has been made.

(3) *Ecoles de jeunes astronomes.* 12 étudiants ont suivi les cours de l'Ecole de Manchester qui ont duré 6 semaines 1/2 (Inde: 3, Egypte: 2, Portugal: 1, USA: 1, Roumanie: 1, Tchécoslovaquie: 1, Pologne: 2, Hollande: 1).

Un rapport a été établi, indiquant les résultats atteints par chacun des étudiants. Il semble que les étudiants des pays en voie de développement aient grandement bénéficié du contact avec des étudiants de pays développés. Les étudiants des pays développés ont en général aisément atteint le niveau du Ph.D. mais les étudiants des pays en voie de développement ont fait des progrès considérables au cours de ces 6 semaines et les meilleurs d'entre eux peuvent être valablement recommandés pour un stage de recherche en Observatoire.

Ceci correspond tout à fait à ma propre expérience. Il faut d'abord arracher les étudiants à de très mauvaises habitudes intellectuelles et les obliger à apprendre une foule de choses qu'ils ignorent avant de les amener à un niveau comparable au Ph.D.

L'expérience peut-elle être continuée?

Les propositions suivantes peuvent être examinées:

Michigan. Participation des étudiants au trimestre printemps-été (spring-summer term May 1 to August 20). La subvention devrait couvrir les frais de voyage et de séjour des jeunes astronomes.

Arcetri. Professor Righini offers to organize a course for 10 students in June-July 1968, in solar astronomy.

We can also plan to have courses organized later at the following places:

JILA, 1969, Solar Physics

Edinburgh 1970, spectroscopy (solar, stellar), photometry, polarimetry.

On the other hand, the following institutions have given positive answers concerning the accommodation of students recommended by the IAU schools:

Kitt Peak	a few graduate students	research only
Caltech	a few good students	courses, research
Cambridge	a few good postgraduates	informal astronomical training
Lick	visitors	research
Arcetri	2	research
Max Planck München	well prepared students	research
Abastumani	1 to 3	astronomical training
Harvard	1 to 2	entire Ph. D. program

I believe that quite a few other institutions might accommodate for 1 or several years one or two young astronomers under recommendation of the IAU.

I suggest therefore the following:

The IAU school continues for 3 more years. I suggest that the executive committee appoints an assistant secretary to Dr Kleczek. When Dr Kleczek will become President of the Commission 46, the assistant secretary will become secretary.

Proposal should be made to the executive committee within 1 year.

(4) *CIES.* E. Schatzman a représenté l'UAI à une réunion de la CIES le 9 Mars 1967. L'opération la plus intéressante de la CIES est sans doute la réunion de Varna en 1968 sur l'intégration des Enseignements scientifiques. Les principes de la réunion de Varna seront exposés dans la réunion de discussion de la commission 46 sur la pédagogie. L'UAI pourrait désigner deux délégués à Varna.