Bulletin nº 176 Septembre 1970

U. R. S. I.

TABLE DES MATIÈRES — CONTENTS

DAVID FORBES MARTYN
1906-1970

Dr. D. F. Martyn, whose death occurred in Australia on 5 March 1970, was one of the foremost in that small band of scientists engaged in radio exploration of the upper atmosphere in the years between 1925 and 1955. During that time the foundations of our knowledge of the ionosphere were being laid, and Martyn played a major part in establishing the principles of its behaviour and of how it affects radio waves travelling through it. While others were busy recording the return of waves reflected from the ionosphere, he was at work unravelling the meaning of their results. Many of the ideas that now form part of the accepted theory originated with him. He was a regular attender at international conferences, particularly those organised by URSI, where the other participants always awaited eagerly to see what new ideas he would try out before them. They were seldom disappointed.

In an early paper, written in collaboration with V. A. Bailey, he showed how two separate radio broadcast programmes could become mixed up, as a consequence of cross-modulation, as they travelled through the ionosphere. On another occasion he showed how the behaviour of a wave travelling obliquely could be deduced from its behaviour when it travelled vertically : the appropriate mathematical expression is now always known as Martyn's Theorem.

He was one of the first to use the radio observations to guide speculations about the nature of the upper atmosphere. With O. O. Pulley he suggested that the temperature at heights of about 200 km could be as great as one or two thousand degrees; he was the first to realise that the upper ionosphere could be moved about by electric fields originating in its lower parts and the papers in his series on "Tides in the Ionosphere" are now classics. Although it had long been known that the aurora was somehow caused by charged particles coming from the sun, Martyn was the first to realise that they were not moving quickly enough to penetrate to the necessary levels in the atmosphere, and he suggested that there must be forces that speeded them up before they became effective.

Until the great upsurge of interest in ionospheric physics in the early 1950s, the few active research groups in three or four different countries were centred, in each, around a leading scientist. In Australia it was the work of Martyn that inspired others to work on problems of the ionosphere, and they worked so successfully that in 1952 URSI, whose meetings had previously been confined to the northern hemisphere, held its General Assembly in Sydney. Those who attended were not disappointed, for they heard Martyn expound important new ideas about the relation between the ionosphere and the magnetism of the earth, ideas which are now widely accepted.

Martyn was a Vice-President of URSI 1950-54, Chairman of Commission V 1952-55 and of Commission III 1954-60. With Sir Mark Oliphant in 1951 he was instrumental in bringing together the group of Fellows of the Royal Society domiciled in Australia to petition for the foundation of the Australian Academy of Science. He held important offices in the Academy and its welfare was one of his main concerns.

SYDNEY CHAPMAN
1888-1970

The death of Professor Sydney Chapman, Fellow of the Royal Society, on 16 June 1970, will be keenly felt in international scientific circles, and not least in URSI Commissions III and IV where so many aspects of his work have long been familiar to those concerned with upper atmospheric and magnetospheric physics. It is difficult to believe that Chapman retired from Oxford University as long ago as 1953, for he continued to be a familiar figure at many scientific events since then. Moreover he was as likely to be present at a meeting in Asia or in Europe as at one in the USA where, since his retirement, he had held positions at the High Altitude Observatory, Boulder (Colorado) and at the Geophysical Institute in Alaska.

Although Chapman's studies at Manchester and Cambridge Universities were mathematical, the appointment he held at the Royal Greenwich Observatory from 1910-1914 afforded him the opportunity to extend his interests into physics. His innumerable classic contributions to the understanding of the variations of the geomagnetic field are widely known.

In URSI, perhaps it is legitimate to refer especially to the theory of geomagnetic storms which, with V. C. A. Ferraro, he developed 40 years ago, and which has often been invoked in discussions, in URSI Commission III and elsewhere, concerning the storm-time variations in the F2 layer of the ionosphere. On the other hand he is probably remembered best of all in URSI for his explanation, published in 1932, of the interaction between solar ionizing radiation and the earth's atmosphere so as to form a "Chapman layer".

Besides his purely scientific work, Chapman played an important role in international scientific administration. In addition to being President of the International Associations for Meteorology and for Terrestrial Magnetism and Electricity, he served also as President of the International Union for Geodesy and Geophysics until 1954.

In 1950 he was a member of the small informal group which endorsed L. V. Berkner's proposal to plan the IGY in 1957-1958. Three years later, in Brussels, Chapman was elected President of the Special Committee for the IGY (CSAGI) and, until the termination of the Committee in 1959, he was responsible for guiding the course of this vast enterprise in active international cooperation in which practically the whole field of geophysics was covered.

Over a period of more than half a century, Chapman published numerous papers in scientific journals. Although these must be sought out in libraries, many a scientist will have, on his personal bookshelf, copies of the two volumes on *Geomagnetism*, which he compiled in cooperation with J. Bartels, and of *The Mathematical Theory of Gases*, written in collaboration with T. G. Cowling. Not far from these serious volumes, it is more than likely that there will be found also a copy of the "birthday tribute" presented to Chapman, on behalf of his friends all over the world, on the occasion of his 80th birthday. This small booklet, containing anecdotes, personal recollections and photographs collected together by S. I. Akasofu, will be treasured by many as a reminder of some of the personal characteristics and human qualities which endeared him to all who knew him and which form, together with his scientific achievements, part of the Chapman legend.

VERY LONG BASELINE INTERFEROMETRY

A Symposium on the above subject was held at Charlottesville (Virginia) from 13-15 April 1970 with the sponsorship of URSI and the National Radio Astronomy Observatory whose Director, Dr. J. W. Findlay, was responsible for the organisation of the programme.

The early interest shown by URSI in the application of radio techniques to astronomical observations was recalled in a message conveyed to the Symposium by Dr. J. L. Locke (Vice-Chairman of URSI Commission V) on behalf of the Board of Officers.

"Radioastronomy was first discussed by the International Union of Radio Science 36 years ago, at its Fifth General Assembly in 1934. On that occasion, a paper was presented on Jansky's discovery of inter-stellar noise in 1933. Later, during the Assembly, a recommendation was made relating to the need for further observations, especially of the direction of arrival and the frequency spectrum of the noise.

"Unfortunately the simple antenna arrays used in the 1930's imposed very severe limitations on the angular resolution that could be achieved at radio frequencies. Some improvement resulted when the first paraboloid reflectors and centimetre techniques became available about 25 years ago. Nevertheless radioastronomers have, for a long time, envied the high angular resolutions that can be achieved by the astronomers who use optical telescopes.

"However, this situation has been completely changed by the recent spectacular developments in the design of radio interferometers using very long base-lines. As a result, it is no longer unusual for radioastronomers to think in terms of resolutions of seconds of arc."

The papers presented at the Symposium dealt with :

Radio Astronomical Observations (17 papers).
Relativistic, Geophysical and Geodetic Applications (12 papers).
Techniques (10 papers).
Angular Size Limits from Interstellar Scattering (3 papers).

On the final day small groups were formed to discuss the following topics :

1. Time and Frequency Standards.
2. Data Recording and Processing.
3. Small Diameter Radio Sources.
4. Relativity, Geophysics, and Geodesy.
5. National and International Cooperation.

The papers will be published in English in *Radio Science* in October 1970.

MOBILE INCOHERENT SCATTER FACILITY

SUMMARY OF A MEETING WHICH TOOK PLACE
ON 18 APRIL 1970 IN WASHINGTON, D. C.

This meeting was convened in response to the recommendation made at the URSI General Assembly in Ottawa that F. du Castel and I form a working group charged with exploring the feasibility of a mobile incoherent scatter facility.

Those able to attend the meeting were M. Baron, H. Booker, F. du Castel, J. Evans, D. Farley (acting chairman), W. Hanson, I. Schmerling, T. Van Zandt, and P. Waldteufel.

The lenghty discussion which took place can be divided into three general areas : (1) the scientific justification for the project, (2) the technical aspects of the different types of facilities which could be constructed, and (3) the problems of organizing and financing such a facility. Agreement was reached quickly in the first area; it proved quite difficult to separate the last two and arrive at any firm conclusions at this stage.

Scientific justification. — It is clear that the arguments in support of a mobile facility are on very firm ground scientifically. It would make possible a large number of extremely interesting experiments which could be carried out in no other way. A good number of these are listed in the original URSI recommendation and are discussed more fully in the report of the NAS Aspen study group ("Physics of the Earth in Space — the Role of Ground-based Research", Report of a study by the Committee on Solar-Terrestrial Research of the Geophysical Research Board, National Research Council, July 1969, National Academy of Sciences, Washington, D. C.) and in the report of Sub-group 9 of the URSI Working Group on Electromagnetic Probing of the Atmosphere (Farley, *J. Atmos. Terrest. Phys.*, **32**, 693-704, 1970). There does not seem to be any point in reiterating the scientific objectives here.

Technical aspects. — A number of ways in which a mobile facility might be realized were discussed, but no one was able to voice a strong preference for any particular scheme without having a better idea of the costs involved and of how much money was likely to be available. Both land-based and sea-based facilities were considered.

Possible land-based systems include (1) a completely portable system including an antenna especially designed to allow rapid disassembly and reconstruction, and (2) various possible systems in which only the transmitter, receiver and computing equipment were portable. Stanford Research Institute has a complete radar system which is reasonably portable and which is now being moved from Stanford to Alaska. It appears, however, that even with a well designed system something like six months or more is lost in the moving operation. Large antennas just cannot be taken apart, shipped, and rebuilt in a few days. The moving procedure could undoubtedly be speeded up if the antenna were not involved. The rest of the system could either be attached to an existing antenna, or else perhaps a relatively inexpensive "throwaway" antenna could be constructed. In any case, the incoherent scatter system would only be moved to sites which already had an appropriate functioning antenna. Such an arrangement would hopefully minimize time lost during moves.

Possible sea-based systems which were discussed were (1) a fairly large conventional radar mounted on a ship, (2) a similar system mounted on a large barge, and (3) a system which included a very large, specially designed floating antenna. The design of either of the first two would be relatively straightforward; the third probably would be the most interesting, powerful, and expensive system. The ship-borne system has been considered in some detail by Waldteufel, and a report discussing some of the important aspects is available. Two obvious advantages of such a system are that it could be moved rapidly and could operate almost anywhere; a disadvantage is that it would probably be expensive to maintain.

Organization and financing. — The current financial situation, particularly in the United States, and the political realities of funding a large scientific project were discussed at some length. It was concluded that in order to make further progress at this stage a single organization, preferably a fairly large one, should assume prime responsibility for the project. The most appropriate organization would appear to be the French National Institute of Astronomy and Geophysics (INAG-CNET), particularly in view of the fact that the original idea for a mobile facility originated there. The first task of this organization would be to carry out more detailed feasibility studies of the various possible types of such a facility. These studies can probably be done for a fairly modest cost since several similar studies have recently been made and Stanford Research Institute has had experience with portable radar systems and research ships. Once the feasibility studies are complete, the financing of the project itself should be discussed with organizations in other interested countries.

It seems clear that some sort of multi-national group should finance and manage the actual facility.

Recommendations. — The results of our discussions can be summarized in the following recommendations :

Since we feel that a mobile incoherent scatter facility would be of great benefit to the scientific community, and since it appears that such a facility could be constructed in a number of different ways, we recommend that :

(1) INAG-CNET assume responsibility for carrying out further detailed feasibility studies and cost estimates of the various schemes proposed;

(2) Upon completion of these studies, the French group explore with other interested countries the possibility of establishing a multi-national organization to finance, construct, and manage the facility.

D. T. Farley.

INCOHERENT SCATTER OBSERVATIONS

Recent developments in the use of the incoherent scatter technique have enabled valuable new information to be obtained on the electron density and temperature in the ionosphere, as well as data on the chemistry and dynamics of the neutral and ionized components of the atmosphere. Measurements made using this technique are of particular importance at present in the compilation of the data for the URSI-COSPAR International Reference Ionosphere.

The great value of the information obtained by incoherent scatter stations was recognised in several Recommendations (III-15, 16, 17, 18, 19) adopted at the URSI General Assembly in 1969 (1), and was mentioned recently in Decision No 10 adopted at the COSPAR Meeting in 1970 (2).

Both URSI and COSPAR are aware of the practical difficulties encountered in maintaining incoherent scatter stations which, in general, are supported by national funds. In URSI, at least, it is felt that some considera-

(1) *URSI Inf. Bull.* No. 172, pp. 29-34 and 70-75.
Proc. URSI Gen. Ass. Vol. XV, pp. 168-173 and 208-213.
(2) *URSI Inf. Bull.* No. 176, p. 44.

tion should be given to the possibility of obtaining partial international support for scatter stations, especially in cases where a station is not regarded as vital to the national research programme of the country in which the station is situated.

The Secretary General of URSI would be glad to make contact whith those responsible for ionospheric scatter stations since it seems important to try to envisage future developments and to see whether any useful coordination of effort could be achieved at an international level.

FUTURE APPLICATIONS OF SATELLITE BEACON EXPERIMENTS

Lindau, 2-4 June 1970

Report prepared by the Coordinator of the Symposium

Dr G. Hartmann

Summary.

The Symposium was sponsored by:
Max-Planck-Institut für Aeronomie,
Deutsche Gesellschaft für Ortung und Navigation
and received financial support from URSI.

The programme included :

(*a*) Reviews of theoretical and practical aspects of trans-ionospheric radio propagation, as a background to detailed discussions.

(*b*) Short reports and discussion notes on very recent results.

(*c*) Actual working sessions :

I. One specific item was the coordination of the beacon measurements with the geostationary NASA satellite ATS-F which is due to be launched in early 1973.

II. Measurements which can now be carried out with low orbiting satellites were discussed. Throughout this decade four US NNSS-navigation satellites will continue to be available on 150 MHz and 400 MHz,

which will enable Faraday and differential Doppler measurements to be carried out.

III. Proposals on new types of satellite beacon experiments as well as on various types of receiving equipments were presented.

IV. Discussions on information exchange and on closer cooperation in general took place.

The Symposium felt that some important aspects of the programme should be emphasized in a more detailed manner.

REVIEWS.

Reduction of data now available from beacon measurements clearly reveals that, to obtain more detailed synoptic investigations, a well-coordinated and distributed network of observing stations is still required for several years. It was suggested that some form of prompt data handling and exchange should be investigated to provoke intercomparison and stimulate practical applications.

The following investigations, amongst others, can be supported by the beacon data :
(1) the daily changes of the total electron content of the ionosphere;
(2) dynamics of the upper atmosphere;
(3) the depletion of the ionosphere during magnetic storms;
(4) the relative importance of hydrogen (H^+) in the topside ionosphere;
(5) studies of neutral winds in the upper atmosphere;
(6) satellite scintillations;
(7) magnetospheric electron content, ionosphere-magnetosphere coupling;
(8) possible calibration of so-called "occultation experiments", e.g. Mariner IV or HELIOS.

An exchange of more detailed information on the design and progress of recent electronic devices usable for beacon measurements should be envisaged.

An important application is the determination of navigation errors of radio navigation systems due to magnetosphere, ionosphere and troposphere. Amplitude, phase, frequency, group delay, angle of arrival, and polarization of the beacon signals are measurable. For application purposes these quantities have to be known fairly accurately as a function of elevation, azimuth and time; furthermore the predictibility and the probability of the errors have to be determined by actual measurements rather than by mere theoretical investigations. These is a great lack of data in the GHz frequency ranges but, even in the VHF-range ($\sim$ 137 MHz), the data are as yet still insufficient. It was strongly emphasized that future beacon measurements could give a good support to many open questions of the application people.

WORKING SESSIONS.

Session I : ATS-F.

One session was devoted to a discussion of the radio beacon specified for the NASA geostationary satellite ATS-F, covering scientific opportunities, engineering aspects, and data reduction. The principal investigator for the beacon is Dr. K. Davies (ESSA Research Laboratories, Boulder, Colorado 80302, USA) who, with Mr. R. B. Fritz and Mr. R. N. Grubb of the same Laboratories, will send out to potential observers information about the progress of the beacon. At a subsequent working group meeting, Dr. G. Hartman (Max-Planck-Institut für Aeronomie, Lindau) and Dr. J. K. Hargreaves (University of Lancaster, England) were asked to serve as a coordinating group for observations in the European sector. It was agreed to apply to IUCAF for frequency protection for the beacon transmissions. It is hoped that information on receiver design and recommendations on data procedures can be made available to intending observers in due course. Various participants offered to consider these matters in detail for discussion at a further meeting, probably to be held at Graz, Austria, in autumn 1971, under the coordination of Dr. R. Leitinger (Institut für Meteorologie und Geophysik der Universität Graz, A-8010 Graz, Halbärthgasse 1).

Dr. A. V. da Rosa, Stanford University, Calif., USA, is going to prepare more detailed suggestions on data handling which will refer to the very basic data and the very final processed data. Dr. J. Aarons, Cambridge Research Laboratory, Bedford, Mass., USA, very likely is also going to submit some suggestions on this topic.

It is suggested that, in view of the wide range of recording and data handling facilities available to individual observers, the possibilities of data exchange at various levels be explored. In this way it is hoped that full participation of the maximum possible number of observers, regardless of individual resources, will be encouraged. All interested groups are kindly asked to send their suggestions or comments to Dr. K. Davies, Dr. G. Hartman and Dr. R. Leitinger. Dr. K. Davies intends to send a questionnaire in early 1971 to all potential observers so as to obtain some more detailed information on their plans.

Session II : NNSS-satellites.

Measurements with the NNSS satellites are highly recommended, not only in polar regions where any geostationary satellite is not observable, but also in all other regions. These beacon data might then be compared with those from geostationary satellites and data on the magnetospheric electron content can be expected if the accurary of the measurements is reasonably good.

Session IV : General.

It is strongly emphasized that the beacon activities should not be restricted to the above-mentioned two types of satellites. All other useful beacons installed aboard any type of satellite which will be available in the near future should also be taken into consideration since data from all over the world are highly desirable and ATS-F, for example, is not visible all over the world. This symposium, which should be regarded mainly as a start of new cooperative beacon activities, kindly invites colleagues from all over the world to participate in this programme and to make comments or suggestions. The next meeting on this topic is envisaged to be held in Graz, Austria, in the autumn of 1971.

The Symposium wishes to thank URSI for financial support.

This report will be sent to URSI and to COSPAR-RTT in anticipation that the Interim Working Group on Satellite Beacon Experiments will be formally sponsored by URSI.

NOTE ADDED BY SECRETARY GENERAL OF URSI.

A detailed list of topics suggested for discussion at the next Symposium has been circulated. Those who are interested in this or in other aspects of satellite beacon experiments should write to Dr. G. Hartman, Max-Planck-Institut für Aeronomie, 3411 Lindau/Harz, Germany.

ATS-F SATELLITE BEACON EXPERIMENT

The probable date of launch of the above geostationary satellite is early 1973. Its position will be Lat. 0° Long. 15° E. The carrier frequencies will be 40.016, 140.056 and 360.144 MHz. A Working Group including members from Asia, Europe and North and South America has been formed to coordinate the collection and analysis of observational data.

Observers who wish to participate in the programme are invited to write to Dr. K. Davies, Space Disturbances Laboratory, ESSA, Boulder, Colorado 80302.

CONFERENCE FOR PRECISION ELECTROMAGNETIC MEASUREMENTS (CPEM)

At the XVI General Assembly of URSI, a resolution was adopted recommending that the Board of Officers consider under what conditions URSI could become more closely associated with the activities of CPEM. The Board discussed this question at its meeting in February 1970, after consultation with Prof. Zhabotinskii (Chairman, URSI Commission I), and agreed to apply for the admission of URSI as a "cooperating sponsor" of CPEM.

Cooperating sponsors have no financial responsibilities; these are shared by the full sponsors : the Institute for Basic Standards of the National Bureau of Standards; the Institute of Electrical and Electronics Engineers; and the US National Committee of URSI.

With the approval of the Executive Committee and the full sponsors of CPEM, URSI's application was formally accepted on 8 May 1970 and the Chairman, Dr. H. M. Altschuler, invited URSI, as a cooperating sponsor, to nominate the Union's representative to the Executive and Conference Committees which met in Boulder on 4 June during the 1970 Conference.

Prof. S. Hahn (Secretary, Polish National Committee of URSI) was designated to represent URSI and his report on the Conference is reproduced below.

CPEM : Boulder, 2-5 June 1970

Report by Prof. Dr. S. Hahn (Warsaw)

The Conferences on Precision Electromagnetic Measurements are organized every two years by a Committee on which the full and cooperating sponsors are represented. Since URSI is now a cosponsor of these conferences, it is suggested that one of the next in the series, probably 1974, should be held outside the USA so as to underline the international character of the CPEM.

At the 1970 Conference there were about 200 participants, and the Technical Committee approved the presentation of nearly 50 papers on the following main topics :
Cryogenic em measurements;
Automated measurements;
Microwave and rf measurements;
DC and lf measurements;
Near-field antenna measurements;
Time domain (pulse) measurements;
International comparisons;
Time and frequency measurements.

Since it would be impossible to refer to all the contributions and to the many problems discussed, only a few are mentioned below. New developments and research on Josephson-junction devices were described, for example high multiplication factor frequency multipliers, noise standards etc. Microwave methods are being used to measure the flow rates of cryogenic fluids.

An automated instrumentation system has been developed to enable the transfer of NBS accuracy to the laboratory for calibrations of thermoelectric and bolometric devices; the uncertainties range from 0.2 % to 0.6 %. An automated instrument was described which could measure and record the polarisation and power flux of an incident electromagnetic wave in the frequency range 2 MHz-70 MHz.

A computerised technique for obtaining precision microwave impedance measurements from slotted-line data, by correcting for system imperfections, has considerably increased the speed of the measurements. The experimental determination of the electromagnetic field pattern in closed regions by the perturbation method and computer-aided calculations enables the determination of the field distribution to be made with an error of a few percent.

The development by NBS of a direct voltage-ratio standard and measuring system was considered to be necessary because of the requirements for better accuracy in the calibration of voltage supplies and digital voltmeters. Uncertainties in measured ratios were shown to be not greater than 2×10^{-7}.

The determination of the far-field pattern of an antenna by near-field measurements and computer-aided calculations enables measurements on antenna of moderate physical size to be carried out inside the laboratory.

The extension of microwave-frequency measuring techniques into the infrared region has been accomplished by the introduction of metal-to-metal point contact junctions capable of responding to infrared-frequency voltages.

Intercomparison measurements of the unperturbed hydrogen hyperfine transition frequency were recorded and reported by four US laboratories. The stability of a NASA prototype hydrogen maser was investigated and the frequency fluctuations determined. Phase noise on high quality signal sources was shown to be measurable, by means of a set of equipment which incorporates a computer as an accessory, to search for anomalies in recorded data. Further developments in the technique of time synchronisation by means of television links was described. Data on the short-term stability of a Russian Rubidium-87 maser were presented.

A special evening session was devoted to reports from representatives of IEC, BIPM, NPL and other organisations concerned with international comparisons of the volt, and especially with recent progress achieved by the utilisation of the Josephson-junction devices.

The papers presented at the Conference will be reviewed and, if accepted for publication, are expected to appear in the November 1970 issue of *IEEE Transactions on Instrumentation and Measurements*. The Conference Editor is R. A. Soderman, General Radio Co., Bolton, Mass.

The Chairman of the 1970 Conference Committee was Dr. K. Tomiyasu of the General Electric Co. Valley Forge Space Center, supported by Dr. G. M. R. Winkler of the US Naval Observatory as Chairman of the Technical Programme Committee.

During the Conference an Open House programme was satisfactorily arranged so as to enable the participants to visit the NBS Laboratories at Boulder, those of the Joint Institute for Laboratory Astrophysics and other facilities.

The organisation of the Conference was of a high standard. The sessions were held at the excellent auditorium of the NBS.

The next CPEM is scheduled provisionally to be held in Boulder in June 1972.

INTER-UNION COMMISSION ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE

Doc. IUCAF/168

Report of 10th Meeting of the Commission held in the Chalmers University of Technology, Göteborg, Sweden on 4, 5, 6 May 1970

Present : Prof. F. G. Smith (in the Chair), Dr. E. J. Blum, Dr. J. W. Findlay, Prof. O. Hachenberg, Dr. J. P. Hagen, Mr. J. W. Herbstreit, Mr. A. J. Higgs, Dr. F. Horner, Prof. C. A. Muller, Mr. T. Nishizaki, Dr. H. Sterky, M. M. Thué, Dr. R. L. Smith-Rose (Secretary General), and Dr. R. Wielebinski, who attended by invitation.

Apologies for absence were reported from Messrs Denisse, Sanamian and Vitkevitch.

1. — WELCOME AND INTRODUCTIONS.

Dr. Sterky welcomed members to this Inter-Union Commission meeting in Sweden. He referred briefly to the work of IUCAF during its ten years existence, and to the resulting improvement of relations between radio astronomers and space scientists, and the authorities responsible for the allocation of frequencies to all radio services.

Dr. Sterky then introduced Professor Olving, Pro-Rector of Chalmers University who, with his colleagues, welcomed the members of the Commission and expressed his confidence in its work and development in preparation for the international meetings to be held next year.

Professor Olving also invited the Commission to a cocktail party in the evening, and trusted that they would enjoy a good trip on the following day.

2. — MINUTES OF THE 9th MEETING, BRUSSELS, FEBRUARY 1969 DOC. IUCAF/155.

Subject to the insertion of the words "at least" before "1390 MHz" in line six of minute 11, the report of the 9th meeting was approved.

3. — FINANCE.

The audited Statements of Income and Expenditure for the years 1968 and 1969, reproduced in Documents IUCAF/149 and /160, were adopted.

The Budget for the year 1970 distributed as Doc. IUCAF/161 was also approved, together with the continuation of the appointement of Dr. Smith-Rose as Secretary General.

It was noted that an extension of the Budget for 1971 would probably be necessary in order to ensure adequate representation by the Commission at the forthcoming World Administrative Radio Conference for Space Telecommunications (WARC-ST), which will be held under the auspices of the International Telecommunication Union (ITU) in June 1971.

4. — REGISTRATION OF FREQUENCIES FOR RADIO ASTRONOMY.

The Commission decided to take the necessary action to bring up to date Doc. IUCAF/101 on "The Registration of Frequencies for Radio Astronomy", and to give the new document wide distribution among radio astronomers, seeking detailed information on the frequencies in use at all observatories throughout the world.

Accordingly, Doc. IUCAF/165 was prepared by a working party under the chairmanship of Professor F. G. Smith. This document is to be addressed to all radio astronomers, and contains a request and appropriate form for them to report the details of the frequencies used for both Class A and Class B observations.

5. — Review of the Frequency Bands required for Radio Astronomy.

At the previous meeting of the Commission in Brussels (February 1969) a review was made of all the frequency bands which radio astronomers are seeking to have protected from interference; this had been circulated as Doc. IUCAF/142. At the present meeting in Göteborg, this review was brought up to date; it has now been distributed as (*a*) Doc. IUCAF/166 relating to frequencies for radio astronomy; and (*b*) Doc. IUCAF/164 for the corresponding frequencies relating to space research.

The following comments were made concerning the various frequency bands detailed in Doc. IUCAF/166.

(i) *Use of Standard Frequency Guard Bands.*

It was agreed that radio astronomers should give up any claim to special protection in the guard bands of the Standard Frequency Service, and that the Inter-Union Commission should press for a more specific allocation of a 20 MHz band within the range 17-23 MHz.

(ii) *37.75-38.25 MHz.*

The Commission agreed that it was desirable to obtain an improvement on the allocation given to this band by Recommendation No 32 of CCIR (Geneva 1959). It is understood that the United Kingdom had been considering the possibility of proposing the allocation of the whole band of 0.5 MHz in width to radio astronomy as a Primary Service. If such a proposal were made, it was hoped that it would receive the support of as many administrations as possible.

(iii) *79.75-80.25 MHz (Region 1 and 3, Footnote 261), 73.0-74.6 MHz (Region 2).*

No change suggested.

(iv) *150.05-153.00 MHz (Region 1).*

No change.

(v) *235-240 MHz.*

A new allocation is to be requested for radio astronomy in this band, which is regarded as satisfactory in the United Kingdom for a good proportion of observing time. The situation is not, however, satisfactory in France and possibly other parts of Europe.

(vi) *322-329 MHz (Footnote 310).*

No change is proposed in this case, but it is important that this band — the Deuterium line — be retained and adequately protected from interference.

(vii) *406-410 MHz.*

It was agreed to request that this band be allocated to Radio Astronomy on a primary and world-wide basis, footnote No 317 being suitably modified to give effect to this.

(viii) *608-614 MHz.*

While footnote No 332 (modified) may remain unchanged, it is desirable to emphasise the importance of this band to the radio astronomy service.

(ix) *1390-1427 MHz.*

In order to take account of continuing natural phenomena giving rise to radiation from hydrogen in this band, the previously allocated exclusive band (1400-1427) should be extended downwards in frequency to 1390-1427 MHz to take account of the continuing change due to Doppler effect.

(x) *1660-1720 MHz.*

To facilitate observation of spectral lines emitted by OH, it is requested that the bands 1660-1670, 1611.5-1612.5 and 1720-1721 MHz be given all practicable protection against interference with radio astronomy observations.

(xi) *2670-2700 MHz.*

It is proposed in this case, that the band 2690-2700 MHz should be upgraded and allocated exclusively to radio astronomy in all three regions of the world. In addition, the band 2670-2690 MHz should be available to radio astronomy on a shared basis if the band 2550-2690 MHz is allocated, wholly or partly, to satellites.

(xii) *Radiation on Spectral Line Frequencies.*

Considerable discussion took place on the wisdom of seeking protection for the radio astronomy service at the frequencies of a large number of other spectral lines, where radiation is known or likely to occur. It was agreed that attention should be concentrated on the more important line frequencies, which are dealt with in Section 15 of Doc. IUCAF/166.

It seems desirable to prepare a document on this matter for presentation through the appropriate CCIR Study Group to the International Telecommunication Union (ITU).

(xiii) *Frequencies above 40 GHz.*

It was stated that the United States authorities would probably put forward proposals for seeking allocations to the radio astronomy service at frequencies above 40 GHz; but the Commission was doubtful about putting forward too detailed a statement at the present time. The matter would be given due consideration at a later meeting.

6. — Reservation of Frequencies for use above the Ionosphere and on the Far Side of the Moon.

The Commission considered Doc. IUCAF/152, which reproduces a Recommendation proposed by the Radio Astronomy Commission of URSI at its General Assembly in Ottawa (August 1969).

This recommendation proposed that prompt action should be taken to ensure that certain portions of the radio frequency spectrum, between 300 kHz and 10 MHz, should be reserved for radio astronomy in the cislunar space outside the earth's atmosphere. This would lead to the result that adequate protection could be given to radio astronomy on the far side of the Moon, which is where radio telescopes should be free from man-made interference over the whole radio spectrum.

It was agreed that, while it was probably premature at the present time to consider frequency allocations in too great detail, encouragement should be given to discussion of the subject at the CCIR and also at some national levels. It was pointed out that the CCIR had been dealing with the technical aspects of this matter for several years past. The Commission was also informed that this subject was under active consideration in the United States of America, together with the corresponding problems of space research on the far side of the Moon.

Doc. IUCAF/163 was prepared during the meeting as a summary of the Commission's views on this subject at the present time.

7. — Review of Frequency Bands required for Space Research (Doc. IUCAF/164).

(i) *Standard Frequency Guard Bands.*

As mentioned in 5 (i) above, it was agreed that radio astronomers were no longer seeking special protection for bands associated with the Standard Frequency Service. As an alternative, the Commission (IUCAF) recommends that these guard bands, associated with the frequencies of 2.5, 5, 10, 15, 20 and 25 MHz, should be allocated to Space Research on a secondary basis.

Furthermore it is proposed that the band at 40 MHz be extended to 40.020 MHz instead of the present value of 40.002 MHz. This would facilitate full harmonic coverage of the corresponding band at 20.010 MHz.

It was noted that the band 41 to 47 MHz is allocated to the broadcasting services in some European countries : but the Commission decided to support a proposal from France that protection "on a Footnote basis" be sought for the band 40.980 to 41.020 MHz for space research. It was noted, however, that the band 39.986 to 40.002 MHz was already allocated to space research on a secondary basis by Footnote Mod 235 (1963).

(ii) *Beacon Frequencies for Ionospheric Research.*

As it seems unlikely that adequate protection can be obtained for a band in the vicinity of 40 or 41 MHz, higher frequencies within the band 400.05 to 401 MHz and related harmonically to those in the 20 and 40 MHz bands, might be allocated to Space Research.

(iii) *Frequencies for Beacon Satellites.*

Attention was drawn to Recommendation No 8A in the Revised Radio Regulations (1963) and the fact that the frequency bands 149.9 to 150.05 and 399.9 to 400.05 MHz have been allocated to the radionavigation-satellite service on an exclusive world-wide basis.

While either of these bands might be shared with the Space Research service, a strong case would be needed from COSPAR, if a claim for the exclusive use of the 150 MHz was to be considered.

(iv) *Frequencies for Geodetic Research.*

The IUCAF recommends that the use of radionavigation-satellite beacons for geodetic research be recognised in the Radio Regulations, and that some protection be given to receiving stations making such use of them. This concerns both the frequency bands — 149.9 to 150.05 and 399.9 to 400.05 MHz — at present allocated to radionavigation-satellites.

In addition, a higher beacon frequency can be used within the band 1700 to 1710 MHz, allocated to Space Research (Telemetering and tracking) in the current (1963) Revised Radio Regulations.

8. — Registration of Frequencies for Space Research.

During the meeting in Göteborg, Doc. IUCAF/162 was prepared as a memorandum addressed to all workers in the Space Research field to seek their co-operation in obtaining freedom from interference in the several bands of frequencies allocated to Space Research by the ITU.

The memorandum requests some detailed information on the various frequencies used for space research, as well as reports of any interference which may limit observational activity in any of the bands allocated by international agreement.

9. — Preparation for the June 1971 World Administrative Radio Conference for Space Telecommunications (WARC-ST).

The Commission discussed at some length the future arrangements for the international meetings leading up to the World Administrative Radio Conference for Space Telecommunications due to meet in Geneva during June 1971. The relevant Study Groups of CCIR would meet, also in Geneva, in early February 1971, and would probably require all contributions to be submitted to them by 30 September 1970. The latest date for documents to be submitted to the WARC-ST was likely to be 30 November 1970.

(a) *Representation of IUCAF.*

The section of the CCIR concerned with "Space Research and Radio-astronomy Services" is now Study Group 2, of which Prof. I. Ranzi (Italy) is chairman, and Dr. J. Hagen (USA) vice-chairman.

The meeting was informed that members of IUCAF who are likely to be attending the CCIR Study Group meetings — apart from Mr. J. Herbstreit as Director, CCIR — would include Messrs Findlay, Horner, Smith, Smith-Rose and Thué, and possibly also Blum, Higgs and Muller, all on a part-time basis.

It was desirable that there should be at least one representative of IUCAF present in Geneva throughout the whole meeting of the WARC-ST.

(b) *Submission of reports to the WARC.*

It was noted that the CCIR would produce one comprehensive report to the WARC, and that national administrations and other bodies such as IUCAF must submit their contributions by 30 September 1970.

Dr. Hagen, as vice-chairman of the Study Group, kindly agreed to act as intermediary liaison member, and would ensure that all CCIR documents relevant to the work of IUCAF were made available to the representatives of this Commission.

(c) *Future meetings of IUCAF.*

In order to maintain and expedite the detailed preparation for the WARC, it was considered desirable that the Inter-Union Commission (IUCAF) should meet first — provisionally in Geneva — at the end of the forthcoming CCIR meeting (February 1971); and second, immediately before the WARC meeting starting in June 1971.

10. — CONCLUSION AND VOTE OF THANKS.

Before concluding the meeting, the chairman thanked Mr. Higgs for his paper on the "Doppler Effect in Radio Astronomy" published in the ITU *Telecommunication Journal*, Geneva, May 1969, and distributed to the Commission as Doc. IUCAF/146.

The members of the Commission also recorded their great appreciation for all the arrangements made in connection with this meeting in Göteborg, including particularly the very interesting visits to (i) the transmitting and receiving stations of Göteborg Radio, (ii) the Onsala Space Observatory, (iii) the Observatory of the Chalmers University of Technology and (iv) the 12th century church at Onsala.

The members of IUCAF also appreciated very much the warm hospitality they received during their meeting, and were unanimous in expressing their gratitude to Dr. Hakan Sterky and Mr. Sven Rahmn for all the arrangements made and carried out so efficiently.

DYNAMICS OF THE UPPER ATMOSPHERE

IUCSTP Working Group 10; Toronto, January 1970
Report prepared by Prof. C. O. HINES

Note by Secretary General URSI. The following Report is being published in *STP Notes.* It is reprinted here in view of the discussion in Parts VII and VIII on the role of meteor radar and ionospheric observations in studies of waves in the atmosphere.

I. INTRODUCTION. — The International Symposium on Waves in the Upper Atmosphere was initiated by the International Commission on the Meteorology of the Upper Atmosphere of IAMAP, and was sponsored by IAMAP, COSPAR, and URSI. Participants in the symposium were invited to join subsequent workshop sessions which were sponsored by IUCSTP through its Working Group 10, on the Dynamics of the Upper Atmosphere. These sessions were designed as an extension of an earlier COSPAR activity initiated by its Panel on the Dynamics and Structure of the Neutral Atmosphere, in which some of the problems of measuring tides and other gravity waves were identified and discussed. The report of that activity by Lindzen (1969) should be read as a complementary precursor to the present report.

The scientific problems to be faced in the IUCSTP sessions were examined in two concurrent workshops, I*a* and I*b*, under the chairmanship of R. S. Lindzen and W. W. Kellogg respectively. I*a* dealt with tides and planetary waves, while I*b* dealt with irregularly occurring shorter-period gravity waves, and to a minor extent infrasonic waves. These two workshops were characterized primarily by an input from the theorists to the experimenters, identifying the types of measurement that seemed most urgently needed.

The practical problems of measurements, particularly in areas that required the cooperation of diverse research groups, were faced in Workshop II under the chairmanship of R. G. Roper. This workshop was characterized by an exchange of views between experimenters, and led to some proposals for facilitating their work.

Workshop III, under the chairmanship of C. O. Hines, sought to identify those opinions and recommendations of the group, expressed in the preceeding workshops or newly formulated, that appeared to warrant formal endorsement by an acknowledged international body with responsibilities in the field, such IUCSTP WG 10 and/or the symposium sponsors.

As planned at the time, the present report was prepared by C. O. Hines as convenor of the IUCSTP workshops. It was first drafted with the aid of material supplied by the workshop chairmen, and then circulated to all symposium registrants and to certain others with a known interest, for recommendations on possible revisions, before being revised and transmitted to WG 10 for further action and to all contributors for information. It does not attempt to be a session-by-session record of proceedings, but rather seeks to emphasize in the most useful fashion the principal views on which participants reached a measure of accord and to which they believed a form of international ratification should be given at the present time. It is published now with the approval of WG 10, after final revision.

II. PLANETARY WAVES. — These waves are to be understood as oscillations on a global scale, with periods exceeding one day.

II.1. — The certain identification of planetary waves virtually requires the use of global maps or their equivalent. Fluctuations not so identified cannot be expected *a priori* to conform to the theory of planetary waves, though they may, advantageously, be compared with that theory to determine the degree of agreement that actually obtains.

II.2. — The isolation of planetary waves from upper atmospheric data requires the determination and removal of superimposed tidal fields. This can be accomplished reliably only from data obtained throughout a period of several consecutive days.

II.3. — The tracing of a planetary wave through the atmosphere would be extremely valuable. In particular, the variatipn of phase with height tells much about the physics of a wave, and observations that reveal this variation are of crucial import.

II.4. — The physics of these and other waves depends upon the intrinsic wave period, that which would be measured in a reference frame moving with the mean background flow. Accordingly, it is essential to theoretical developments that this flow be determined. For the planetary waves, the *zonal mean flow* (which is the zonal flow averaged around a latitude circle) is the parameter most urgently required, and not, for example the *mean zonal flow* (which is averaged in time at a single station). Determination of the former clearly requires that observations be available from longitudes all round the earth.

II.5. — More detailed information on ozone distribution and photochemistry is required for the calculation both of planetary waves and of tides. Such information may also contribute to an understanding of the quasi-biennial oscillation, for which it would be particularly desirable to have weekly data on vertical distribution at an equatorial station for a continuous period of a few years.

III. TIDES. — These are to be taken as oscillations on a global scale with periods that are integral fractions of 24 (solar or lunar) hours.

III.1. — Observations made over only a few days at a single station are inadequate to establish whether or not a true tide (i.e., global in scale) is being revealed. The terms "daily variation" or "x-hour oscillation" are therefore preferable to the term "tide" in discussions of tide-like variations, though the data may, advantageously, be compared with tidal theory to establish the plausibility of a tidal interpretation.

III.2. — Individual tidal modes, defined with the aid of corresponding individual Hough functions, are standing waves in the north-south direction, and this property implies that their zonal and meridional wind components will be in phase quadrature. Departure from phase quadrature in an observed tidal oscillation then implies that more than one mode has a significant amplitude or that serious departures occur from the idealizations of tidal theory.

III.3. — Latitudinal variations of tidal oscillations should be determined observationally to check on various theoretical predictions, e.g. : that the diurnal tide above 80 km (and below, perhaps, 120 km) should have small wind amplitudes polewards of 50° and large amplitudes equatorwards of 30°; and that the higher-order semidiurnal modes (2, 4) and (2, 6) should have maximum amplitudes at 50°-60°.

III.4. — In addition to the solar tidal modes that propagate round the globe with the sun, there are other, standing modes, whose phases depend on universal (rather than local) time. In order to determine the relative importance of these modes, longitudinal variations of tidal oscillations must be measured for several weeks in each season.

III.5. — Height variations of 24-hour and 12-hour oscillations, especially of their phases, are crucial in any attempt at a plausible identification of tidal modes from single-station observations, and would be important even if global data were available. Good height resolution (with autocorrelation radius $<$ 3-10 km) is necessary for most modes, and is therefore to be sought when possible. Nevertheless, poor height resolution is adequate for the very important (2, 2) mode and for evanescent modes. Data-gathering systems that provide only poor height resolution are, in consequence, still able to contribute significantly to the study of tidal systems.

III.6. — The quiet-day magnetic variations (Sq) provide an extreme example of data with poor height resolution but apparently high information content, at least for the first evanescent diurnal mode. (The diurnal wind system deduced by S. Kato from magnetogram data appears now to represent well the first evanescent diurnal tidal mode; that it might well be expected to do so, on the basis of tidal and dynamo theory, has been established by R. J. Stening and by D. Tarpley.) They are, moreover, global in scale and comparatively low in cost. Their value as a contributor to tidal studies ought now to be much more fully exploited.

III.7. — Theory suggests that the diurnal tide is quasi-statically unstable over the altitude range 90-110 km (approximately), in equatorial latitudes. This instability would have important theoretical and observational consequences, so an experimental check on its existence should be sought.

III.8. — A synoptic picture of the tidal winds at heights of 100-120 km is wanted, to be used as a lower boundary condition for studies of daily variations in the thermosphere, and to permit evaluation of the filtering effect that tides have on shorter-period gravity waves (via changes in the intrinsic frequencies of those waves).

III.9. — Lunar tides, though generally weaker than solar tides in the atmosphere, should be identified and studied where possible. By virtue of their accurately known source function, they would permit an accurate determination of the combined influence of various propagational factors such as partial reflections and atmospheric damping.

IV. Gravity waves. — These are to be taken as waves in which the gravitational force plays a dominant role in the determination of wave properties. They exclude (at least, for present purposes) planetary and tidal waves. Instead, their wave periods lie typically in the range 0.1-10 hours, and their occurrence is irregular.

IV.1. — The identification of individual gravity waves, or more properly wave packets, tends to be hampered because of the broad spectrum of such waves that is often present, and because of superimposed motions of other origins. It must be recognized, then, that certain types of observation may contribute more toward the statistics of these waves than to the study of their properties individually; but, at the same time, that such statistics are themselves of considerable significance (in questions concerned with energy and momentum transfer, or chemical variations, for example).

IV.2. — In certain circumstances, individual wave systems can be identified with little ambiguity, by virtue of their great amplitude relative to other fluctuations on a similar time and/or spatial scale. Such circumstances should be exploited to the full, for at least two reasons. First, they provide an opportunity for determining wave parameters in sufficient detail to permit a check on internal consistency as defined by theory, and may even permit the determination of some atmospheric parameter not otherwise accessible to observation. Second, with the wave parameters determined, the possibility exists that the source of the wave energy may be identified via ray-tracing backward in time.

IV.3. — Empirical evidence and theoretical support now abound, that some of the strongest gravity waves in the upper atmosphere are launched by ionospheric currents in the auroral zone. This suggests that special efforts for the study of wave properties, preferably by a variety of techniques, should be timed to follow upon the detection of strong auroral-zone currents by magnetometers.

IV.4. — Except for auroral-zone currents (and, on one occasion, a major earthquake), natural sources of upper atmospheric gravity waves have yet to be identified with any degree of certainty. A number of possible sources are recognized, most of them located low in the atmosphere — flow over mountains, weather fronts, storm systems, jet streams, and local shear instabilities, for example — but unambiguous associations between any one of these and some particular upper atmospheric wave system remains for the future. Methods by which such associations might be established are needed badly. The difficulty stems in part from the breadth of the spectra often observed on high, and even more from the greater breadth of the spectra emitted; in part from the filtering action of the intervening atmospheric levels, including in particular that associated with regions where the waves are evanescent; and in part from the uncertainties of ray tracing through the imperfectly known wind systems of the middle atmosphere, not to mention the irrelevance of standard ray tracing techniques in regions of evanescence. These difficulties lead to the pessimistic view that we may be unable to derive much beyond an empirical relationship between gross patterns in the lower atmosphere and statistical variations of the spectrum in the upper atmosphere. Even this much would be of considerable value, however, and should be sought.

IV.5. — Despite this pessimistic prospect, it is advisable to continue attempts at determining specific linkages. The role of individual upper atmospheric wave systems has already been mentioned in this connection, in IV.2, and some preliminary results (relating noctilucent-cloud waves to tropospheric jets) have in fact been encouraging. As another method of attack, likely individual sources may be identified; their consequences may then be predicted theoretically and sought observationally. Attempts might be made, for example, to take advantage of orographic sources that may be expected to have favourable properties. The hills of Wales, as one illustration, are reported to give rise to a relatively narrow spectrum of waves under appropriate wind conditions, and tests for the presence of that spectrum might be made. Winds blowing over an isolated oceanic island would provide an easily identifiable source, though azimuthal spreading of the wave energy might be too severe to permit detection at great altitudes. Variable winds blowing across the Rocky Mountains should yield a broad spectrum of waves, with waves of differing periods launched at different angles of elevation, such that a characteristic variation of wave period with distance from the mountain chain would be produced at any given upper-atmospheric level, while the great length of the mountain system would minimize the effects of azimuthal spreading.

IV.6. — Waves that propagate with relatively high horizontal trace speeds, and those that propagate across the background wind field, are relatively unaffected by background winds; ray tracing is, for them, a more certain process. This suggests that sources (e.g. frontal systems) that move rapidly, and/or move primarily along a north-south axis, may provide particularly good opportunities for establishing unambiguous linkages between the lower atmosphere and the waves of the upper atmosphere.

IV.7. — There is good reason to believe that gravity waves account for much of the irregular thermal structure of the mesosphere and lower thermosphere that is observed particularly at high latitudes in winter, and to suspect that they affect the chemical composition at the same and overlying levels. The mechanism by which compositional changes might be effected is not clear, however, since at least three processes might be operative (viz., changing the circulation; "corkscrew" action; turbulent mixing) and none of them is fully understood. Theoretical advances are needed, but they must be complemented by experiments. These could be of two general types : those that examine the broad winter-time spectrum of gravity waves and its effects, and those that exploit the quieter summer conditions for purposes of calibration and single-case studies.

V. Infrasonic waves. — These waves have periods of a few minutes and less. They mark a transition from the dynamical processes of the atmosphere, which include the wave types previously discussed, to ordinary sound waves. Their occurrence in the ionosphere is well recognized with detection being effected best, perhaps, by Doppler radar. Some of their sources in the lower atmosphere (e.g. cold fronts, thunderstorms) have been identified tentatively and linkages between the two levels continue under examination. Certain auroral forms in supersonic motion generate such waves, which are then detectable at ground level and which contain new information on the aurora. Since infrasonic waves are contiguous to gravity waves in the spectrum of atmospheric waves, they provide a valuable adjunct to studies of those waves and so can contribute to the understanding of atmospheric dynamical processes.

VI. Observational practices. — Certain general comments and recommendations on observational practices emerge from the preceding items, and from the workshop discussion that surrounded them. These are collected here, prior to a survey of the role expected of individual observational techniques.

VI.1. — It goes without saying that one would ideally like to have global coverage, at all heights, with temporal continuity, for all relevant parameter fields; and equally, that this is an impossibility. The only practical approximation to the desired state is obtained by slicing : to provide latitudinal variations, say, or longitudinal variations; to provide long-term unsophisticated measurements of one or two parameters or short-term sophisticated measurements of several; etc. While no general advice on the slicing most appropriate to specific programs can be given, in that different slicings can give rise to different types of equally useful data collections, it does seem proper to record that the days are past when *any* data input could be considered useful. More specifically, when programs are being planned, the planners should take pains to ensure that the data they do produce from their proposed slice will indeed be of a useful type, as measured by objectives such as those set out in Lindzen (1969) and in the preceding paragraphs. As an extreme case, it may be mentioned that a single wind profile obtained at a single site can no longer hope to add significantly to our present knowledge. Statements of a more positive nature follow.

VI.2. — Good resolution, both in time and in space (and particularly in altitude), are now essential for most avenues of advance. The definition of "good resolution" varies, however, with the type of wave to be studied (cf. III.5), and the definitions for time and for space are not independent. Efficient program design will demand that sophistication of temporal and of spatial resolution should proceed at complementary rates, determined by the wave type of interest, for otherwise expensive data may prove to be of no value. Implementation of this stricture will demand cooperation between various research groups on occasion. Mechanisms for establishing this cooperation must be introduced where they are now absent, and some steps in this direction are set out in later paragraphs.

VI.3. — Longitudinal variations provide a case in point (cf. II.4 and III.4, for example). Measurements round one or more circles of latitude are needed. As a first step, it is suggested that the latitude belt 30°-45° N provides a realistic opportunity for establishing a chain of stations, in which no two would be separated by more than about 90° of longitude, provided workers in a number of countries participate. Crucial to such a chain would be Japan and the United States of America, while a number of alternatives for completing the chain through the European/African/Asian sector appear possible. The Meteorological Rocket Network is already well represented in this belt; its extension round the belt and further exploitation, and the introduction of complementary techniques, is now urged most strongly. Emphasis on this particular belt is not intended to detract from possibilities, where they exist, of developing other belts where specific techniques may be particularly plentiful — e.g., a belt of partial-reflection mesospheric "drift" stations (see VI.4) at latitudes closer to 55°. Nor is emphasis on continental locations intended to detract from possibilities, where they exist, of employing widespread oceanic measurements using island stations or shipboard facilities — e.g. meteorological sondes released from merchant ships. Such extensions are clearly advisable, and to be encouraged where practicable.

VI.4. — For many purposes, as in the collection of statistical and synoptic information (e.g. III.6, III.8, IV.1, IV.4), regularity, continuity, and length of data series are more important than sophistication of observational techniques. Intermittency, or premature termination, may totally destroy the value of programs that are instituted to obtain such collections. In the case of university-based programs of this type, which are usually dependent on seriously fluctuating sources of labour (e.g., graduate students) and funds, collaboration with service organizations (e.g., weather bureaux) is urged as a means of effecting stability; and conversely, such organizations are urged to view sympathetically requests for this collaboration, as a contribution to their own ultimate objectives.

VI.5. — The repeated emphasis on global measurements (particularly in Parts II and III above) underscores the necessity of global networks for the acquisition of data by various techniques, and the desirability of coordinators to facilitate the operation of these networks on a collaborative basis. Coordinators for certain networks were nominated in the course of the workshops, duplicating, where practicable, those already established by international agencies or by *de facto* recognition from the bulk of the observers concerned. These individuals are named as appropriate in Part VII below, with the expectation of ratification by IUCSTP WG 10 in order to establish formal international recognition.

It was agreed that, insofar as IUCSTP should be concerned, the coordinators were not to be considered in any sense as directors of the programs conducted by their respective networks, nor were the individual stations to be considered subservient to the network as a whole. Rather, insofar as IUCSTP should be concerned, participation in the network could be only on a voluntary basis, and participating scientists should be expected to operate their stations in conformity with general network requirements only when they were persuaded that they could make their best contribution by doing so. Similarly, rights to the data would remain with the participating scientists individually unless and until they felt it appropriate to share that data, except as they might otherwise agree in advance. Implicit in these understandings was the recognition that, insofar as a collaborative program was indeed of value to the science in which they were involved, the individual scientists would wish to make their respective contributions to that program, and would do so if given the opportunity and at the same time the freedom of decision.

With this as background, the role of a coordinator was seen to include some or all of the following items, and perhaps others as events dictated :

(1) Serve as a center for communications, between members of the network, on matters affecting the network as a whole. (2) Seek to establish and update agreement between participants on the primary scientific objectives of the network as such. (3) Seek to establish and update agreement on *basic* system design, at least in the matter of minimum (scientific) specifications consistent with the objectives, and where possible on the *actual* design of a standard, reliable, fieldtested equipment, preferably with the potential for updating as techniques or data requirements change. (4) Seek to establish and update optimum coordination of scheduling (as defined by the objectives) throughout the network, in cases where observations may be intermittent. (5) Seek to establish and update agreement on methods of data recording, storage, and exchange, at least for those data that are relevant to network objectives. (6) Facilitate data exchange, when necessary, or seek the aid of World Data Centers in facilitating the exchange. (7) Serve as a center of information to anyone interested in joining the network, in order to facilitate his entry with techniques already standardized. (8) Maintain contact with other coordinators, particularly with a view to making more effective items (2) and (4) above. (9) Advise IUCSTP WG 10 from time to time on the status of the network and its activities, perhaps with the aid of reports that might be published in *STP Notes* for wider dissemination.

VII. Individual techniques. — The following sections bring some of the foregoing material into the context of individual techniques, add to it, and in some cases introduce recommendations for improved utilization.

VII.1. *Meteorological Rocket Network.* — The contribution of the MRN to the study of upper atmospheric waves has already been great, and can be much greater. It lies both in the establishment of the background flow and in the identification of wave systems : tidal oscillations have been determined by this means, and the potential for the study of planetary waves is high. Increased global coverage would be of value, of course, and special emphasis on the latitude belt 30°-50° N (as suggested in VI.3) in the European/African/Asian sector is particularly desirable. However, workshop participants were strongest in their urging that methods be sought to extend the MRN upward in height, from the present typical limit to 60 km to a new goal of 85 km as a bare minimum, in order to overlap the meteor data; and even further if at all possible, say to 100 km, in order to check on that data as called for in VIII.1 below, and as a contributor to the global coverage whose need is implied, for example, in II.1, III.1 and III.8 above. This upward extension would be of major significance even if it yielded wind data alone, though subsidiary measurements (e.g. of temperature) would of course be welcomed. In this connection, the workshop participants were encouraged by the report of Dr. A. Azcarraga, of the Instituto Nacional de Tecnica Aeroespacial, Madrid, of plans to launch a series of rockets to study mesospheric winds by means of radar-detected chaff, using special chaff developed at the Max-Planck-Institut für Aeronomie, Lindau, Harz, FRG. (Successful launching has since been reported, of 27 rockets at 4-hour intervals, with wind data obtained over the height range 70-98 km.) It was also noted that the pure tidal harmonics could be determined from a long sequence of one-a-day launchings, provided those launchings were made at variable rather than fixed hours; systematic variation of launch time could then yield valuable tidal information at little increase over the standard rate of expenditure for one-a-day launchings.

VII.2. *Meteor radar.* — Many vital advances now hinge on the acquisition of adequate data at meteor heights, wind data in particular. There is a widespread consensus that the meteor-radar technique should be pressed forward urgently. Some reservations remain as to the time and height resolution that might be obtained by operational systems, but items such as III.5 and IV.1 make it clear that these reservations do not undermine — but only limit — the value that can be derived. There have been strong pressures from within the meteor-radar community, moreover, towards the establishment of some global collaboration in the development and application of the technique. Indeed, at an informal meeting of meteor-radar workers held during the symposium, agreement was reached on the desirability of standardized minimum specifications. The Stanford University radar was recognized as a model that would likely meet such specifications, and have additional favourable attributes; it might well serve as a standard instrument for global adoption.

In order that this and related matters might be pressed forward in the fashion outlined in VI.5 above, Dr. R. G. Roper agreed to serve as coordinator for a meteor-radar network. Collaboration of existing meteor-radar facilities was to be sought by him, and extensions of the network, particularly in the latitude belt 30°-45° N (see VI.3), was most strongly recommended.

VII.3. *Artificial vapour trails.* — Vapour trails released by rockets and shells provide one of the few means of determining winds above meteor heights, and their further use was therefore urged. Their utilization in daytime would mark a major step forward, and intense efforts to find the means of accomplishing this were urged. It was recommended that present programs be extended to include (1) barium releases at heights down to 100 km, (2) isolated vapour puffs (in contrast to trails) to reveal the full wind vector, (3) the determination of horizontal wind divergence by combining up and down trails, and (4) TMA releases in the 30-90 km altitude range.

It was noted that different observers report different characteristics for the wind fields obtained from their own vapour releases (e.g. "corners" in the wind profile being a common occurrence or not, and "turbulence" being present or not), and a strong suspicion was expressed that these discrepancies might result from differences of data acquisition or reduction rather than from real differences in the wind fields monitored by the different workers. In orders that this possibility might be resolved, and hence some confidence be placed in one or other of the competing claims, it was urged that different groups should acquire and reduce data by their own techniques, all using the *same* vapour trails; or, at the very least, that some of the data acquired by each group should be reduced by the other groups according to their separate techniques. Only by these means could discrepant conclusions be traced to their sources, and it was felt that the time was long past when such discrepancies should be permitted to go unexplained.

VII.4. *Partial reflections.* — The partial reflection technique, for determining ionospheric "drifts" at mesospheric heights, provides a vital source of relatively inexpensive information relating to a very difficult height range for observation. Its further use was urged (but see VIII.1 below, concerning a qualification as to the interpretation of the data). There already exists a small loosely knit network of stations, SOMED, concerned with the electron density of the mesosphere, coordinated in a fashion by Dr. J. B. Gregory. Most of the SOMED stations employ the partial-reflection technique, and some do so in a fashion that permits the detection of "drifts". Dr. Gregory agreed to undertake the role of coordinator, in the sense outlined in VI.5 above, with respect to "drifts" as measured by partial reflections.

VII.5. *Ionospheric "drifts".* — The total-reflection technique analogous to VII.4, which is widely employed to reveal "drifts" in the ionospheric E and lower F regions, provides a further vital source of relatively inexpensive information, and one that is already being exploited on a global basis. Its further use was urged (but see VIII.1 below). There already exists a form of global coordination of "drift" studies, established by URSI with Professor R. W. H. Wright as rapporteur. It was agreed that Professor

Wright should be asked to undertake the role of coordinator for the drift network, in the sense outlined in VI.5 above.

Crucial new data relating to the interpretation of "drift" observations were presented during the symposium, both by W. Pfister and by R. A. Vincent. Pfister's work in particular showed that, with proper use of radio phase information, the "drift" data could be analysed in more detail than before, and that the results could be interpreted only as a wavelike behaviour of the reflecting areas. Whether this behaviour resulted from gravity waves, or from the formative stages of turbulence, to cite two possibilities that he suggests, remains as yet an open question in his mind. Rapid publication of this work was urged upon Dr. Pfister, and independent checking by other groups was considered to be of prime importance: the correct interpretation of a large quantity of data is involved.

VII.6. *Ionosondes.* — Spaced ionosondes, or their equivalent, have provided a large body of information on TID's and hence on gravity waves at F-region heights. The statistics they provide are severely contaminated by observational factors, as was demonstrated by W. H. Hooke in the course of the symposium, to such an extent that they cannot be considered a reliable source of neutral-gas gravity-wave statistics *per se*. On the other hand, individual ionosondes can provide useful data on the temporal variation of the spectrum they do detect, while spaced ionosondes are ideal for measuring strong individual waves, since both the horizontal and the vertical structure, and its propagation, can be determined readily by them. For the purpose of propagation studies of TID's, regional networks are more appropriate than global. Again, standardization of equipment is not of serious concern, since most ionosondes meet all the requirements for these studies already (except, perhaps, in their capacity for repeated soundings at short intervals, e.g., 5 minutes). No global network was proposed, though it was noted that TID measurement comes within the purvue of Professor Wright in his URSI role. The existing ionosonde network itself, however, falls within the URSI purvue of Mr. W. R. Piggott; it was not clear whether he might not be a more appropriate contact. The matter was left for subsequent clarification by the W. G. Steering Committee. The development of regional networks for the study of aurorally launched TID's (see IV.3) was advocated most strongly, and Europe was specified as an area where a suitable network could be established readily, almost from existing stations exclusively. Such a network indeed exists in embryo form; its further development, and the development of others like it, was urged.

VII.7. *Incoherent scatter.* — The remarkable potential of the incoherent scatter technique for the study of gravity waves in the F region was illustrated at the symposium by J. Testud, in that phase propagation, air-parcel motion, and temperature variations could all be inferred. Indeed, scatter systems, when designed to exploit the Doppler shift of the returning signal, were seen to provide a much needed means of monitoring the bulk motion of the atmosphere (albeit, as reflected in induced ion bulk motion) with temporal continuity and with ground-based equipment. While the expense of scatter facilities will probably preclude their introduction purely for wave-oriented studies, their versatility will almost certainly lead to their more widespread use with the passage of time. It was urged that, in the development of such facilities in the future, requirements such as those set out in Parts II-VI for wave studies should be taken into account fully at the design stage as well as the operational stage. In particular, the Doppler shift should be a measurable parameter, and height resolution should be sought consistent with important vertical wavelengths (e.g., down to 1 km at 100 km altitude, and perhaps 50 km at 200 km). Incoherent scatter systems may also contribute to the measurement of D-region winds since, in the D region, Doppler shifts should be directly attributable to neutral-gas bulk movement.

VII.8. *Noctilucent clouds.* — NLC often provide evidence of well-defined wave systems of the type whose merits are noted in VI.2 above, and they have in fact been used advantageously already (see IV.5). It is possible, too, that the region of formation of the NLC is itself in part determined by waves, both of planetary scale and of gravity-wave scale. The latter possibility can be probed by relatively crude NLC observations, but full exploitation of the well-defined wave systems can come about only with more comprehensive measurements, including in particular time-lapse photography. It was not clear that NLC workers in general recognized the important contribution that their research might make to wave studies, particularly if they were to instrument more thoroughly. The existence of an international NLC quarterly newsletter, edited by Dr. A. Christie, was noted, and his good offices were sought in bringing this message to the NLC community.

VII.9. *Microbarographic network.* — The recent increase of interest in relating low-altitude waves to upper atmospheric dynamics is reflected in much of Parts IV and V above. Microbarographs provide one means, and a most valuable one, of determining ground-level wave systems. A network already exists, coordinated by Dr. R. K. Cook, for infrasonic studies. It was agreed that Dr. Cook should be asked to serve as coordinator, in the sense outlined in VI.5 above, for microbarographic networks — with the thought that the infrasonic capabilities of the present network might prove relevant to the work on longer-period waves and might aid in implementing the suggestion in IV.3 by giving warning of suitable auroral events, and with the hope that the limited sensitivity at longer periods might in time be improved to give direct measurements at those periods. (Dr. Cook subsequently agreed to serve.)

VII.10. *Magnetogram network.* — As already noted in III.6 magnetogram data appear to be of considerable value for tidal studies. This value is enhanced by consideration of item III.8 on the need for a synoptic picture, not only because of the direct dynamical implications of the neutral-gas motion, but also because of the indirect electrodynamic effects that are of major significance in tidal oscillations above the dynamo region. Apart from the tidal aspects, there exist several rather sketchy reports of magnetic variations associated with tropospheric disturbances, which suggest that gravity-wave coupling might be operative. Finally, magnetic fluctuations provide the most direct means of identifying occasions suitable for initiating the detailed recording program anticipated in IV.3, and the only means for interpreting the results of such a program in terms of the wave source.

There appears to be no present problem in the matter of data acquisition, but a serious one in long-term data reduction : a great backlog of data has accumulated, and the data currently being gathered are, for the most part, not being analysed with wave-oriented studies in mind. Fuller use of magnetogram data in such studies, particularly for the monitoring of the tidal system, was therefore urged.

VIII. Recommendations. — The bulk of the foregoing discussion carries, either implicitly or explicitly, a wide variety of recommendations on scientific objectives and operational implementation. Three further recommendations were isolated for special emphasis :

VIII.1. *Joint wind studies.* — There is a certain measure of gnawing uncertainty with respect to the accuracy, if not the very interpretation, of virtually all measurements of upper atmospheric winds — even of those that are among the most direct, e.g. derived from meteor radar. This uncertainty reaches an extreme in the case of ionospheric "drifts", as revealed both by the partial reflection technique (VII.4) and by the total reflection technique (VII.5) : these "drifts" are held by many to represent true winds, but in principle they are subject to contamination or even dominance by other factors, in part through their dependence on ionization, and in part because a wave propagation speed rather than an air-parcel transport speed may well be involved. This latter possibility was underscored yet again by the work of Pfister and of Vincent, mentioned in VII.5 above.

The workshop participants, with some exceptions, were quite unable to agree with the URSI-CIG Working Party on Ionospheric Drift Analysis (URSI 1968) "that the D1 method of measuring ionospheric drifts", (i.e., the method under discussion in VII.5 above, and by extrapolation that in VII.4) "when properly interpreted, can provide direct information concerning the circulation of the neutral wind in the D and E regions of the ionosphere, or ionospheric meteorology." Evidence in support of such a belief was held to be inadequate, and the "proper" method of interpretation was thought still to be established, if it existed at all. Even the support that has been adduced, for the detection of tidal winds from mean "drift" data, was considered inadequate by virtue of spatial and/or temporal separation of the "drift" site from the site of the supposedly confirmatory measurements; and even if that support were accepted it provided no criterion for establishing the validity of the interpretation on individual occasions.

In consequence of these various uncertainties, which undermine confidence in the interpretation and so in the use of great masses of data, it was recommended as a matter of urgent and major importance, that all possible opportunities be taken to measure upper atmospheric motions at the same place and the same time by as many different techniques as may be practicable, and that special efforts of this type be directed to a comparison of "drift" measurements with more certain measurements of atmospheric winds, repeatedly in all relevant altitude ranges.

VIII.2. *Analysis of irregular data.* — All forms of data acquisition for upper atmospheric dynamics are subject to data gaps, if not in their temporal continuity then at least in their spatial coverage, vertical and/or horizontal. How can such data best be analysed, for example to determine Fourier components, and what are the uncertainties of the results ? Do random and non-random data gaps affect the results differently ? May data for a fraction of a day be analysed legitimately for tidal periods and, if so, what confidence can be placed in the results ? How are vertical shifts in phase best accounted for, in the analysis of a sequence of height profiles, and how does an exponential growth of amplitude with height (when and if present) complicate the answer ? How many data are necessary for statistically stable results ? What precautions of interpretation must be introduced, when the statistical properties change during the course of collecting even a minimal data sample ?

For the most part, those who acquire the data and those who seek to determine its geophysical import are not well equipped to answer questions such as these. Indeed, it would take an exceptional individual, thoroughly versed in statistical techniques and familiar with the geophysical type of data, even to come to grips with many of them. Such individuals are rarely associated with programs whose financial investment is on the scale typical of most individual upper atmospheric programs. On the other hand, a program on the scale of the combined global efforts that go into upper atmospheric dynamics, or even into upper atmospheric waves alone, can scarcely operate efficiently or effectively without a major input from at least one such individual.

Accordingly, it was recommended as a matter of urgent and major importance, that a professional statistician of the first rank, familiar with or readily adaptable to the type of data acquired in studies of upper atmospheric waves, be called in to study present methods of data reduction, to recommend on their improvement, and to advice on the reliability of the end products; and that sponsorship be sought to provide adequate incentive, remuneration, and travel support, for a person of the quality that is wanted.

VIII.3. *Specification of analysis method and errors.* — Pending the results of a study such as that just proposed, or in any event, all observers were urged to be specific when reporting their results as to the method of analysis they employed, including in particular the method of time and space smoothing, in order to permit other workers to make meaningful comparisons of data. The specification of probable errors, resulting both from data acquisition and from data analysis, was likewise noted as being of importance to the identification of significant discrepancies, but as being too often omitted from otherwise good reports.

REFERENCES

LINDZEN, R. S. (1969). — *J. Atmos. Terr. Phys,.* **31**, 449-456.
URSI (1968). — *URSI Inf. Bull.* No. **167**, p. 32.

DECISIONS
ADOPTED BY THE XIIIth PLENARY MEETING
OF COSPAR

Leningrad, 29 May 1970

Decision No 1 proposed by the Executive Council on the proposal of Working Group 1

COSPAR,

considering that a large international group of observers of ionospheric beacon satellites EXPLORER 22 and 27 have made important contributions to ionospheric studies that should be continued; and

believing that, in addition to planned geostationary beacons, only low altitude satellites are adequate for the continuation of many types of observations; again

invites those administrations who are planning satellite programmes to consider the possibility of putting ionospheric beacons on low-altitude satellites, using harmonic frequencies near 30, 40 and 41 MHz, and possibly 360 MHz. (See Decision No 6, COSPAR XII Meeting, Prague 1969.)

Decision No 7 proposed by the Executive Council on the proposal of Working Group 1

COSPAR,

noting with satisfaction that the lunar laser experiment has been successful in its initial phase, but

recognizing that the scientific value of the experiment will be fully realized only under the following conditions :

(1) when several retroreflectors are widely distributed on the lunar surface;
(2) when there are as many terrestrial observing stations as practicable, well distributed geographically, with at least one station in the southern hemisphere;
(3) when the data are made available to the scientific community;

urges space agencies launching lunar landing spacecraft to place on the lunar surface more optical retroreflectors, some of which should be large enough to be used easily with one-metre telescopes,

encourages all countries to develop and build lunar laser ranging systems and to participate in the observations, and

establishes a working party of Working Group 1 on Lunar Laser Ranging under the chairmanship of Dr. C. O. Alley (USA) in order to initiate international coordination and data exchange in this field.

Decision No 8 proposed by the Executive Council on the proposal of Working Group 2

COSPAR,

recognizing that a standard system of numerical indices for describing the solar proton events would be useful to the scientific community concerned, and

noting :

(1) that a Solar Proton Event Classification System, with indices based on data on proton fluxes from spacecraft, from riometers, and from terrestrial neutron monitors, has been proposed and provisionally adopted under IUCSTP auspices, and
(2) that World Data Center A has agreed to calculate and publish these indices,

endorses the Solar Proton Event Classification System and

recommends its uniform use by research workers.

Decision No 9 proposed by the Executive Council on the proposal of Working Group 4

COSPAR,

noting certain deficiencies in atmospheric studies as detailed below,

recommends to the interested members of the world scientific community and to those agencies supporting them the adoption of the following programme of investigations :

(1) At all altitudes above 90 km, but particularly in the 90 to 200 km region, measurements of density, temperature, pressure, mass motion and

composition using instrumented rockets, low altitude satellites and ground-based radio techniques to determine the systematic variations of these parameters so that improved models can be developed for future COSPAR International Reference Atmospheres and other reference and standard atmospheres.

(2) In the polar regions (latitudes above 70°) measurements of density, temperature and winds in the altitude range 25 to 400 km by instrumented rockets, low altitude satellites and ground-based techniques, essential to developed models of this region for the COSPAR International Reference Atmosphere.

Decision No 10 proposed by the Executive Council on the proposal of Working Group 4

COSPAR,

noting the very small number of existing incoherent-scatter stations, the difficulties encountered by several of these and the great importance of data obtained by this technique for the study of the interaction between the neutral and ionized parts of the atmosphere, their chemistry and dynamics;

noting also the importance of these measurements to ionosphere-magnetosphere interactions to be studied during the future international magnetospheric programme (now under discussion);

and further noting the need for such data for the URSI-COSPAR International Reference Ionosphere;

recommends that all stations using this technique continue their observations on a regular schedule;

and further recommends that new stations applying this technique in its most modern form be established in regions of the world not presently covered.

The attention of URSI is drawn to this Recommendation.

Decision No 12 proposed by the Executive Council

COSPAR,

noting that there is a need to coordinate conferences and other activities concerning investigations of the Moon that are of mutual interest to the Unions, as set out in a letter from the IAU, and *noting* that COSPAR already provides a forum for interdisciplinary and Inter-Union discussions of the Moon,

recommends to ICSU (1) that a small Inter-Union Lunar Coordinating Group be created, utilizing whenever possible the Union representatives to COSPAR Working Group 7, and (2) that the proposed Group be invited to meet at the same time and place as COSPAR.

Decision No 19 proposed by the Executive Council

COSPAR,

noting the need for cooperative program on the International Magnetospheric Survey and that the final Draft Program for IMS should be submitted for final approval at the 1971 COSPAR Meeting or earlier,

endorses in full the steps proposed in the recommendation (given below) of IUCSTP Bureau on 27 May, 1970 and

offers full cooperation of COSPAR in preparation and realization of this program.

Recommendation of IUCSTP Bureau

27 May, 1970

Taking into account the report presented to IUCSTP by members of the *ad hoc* Committee on the International Magnetospheric Survey (IMS) established by COSPAR in 1969, and

noting that needs for cooperative research such as outlined in the 1969 COSPAR proposal have clearly emerged from discussions during the recent Symposium on Solar Terrestrial Physics, and further

noting that in view of the presently proposed time schedule for the IMS (1974-1976), the task of planning must be started immediately in order to be able to submit a final program for final approval not later than at the 1971 COSPAR Meeting, and also

taking into account that a considerable amount of information for the preparation of such a draft program is already available in the form of IUCSTP and national study group reports,

IUCSTP

requests COSPAR to endorse the following proposed action, to be taken by IUCSTP:

(1) IUCSTP takes the responsibility to define the scope, to draft a program, and later on to coordinate the work for the IMS, in consultation with COSPAR and the participating Unions and countries.

(2) In order to organize such an enterprise, IUCSTP will create a Special Study Group to work with COSPAR for which it proposes the following membership:

Gendrin R.	Roederer J.
Haerendel G.	Švestka Z.
King J.	Vernov S.
Ness N.	Zhulin I.

with a Convenor to be named from among these in consultation with COSPAR.

(3) This Study Group shall meet with representatives from ESRO, INTER-COSMOS and individual countries interested in contributing with satellite programs to the IMS not later than 15th February, 1971 with the following agenda:

(i) discussion of and agreement on a final name, principal scientific objectives and dates for the International Magnetospheric Survey;

(ii) identification and description of those satellites likely to be operating after the beginning of 1974;

(iii) identification of obvious gaps in planned satellite coverage in time, space and instrumentation;

(iv) review of current and planned ground-based research programs of relevance to the IMS;

(v) assignments of responsibilities for drafting a written report to be submitted to IUCSTP and COSPAR for consideration in June 1971.

(4) Based on the report of the Special Study Group for the IMS, IUCSTP would organize its Working Group structure in such a way as to ensure a full-scale participation of all solar-terrestrial disciplines in support of and as a complement to the IMS.

COMITÉ CONSULTATIF POUR LA DÉFINITION DE LA SECONDE

Compte rendu abrégé (1) de la 5e session

18-19 juin 1970

La définition de la seconde, adoptée par la Conférence Générale des Poids et Mesures en 1967, reste la meilleure.

La précision et l'exactitude des étalons primaires de fréquences à jet de césium continuent à progresser; des progrès ultérieurs et des étalons supplémentaires sont désirables, principalement pour l'établissement d'une échelle de temps atomique international exacte et uniforme.

Des études continuent sur le maser à hydrogène et sont entreprises sur d'autres dispositifs, tels que le jet d'hydrogène avec ballon de stockage (sans effet maser) et le laser hélium-néon stabilisé par absorption saturée avec du méthane comme gaz absorbant.

Des échelles atomiques de temps fondées sur la définition de la seconde sont maintenues dans divers pays.

Le Bureau International de l'Heure (BIH), avec des moyens très limités en personnel et en matériel, établit et diffuse une échelle de temps atomique international; son œuvre est appréciée d'une façon élogieuse; il reçoit une aide bénévole considérable provenant d'établissements de plusieurs pays, principalement des Etats-Unis d'Amérique et de la France. Le BIH continue son activité initiale qui est d'établir l'échelle de temps astronomique appelée « temps universel » (TU), et il a la responsabilité des décisions concernant la date et l'amplitude des sauts et des décalages de fréquence de l'échelle de temps employée couramment sous le nom de « temps universel coordonné » (TUC). Le Comité Consultatif, dans sa majorité, estime qu'il faut laisser ces diverses activités à la charge du même établissement, c'est-à-dire du BIH.

Le Comité Consultatif a adopté formellement la définition d'un temps atomique international (TAI); cette définition est volontairement prudente

(1) Ce compte rendu, rédigé par moi seul au lendemain de la session, est destiné à fournir une information immédiate approximative; le rapport officiel et plus complet viendra plus tard, probablement en septembre 1970.

à cause de l'insuffisance des données disponibles concernant par exemple le comportement des étalons de fréquence et les effets relativistes. Cette définition formelle est complétée par des recommandations de mise en pratique (voir les Recommandations ci-jointes).

Jusqu'à présent, les organismes de la Convention du Mètre, c'est-à-dire en l'occurrence la Conférence Générale, le Comité International, le Bureau International des Poids et Mesures et le Comité Consultatif pour la Définition de la Seconde, avaient limité leur compétence à l'aspect « intervalle de temps », c'est-à-dire à la définition de la seconde et aux étalons de fréquence. Plusieurs organismes internationaux et des organismes nationaux ont demandé que cette compétence soit étendue à l'aspect « échelle de temps », qui était traité auparavant par des organisations internationales, non-gouvernementales, telles que l'Union Astronomique Internationale et l'Union Radio-scientifique Internationale, et par le Comité Consultatif des Radio-communications (Union Internationale des Télécommunications).

C'est en réponse à cette demande que le Comité Consultatif propose au Comité International des Poids et Mesures la définition du TAI donnée ci-joint.

Cet élargissement de la compétence des organismes de la Convention du Mètre entraîne logiquement deux conséquences, l'une administrative, l'autre financière.

On devra éclaicir les relations administratives entre ces organismes et ceux qui s'occupaient, ou continueront de s'occuper à l'avenir, des échelles de temps; en particulier, si le BIH est chargé d'établir le temps atomique international, il doit s'appuyer sur des directives générales conclues par un accord entre les organismes internationaux représentant les intérêts divers.

La Conférence Générale des Poids et Mesures devra contribuer financièrement à l'entretien du BIH. Etant admis que le BIH continuera de recevoir des aides bénévoles comme par le passé, le Comité Consultatif estime que le BIH pourra accomplir sa tâche, pendant une période prévisible d'environ quatre années, même si la Conférence Générale des Poids et Mesures limitait sa subvention à une somme minimale de 12 000 dollars par an, mais une somme un peu supérieure assurerait une bien plus grande sécurité.

C'est sans doute le Comité International des Poids et Mesures qui devra négocier les arrangements convenables avec sa Conférence Générale et avec les organisations internationales. Le Comité Consultatif recommande que les décisions qui seront prises laissent une liberté d'action suffisante, car les éléments d'information disponibles dès à présent ne permettent pas de prévoir avec certitude l'évolution future, en ce qui concerne la répartition des responsabilités entre les organisations, les besoins des usagers du TAI, et les techniques expérimentales.

En ce qui concerne la subvention financière en faveur du BIH qui sera demandée par le Comité International des Poids et Mesures à la Conférence Générale, c'est-à-dire aux Gouvernements des Etats de la Convention du Mètre, il serait bien désirable d'être renseigné à l'avance sur le montant que ces Gouvernements seraient disposés à payer; il semble que les membres du Comité International seraient les mieux placés pour obtenir ce renseignement, mais tout autre personne capable de l'obtenir contribuerait au succès de l'établissement du temps atomique international en informant le directeur du Bureau International des Poids et Mesures.

Le Comité Consultatif s'est abstenu d'engager des discussions officielles sur les améliorations du temps universel coordonné (TUC) envisagées par l'Assemblée plénière du CCIR (New Delhi, 1970).

Il s'est assuré que la 14e Assemblée Générale de l'Union Astronomique Internationale (août 1970) pourrait être informée des conclusions auxquelles il est parvenu, malgré que ces conclusions ne soient que des avis soumis à l'approbation du Comité International des Poids et Mesures qui se réunira en octobre 1970.

Le Directeur,
J. Terrien.

Destinataires :

Les participants du CCDS.
Les membres du CIPM.
Mr. Sadler, Président de la FAGS.
Mr. Zagar, Président de la Commission 31 de l'UAI.
Mr. Perek, Secrétaire général de l'UAI.
Mr. Wilkins, Président de la Commission 4 de l'UAI.
Mr. Minnis, Secrétaire général de l'URSI.
Mr. Herbstreit, Directeur du CCIR.

Recommandations du Comité Consultatif pour la Définition de la Seconde présentées au Comité International des Poids et Mesures

Proposition d'adoption d'une Echelle de Temps Atomique International
Recommandation S1 (1970)

Le Comité Consultatif pour la Définition de la Seconde,

Considérant

1° le désir général de synchroniser ou de coordonner l'ensemble des émissions de signaux horaires diffusés dans le monde;

2° le besoin d'une référence de temps uniforme pour l'étude de la dynamique des systèmes et, en particulier, pour l'étude des mouvements des corps célestes naturels et artificiels;

3° l'utilité d'une échelle de temps aussi uniforme que possible pour servir de base à la comparaison des étalons de fréquence opérant en des lieux et à des instants différents;

4° que des demandes dans le même sens ont été approuvées par le Comité Consultatif International des Radiocommunications (CCIR) à sa 12e Assemblée Plénière (New Delhi, 1970) et par l'Union Radio-scientifique Internationale (URSI) à sa 16e Assemblée Générale (Ottawa, 1969, Résolution I.4);

Recommande l'adoption d'une Echelle de Temps Atomique International.

Proposition de définition du Temps Atomique International
Recommandation S2 (1970)

Le Comité Consultatif pour la Définition de la Seconde propose de définir le Temps Atomique International (TAI) comme suit :

« Le Temps Atomique International est la coordonnée de repérage temporel établie par le Bureau International de l'Heure sur la base des indications d'horloges atomiques fonctionnant dans divers établissements conformément à la définition de la seconde, unité de temps du Système International d'Unités ».

Mise en pratique de l'Echelle de Temps Atomique International
Recommandation S3 (1970)

Le Comité Consultatif pour la Définition de la Seconde propose les règles suivantes pour la mise en pratique de l'Echelle de Temps Atomique International :

1° La durée de l'intervalle unitaire de l'Echelle de Temps Atomique International est déterminée par le Bureau International de l'Heure (BIH) de façon qu'elle soit en accord étroit avec la durée de la seconde du Système International d'Unités rapportée à un point fixe de la Terre au niveau de la mer.

2° La durée de l'intervalle unitaire de l'Echelle de Temps Atomique International est maintenue aussi constante que possible. Elle est fréquemment comparée à la durée de la seconde du Système International d'Unités telle qu'elle est obtenue à l'aide des étalons primaires de fréquence de divers établissements. Les résultats de ces comparaisons sont portés à la connaissance du BIH.

3° La durée de l'intervalle unitaire de l'Echelle de Temps Atomique International n'est changée intentionnellement que si elle diffère d'une façon significative de la durée de la seconde spécifiée en 1°. Ces ajustements n'auront lieu qu'à des dates convenues à l'avance et annoncées par le BIH.

4° L'origine de l'Echelle de Temps Atomique International est définie conformément aux recommandations de l'Union Astronomique Internationale (XIII^{e} Assemblée Générale, Prague, 1967), c'est-à-dire que cette échelle s'accorde approximativement avec le TU2 à 0 heure le 1er janvier 1958.

5° Le procédé par lequel le Temps Atomique International est actuellement porté à la connaissance des usagers, c'est-à-dire par la publication mensuelle des écarts des échelles locales, est considéré comme satisfaisant.

Poursuite des recherches sur les étalons atomiques de fréquence et sur les méthodes d'évaluation du Temps Atomique International
Recommandation S4 (1970)

Le Comité Consultatif pour la Définition de la Seconde,

Considérant que le nombre des étalons primaires de fréquence et leur exactitude sont à peine suffisants pour contrôler le maintien d'une durée constante de l'intervalle unitaire de l'Echelle de Temps Atomique International,

Recommande aux organismes compétents d'entreprendre ou de poursuivre activement les recherches en vue d'une réalisation plus exacte de la seconde du Système International d'Unités.

Recommandation S5 (1970)

Le Comité Consultatif pour la Définition de la Seconde,

Considérant que l'expérience acquise n'est pas suffisante pour que l'on puisse dès maintenant fixer les règles de pondération des indications des horloges atomiques contribuant à l'Echelle de Temps Atomique International,

Recommande que cette question soit étudiée activement.

INTERNATIONAL URSIGRAM AND WORLD DAYS SERVICE (IUWDS)

Report on Activity during 1969

The International Ursigram and World Days Service (IUWDS) is one of the Permanent Services of the Federation of Astronomical and Geophysical Services (FAGS), through which it receives subventions from UNESCO for part of its activities and publications. It is administered by the International Union of Radio Science (URSI) in association with the International Astronomical Union (IAU) and the International Union for Geodesy and Geophysics (IUGG).

According to its terms of reference, "the Service aims to provide information rapidly to the world scientific community to assist in the planning, coordination and conduct of scientific work in relevant disciplines". In fact the IUWDS is mostly concerned with solar-terrestrial physics and it has to react in order to be efficient according to the actual interests and requirements of the scientific community and according to the level of solar activity. The year 1969 has coincided with the beginning of the decreasing phase of the present solar cycle, a very disappointing one with around half the sunspot activity of the IGY maximum of the solar cycle. Thus in many countries solar-terrestrial and space research has had to restrain its activity just at the time of its most popular success. However, IUWDS people have been working sucessfully in order to improve their capability of helping the work of their scientific colleagues.

A new 157-page Code Booklet giving the format for telegraphic data messages was issued in April 1969 greatly altering the 1965 edition for the better. A long introduction gives a review of the problems involved in preparing forecasts of solar activity and of propagation and is intended to stimulate the interest of observers who cooperate by providing data. Several kinds of alerts and combined messages are described. Thirty codes are included some of which permit the presentation of new data : detailed magnetic structure of sunspot groups, solar particle events, solar wind parameters and detailed solar activity of the active centres. The scheme for identifying observing stations is now formulated according to their geographic coordinates. Also more details are given on the Warning Centres' activities. We must point out that it has been possible to prepare this edition only thanks to the longstanding cooperation between the IUWDS officers and the people in charge of all the IUWDS Warning Centres. The new Code Booklet may be obtained free of charge from the Secretary, at Meudon, or from the Deputy Secretary, Miss J. V. Lincoln, at Boulder.

At its meeting in Ottawa, at the time of the URSI General Assembly, the IUWDS Steering Committee reconfirmed the IUWDS officers : Mr. A. H. Shapley (Chairman), Dr. P. Simon (Secretary) and Miss J. V. Lincoln (Deputy Secretary).

Another interesting decision relates to the introduction of a new format for the daily world-wide alerting message, "Geoalerts", to be effective January 1, 1970. Beginning on that date, the Geolaerts describe the forecast of the activity of each spot group according to a four-step classification (quiet, eruptive, active or proton), and specify by means of alerts the exceptional phenomena expected in the near future. This new format supplies better information than in the past to the institutions receiving only the Geoalert messages. The WMO has continued to cooperate by assisting in the world-wide distribution of the Geoalerts in this new format.

We must point out that this improvement is the first outcome of work started three years ago at Meudon, and continued mostly in cooperation with

Boulder, designed to classify Solar Events according to their Geophysical Effects and to classify Spot Groups according to their capacity for producing these Solar Events. According to this classification a solar event may be mainly a chromospheric event, or one which produces X-ray and centimetric emission, or a high-energy event with acceleration of particles to an energy of several tens of MeV. The spot group during a 24-hour day may be very quiet, or may produce several chromospheric events, or some strong X-ray and centimetric outbursts, or some high-energy event.

This classification will certainly be improved in the future, but now it provides material in order to evaluate the success of the solar activity forecast. We shall have to establish the most realistic way of making this evaluation, but a gross estimate indicates that nearly 80 % forecasts are correct, 50 % of the events are forecast in advance and 50 % of the alerts are failures. However, these figures give a very incorrect view of the practical efficiency of the forecast which in fact is low for the frequently occurring events but becomes valuable with the unusual high-energy events. During a "Proton Alert" there is a 200 times greater chance of observing a proton event than at other times.

The IUWDS continues to give its support to particular international programmes : the latest one was the Proton Flare Project of Working Group 2 of the Inter-Union Commission on Solar-Terrestrial Physics. Unfortunately in 1969 the sun was not very cooperative, and during the observing time of this programme (May/July 1969) no large proton events were reported despite the fact that several complex groups transited the solar disk at that time.

For the IAU, 42 astronomical telegrams have been distributed to about 100 subscribers reporting promptly the close approach of the asteroid Geographos, the optical identification of the Crab pulsar NP 0532, the appearance of 9 comets, 8 supernovae and 3 other unusual objects.

The SPACEWARN activity operated on behalf of COSPAR has been transferred from the WWA at Boulder to the World Data Centre A for Rockets and Satellites which serves as the IUWDS World Warning Agency for Satellites. In 1969 this involved the designation of 110 satellites, the distribution of numerous launching announcements and the issue of the 26 bi-weekly SPX-Bulletins.

We need not expand on the two other regular publications of the IUWDS described fully in our previous annual reports : the International Geophysical Calendar and the Abbreviated Calendar Records. The latter are now published regularly in Part II (Comprehensive Reports) of the *Solar-Geophysical Data* prepared by the ESSA Research Laboratories at Boulder.

A Condensed Calendar Record will be published in *STP Notes*. Related to the 12 programmes of international cooperation organised by the IUCSTP, these publications have received this year a wide distribution among the many groups involved in this cooperative work.

June 1970.

P. Simon,
Secretary.

RAPID-RUN MAGNETOGRAMS

During the IQSY (1964-1965) nearly 250 observatories were engaged in making geomagnetic recordings. A list of these observatories, annotated to show the types of recording made, has recently been published (1).

Since the IQSY, the growth of interest in the generation and propagation of electromagnetic waves in the magnetosphere, and in the recording of these at ground stations as micropulsations, has led to a considerable increase in the number of geomagnetic observatories making rapid-run records. A list of such observatories was compiled in 1969 by H. B. Liemohn at the Boeing Research Laboratories, Seattle. This list contains :

(*a*) 42 observatories at locations not included in the IQSY list;

(*b*) 30 observatories which, according to the IQSY list, did not make rapid-sun recordings in 1964-1965.

Assuming that all the 100 or more observatories making rapid-run recordings in 1964-1965 have continued this activity, the total number making such records has nearly doubled over the past five years.

The observatories mentioned in (*a*) and (*b*) above are listed in Tables 1 and 2 respectively. Table 2 gives only the name of the station, but full information on its location can be obtained from the IQSY list by referring first to the alphabetical list of stations (2). Table 3 lists the spacecraft, launched by the USA, in which magnetometer experiments are carried.

(1) *Annals of the IQSY*, **7**, 27-39 (1970).
(2) *Annals of the IQSY*, **7**, 9-22.

TABLE 1. Rapid-run observatories not contained in the IQSY list.

Observatory	Sponsor	Geographic	
		Latitude (deg)	Longitude (deg)
Bar Is.	C	69.6 N	140.18 W
Cambridge Bay	C	69.1 N	105. W
Inuvik	C	68. N	130 W
Kotzebue	U	66.92 N	162.60 W
Ft. Reliance	C	62.7 N	109. W
Anchorage	U	61.10 N	149.55 W
Ft. Smith	C	60.0 N	111.9 W
Ft. Chepewyan	C	58.7 N	111. W
McMurray	C	56.7 N	111.3 W
Leduc	C	53.6 N	113.4 W
Red Deer	C	52.3 N	113.8 W
Calgary	C	51.0 N	114.2 W
Newport	U	48.26 N	117.12 W
Tulalip	U	48.08 N	122.19 W
Cougar Mt.	U	47.63 N	122.35 W
Baie St. Paul	C	47.37 N	70.55 W
Ashland	U	46.3 N	68.3 W
Mt. St. Hilaire	C	45.53 N	73.15 W
La Grande	U	45.5 N	118. W
Kingston	U	41.62 N	71.73 W
Lebanon	U	39.63 N	74.5 W
Borrego	U	33.36 N	116.28 W
Austin	U	30.18 N	97.47 W
Kaui	U	22.15 N	159.30 W
Dillingham	U	21.6 N	158.0 W
Maui	U	20.71 N	156.26 W
Camp Toruguero	U	18.29 N	66.25 W
Trinidad	U	10.42 N	61.38 W
Cebu	P	10.33 N	123.9 E
Parakou	F	09.35 N	02.62 E
Banda	F	09.16 N	18.36 E
"Hollandia"	I	02.57 S	140.52 E
Canton Is.	U	02.83 S	171.67 W
Lae	A	06.07 S	146.9 E
Pamatai	F	17.57 S	149.57 W
Townsville	A	19.32 S	146.73 E
Tongatapu	U	21.17 S	175.17 W
Woomera	A	31.11 S	136.54 E
Newcastle (Univ.)	A	32.75 S	151.5 E
Auckland	Z	36.51 S	174.45 E
Hobart	A	42.87 S	147.33 E
Oamaru	Z	44.99 S	170.97 E
Syowa	J	69.0 S	39.35 E
Plateau	U	79.47 S	40.58 E

Key to Sponsor : A — Australia; C — Canada; F — France; I — Indonesia; J — Japan; P — Philippines; U — USA; Z — New Zealand.

TABLE 2. Observatories included in the IQSY list, but not making rapid-run recordings in 1964-1965.

Alma Ata	Koror
Amundsen Scott	Legon
Baguio	Mawson
Brisbane	Meanook
Cape Chelyuskin	Noordoost Polder
Dixon	Novolazarevskaya
Fort Yukon	Palo Alto
Freetown	Tamanrasset
Göttingen	Tixie Bay
Habana (Centro Geofisico)	Toolangi
Heiss Is.	Ulan Bator
Ibadan	Victoria
Invercargill	Vostok
Kampala	Wellen

TABLE 3. US Spacecraft carrying magnetometers.

ATS 1 (66-110A).

Dodge (67-66F).

Explorer 6 (59 delta 1), 10 (61 kappa 1), 12 (61 upsilon 1), 14 ( ), 18 (63-64A), 21 (64-60A), 26 (64-86A), 33 (66-52A), 34 (67-51A), 35 (67-70A).

IMP G ( ).

OGO 1 (64-54A), 2 (65-81A), 3 (66-49A), 4 (67-73A), 5 (68-14A), 6 ( ).

Pioneer 1 (58 eta 1), 5 (60 alpha 1), 6 (65-105A), 7 (66-75A), 8 (67-123A), 9 (68-100A).

Thor-Able-Star (63-38C).

Vanguard 3 (59 eta 1).

Vela 2B (64-40B), 4A (67-40A).

No name (64-83C), (68-02A).

N.B. — Both the popular titles and the COSPAR designation are given.

PHYSICS AND CHEMISTRY OF SEMICONDUCTOR HETEROJUNCTIONS AND LAYER STRUCTURES

An International Conference on the above subject will be held in Budapest, Hungary from 11-17 October 1970. The Conference is sponsored by IUPAP and the European Physical Society and organised by the Hungarian Academy of Sciences and two of the principal scientific societies in Budapest.

The main topics of the Conference will be

1. Preparation and structure of heterojunctions with special regard to the structure and composition of the junction profile and role of crystal defects.
2. Electrical, optical and surface properties of heterojunctions, electroluminescence included.
3. Preparation and structure of thin film semiconductors with special regard to semiconductors on insulator substrates.
4. Electrical and optical properties (luminescence included) of thin film semiconductors.
5. Preparation and properties of MOS and MIS structures.

The Chairman of the Organising Committee is Dr. G. Szigeti. Information regarding attendance may be obtained from the Secretary, B. Pödör, at Ujpest 1, Pf. 76, Budapest, Hungary.

L'ESPACE ET LA COMMUNICATION

Un colloque international intitulé « L'Espace et la Communication » aura lieu à Paris du 29 mars au 2 avril 1971. Le Comité d'honneur sera placé sous la présidence de M. le Général Aubinière, Directeur Général du Centre National d'Etudes Spatiales.

L'objet du colloque est de traiter des problèmes techniques posés en radio-electricité et en électronique par la communication, qu'ils découlent de l'utilisation directe de systèmes spatiaux comme moyen de communication ou de leur emploi pour d'autres applications. Les exposés devront être relatifs à :

— la présentation de systèmes d'applications et la description de nouvelles techniques;
— la description fonctionnelle et la réalisation de sous-ensembles;
— les composants et les technologies d'assemblage.

Il est demandé aux auteurs de communications de bien vouloir se faire connaître dès maintenant, et en tout état de cause avec le 15 novembre 1970, en précisant le titre possible de la communication qu'ils envisagent de présenter.

Les droits d'inscription sont fixés à 500 F par personne. Ce prix comprend la participation aux travaux et la fourniture des résumés des conférences et, après le colloque, des textes complets.

Tous renseignements complémentaires peuvent être obtenus en s'adressant au Secrétariat du Colloque — 16, rue de Presles — Paris 15^{e} — tél. 273.24.70.

FIRST EUROPEAN EARTH AND PLANETARY PHYSICS COLLOQUIUM

30 March - 2 April 1971

The above Colloquium will be held at the University of Reading, Berkshire England. Its objective will be to provide opportunities to the younger scientists in Europe to meet and to discuss research results and ideas with each other and with their more senior colleagues in Europe.

The open General Sessions will deal with planetary interiors, neutral and charged planetary atmospheres and inter-planetary processes. In addition there will be several Specialist Symposia on geophysical topics of particular interest in Europe, including the application of European space research programmes to future studies of the Earth and its environment. Finally it is intended to arrange several lectures on the frontiers of geophysical research.

Those who are interested in attending are invited to complete a preliminary registration form which can be obtained from Mrs J. Roberts, School of Physics, The University, Newcastle Upon Tyne, NE1 7RU.

INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC WAVE THEORY

Tbilisi, USSR, 9-15 September 1971

FIRST ANNOUNCEMENT

The Symposium on Electromagnetic Wave Theory will be held in Tbilisi (USSR) from Thursday, 9 September to Wednesday 15 September, 1971. The sponsors are the International Union of Radio Science (URSI), the Soviet

National Committee of URSI, the Academy of Sciences of the Georgian SSR, and the Institute of Radio Engineering and Electronics of the Academy of Sciences of the USSR. An international Programme Committee has been formed to plan the details of the Symposium.

This Symposium will be the next one in the series of symposia which includes : Montreal, Canada, 1953; Ann Arbor, Michigan, USA, 1955; Copenhagen, Denmark, 1962; Delft, Netherlands, 1965; Stresa, Italy, 1968, carried out according to the programme of URSI Commission VI.

The aim of the Symposium is to discuss progress in the field of electromagnetic wave theory. Papers will be welcomed in the following topics :

1. Radiation, propagation, diffraction and scattering of waves in different media : inhomogeneous, anisotropic (including plasma) and fluctuating.
2. Asymptotic methods of diffraction theory.
3. Open lines. Open resonators. Quasi-optics.
4. Numerical methods and application of computers in diffraction theory and wave propagation.
5. Antenna theory and feeders.
6. Nonlinear and parametric phenomena in wave propagation.

Papers can be either original or reviews.

The official languages at the Symposium are English and French.

The papers must be presented at the Symposium by the author (or by one of the authors). Authors are requested to submit a summary, containing not less than 800 words or more than 1200 words. The summaries should be sent to the Symposium Secretariat.

The deadline for papers submitted by Soviet authors is 1 January, 1971, by foreign authors — 1 March 1971.

Soviet authors should submit the summaries of papers in Russian and English. The foreign authors may send the summary of papers in one of the official languages to their URSI National Committee or directly to the address given below.

The texts of papers submitted before 1 May, 1971 will be printed and distributed among the participants at the Symposium.

For a journey to the USSR, foreign participants are free to make their own arrangements with any tourist company of their country which is a contractor of "Intourist USSR".

The registration fee is US$25.

All correspondence should be sent to : Dr. V. V. Shevchenko, Secretary, Symposium on EM Theory, National URSI Committee, Marx Avenue 18, Moscow Centre. GSP-3 USSR.

CCIR STUDY GROUPS

At its XII Plenary Assembly, held in New Delhi in January-February 1970, CCIR reorganised its Study Groups. The titles of the new Groups are given below together with supplementary details for the Groups whose work is of special interest to URSI. The new Study Groups bear arabic numbers so as to distinguish them from the old ones with roman numbers (1).

1. — Spectrum utilization, monitoring

2. — Space research and radioastronomy services
Chairman : Prof. I. Ranzi (Italy)
Vice-Chairman : Prof. J. Hagen (USA)

Terms of reference :

— to study questions relating to communications for scientific satellites, space probes, spacecraft, and exploration satellites (e.g. meteorological and geodetic);
— to study questions relating to interference problems concerning the radioastronomy and radar astronomy services.

3. — Fixed services below about 30 MHz

4. — Fixed services using satellites

5. — Propagation in non-ionized media
Chairman : Mr. J. A. Saxton (UK)
Vice-Chairman : Mr. A. I. Kalinin (USSR)

Terms of reference :

— to study the propagation of radio waves (including radio noise)
(*a*) at the surface of the earth;
(*b*) through the non-ionized regions of the earth's atmosphere;
(*c*) in space where the effect of ionization is negligible, with the object of improving radio communication.

(1) Extracted from *Telecommunication Journal*, May 1970.

6. — Ionospheric propagation
Chairman : Mr. D. K. Bailey (USA)
Vice-Chairman : Mr. C. Terzani (Italy)

Terms of reference :

— to study the propagation of radio waves (including noise) through the ionosphere, with the object of improving radio communication.

7. — Standard frequency and time-signal services
Chairman : Mr. J. T. Henderson (Canada)
Vice-Chairman : Mr. G. Becker (Federal Republic of Germany)

Terms of reference :

— to co-ordinate a world-wide service of standard frequency and time-signal emissions;
— to study the technical aspects of emission and reception in this service, and to improve the accuracy of measurement.

8. — Mobile services.

9. — Fixed services using radio-relay systems

10. — Sound broadcasting service

11. — Television broadcasting service

Joint CCIR/CCITT Study Group — Television and sound transmission
Joint CCIR/CCITT Study Group — Vocabulary.

ATLAS OF IONOGRAMS

In any discussion of ionospheric soundings, it is difficult to avoid referring to the first experiments of this kind made 45 years ago by Appleton and Barnett and by Breit and Tuve. The pulse technique introduced by Breit and Tuve was more convenient for use at stations intended to provide regular series of ionospheric data; the automatically produced plots of virtual height against frequency (ionograms) have long been one of the most important sources of the vast amount of information about the ionosphere which is available in the World Data Centres.

Until the IGY the interpretation of ionograms was the preserve of a comparatively small body of people since most ionosondes were attached to institutions directly engaged on ionospheric research. The considerable expansion of the world network of ionosondes in preparation for the IGY implied the training of staff to work at the new stations, often in isolation from more experienced workers.

The World-Wide Soundings Committee of URSI, under its Chairman A. H. Shapley, played an important part in making preparations for the IGY ionospheric soundings programme and initiated the issue of an Atlas of Ionograms in June 1957. This Atlas was of great value as a training manual at that time, and well-thumbed copies of it still serve as an introduction to a later generation of ionospheric physicists.

The recent publication of a completely new Atlas (1) will be most welcome and it is very fortunate that Mr. Shapley, with his long experience in ionospheric work, has been able to devote his time to the editing of the new volume.

The principal contents of the Atlas are the numerous photographic reproductions of ionograms, with explanatory remarks, arranged in order of the magnetic dip angle of the stations. Separate sections deal with midnight and midday ionograms and another section is devoted to special phenomena : types of Es, spread-F (with a brief reference to the new parameter *fxI*), high-latitude layers, lunar stratification, etc.).

Since the ionograms have been collected from 50 different organisations, there are considerable superficial differences in their appearance which can often confuse the newcomer. So as to minimise this difficulty, the technical characteristics of the different ionosondes are given together with a reproduction of a typical ionogram for each type of equipment.

The Atlas includes also a list of ionospheric stations, in order of magnetic dip angle, with their geographic and geomagnetic coordinates. There are, in addition, a map showing the locations of the stations illustrated in the Atlas and one which permits conversion between geomagnetic and geographic coordinates.

A great deal of care has been expended by Mr. Shapley and his collaborators in the compilation of the material for the Atlas, but this is not reflected in the low price at which copies can be purchased.

(1) Ed. A. H. Shapley. *Atlas of Ionograms. Report UAG-10.* pp. xvi + 242. Published by US Dept. of Commerce, ESSA. May 1970.

(Copies can be purchased from Superintendent of Documents, Government Printing Office, Washington D. C. 20402. USA. Price $1.50.)

MICROWAVE COMMUNICATIONS

The series of Colloquia on Microwave Communication, organised in Budapest by Acad. G. Bognar, began in 1959 and has become an international forum for the presentation of results over a broad range of subjects relating to the problems of communication at very high frequencies.

The Fourth Colloquium was held in April 1970 and was the occasion for the presentation of 177 papers by scientists from 17 countries. Authors were required to submit their papers in advance and this enabled the organisers to reproduce the texts photographically for use by the participants at the Colloquium. The five volumes, containing approximately 1500 pages, have now been published (1) and the organisers are to be congratulated on making the papers available to a wider audience so soon after the Colloquium.

With the exception of 27 papers in Russian, mostly in Vol. I, all the others are in English. The papers have been grouped together according to subject matter and the wide variety of topics covered is indicated by the subtitles :

Vol. I Communication Theory.
Vol. II Circuit Theory.
Vol. III Electromagnetic Theory.
Vol. IV Microwave Theory and Techniques.
Vol. V Microwave Electronics, System Measurements.

CHAMPS MAGNÉTIQUES FAIBLES

Le Colloque international « Champs magnétiques faibles d'intérêt géophysique et spatial » a eu lieu à Paris du 20 au 23 mai 1969 à l'initiative du Professeur P. Grivet, ancien Président de la Commission VII de l'URSI.

(1) Editor : G. BOGNAR. *Proceedings of the Fourth Colloquium on Microwave Communication, Budapest, April 1970, Vols. I-V.* Published by Akadémiai Kiado, Budapest 1970. Price $36.

Les comptes rendus des exposés et communications présentés ont été publiés et sont en vente au *Journal de Physique*, 33, rue Croulebarbe, Paris 13e, France.

Le prix du volume est de $7 pour la vente à l'étranger ou FF 30 pour la vente en France (virement postal : CCP 239-87 Paris).

La quarantaine de contributions présentées à cette occasion en anglais ou en français traitent non seulement du développement de nouveaux dispositifs pour la mesure des champs faibles : magnétomètres au pompage optique, exploitation de techniques basées sur la supraconductivité, etc., mais aussi des applications de ceux-ci à l'exploration des champs dans la magnétosphère et l'espace planétaire.

ICSU ABSTRACTING BOARD : RECENT PUBLICATIONS

The ICSU Abstracting Board announces the publication of :

Tentative List of Publications of ICSU Scientific Unions, Special and Scientific Committees and Commissions of ICSU, Year 1969, and Corrections and Additions to the 1968 List.

(May 1970, 44 pp. Price US$5 plus mailing charges.)

Survey of the Activities of the ICSU Scientific Unions, Special and Scientific Committees and Commissions of ICSU in the Field of Scientific Information during the Year 1969.

(May 1970, 365 pp. Tables, Price US$12 plus mailing charges.)

This Report describes briefly the activities of ICSU bodies in the field of scientific information. It is published regularly each year since 1965.

More than 170 Commissions or Committees are listed; for each of them general information is given (name of the Commission, Chairman, Secretary, periodicity of meetings, etc.) as well as general description of the activities of the Commission and a summary of its activities during the year 1969.

Both publications are now on sale and may be obtained from the ICSU AB Secretariat, 17 rue Mirabeau, Paris 16e, France.

OBSERVATIONAL DATA : PERIOD 6-10 MARCH 1970

World Data Center A has expressed its willingness to publish, in late 1970, an Upper Atmosphere Geophysics Report containing data acquired during the above period which includes an intense magnetic storm and a solar eclipse.

Those who wish to submit contributions are requested to send the information listed below to : Miss J. V. Lincoln, Director, World Data Center A, Upper Atmosphere Geophysics, ESSA, Boulder, Colorado 80302, USA.

(*a*) Title; (*b*) Authors; (*c*) No of pages; (*d*) No of figures; (*e*) Probable dates of observations to be submitted; (*f*) Probable date of submission of manuscript.

SPECIAL COMMITTEE ON PROBLEMS OF THE ENVIRONMENT (SCOPE)

The ICSU Officers have agreed on the following composition of SCOPE :

ICSU Representatives :

Dr. J. E. Smith (Chairman) (UK);
Prof. F. Bourlière (France);
Dr. F. di Castri (Chile);
Dr. K. Grasshoff (BRD);
Prof. T. Kira (Japan);
Prof. V. Kovda (USSR);
Prof. B. Lundholm (Sweden);
Dr. R. E. Munn (Canada);
Dr. K. Szesztay (Hungary);
Prof. T. Tachev (Bulgaria);
Prof. R. Truhaut (France).

Union Representatives :

IGU Prof. G. F. White (USA);
IUBS Prof. D. S. Farner (USA);
IUGG Dr. T. F. Malone (USA);
IUGS Dr. J. C. Frye (USA);
IUPAC Dr. W. Gallay (Canada);
IUPS Prof. J. S. Weiner (UK);
IUPAB Prof. M. Meselson (USA);
IUNS Prof. J. F. Stare (USA).

The first meeting will be held in Madrid in September 1970.

INDIAN NATIONAL SCIENCE ACADEMY

The name of the body in India which adheres to ICSU and the Scientific Unions has recently been changed from National Institute of Sciences of India to Indian National Science Academy. The address is : Bahadur Shah Zafar Marg, New Delhi - 1, India.

MEMBER COMMITTEES OF URSI ; URSI COMMISSIONS

The lists reproduced below give the names and addresses of :

(*a*) the Presidents and Secretaries of the URSI Member Committees;

(*b*) the Chairmen, Vice-Chairmen and Official Members of the URSI Commissions.

The information is based on the records available in the URSI Secretariat on 18 August 1970. It would be appreciated if notification of changes or corrections could be sent to the Secretary General before mid-November for inclusion in the next issue of the Bulletin.

Member Commitees

Argentina :

President : Ing. A. M. Andreu, CORCA, Av. Libertador 327, Vicente Lopez (B.A.).

Secretary : Ing. V. H. Padula-Pintos, CORCA, Av. Libertador 327, Vicente Lopez (B.A.).

Australia :

President : Prof. W. N. Christiansen, School of Electrical Engineering, University of Sydney, Sydney, 2006.

Austria :

President : Univ. Prof. Dr. O. M. Burkard, Institut für Meteorologie und Geophysik, Universität Graz, Halbärthgasse 1, A-8010 Graz.

Belgium :

President : Prof. J. Charles, Ecole Royale Militaire, Laboratoire des Télécommunications, 30 avenue de la Renaissance, B-1040 Bruxelles.

Secretary : M. J. L. van Eck, Université Libre de Bruxelles, Laboratoire d'Electronique générale et de Radioélectricité, 50 avenue F. D. Roosevelt, B-1050 Bruxelles.

Brazil :

President : Dr. F. de Mendonça, Scientific Director, CNAE, C.P. 515, Sao Jose dos Campos, Sao Paulo.

Secretary : Mr. J. E. Guisard Ferraz.

Canada :

President : Dr. M. P. Bachynski, Research Laboratories, RCA Ltd, 1001 Lenoir Street, Montreal, Quebec.

Secretary : Mr. W. A. Cumming, Radio and Electrical Engineering Division, National Research Council of Canada, Ottawa 7, Ontario.

Ceylon :

President : Dr. S. Gnanalingam, Head, Applied Physics Section, Ceylon Institute of Scientific and Industrial Research, P. O. Box 787, Colombo.

CHINA (Taipei) :

President : Prof. G. C. Chien, Ministry of Communications, P. O. Box 84, Taipei, Taiwan.

Secretary : Prof. T. V. Miao, Ministry of Communications, P. O. Box 84, Taipei, Taiwan.

CZECHOSLOVAKIA :

President : Prof. Dr. Ing. J. Stránský, Technical University of Prague, Faculty of Electrical Engineering, Technická 1902, Praha 6-Dejvice.

Secretary : Dr. J. Pokorny, Institute of Radio Engineering and Electronics, Czechoslovak Academy of Sciences, Lumumbova 1, Praha 8.

DENMARK :

President : Dr. J. K. Olesen, Ionosphere Laboratory, Technical University, DK-2800 Lyngby.

EAST GERMANY :

President : Prof. Dr. Ing. H. Frühauf, Technische Universität Dresden, Helmholzstrasse 18, DDR-8027 Dresden.

Secretary : Dr. J. Taubenheim, Zentralinstitut für Solar-Terrestrische Physik der DAW, Rudower Chaussee 5, DDR-1199 Berlin-Adlershof.

FINLAND :

President : Prof. Dr. M. Tiuri, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

Secretary : Dr. S. J. Halme, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

FRANCE :

President : M. J. Voge, Directeur des Services d'Enseignement, 46 rue Barrault, Paris 13e.

Secretary : M. M. Thué, Secrétaire général du CNFRS, 3 avenue de la République, F-92 Issy-les-Moulineaux.

GHANA :

Secretary : Mr. M. N. B. Ayiku, c/o Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

HUNGARY :

President : Dr. G. Bognar, Member of the Hungarian Academy of Sciences, V. Münnich F.u. 7, Budapest.

Secretary : Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoczek u.2, Budapest.

INDIA :

President : Prof. J. N. Bhar, Head, Department of Radio Physics and Electronics, University College of Technology, 92 Acharya Prafulla Chandra Road, Calcutta 9.

Secretary : Dr. A. P. Mitra, Radio Propagation Unit, National Physical Laboratory, Hillside Road, New Delhi 12.

ISRAEL :

President : Prof. W. Low, Department of Experimental Physics, The Hebrew University of Jerusalem, Jerusalem.

ITALY :

President : Prof. G. Barzilai, Istituto di Elettronica, Facolta di Ingegneria, Via Eudossiana 18, Roma.

Secretary : Dr. G. d'Auria, Istituto di Elettronica, Facolta di Ingegneria, Via Eudossiana 18, Roma.

JAPAN :

President : Prof. A. Kimpara, Chubu Institute of Technology, 1200, Matsumoto-cho, Kasugai-shi, Aichi Prefecture 487.

Secretary : Prof. Y. Taki, Faculty of Engineering, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, 113 Tokyo.

MEXICO :

President : Ing. Carlos Nunez A., Vocal Director de Coordinacion, Comision Nacional del Espacio Exterior SCT, Dr. Vertiz 800-4to. Piso, Mexico 12, DF.

MOROCCO :

Secretary : M. Aoud, Division des Télécommunications, Ministère de PTT, Rabat.

NETHERLANDS :

President : Prof. F. L. Stumpers, Philips Research Laboratories, Eindhoven.

Secretary : Dr. P. A. H. Hart, Philips Research Laboratories, Eindhoven.

NEW ZEALAND :

President : Mr. L. H. Martin, N. Z. Broadcasting Corporation, Bowen State Building, Bowen House, Wellington 1.

Secretary : Mr. G. J. Burtt, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

NIGERIA :

President : Prof. O. Awe, School of Mathematical and Physical Sciences, University of Lagos, Lagos.

Secretary : Dr. Ebun Oni, Department of Physics, University of Ibadan, Ibadan.

NORWAY :

President : Dr. B. Landmark, Chief Scientist, NDRE, P. O. Box 25, N-2007 Kjeller.

Secretary : Mr. Gunnar Skovli, Scientific Officer, NDRE, P. O. Box 25, N-2007 Kjeller.

PERU :

President : Dr. A. A. Giesecke, Geophysical Institute of Peru, Ministerio de Fomento, Apartado 3747, Lima.

POLAND :

President : Prof. Dr. J. Groszkowski, President of the Polish Academy of Sciences, Krucza 24/26, VI ptr. ITE, Warsaw.

Secretary : Prof. Dr. S. Hahn, Krucza 24/26, VI ptr. ITE, Warsaw.

PORTUGAL :

President : Mr. A. Silva de Sousa, Director General, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

SOUTH AFRICA :

President : Dr. F. J. Hewitt, Vice-President, CSIR, P. O. Box 395, Pretoria.

Secretary : Mr. P. J. van der Westhuizen, CSIR, P. O. Box 395, Pretoria.

SPAIN :

President : Col. L. Azcarraga, Director General de Proteccion de Vuelo, Ministerio del Aire, Madrid.

Secretary : Mr. R. Rivas, Paseo della Castellana 98, Madrid 6.

SWEDEN :

President : Prof. Stig Lundquist, The Institute of High Tension Research, S-755 90 Uppsala.

Secretary : Mr. P. Åkerlind, Swedish Telecommunications Administration, S-123 86 Farsta.

SWITZERLAND :

President : Dr. W. Gerber, Elfenauweg 64, CH-3000 Berne.

Secretary : Dr. N. Schaetti, Laettenwiesenstrasse 8, CH-1852 Glattbrugg.

UNITED KINGDOM :

President : Prof. H. M. Barlow, Department of Electronic and Electrical Engineering, University College of London, Torrington Place, London W.C.1.

Secretary : Dr. D. C. Martin, Executive Secretary, The Royal Society, 6 Carlton House Terrace, London S.W.1.

USA :

President : Prof. A. T. Waterman, Stanford Electronics Laboratory, Stanford University, Stanford, Calif. 94305.

Secretary : Dr. J. V. Evans, Lincoln Laboratory, MIT, P. O. Box 73, Lexington, Massachusetts 02193.

USSR :

President : Academician A. M. Prokhorov, Lebedev Physical Institute, Leninskii Prospekt 53, g-Moskva, V-312.

Secretary : Dr. V. V. Grigorjanc, URSI Committee in the USSR, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

WEST GERMANY :

President : Dr. W. Becker, Max-Planck-Institut für Ionosphärenphysik, 3411 Lindau/Harz.

Secretary : Dr. A. Ochs, Fernmeldetechnisches Zentralamt, 3 Am Kavalleriesand, D-61 Darmstadt.

YUGOSLAVIA :
President : Ing. Dj. Kovačević, ETAN/URSI, P. O. Box 356, Beograd.
Secretary : Dr. Ing. D. Bajić, ETAN/URSI, P. O. Box 356, Beograd.

COMMISSION I ON RADIO MEASUREMENTS AND STANDARDS

Chairman : Prof. M. E. Zhabotinskii, Soviet Committee of URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3, USSR.

Vice-Chairman : Mr. P. O. Lundbom, Head of Division, Research Institute of National Defence, Department 3, S - 104 50 Stockholm 80, Sweden.

Official Members :

Argentina : c/o Ing. V. H. Padula-Pintos, Executive Secretary, CORCA, Av. Libertador 327; Vicente Lopez (B.A.).

Australia : Mr. J. F. Lehany, Chief, CSIRO Division of Applied Physics, University Grounds, Sydney 2006.

Austria : Dipl. Ing. W. Stiefler, Bundesamt für Eich- und Vermessungswesen, Arltgasse 35, A-1160 Wien.

Belgium : M. P. Hontoy, Laboratoire de Radioélectricité, Université Libre de Bruxelles, 50 avenue F. D. Roosevelt, B-1050 Bruxelles.

Brazil : c/o Dr. Fernando de Mendonça, Scientific Director, CNAE, C. P. 515, Sao Jose dos Campos, Sao Paulo.

Canada : Mr. C. F. Pattenson, Radio and Electrical Engineering Division, National Research Council, Sussex Street, Ottawa.

Ceylon : Mr. W. M. G. Fernando, Lecturer in Electrical Engineering, Faculty of Engineering, University of Ceylon, Peradeniya.

China (Taipei) : c/o Prof. T. V. Miao, Ministry of Communications, P. O. Box 84, Taipei, Taiwan.

Czechoslovakia : Ing. J. Tolman, Institute of Radio Engineering and Electronics, ČSAV, Lumumbova 1, Praha 8 - Kobylisy.

Denmark : Prof. G. Brunn, Laboratory of Electronics, Technical University of Denmark, DK-2800 Lyngby.

East Germany : Dr. W. Kemnitz, Deutsches Amt für Messwesen und Warenprüfung, Bereich Messwesen, Wallstrasse 6, DDR-106 Berlin.

Finland : Prof. Dr. P. Jääskeläinen, Electrical Engineering Department, Technical University of Helsinki, Otaniemi..

France : M. J. Uebersfeld, Professeur à la Faculté des Sciences, Tour 12, 9 quai St-Bernard, F-75 Paris 5.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Dr. K. H. Mathur, Division of Weights and Measures, National Physical Laboratory, Hillside Road, New Delhi 12.

Israel : Mr. Y. Siev, Ministry of Posts, Engineering Services, P. O. Box 735, Jerusalem.

Italy : Prof. C. Egidi, Istituto Elettrotecnico Nazionale « G. Ferraris », Corso Massimo d'Azeglio 42, Torino.

Japan : Prof. S. Okamura, Faculty of Engineering, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113.

Mexico : Ing. Melesio Fernandez Quiroz, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to Piso, Mexico 12, D.F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Ir. L. M. R. Vos de Wael, Laan van Oostenburg 49, Voorburg.

New Zealand : Mr. G. J. Burtt, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

Nigeria : Mr. A. A. Bodede. Nigerian External Telecommunications, Newcom House, 15 Marina, P. O. Box 173, Lagos.

Norway : Mr. Sture Koch, Director, Weight and Measure Department, Board of Trade, Nordahl Brungst 18, Oslo 1.

Peru : c/o Ing. A. A. Giesecke, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : Prof. Dr. S. Ryżko, Technical University, Pl. Jedności Robotniczej 1, Warszawa.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Dr. K. Posel, University of the Witwatersrand, Milner Park, Johannesburg.

Spain : Ing. J. Rodriguez-Navarra de Fuentes, Instituto Geografico y Cadastral, Calle del General Ibanez de Ibero 3, Madrid.

Sweden : Mr. P. O. Lundbom.

Switzerland : Dr. J. Bonanomi, 54 rue de l'Observatoire, CH-2000 Neuchâtel.

United Kingdom : Mr. A. E. Bailey, National Physical Laboratory, Teddington, Middlesex.

USA : Dr. H. M. Altschuler, Institute for Basic Standards, 252.00, NBS, Boulder, Colorado 80302.

USSR : Prof. M. E. Zhabotinskii.

West Germany : Prof. U. Adelsberger, Physikalische-Technische Bundesanstalt, Bundesallee 100, D-33 Braunschweig.

Yugoslavia : Dr. Ing. B. Kovačević, Institute Mihailo Pupin, POB 906, Belgrade.

Commission II on Radio and Non-Ionized Media

Chairman : Professor W. E. Gordon, Dean of Engineering and Science, Rice University, Houston, Texas 77001, USA.

Vice-Chairman : M. P. Misme, CNET, 3 avenue de la République, F-92 Issy-les-Moulineaux, France.

Official Members :

Argentina : c/o Ing. V. H. Padula-Pintos, Executive Secretary, CORCA, Av. Libertador 327, Vicente Lopez (B.A.).

Australia : Mr. M. L. Harris, BMC Research Laboratories, 59 Collins St., Melbourne, Victoria.

Austria : Univ. Prof. Dr. F. Steinhauser, Direktor der Zentralanstalt für Meteorologie und Geodynamik, Hohe Warte 38, A-1190 Wien.

Belgium : M. Maenhout, Institut Royal Météorologique, 3 avenue Circulaire, B-1180 Bruxelles.

Brazil : Mr. Mauro Soares de Assis, c/o Dr. F. de Mendonça, Scientific Director, CNAE, C.P. 515, Sao Jose dos Campos, Sao Paulo.

Canada : Dr. D. R. Hay, Physics Department, University of Western Ontario, London, Ontario.

Ceylon : Mr. L. A. D. I. Ekanayake, Director, Department of Meteorology, Bauddhaloka Mawatha, Colombo 7.

China (Taipei) : Prof. T. V. Miao, Ministry of Communications, P. O. Box 84, Taipei, Taiwan.

Czechoslovakia : Doc. Dr. J. Prokop, Faculty of Electrical Engineering, Czech University in Prague, Technická 1902, Praha 6-Dejvice.

Denmark : Mr. M. Gronlund, Microwave Laboratory, Technical University of Denmark, DK-2800 Lyngby.

East Germany : Dr. U. Kähn, Rundfunk- und Fernsehtechnisches Zentralamt, DDR-1601, Kolberg.

Finland : Lic. Techn. T. Haikonen, Finnish PTT, P. O. Box 10511, Helsinki 10.

France : M. P. Misme.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek, u. 2, Budapest.

India : Dr. M. B. Sarwate, Wireless Planning and Coordination, Ministry of Communications, Government of India, New Delhi.

Israel : c/o Prof. W. Low, Department of Experimental Physics, The Hebrew University of Jerusalem, Jerusalem.

Italy : Prof. G. B. Stracca, Istituto di Elettrotecnica, Facolta d'Ingegneria, Piazza Europa 2, Trieste.

Japan : Prof. S. Ugai, Faculty of Engineering and Science, Sophia University, Kioi-cho, Chiyoda-ku, Tokyo 102.

Mexico : Ing. Joaquin Duran Saldana, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to Piso, Mexico 12, D.F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Dr. L. Krul, University of Technology, Delft.

New Zealand : Mr D. C. Rose, C/-Engineer in Chief, New Zealand Post Office, Wellington 1.

Nigeria : Mr A. A. Bodede, Nigerian External Telecommunications, Newcom House, 15 Marina, P. O. Box 173, Lagos.

Norway : Dr. D. T. Gjessing, Chief Scientist, NDRE, P. O. Box 25, N-2007 Kjeller.

Peru : c/o Dr. A. A. Giesecke, Geophysical Institute of Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : c/o Prof. Dr. S. Hahn, Polish Committee for URSI, Krucza 24/26, VI ptr. ITE, Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Mr. R. W. Vice, Director, National Institute for Telecommunication Research, P. O. Box 3718, Johannesburg.

Spain : Prof. F. Moran Sammaniego, Faculté des Sciences de l'Université de Madrid, Madrid.

Sweden : Mr. F. Eklund, Head of Radio Propagation Division, Research Institute of National Defence, Div. 3, S-104 50 Stockholm 80.

Switzerland : Dipl. Ing. W. Klein, Brunnenweg 6, CH-3074 Muri.

United Kingdom : Dr. J. A. Saxton, Director, Radio and Space Research Station, Ditton Park, Slough, Bucks.

USA : Dr. C. I. Beard, Boeing Sci., Research Labs, P. O. Box 3981, Seattle, Washington 98124.

USSR : Dr. V. N. Troitskii, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany: Dr. J. Grosskopf, Fernmeldetechnisches Zentralamt, Forschungsbereich D3, Postfach 800, D-61 Darmstadt.

Yugoslavia: Dipl. Ing. J. Budin, Elektrotehnički Fakultet, Tržaška 25, Ljubljana.

Commission III on the Ionosphere

Chairman : Prof. K. Rawer, Arbeitsgruppe für physikalische Weltraumforschung, Kronenstrasse 13, 78 Freiburg im Breisgau.

Vice-Chairman : Prof. S. A. Bowhill, Department of Electrical Engineering, University of Illinois, Urbana, Illinois.

Official Members :

Argentina: Ing. V. H. Padula-Pintos, Executive Secretary, CORCA, Av. Libertador 327, Vicente Lopez, B. A.

Australia: Prof. C. R. Ellis, Physics Department, University of Hobart, Hobart, Tasmania.

Austria: Univ. Prof. Dr. O. Burkard, Institut für Meteorologie und Geophysik, Universität Graz, Halbärthgasse 1, A-8010 Graz.

Belgium: Dr. L. Bossy, Institut Royal Météorologique, 3 avenue Circulaire, B-1180 Bruxelles.

Brazil: Dr. F. de Mendonça, Scientific Director, CNAE, C. P. 515, Sao Jose dos Campos, Sao Paulo.

Canada: Mr. J. H. Meek, Defence Research Board, A Building, DND, Ottawa, Ontario.

Ceylon: Dr S. Gnanalingam, Head, Applied Physics Section, Ceylon Institute of Scientific and Industrial Research, P. O. Box 787, Colombo 7.

China (Taipei): Prof. K. H. Pai, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.

Czechoslovakia: Dr. Ludmila Třísková, Geophysical Institute ČSAV, Boční II-la, Praha 4 -Spořilov.

Denmark : Dr. J. K. Olesen, Ionosphere Laboratory, Technical University of Denmark, DK-2800 Lyngby.

East Germany : Dr. K. Sprenger, Zentralinstitut für Solar-Terrestrische Physik, Observatorium für Ionosphärenforschung, Mitshurinstrasse, DDR-2565 Ostseebad Kühlungsborn.

Finland : Dr. P. Mattila, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

France : M. F. du Castel, CNET, 3 avenue de la République, F-92 Issy-les-Moulineaux.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute for Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Dr. A. P. Mitra, Radio Propagation Unit, National Physical Laboratory, Hillside Road, New Delhi 12.

Israel : Dr. J. Mass, Scientific Department, Israel Ministry of Defense, POB 7063, Hakyrya, Tel Aviv.

Italy : Prof. P. F. Checcacci, Centro Microonde, Via Panciatichi 56, Firenze.

Japan : Prof. K. Maeda, Faculty of Engineering, Kyoto University, Yoshida-hon-machi, Sakyo-ku, Kyoto 606.

Mexico : Ing. Carlos Nunez A., Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to Piso, Mexico 12, D.F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Prof. J. Veldkamp, Koninklijk Nederlands Meteorologisch Instituut, de Bilt, Utrechseweg 297.

New Zealand : Mr. G. A. M. King, Geophysical Observatory, DSIR, Box No 2111, Christchurch.

Nigeria : Prof. O. Awe, School of Mathematical and Physical Sciences, University of Lagos, Lagos.

Norway : Dr. E. Thrane, Scientific Officer, NDRE, P. O. Box 25, N-2007 Kjeller.

Peru : c/o Dr. A. A. Giesecke, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : Prof. S. Jasiński, Telecommunication Institute, ul. Szachowa 1, Miedzeszyn-Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Prof. J. A. Gledhill, Department of Physics, Rhodes University, Grahamstown.

Spain : Prof. Dr. J. Balta Elias, Director, Instituto di Fisica « Alonso de Santa Cruz », Serrano 119, Madrid.

Sweden : Prof. B. Hultquist, Kiruna Geophysical Observatory, S-981 00 Kiruna.

Switzerland : Dr. J. Rieker, rue de la Vignette 18, CH-1530 Payerne.

United Kingdom : Dr. J. W. King, Radio and Space Research Station, Ditton Park, Slough, Bucks.

USA : Dr. E. R. Schmerling, NASA Headquarters, Code SG, Washington D.C. 20546.

USSR : Prof. K. I. Gringauz, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany : Dr B. Beckmann, Fernmeldetechnisches Zentralamt, Forschungsgruppe D 33, Postfach 800, D-61 Darmstadt.

Yugoslavia : Dr. M. Vukičević-Karabin, Institute Mihailo Pupin, P. O. Box 906, Beograd.

Commission IV on the Magnetosphere

Chairman : Prof. J. W. Dungey, Physics Department, Imperial College of Science and Technology, South Kensington, London S.W.7, England.

Vice-Chairman : Dr. F. L. Scarf, TRW Systems Group, Building R-1/1070, One Space Park, Redondo Beach, Calif. 90278.

Official Members :

Argentina : c/o Ing. V. H. Padula-Pintos, Executive Secretary, CORCA, Av. Libertador 327, Vicente Lopez (B.A.).

Australia : Prof. C. D. Ellyett, c/o Prof. W. Christiansen, School of Electrical Engineering, University of Sydney, Sydney 2006.

Austria : Prof. Dr. Max Toperczer, Institut für Meteorologie und Geophysik, Universitat Wien, Boltzmanngasse 5, A-1090 Wien.

Belgium : Prof. E. Lahaye, 44 avenue du Pesage, B-1050 Bruxelles.

Brazil : Dr. Rege Romeu Scarabucci, c/o Dr. F. de Mendonça, Scientific Director, CNAE, C. P. 515, Sao Jose dos Campos, Sao Paulo.

Canada : Dr. F. J. F. Osborne, Research Laboratories, RCA Ltd, 1001 Lenoir Street, Montreal, Quebec.

Ceylon : Dr. M. L. T. Kannangura, Senior Lecturer in Physics, Physical Laboratories, University of Ceylon, Colombo 3.

China (Taipei) : Prof. Y. K. Tai, Institute of Geophysics, National Central University, Miao-Li, Taiwan.

Czechoslovakia : Ing. František Jiříček, Geophysical Institute, ČSAV, Boční II-I*a*, Praha 4 - Spořilov.

Denmark : Dr. E. Unstrup, Technical University of Denmark, DK-2800 Lyngby.

East Germany : Dr. Chr.-U. Wagner, Zentralinstitut für Solar-Terrestrische Physik, Abt. Geomagnetisches Aussenfeld, Telegrafenberg, DDR-15 Potsdam.

Finland : Prof. Dr. M. Tiuri, Technical University of Helsinki, Otaniemi.

France : Dr. J. Delloue, Laboratoire de Physique, Ecole Normale Supérieure, 24 rue Lhomond, F-75 Paris V.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Prof. K. R. Ramanathan, Physical Research Laboratory, Navrangpura, Ahmedabad 9.

Israel : Prof. W. Low, Department of Experimental Physics, The Hebrew University of Jerusalem, Jerusalem.

Italy : Prof. M. Giorgi, Istituto di Fisica dell'Atmosfera, P.le Sturzo 31, Roma.

Japan : Prof. T. Nagata, Geophysical Institute, University of Tokyo, 2-11-16, Yayoi, Bunkyo-ku, Tokyo 113.

Mexico : Dr. Ruth Gall, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to Piso, Mexico 12, D.F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Prof. J. Veldkamp, Koninklijk Nederlands Meteorologisch Instituut, de Bilt, Utrechtseweg 297.

New Zealand : Mr. G. McK. Allcock, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

Nigeria : Dr. J. A. Dawson, Department of Physics, Ahmadu Bello University, Zaria.

Norway : Dr. B. Maehlum, Scientific Officer, NDRE, P. O. Box 25, N-2007 Kjeller.

Peru : Mr. Carlos Romero, Radio Observatorio de Jicamarca, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : Prof. S. Manczarski, Director of the Geophysics Laboratory, ul. Pasteura 3, Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho, 2, Lisboa 3.

South Africa : Prof. N. D. Clarence, Physics Department, University of Natal, King George V Avenue, Durban, Natal.

Spain : Ing. Novoa Gonzales, Director, Escuela Official de Telecommunicacion, Conde Penalver 19, Madrid.

Sweden : Prof. S. Lundquist, Institute of High Tension Research, S-755 90, Uppsala.

Switzerland : c/o Dr. N. Schaetti, Laettenwiesenstrasse 8, CH-8152, Glattbrugg.

United Kingdom : Dr. J. P. Dougherty, Department of Applied Mathematics and Theoretical Physics, Silver Street, Cambridge.

USA : Dr. J. A. Fejer, Department of Applied Electrophysics, University of California San Diego, P. O. Box 109, La Jolla, Calif. 92037.

USSR : Dr. V. I. Aksënov, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany : Prof. Dr. G. Elwert, Lehrstuhl für theoretische Astrophysik, Hausserstrasse 64, D-74 Tübingen.

Yugoslavia : c/o Dr. Ing. D. Bajić, ETAN/URSI, P. O. Box 356, Beograd.

Commission V on Radio Astronomy

Chairman : Prof. C. A. Muller, Radiosterrewacht, Dwingeloo, The Netherlands.

Vice-Chairman : Dr. J. L. Locke, Radio and Electrical Engineering Division, National Research Council, Ottawa 7, Canada.

Official Members :

Argentina : Dr. Carlos Varsavsky, Instituto Argentino de Radioastronomia, C. Correo 5, Villa Elisa (B. A.).

Australia : Prof. W. N. Christiansen, School of Electrical Engineering, University of Sydney, Sydney 2006.

Austria : Prof. Dr. J. Hopmann, Universitäts Sternwarte, Türkenschanzstrasse 17, A-1180 Wien.

Belgium : Prof. R. Coutrez, Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, 50 avenue F. D. Roosevelt, B-1050 Bruxelles.

Brazil : Dr. Pierre Kaufmann, Universidade Mackenzie, Centro de Radioastronomia e Astrofisica, Rua Maria Antonia 403, Sao Paulo.

Canada : Dr. V. A. Hughes, Queen's University, Kingston, Ontario.

China (Taipei) : c/o Prof. T. V. Miao, Ministry of Communications, P. O. Box 84, Taipei, Taiwan.

Ceylon : Dr. S. Gnanalingam, Head, Applied Physics Section, Ceylon Institute of Scientific and Industrial Research, P. O. Box 787, Colombo 7.

Czechoslovakia : Dr. A. Tlamicha, Astronomical Institute, ČSAV, Odřejov, okr. Praha-východ.

Denmark : Prof. Dr. A. Reiz, Astronomical Observatory of the University of Copenhagen, Øster Voldgade 3, Copenhagen K.

East Germany : Prof. Dr. H. Daene, Zentralinstitut für solar-terrestrische Physik, Rudower Chaussee 5, DDR-1199 Berlin-Adlershof.

Finland : Prof. Dr. J. Tuominen, Institute of Astrophysics, Astronomical Observatory, Helsinki 14.

France : Dr. J. L. Steinberg, Service de Radioastronomie, Observatoire de Paris, 92 - Meudon (Hauts de Seine).

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Dr. A. P. Mitra, National Physical Laboratory, Hillside Road, New Delhi 12.

Israel : c/o Prof. W. Low, Department of Experimental Physics, The Hebrew University of Jerusalem, Jerusalem.

Italy : Prof. M. Ceccarelli, Istituto di Fisica, Via Irnerio 46, Bologna.

Japan : Prof. H. Tanaka, Research Institute of Atmospherics, Nagoya University, Ichida-cho, Toyokawa-shi, Aichi Prefecture 442.

Mexico : Ing. A. Joskowicz, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to Piso, Mexico 12, D. F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Prof. J. H. Oort, University Observatory, Leiden.

New Zealand : Dr. G. J. Fraser, Department of Physics, University of Canterbury, Christchurch.

Nigeria : c/o Prof. O. Awe, Department of Mathematical and Physical Sciences, University of Lagos, Lagos.

Norway : Mr. Øystein Elgarøy, Assistant Professor, Astrophysical Institute, University of Oslo, Blindern, Oslo 3.

Peru : c/o Dr. A. A. Giesecke, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : Dr. S. Gorgolewski, Astronomical Observatory, N. Copernicus, Torun, Sienkiewicza 30.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Mr. G. Nicholson, NITR, P. O. Box 3718, Johannesburg.

Spain : R. P. Romana-Pujo S. J., Directeur, Observatoire de l'Ebre, Tortosa.

Sweden : Prof. B. Höglund, Chalmers Institute of Technology, S-412 58 Göteborg.

Switzerland : Prof. Dr. M. Waldmeier, Wirzenweid 15, CH-8053 Zurich.

United Kingdom : Dr. A. Hewish, Cavendish Laboratory, Cambridge.

USA : Prof. M. H. Cohen, Owens Valley Radio Observatory, California Institute of Technology, Pasadena, Calif. 91109.

USSR : Prof. V. V. Vitkevitch, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany : Prof. Dr. O. Hachenberg, Max-Planck Institut für Astronomie, Argelander Strasse 3, D-53 Bonn.

Yugoslavia : c/o Dr. Ing. D. Bajić, ETAN/URSI, POB Box 356, Beograd.

Commission VI on Radio Waves and Circuits

Chairman : Prof. H. M. Barlow, Department of Electronic and Electrical Engineering, University College of London, Torrington Place, London W. C. 1, England.

Vice-Chairman : Prof. K. M. Siegel, KMS Industries Inc., 220 East Huron Street, Ann Arbor, Michigan 48106.

Associate Vice-Chairman for Information Theory : Prof. V. I. Siforov, Soviet Committe for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

Official Members :

Argentina : Ing. J. M. Barcala, 71-No385, La Plata (B. A.).

Australia : Prof. R. M. Huey, Department of Electrical Engineering, University of New South Wales, Box 1, Post Office Kensington, N. S. W.

Austria : Hochschulprof. Dr. E. Ledinegg, Institut für Theoretische Physik, Technische Hochschule, Kopernikusgasse 24, A-8010 Graz.

Belgium : Prof. F. Baudoux, Université Libre de Bruxelles, 50 avenue F. D. Roosevelt, B-1050 Bruxelles.

Brazil: Mr. Luiz Gonzaga Rios, c/o Dr. F. de Mendonça, Scientific Director, CNAE, C. P. 515, Sao Jose dos Campos, Sao Paulo.

Canada : Dr. J. L. Yen, Department of Electrical Engineering, University of Toronto, Toronto 181, Ontario.

Ceylon : Mr. W. M. G. Fernando, Lecturer in Electrical Engineering, Faculty of Engineering, University of Ceylon, Peradeniya.

China (Taipei) : Prof. C. Hsu, Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.

Czechoslovakia : Prof. Ing. J. Chmúrny, C. Sc., Technical University of Slokavia, Vazozova 1b, Bratislava.

Denmark : Prof. L. H. Knudsen, Royal Technical University, DK-2800 Lyngby.

East Germany : Prof. Dr. F. Wiegmann, Technische Universität Dresden, Sektion 9, Helmholmstrasse 18, DDR-8027 Dresden.

Finland : Prof. Dr. M. Tiuri, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

France : Prof. E. Roubine, Faculté des Sciences de Paris, Ecole Supérieure d'Electricité, 10 avenue Pierre Larousse, 91 - Malakoff.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committe, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Mr. B. V. Baliga, General Manager, M/S Bharat Electronics Ltd, P. O. Jalahalli, Bangalore.

Israel : Prof. I. Cederbaum, Faculty of Electrical Engineering, Technion, Haifa.

Italy : Prof. L. Lunelli, Politecnico di Milano, P.le Leonardo da Vinci 32, Milano.

Japan : Prof. K. Morita, Research Laboratory, Oki Electric Co. Ltd., 4-11-20 Shibaura, Minato-ku, Tokyo 108.

Mexico : Ing. Jorge Suarez Diaz, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to. Piso, Mexico 12, D. F.

Netherlands : Prof. Ir. J. W. Alexander, University of Technology, Delft.

New Zealand : Mr. J. Mawdsley, Physics Department, Victoria University of Wellington, P. O. Box 196, Wellington.

Nigeria : Mr. A. A. Bodede, Nigerian External Telecommunications, Newcom House, 15, Marina, P. O. Box 173, Lagos.

Norway : Prof. Dr. T. Wessel-Berg, Norwegian Technical University, N-7034 Trondheim-NTH.

Peru : c/o Dr. A. A. Giesecke, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : c/o Prof. Dr. S. Hahn, Secretary, URSI Committee, Krucza 24/26, VI ptr. ITE, Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Mr. P. Meerholz, C. J. F. Electronics, Vereniginghoofweg, Alberton, Transvaal.

Spain : Prof. Dr. J. Santemassa, Departamente de Electricidad, Consejo Superior de Investigaciones Scientificas, Serrano 123, Madrid.

Sweden : Prof. C.-G. Aurell, Chalmers Institute of Technology, S-412 58 Göteborg.

Switzerland : Prof. Dr. E. Baldinger, Weidengasse 35, CH-4000 Basel.

United Kingdom : Prof. J. Brown, Department of Electrical Engineering, Imperial College, London S. W. 7.

USA : Dr. L. B. Felsen, Polytechnic Institute of Brooklyn, Graduate Center, Route 110, Farmingdale, N. Y. 11735.

USSR : Prof. V. V. Migulin, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr. GSP-3.

West Germany : Prof. Dr. G. Piefke, Institut für theoretische Elektrotechnik der Technischen Hochschule, Schlossgartenstrasse 2, D-61 Darmstadt.

Yugoslavia : Prof. R. Horvat, Elektrotehnički Fakultet, Bul. Revolucije 73, Beograd.

COMMISSION VII ON RADIO ELECTRONICS

Chairman : Prof. M. Chodorow, Microwave Laboratory, Stanford University, Stanford, Calif. 94305, USA.

Vice-Chairman : Prof. A. L. Cullen, Department of Electronic and Electrical Engineering, University College of London, Torrington Place, London W. C. 1, United Kingdom.

Official Members :

Argentina : Ing. José A. Rodriguez, DEN, Malabia 3029 (B.A.).

Australia : Prof. H. E. Aitcheson, School of Electrical Engineering, University of Sydney, Sydney 2006.

Austria : Hochschulprof. Dr. H. König, Technische Hochschule, Institut für Hochfrequenztechnik, Gusshausstrasse 25, A-1040 Wien.

Belgium : Prof. J. Van Bladel, Laboratorium voor Electromagnetism en Acoustica, Rijksuniversiteit Gent, St-Pietersnieuwstraat 41, B-9000 Gent.

Brazil : Dr. Carlos Americo Morato de Andrade, c/o Dr. F. de Mendonça, Scientific Director, CNAE, C. P. 515, Sao Jose dos Campos, Sao Peulo.

Canada : Prof. G. W. Farnell, Department of Electrical Engineering, McGill University, Montreal, Quebec.

China (Taipei) : Prof. Chu-I Chang, College of Engineering, National Chiao Tung University, Hsin-chu, Taiwan.

Ceylon : Prof. P. C. B. Fernando, Vidyodaya University of Ceylon, Nugegoda.

Czechoslovakia : Ing. V. Zima, Institute of Radio Engineering and Electronics, ČSAV, Lumumbova 1, Praha 8 - Kobylisy.

Denmark : Prof. P. E. Gudmandsen, Laboratory of Electromagnetic Field Theory, Technical University of Denmark, DK-2800 Lyngby.

East Germany : Prof. Dr. J. Auth, Humboldt-Universität, Sektion Physik, Hessische Strasse 2, DDR-104 Berlin.

Finland : Prof. Dr. T. Stubb, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

France : Prof. M. Y. Bernard, 229 avenue Victor Hugo, F-92 Clamart.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : c/o Dr. A. P. Mitra, National Physical Laboratory, Hillside Road, New Delhi 12.

Israel : Prof. M. Zakai, Faculty of Electrical Engineering, Technion, Haifa.

Italy : Prof. N. Carrara, Centro Microonde, Via Panciatichi 56, Firenze.

Japan : Prof. M. Kamiyama, Faculty of Engineering, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113.

Mexico : Ing. Jorge Suarez Diaz, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to. Piso, Mexico 12, D. F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Prof. Dr. Ing. A. A. T. M. van Trier, University of Technology, Eindhoven.

New Zealand : Mr. G. J. Burtt, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

Nigeria : Mr. A. A. Bodede, Nigerian External Telecommunications, Newcom House, 15 Marina, P. O. Box 173, Lagos.

Norway : Prof. Dr A. Tonning, Norwegian Technical University, N-7034 Trondheim-NTH.

Peru : c/o Dr A. A. Giesecke, Instituto Geofisico del Peru, Ministèrio de Fomento, Apartado 3747, Lima.

Poland : Prof. Dr. A. Smoliński, Technical University of Warsaw, 1 Pl. Jedności Robotniczej, Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Carvalho 2, Lisboa 3.

South Africa : Mr P. Meerholz, C. J. F. Electronics, Vereniginghoofweg, Alberton, Transvaal.

Spain : Ing. R. Rivas, 98 Paseo della Castellana, Madrid 6.

Sweden : Dr. S. Tomner, Swedish Board for Technical Development, Box, S-100 72 Stockholm 43.

Switzerland : Prof. Dr. F. Borgnis, Bergstrasse 99, CH-8032 Zürich.

United Kingdom : Prof. A. L. Cullen.

USA : Prof. R. Collins, Department of Electrical Engineering, University of Minnesota, Minneapolis, Minn. 55455.

USSR : Prof. A. L. Mikaeljan, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany : Dr. W. Veith, Siemens AG, Wernerwerk für Bauelemente, Röhrenfabrik, Entwicklung I, St. Martin-Str. 76, 8 München 9.

Yugoslavia : Dipl. Ing. Dr. F. Ivanek, Zavod za Automatizaciju, Tržaška 2, Ljubljana.

Commission VIII on Radio Noise of Terrestrial Origin

Chairman : Prof. R. Rivault, Faculté des Sciences de Poitiers, Laboratoire de Physique de la Haute Atmosphère, Route de Chauvigny, 86 - Poitiers.

Vice-Chairman : Prof. N. D. Clarence, Department of Physics, University of Natal, King George V Avenue, Durban, Natal, South Africa.

Official Members :

Argentina : c/o Ing. V. H. Padula-Pintos, Executive Secretary, CORCA, Av. Livertador 327, Vicente Lopez (B. A.).

Australia : Prof. H. C. Webster, Physics Department, University of Queensland, St-Lucia, Brisbane, Queensland.

Austria : Univ. Prof. Dr. F. Steinhauser, Zentralanstalt für Meteorologie und Geodynamik, Hohe Warte 38, A-1109 Wien.

Belgium : c/o M. J. L. van Eck, Université Libre de Bruxelles, Laboratoire d'Electronique générale et de Radioélectricité, 50 avenue F. D. Roosevelt, B-1050 Bruxelles.

Brazil : Mr. P. Rosenfeld, c/o Dr. F. de Mendonça, Scientific Director, CNAE, C. P. 515. Sao Jose dos Campos, Sao Paulo.

Canada : Mr E. A. Walker, c/o Canadian Defence Research Staff, 2450 Massachusetts Ave., N. W., Washington 20008, USA.

Ceylon : Mr. H. D. S. A. Gunawardene, Engineer, Post and Telecommunications Department, P. O. Box 503, Colombo 1.

China (Taipei) : Mr. C. M. Chuang, Radio Wave Research Labs., Ministry of Communications, 54 Chi-chou St., Ching-mei Town, Taipei Hsian, Taiwan.

Czechoslovakia : Ing. F. Jiříček, Geophysical Institute, ČSAV, Boční II - 1a, Praha 4 - Spořilov.

Denmark : Dr. E. E. Ungstrup, Danish Space Research Institute, Technical University, DK-2800 Lyngby.

East Germany : Dr. B. Schäning, Zentralinstitut für Solar-Terrestrische Physik, Observatorium für Ionosphärenforschung, Mitschurinstrasse, DDR-2565 Ostseebad Kühlungsborn.

Finland : c/o Dr. P. Mattila, Electrical Engineering Department, Technical University of Helsinki, Otaniemi.

France : Prof. R. Rivault.

Ghana : c/o Mr. M. N. B. Ayiku, Secretary, URSI Committee, Institute of Standards and Industrial Research, Ghana Academy of Sciences, P. O. Box M. 32, Accra.

Hungary : c/o Dr. K. Géher, Associate Professor, Polytechnical University of Budapest, XI. Stoezek u. 2, Budapest.

India : Prof. S. V. C. Aiya, Director, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 16.

Israel : c/o Prof. W. Low, Department of Experimental Physics, The Hebrew University of Jerusalem, Jerusalem.

Italy : Prof. M. Giorgi, Istituto di Fisica dell'Atmosfera, P.le Sturzo 31, Roma.

Japan : Dr. H. Shinkawa, Japan's Overseas Radio and Cable System (KKD), 3-2-5 Kasumigaseki, Chiyoda-ku, Tokyo 100.

Mexico : c/o Ing. Carlos Nunez A., Vocal Director de Coordinacion, Comision Nacional del Espacio Exterior, SCT, Dr. Vertiz 800-4to. Piso, Mexico 12, D. F.

Morocco : c/o M. Aoud, Division des Télécommunications, Ministère des PTT, Rabat.

Netherlands : Mr. J. J. Bloemsma, Mient 551, The Hague.

New Zealand : Mr. G. McK. Allcock, Physics and Engineering Laboratory, DSIR, Private Bag, Lower Hutt.

Nigeria : Mr. J. O. Shotunde, Nigerian Broadcasting Corporation, Broadcasting House, Ikoyi, Lagos.

Norway : Mr. J. R. Veastad, Chief Engineer, The General Direction of Telecommunications, Universitetsgt 2, Oslo 1.

Peru : c/o Dr. A. A. Giesecke, Instituto Geofisico del Peru, Ministerio de Fomento, Apartado 3747, Lima.

Poland : c/o Prof. Dr. S. Hahn, Secretary, URSI Committee, Krucza 24/26, VI ptr. ITE, Warsaw.

Portugal : c/o Mr. A. Silva de Sousa, Serviço Meteorologico Nacional, R. Saraiva de Calvalho 2, Lisboa 3.

South Africa : Dr. D. J. Malan, Bernard Price Institute, University of the Witwatersrand, Milner Park, Johannesburg.

Spain : c/o Ing. R. Rivas, Paseo della Castellana 98, Madrid 6.

Sweden : Prof. S. Lundquist, The Institute of High Tension Research, S-755 90 Uppsala.

Switzerland : Dr. J. Rieker, rue de la Vignette 18, CH-1530 Payerne.

United Kingdom : Dr. F. Horner, Radio and Space Research Station, Ditton Park, Slough, Bucks.

USA : c/o Dr. J. V. Evans, Secretary USNC/URSI, Lincoln Laboratory, MIT, P. O. Box 73, Lexington, Mass. 02193.

USSR : Dr. Ya. I. Likhter, Soviet Committee for URSI, Prospekt Marksa 18, g. Moskva, Centr, GSP-3.

West Germany : Dr. H. Volland, Radio Sternwarte Stockert, Poppelsdorfer Allee 49, D-53 Bonn.

Yugoslavia : c/o Dr. Ing. D. Bajić, ETAN/URSI, P. O. Box 356, Beograd.