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U. R. S. I.

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EVENTS : NATIONAL AND INTERNATIONAL

Although URSI is an international organization, it is important to remember that the Members of the Union are the 37 National Committees which together represent, on a world-wide scale, research and investigations in the field of radio science.

During 1969 attention will tend to concentrate on the General Assembly of the Union in Ottawa and on the actions to be taken by the Executive Committee on which all the National Committees have the right to be represented. However, it would be wrong to allow our attention to be diverted completely from the activities of the National Committees themselves, or from national events which seem to be of importance or interest to the international community.

This issue of the *Bulletin* contains articles which describe two events of this kind. The first refers to the Centenary of the birth of General Gustave Ferrié, the first President of URSI and a member of the International Commission which met in 1913 and 1914 and which developed into URSI in 1919 with the creation of the International Research Council. Monsieur Decaux, Honorary President, has prepared an account of the impressive commemorative ceremonies, held in Paris and elsewhere in France, at which URSI was represented by another Honorary President, Dr. Smith-Rose. An interesting sidelight of the occasion was the award of the « Grand Prix de l'Electronique Général Ferrié » 1968 to M. Thué, Secretary General of the French National Committee for URSI and well-known as a member of the French Delegation at recent Assemblies.

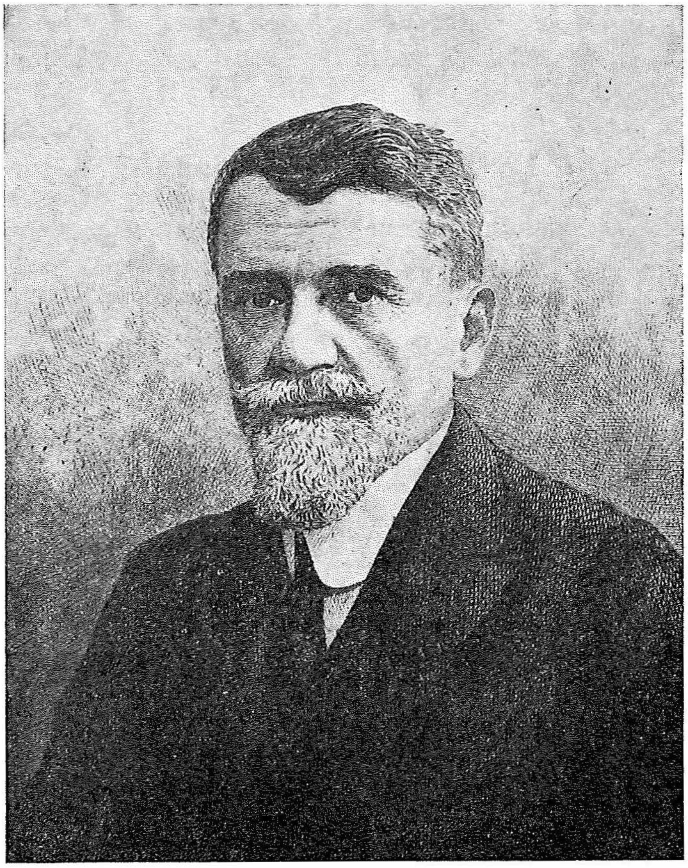
A short article by Dr. Stumpers reports on a Technical Conference held in the Netherlands. The object of the Conference was to draw attention to URSI and to its work, especially among research workers who had no close connections with the National Committee. It seems possible that, in other countries also, meetings may be held to highlight the international aspect of radio science and brief reports on these would be welcome.

The 50th Anniversary of the formation, in 1913, of the International Commission mentioned above, which later became URSI, was celebrated at the XIV General Assembly in Tokyo in 1963. The year 1969 marks the 50 Anniversary of the admission of URSI as a founder member of the International Research Council, now the International Council of Scientific Unions. The Jubilee Year of ICSU provides an appropriate occasion for URSI to offer its congratulations to the Council and to the other Unions which were founder members at the time of the Constitutive Assembly of the Council in Brussels in July 1919.

At the Closing Plenary Meeting of the Assembly, the Permanent Secretary of the Académie Royale de Belgique, Professor Pelseneer, concluded the meeting with some remarks which seem worth repeating 50 years later.

« Et je termine en exprimant, avec une entière confiance,... la certitude que l'enfant né en Belgique, sous l'égide et par la collaboration des Académies... grandira et prospérera, et témoignera par là de l'opportunité et de l'utilité de l'institution que nous avons édifiée.

» Nous aurons ainsi démontré nous-mêmes, par le travail et par le résultat obtenu, que ... nous n'avions pas de plus ardent désir que de constituer par notre action collective, des œuvres fécondes de paix et de confraternité internationales ».



Général Ferrié,
1868-1932.

LES CÉRÉMONIES COMMÉMORATIVES DU CENTENAIRE DE LA NAISSANCE DU GÉNÉRAL FERRIÉ, PREMIER PRÉSIDENT DE L'URSI

Le *Bulletin d'Information* de l'URSI a signalé le 100ᵉ anniversaire de la naissance, le 19 novembre 1968 à Saint-Michel-de-Maurienne en Savoie, du Général Gustave Ferrié. Diverses cérémonies commémoratives ont été organisées par un Comité comprenant des représentants des ministères ou grands organismes dont l'activité fut en rapport avec sa carrière et son œuvre.

Les manifestations ont débuté le 20 octobre 1968 (1) à Saint-Michel-de-Maurienne devant la plaque commémorative posée sur la maison natale du Général Ferrié. Les autorités civiles et militaires ont rendu hommage à sa mémoire.

Le 4 novembre, M. Le Theule, ministre de l'Information, inaugurait à la Maison de la Radio l'exposition « Centenaire du Général Ferrié ». Celle-ci comprenait une partie historique, rappelant par des documents et des appareils de l'époque, l'évolution de la « T.S.F. » sous l'impulsion de Ferrié, depuis ses premières expériences de 1899 jusqu'après la guerre de 1914-1918. Une autre partie montrait l'état le plus actuel des applications modernes de la radioélectricité et de l'électronique : radar, radiodiffusion, télévision en couleur, informatique, laser et holographie, microélectronique, etc.

Une cérémonie militaire s'est déroulée le 16 novembre, en présence des plus hautes autorités militaires, devant le monument du Général Ferrié élevé dans le Champ de Mars à l'entrée de l'ancien poste souterrain de la Tour Eiffel. A cette occasion fut également inaugurée, en présence du Capitaine de Vaisseau Jeance, une plaque rappelant les premières émissions de téléphonie sans fil que celui-ci effectua en 1908 avec le Lieutenant de Vaisseau Colin, à partir de la Tour Eiffel, ainsi que les liaisons avec Casablanca.

L'hommage solennel fut rendu le 20 novembre dans le grand studio de la Maison de la Radio. La cérémonie, présidée par M. Messmer,

(1) Déjà, les 25 et 26 mai, avait eu lieu un concours international spécial de Radio-Amateurs.

Ministre des Armées, se déroula devant plusieurs hautes personnalités et les représentants de très nombreux organismes. L'URSI était représentée par le Dr. R. L. Smith-Rose, ancien Président et Président d'Honneur.

Des discours furent successivement prononcés par le Duc de Broglie, de l'Académie Française, Secrétaire perpétuel de l'Académie des Sciences, Prix Nobel de Physique, qui avait travaillé sous les ordres de Ferrié, par le Général Gilson qui fut son proche collaborateur, enfin par M. Messmer, Ministre des Armées. L'Orchestre Symphonique de la Garde Républicaine apportait son concours à la cérémonie.

Celle-ci fut terminée par la remise, par le Général Marty, Président du Comité d'Organisation, du Grand Prix de l'Electronique « Général Ferrié » 1968 à M. Marcel Thué, Ingénieur en Chef des Télécommunications, chef du Groupement « Etudes Spatiales et Transmissions » du Centre National d'Etudes des Télécommunications. Il y a lieu de souligner que M. Thué est aussi le Secrétaire Général du Comité national français de l'URSI ; il est bien connu de tous ceux qui ont participé aux récentes Assemblées Générales de l'Union.

Une médaille à l'effigie du Général Ferrié a été frappée par l'Administration de la Monnaie à l'occasion du centenaire.

B. Decaux,
Président d'Honneur de l'URSI.

La carrière scientifique du Général Ferrié

Comme cela arrive souvent, la carrière scientifique du premier Président de l'URSI s'est trouvée orientée dès son début par les circonstances du moment. Sorti de l'Ecole Polytechnique dans l'arme du Génie, il fut nommé à la Télégraphie Militaire qui, à cette époque, ne connaissait que le télégraphe optique et le télégraphe à fil. Désigné pour assister aux expériences de Marconi à travers la Manche en 1899, il s'enthousiasma pour le nouveau mode de communication et réussit à faire partager son enthousiasme au ministre de la Guerre, M. de Freycinet. Celui-ci le chargea alors de réaliser en France des applications militaires de la télégraphie « sans fil ».

A partir de ce moment, la carrière de Ferrié se trouva fixée. Malgré de multiples obstacles matériels, et surtout malgré l'incompréhension et le scepticisme de beaucoup, il réussit, à force d'acharnement et de travail, à créer méthodes et matériel susceptibles de résoudre les problèmes posés. De plus, son esprit ouvert à toutes les questions scientifiques l'amena à chercher et réaliser des applications de l'outil magnifique qu'il avait su mettre en jeu, dans les divers domaines de la science. Il fut, dans ses épreuves, soutenu par deux grands ingénieurs, l'électricien André Blondel et le constructeur Gustave Eiffel, qui mit à disposition des locaux et surtout l'incomparable support d'antenne qu'était sa Tour de 300 mètres.

Sans insister sur les aspects militaires des recherches de Ferrié, rappelons les grandes lignes de leur déroulement.

A l'époque de ses débuts, l'émission s'effectuait avec des bobines de Ruhmkorff, la réception avec le « radio-conducteur » (cohéreur) de Branly et inscription sur bande Morse. En France, quelques précurseurs avaient présenté en 1898 des ébauches du nouveau système. Ducretet avait relié la Tour Eiffel et le Panthéon (4 km) ; le Lieutenant de Vaisseau Tissot (né comme Ferrié en 1868) faisait les premières liaisons avec un navire de guerre (à 1,8 km), que réalisait de son côté le Lieutenant de Vaisseau Maurice de Broglie.

Ferrié entreprit de perfectionner les méthodes utilisées, à la fois du côté émetteur où il remplaça la bobine de Ruhmkorff par un transformateur alimenté en courant alternatif, et du côté récepteur pour lequel il imagina le détecteur électrolytique permettant la lecture au son ; cela augmenta considérablement la sensibilité et la sélectivité des réceptions. De plus, il étudia soigneusement les éclateurs, ainsi que les antennes et leur accord. Pour travailler d'une façon méthodique et systématique, il créa tout un ensemble d'appareils de mesure.

Rapidement, les progrès se succédèrent. Les puissances d'émission et les portées s'accrurent, montrant l'efficacité de la T.S.F. En 1902, le Capitaine Ferrié rétablit ainsi les communications entre la Martinique et la Guadeloupe, rompues par l'éruption catastrophique de la Montagne Pelée. En 1908, la Tour Eiffel pouvait assurer la communication avec le corps expéditionnaire au Maroc, grâce au croiseur Kléber, équipé par le Lieutenant de Vaisseau Jeance [1].

En 1910, le Commandant Ferrié entamait une nouvelle étape avec l'installation d'un nouveau poste très puissant, dans un vaste local situé sous le Champ de Mars. La mise en service fut retardée par les graves inondations de janvier 1910. Une très grande antenne était construite,

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[1] Qui assistait aux cérémonies du Centenaire (voir plus haut).

et la portée de l'émetteur fut ainsi progressivement portée à plus de 5 000 km. Grâce à cet émetteur, Ferrié put entreprendre des expériences sur certaines applications scientifiques de la T.S.F.

En premier lieu, celle-ci fournissait le moyen idéal pour diffuser l'Heure. Déjà en 1907, sur la proposition de Tissot, la Tour Eiffel effectua des transmissions de signaux horaires, qui furent reçus à Brest. En 1908, le Bureau des Longitudes suggéra l'organisation d'émissions régulières commandées par les horloges de l'Observatoire de Paris. Celles-ci commencèrent à la Tour Eiffel et ne furent arrêtées que par la destruction de la station 30 ans plus tard. En 1912, Ferrié fut Secrétaire de la Conférence Générale de l'Heure réunie à l'Observatoire de Paris, qui organisa l'ensemble des signaux horaires mondiaux et créa le Bureau International de l'Heure.

Les émissions de signaux horaires rendaient possible le rêve de tous les géodésiens et navigateurs : mesurer les différences de longitudes avec précision. Après divers essais, Ferrié osa entreprendre entre 1912 et 1914 la détermination de la différence de longitude entre Paris et Washington. Avec la collaboration de divers physiciens, en particulier Henri Abraham (né lui aussi en 1868), il réussit avec succès ce véritable tour de force. Avec des émetteurs d'ondes amorties de 50 kW environ et sans aucun amplificateur à la réception, l'enregistrement photographique des signaux permit d'apprécier l'instant de réception à près de 0,01 s près. La vitesse de propagation des ondes fut déterminée pour la première fois par-dessus l'Atlantique, et le résultat montra qu'elles parcouraient un trajet plus long que l'arc de grand cercle (ébauche de la propagation ionosphérique).

La guerre de 1914 allait montrer toutes les qualités du Colonel Ferrié : chef militaire, savant, et surtout organisateur de premier plan. Il réunit autour de lui une prestigieuse équipe de savants qui firent progresser la technique à pas de géant. C'est à propos de cette équipe que le grand physicien Charles Fabry a prononcé ce remarquable éloge de Ferrié :

« Ferrié était, certes, un excellent militaire, sachant commander et obéir, c'était aussi un bon technicien, mais c'était avant tout un homme d'un admirable caractère. Beaucoup de personnes, généralement médiocres, sont atteintes de cette singulière maladie de ne pouvoir souffrir un homme de talent auprès d'elles, probablement dans la crainte d'être éclipsées. Mesquinerie et maladresse : un chef ne peut rien faire s'il est entouré de médiocres. Ferrié avait la mentalité exactement inverse : il recherchait les hommes de talent, leur rendait justice, s'effaçant derrière eux, et arrivant ainsi à constituer une équipe dont il était vraiment le chef. »

La principale révolution qui apparut alors dans les laboratoires de Ferrié fut l'emploi des tubes triodes. Il avait clairement discerné leur importance et, grâce encore à H. Abraham, il créa dès la fin de 1914 une fabrication industrielle de ces « lampes ». L'étude de leurs propriétés (alors mal connues) et de leurs applications fut poussée avec acharnement. Les appareils sortirent en grandes séries : amplificateurs, hétérodynes, émetteurs, radiotéléphones, radiogoniomètres, etc. Lorsque l'armée américaine arriva en France en 1917, elle adopta le matériel créé par Ferrié. L'œuvre scientifique de « l'équipe Ferrié » fut prolongée ensuite dans le Laboratoire National de Radioélectricité qu'il créa en 1926.

La guerre terminée, Ferrié arrivait au sommet de sa prestigieuse carrière. Nommé Général, puis maintenu exceptionnellement en activité à vie, élu triomphalement à l'Académie des Sciences, comblé d'honneurs, il présidait d'innombrables organismes nationaux et internationaux dans lesquels se manifestait l'autorité mondiale qu'il avait acquise. Il organisa la première Opération Mondiale des Longitudes qui montra, en 1926, l'énorme progrès accompli depuis 1914. Il préparait la deuxième pour 1933, lorsqu'il mourut le 16 février 1932.

Son ouverture d'esprit le faisait s'intéresser à toutes les nouveautés, même en dehors de sa spécialité. Il entreprit des recherches sur les applications des cellules photoélectriques à l'astronomie : enregistrement du passage des étoiles, photométrie stellaire, entretien sans contact des oscillations des pendules, etc. Vers 1925 il se passionna pour l'astronautique, considérée à cette époque comme chimérique. Avec R. Esnault-Pelterie, il fonda la Société Française d'Astronautique (ce dernier terme fut alors imaginé par le romancier Rosny aîné).

C'est volontairement que nous n'avons pas cité, à son ordre chronologique, le rôle joué par Ferrié dans les destinées de l'URSI. Il y a lieu, en effet, d'en faire une mention spéciale. Lorsqu'on feuillette le rarissime numéro 1 (et unique...) du *Bulletin de la Commission Internationale de Télégraphie sans Fil Scientifique* daté de mai 1914, on peut y lire, sous la signature de son Secrétaire Général R. B. Goldschmidt, le récit de la création de cette Commission. Le Commandant Ferrié y participa au nom de la France en même temps qu'H. Abraham. Une photographie (reproduite dans le Mémorial du Jubilé d'Or de l'URSI) montre ces deux personnalités parmi la quinzaine de spécialistes mondiaux de l'époque. En 1919, l'URSI remplaça cette Commission préliminaire ; Ferrié en devint le premier Président et le resta jusqu'à sa mort. Son rôle et l'influence qu'il y prit ont été excellemment exposés en 1934 par R. B. Goldschmidt.

« Le Général Ferrié était non seulement le premier Président de notre association mais, en réalité, il en était le fondateur. C'est lui qui fit acquérir à l'Union son caractère hautement utilitaire et universel indiscuté, et il sut grouper sous son égide les savants les plus éminents du monde entier spécialisés dans la science qui nous est chère.

» Redire ici son rôle primordial, montrer son influence animatrice, rendre tangible d'une façon complète la haute valeur de sa si compétente direction et des conseils éclairés qu'il ne cessait de prodiguer est une tâche qu'un rapport tel que celui que j'ai l'honneur de vous faire ne pourrait, hélas, pas entreprendre.

» Je compte sur vos sentiments de profonde reconnaissance, Messieurs, pour apprécier toute l'étendue de la précieuse et inoubliable collaboration du regretté Général Ferrié et comprendre que les débats qui s'ouvrent aujourd'hui, vont encore se poursuivre imprégnés de sa haute pensée, à laquelle ils doivent leur ampleur remarquable, leur intérêt profond et leur haute valeur scientifique. » (1)

Nous n'avons donc rien à y ajouter. Ferrié fut, bien entendu, le créateur et le président du Comité National Français. Nous rappellerons, pour terminer, qu'il joua aussi un très grand rôle au sein de l'Union Internationale des Télécommunications et qu'il présida à la création du grand réseau français de radiodiffusion.

Tous ceux qui l'ont connu, et ceux qui ont eu l'honneur et le privilège de travailler sous ses ordres, gardent, émus et reconnaissants, le souvenir ineffaçable de ce grand homme.

B. Decaux,
Président d'Honneur de l'URSI.

(3) Extrait du Rapport présenté par R. B. Goldschmidt, Secrétaire général, à la Ve Assemblée générale de l'URSI, Londres 1934.

URSI TECHNICAL CONFERENCE IN THE NETHERLANDS

On 22 November 1968, the Netherlands Society of Radio and Electronics Engineers (NERG) and the Benelux Section of the IEEE organized a full-day technical conference devoted to "The International Union of Radio Science, and subjects of interest to it".

The meeting was opened by Professor Piket, who welcomed especially Professor Dieminger, Vice-President of URSI.

The following lectures were given :

"The International Union of Radio Science, its aims and its structure", by Dr. F. L. H.M. Stumpers (Philips Research Laboratories, Eindhoven).

"Ionospheric research, new results", by Prof. Dr. W. Dieminger (Max-Planck Institut für Aeronomie, Lindau).

"Electrical currents in the magnetosphere", by Dr. D. van Sabben (KNMI, de Bilt).

"New instrumentation in radioastronomy", by J. W. M. Baars (Radio Astronomy Station, Dwingeloo).

"Space research, especially the contribution of the Netherlands to it", by Dr. L. D. de Feiter (Astronomical Observatory, Utrecht).

"Plasma theory and propagation of long waves", by Prof. H. Bremmer (Technological University, Eindhoven).

Dr. Stumpers, President of the Netherlands Committee of URSI, guided the discussions.

The meeting was well attended (about 100 participants) and many of the lectures inspired the audience and stimulated a discussion. The conference achieved its aim of highlighting URSI and the work being carried out under its auspices.

Dr. F. L. Stumpers,
Chairman, Netherlands Comittee of URSI.

WHAT IS A GENERAL ASSEMBLY?

1. — Introduction

In the narrowest sense the General Assembly of one of the Scientific Unions is the occasion when the representatives of the Members of the Union meet to elect new office bearers and to deal with matters which are of a largely administrative nature. Two days would probably be sufficient to deal with all the items on the agenda.

Following long tradition URSI, in common with some other Unions, does not regard its Assemblies as purely formal occasions for the transaction of business much of it not strictly scientific. Although the scientists who are concerned with the activities of URSI recognize the need for proper handling of the administration of the Union in accordance with its Statutes, they are first of all active scientists; thus they are well aware of the value of the personal contacts, made during Assemblies, not only with those who work in fields closely related to their own but also with workers in other fields. In URSI Assemblies, in consequence, the scientific activities predominate over those concerned with administration and the Assembly lasts for about ten days.

It is often said that the opportunities presented at scientific meetings for making personal contacts and for holding informal discussions with other scientists are at least as important as the formal programme of the meeting. URSI Assemblies are arranged so that some free time is available, but in practice it is difficult to plan the scientific programmes for the eight Commissions within a ten-day period and, at the same time, leave more than a few half-days completely free from organized meetings.

During the last two or three years, the concept of the General Assembly in URSI has been reviewed following consultations with the National Committees and further discussion by the Board of Officers and by the Chairmen and Vice-Chairmen of Commissions. Particular attention has been given to the relative merits of two different ways of organizing the scientific programme during a General Assembly.

From these consultations and discussions it has been possible to extract the general consensus of opinion on the programme of a General Assembly. The general principles and the basic ideas which determine the programme are summarized in the remainder of this article which was prepared in its original form about one year ago.

2. — Administrative and Scientific Sessions

An URSI General Assembly includes two types of meeting :

(*a*) administrative meetings (Plenary Sessions; Executive Committee; Board of Officers; Finance Committee, etc.);

(*b*) scientific meetings (Scientific Sessions organised by a single or by several Commissions; working groups, Scientific Committees, etc.).

Decisions of an administrative or an organizational nature ultimately react on research. Hence it is desirable that those who make these decisions should do so in an appropriate scientific atmosphere, even if they themselves are not directly engaged in research. At the same time it is desirable that active scientists should take some interest in administrative and organizational questions so as to ensure that, when decisions of an administrative nature are made, they take into account informed scientific opinion.

These are the main reasons for combining administrative and scientific meetings in General Assemblies.

3. — Reviews and Symposia

During the past decade, in the scientific sessions organized by the Commissions at URSI Assemblies, the main emphasis has been placed on the presentation of several review papers. Opportunities for discussion are provided after the presentation of each paper. In principle, individual contributed papers are not permitted during the discussion period but, in practice, some Commission Chairmen have permitted a few papers in special cases.

The alternative view has been expressed that more individual contributions should be permitted and that the scientific sessions should be planned as symposia, dealing mainly with recent results, in which the speakers describe either their own results or those of the groups in which they work.

It is convenient to refer to these two rather different points of view as the "review concept" and the "symposium concept". They formed the subject of discussions by Commission Chairmen in 1966 and 1968, and by the Board of Officers in 1967 and 1968.

4. — Tentative Conclusions

The tentative conclusions reached may be summarised as follows :

4.1. — SYMPOSIA.

(*a*) A clear distinction must be made between an URSI General Assembly and a Symposium, since they serve different purposes.

(*b*) The scientific sessions at an Assembly should provide an occasion for the examination of progress over the broad field of radio science during the period since the previous Assembly; they should aim also to identify factors which seem likely to influence the way in which future research will develop.

(*c*) Symposia are too specialized and too detailed in their approach to be of material help in the attainment of the objectives stated in 4.1.(*b*).

4.2. — REVIEWS.

(*a*) Reviews are much more effective in achieving the objectives stated in 4.1.(*b*).

(*b*) Reviews which present the main elements of recent and current research and of progress since the previous Assembly provide a better background than do Symposia for the administrative decisions referred to in Sect. 2.

(*c*) Review papers must not be mere recitations of the historical facts of the preceding three years; such facts are probably familiar to delegates and they are not all important and interesting.

(*d*) Reviews should be selective and critical in relation to the work under consideration, rather than comprehensive.

(*e*) Reviews should attempt to assess and to place emphasis on the present state of research in a general field, with a few essential references to the more important work done in the past. On no account may the reviewer concentrate on his own work or that of his national colleagues.

(*f*) Reviews should also place particular emphasis on work which points to new or potential developments, or to new lines of research.

4.3. — SELECTION OF REVIEWERS.

It is recognised that the preparation of a good review is not an easy task and that, if it is to be of high quality, considerable effort is required on the part of the author. The reviewer need not, however, be actively engaged in research himself, provided that he has a wide knowledge of the field. Obviously he must be very carefully selected by the Commission Chairman who must keep in close contact with him and must insist on adherence to the objective of obtaining an original, constructive and forward-looking review.

Successful reviews of the type indicated above are likely to stimulate discussion, especially on questions relating to future progress, suggested projects, and new directions in research.

4.4 — STATUS REPORTS.

During Assemblies, each Commission should set up a Working Group with the task of preparing a report on the current status of the topics discussed in the scientific sessions. Such reports should include also the essence of the discussions and, in particular, any suggestions regarding the solution of outstanding problems or proposals for future research.

5. — THE SYMPOSIUM CONCEPT

The Symposium concept receives support on two grounds :

(*a*) Research workers, especially those in delegations from countries far from the location of the Assembly, would prefer to play a more active role at Assemblies by contributing to a specialized symposium rather than by listening to reviews covering a wider field.

(*b*) Discussions at a symposium are more likely to be lively because the participants will usually be actively interested in the subject.

The general principles regarding the aims of an Assembly, as outlined in Sect. 2, emphasise the importance of broad surveys rather than specialised studies of the type normally selected for symposia. The conclusion in 4.1 *(c)* seems to preclude symposia from the Assembly programme as a general rule.

Even if several symposia were planned for an Assembly, this would not guarantee good discussions. It is widely recognised that symposia and other meetings which cover a wide field and which are open to many participants lead to rather superficial discussion. Detailed disciplined discussion, with the necessary concentration on difficult problems, is best achieved at small informal symposia to which only a few experienced specialists are invited. This question is discussed more fully in Sect. 8. In any case the wide-range type of symposium appears to be less likely to achieve the objects mentioned in Sect. 2 than good review papers.

On the other hand, informal groups of delegates with common interests are often formed at Assemblies so as to allow limited problems to be discussed in detail. The suggestion has been made that, in general, formal scientific sessions should be held in the morning and administrative meetings in the afternoon. Such an arrangement would leave room for small specialist working or study groups to meet in the afternoon but it is not possible, in pratice, to leave every afternoon free given the limited duration of an URSI Assembly.

6. — Individual Contributions during Discussions

Even if the scientific sessions include no symposia, it is necessary to give some guidance to Commission Chairmen on whether individual contributions should be permitted during the discussion periods.

It has been pointed out that the individual delegates at Assemblies form part of their national delegations and that they represent radio science as a whole in their countries, rather than their personal contributions to it. During the discussion periods there appears to be no objection to allowing speakers to refer to recent work done in their countries provided that it is relevant to the discussion. However, they should certainly not place undue emphasis on their own work and should not introduce material which is not closely allied to the subject under discussion.

In special cases some limited freedom should be allowed to Commission Chairmen in the interpretation of the rules for discussions. Where it seems desirable, it may be worth while to consider arranging a special additional session for more detailed discussion of some important but unexpected new theme of current interest, or for a continuation of an earlier unfinished discussion during a normal session.

7. — Joint Sessions of Commissions

It is agreed that scientific sessions organized jointly by several Commissions are very important and that URSI should not be regarded as a group of eight independent Commissions. More attention should be given to finding suitable topics for such sessions and Commission Chairmen should stimulate their Official Members to suggest topics for consideration. Even where the ultimate research objectives are very different, it may often be valuable to organise joint discussions on techniques and methodology. Joint sessions should also help to disclose new fields of research as well as cross-connections between different parts of the whole field of radio science.

8. — National Delegations

National Committees must agree to restrict the size of their delegations. Also they must remain free to select their delegates even if this means that not all the individuals whom Commission Chairmen would like to see can be included in the delegations. Chairmen should however be allowed to invite National Committees to include, in their delegations, those who would be willing to present review papers.

Delegations should be representative of radio science in their respective countries and the members should, as far as possible, be able to speak also for their immediate colleagues who are not included in the delegation. National Committees should be encouraged to develop this idea. Some younger delegates should be included, but not with the intention that they will present papers dealing with the work that they themselves are doing.

The general theme of an Assembly, or at least the central theme for each Commission, should be announced early. This would allow National Committees to select the members of delegations in the most appropriate way. The procedures to be adopted during the scientific sessions and the discussions should be clearly stated in advance and should not be too complex.

9. — The Relation between the Size of a Group and the type of Discussion

9.1. — Basic Ideas.

It is difficult to deny that there is an association between the size of a group of people and the quality of the discussions which can take place in it.

For example, at a large symposium where a broad range of topics has been included in the programme, it is unlikely that many of those present will be sufficiently familiar with the subject under discussion at any time to be able to contribute usefully to the debate. In consequence the audience is a mainly passive one and the discussions which take place tend to be superficial and inconclusive.

On the other hand, if a much smaller number of people with an active interest in a particular subject are invited to meet informally to discuss certain aspects of the subject and associated problems, it is very likely that the discussions will be serious and penetrating, and that they will lead to positive conclusions.

Between these two extremes there is a wide variety of large and small meetings. These are illustrated diagrammatically in Table 1 which is to be interpreted qualitatively rather than quantitatively. The Table indicates also whether or not the participants are interested in the proceedings of a meeting and the associated discussions.

9.2. — URSI ASSEMBLIES.

At URSI Assemblies, the programme consists mainly of the type of meeting shown near the centre of the Table. In addition, there are the Opening and Closing Plenary Meetings, and a few small meetings convened for special purposes.

It is believed that, on most days during an Assembly, such a programme is capable of providing something of interest to the great majority of delegates. Such an objective would not be achieved by holding a large wide-range symposium, and it would be impracticable to arrange a large number of small specialized symposia without breaking up the cohesion of the Assembly and its Commissions.

Thus it seems that the underlying basis for discussions on the relative merits of the "review" and the "symposium" concepts for an Assembly are related to the search for a proper balance between the extreme types of programme: on the one hand, a programme which consists of a small number of meetings in which all the delegates can take a superficial interest and, on the other, a large number of small meetings from which every delegate can choose one where the subject and the discussions are of considerable interest to him.

10. — CONCLUSION

The XVI URSI Assembly has been planned taking into account the points of view expressed in this article, for it is believed that they represent those of most of the National Committees. However, points of view and opinions are not to be regarded as fundamental constants, but rather as time-dependent variables. Hence it will be desirable to keep under review the opinions of the National Committees and to bear these in mind in making plans for the XVII Assembly in 1972.

TABLE 1. — *The Association between the Size of a Meeting and the Interest of the Participants.*

Type of Discussion	Number of Participants (order of magnitude): Many (10^3) — Restricted (10^2) — Few (10^1)
Superficial (Participants not very interested)	1 Plenary Meetings (formal business)
	2 Open Symposium (wide range)
	3 Review papers (broad topic)
	4 Restricted Symposium (limited range)
Useful (Participants interested)	5 Review papers (limited topic)
	6 Executive Committee (formal business)
	7 Commissions (formal business)
	8 Discussion on limited topics (verbal or written intro.)
	9 Discussion on cooperative project (verbal or written intro.)
Detailed (Participants very interested)	10 Working Group (specific task)
	11 Closed Symposium (narrow range)

C. M. Minnis.

COMITÉ DE L'URSI POUR LA PHYSIQUE SOLAIRE-TERRESTRE

1. — Au cours de sa dernière réunion tenue à Munich le 13 septembre 1966, le Comité exécutif de l'URSI a accepté plusieurs propositions présentées par le Prof. W. J. G. Beynon (Président du Comité URSI-CIG), à savoir :

1.1. que le Comité URSI-CIG soit dissous en même temps que le Comité International de Géophysique (CIG) et le Comité des AISC ;

1.2. qu'un nouveau Comité soit constitué, sous le nom de « Comité URSI-STP », pour participer aux travaux de la Commission inter-Unions de Physique solaire-terrestre (IUCSTP) ;

1.3. que le Comité URSI-STP ait le même mandat que le Comité URSI-CIG, moyennant les quelques modifications qui s'imposent ;

1.4. que les Présidents des Commissions II, III, IV et V, sous la présidence du Prof. Beynon, examinent la question de la composition du Comité URSI-STP ainsi que celle de la représentation de l'URSI auprès de l' IUCSTP ;

1.5. qu'au moins une réunion du Comité URSI-STP soit organisée avant la XVI[e] Assemblée générale de l'URSI en août 1969.

2. — Les modifications au mandat et la composition du Comité ont été examinées à Munich au cours d'une réunion convoquée conformément au point 1.4. ci-dessus. Toutefois, le Comité exécutif n'ayant pas siégé ultérieurement, les recommandations n'ont pu être soumises à son approbation.

3. — Le CIG et le Comité des AISC ont été dissous le 31 décembre 1967. Conformément aux points 1.1 et 1.2. ci-dessus, le Comité URSI-CIG a mis fin à ses activités à la même date. En même temps a été provisoirement constitué le Comité URSI-STP avec le mandat et la composition cités au para 2.

4. — Au cours de sa réunion à Bruxelles, le 29 mars 1968, le Bureau de l'URSI a constaté que l'IUCSTP se montrait d'ores et déjà très active dans la préparation de programmes internationaux intéressant l'URSI. Il a dès lors décidé de reconnaître provisoirement le Comité URSI-STP et d'approuver le Mandat figurant à l'annexe ci-dessous. Le Prof. Beynon, qui avait déjà été élu en 1966 représentant de l'URSI auprès de l'IUCSTP, a été désigné par le Bureau comme Président du Comité URSI-STP.

5. — Conformément aux termes des Statuts de l'URSI, le Comité exécutif sera invité à ratifier l'action du Bureau.

Annexe

Mandat et Composition du Comité URSI-STP

1. *Mandat.*

Le Comité URSI-STP a pour objectifs principaux :

1.1. de coopérer avec la Commission inter-Unions de Physique solaire-terrestre (IUCSTP) dans tous les domaines de la physique solaire-terrestre qui intéressent l'URSI ;

1.2. de coordonner les activités des Commissions de l'URSI s'intéressant particulièrement aux recherches dans le domaine de la physique solaire-terrestre ;

1.3. de traiter toutes les questions relatives à l'AGI et aux AISC qui étaient antérieurement prises en considération par le Comité URSI-CIG, y compris l'acheminement, vers les Centres Mondiaux de Données, des données de l'AGI, des AISC et autres ressortissant au domaine de la radioélectricité scientifique, ainsi que la publication de ces données ;

1.4. de coordonner les activités particulières de l'URSI dans le cadre des programmes de recherches spéciaux qui seront projetés par l'IUCSTP ;

1.5. de coordonner et de présenter les vues de l'URSI sur l'organisation de colloques dans le domaine de la physique solaire-terrestre.

2. *Composition.*

Le Comité URSI-STP aura la composition suivante :

a) un Président (désigné par le Bureau),
b) un Secrétaire (désigné par le Président du Comité),
c) les Présidents et Vice-Présidents des Commissions II, III, IV, V et VIII de l'URSI,
d) les Présidents des Groupes de travail spécialisés constitués par le Comité URSI-STP,
e) les membres de l'IUCSTP travaillant activement au sein de l'URSI.

3. *Groupes de Travail.*

3.1. Le Comité URSI-STP peut constituer des Groupes de Travail chargés de l'étude de questions spéciales entrant dans le cadre du mandat du Comité.

3.2. Les Groupes de Travail peuvent être composés partiellement ou entièrement de personnes non-membres du Comité.

URSI-STP COMMITTEE

1. — At the final meeting of the URSI Executive Committee held in Munich on 13 September 1966, several proposals were submitted by Prof. W. J. G. Beynon (Chairman of the URSI-CIG Committee). These proposals were accepted and are as follows :

1.1. that the URSI-CIG Committee be dissolved at the same time as the dissolution of CIG and the IQSY Committee ;

1.2. that a new committee be formed, with the title "URSI-STP Committee", to participate in the work of the Inter-Union Commission on Solar-Terrestrial Physics (IUCSTP) ;

1.3. that the terms of reference of the URSI-STP Committee be those of the URSI-CIG Committee with appropriate changes ;

1.4. that the Chairmen of URSI Commissions II, III, IV and V, with Prof. Beynon as convenor, should consider the membership of the URSI-STP Committee and the question of URSI representation on IUCSTP;

1.5. that at least one meeting of the URSI-STP Committee be held before the XVI URSI General Assembly in August 1969.

2. — The revised terms of reference and the membership were discussed in Munich at a meeting convened in accordance with 1.4. above, but there was no further opportunity to submit the resulting recommendations to the Executive Committee for approval.

3. — Both CIG and the IQSY Committee were dissolved on 31 December 1967. In accordance with 1.1. and 1.2. above, the URSI-CIG Committee is thus assumed to have terminated on the same date. At the same date, the URSI-STP Committee was provisionally established with the Terms of Reference and Membership referred to in 2.

4. — At the meeting of the URSI Board of Officers in Brussels on 29 March 1968, it was noted that IUCSTP was already very active in the preparation of international programmes of interest to URSI. In view of this, it was agreed to recognize provisionally the URSI-STP Committee with the Terms of Reference given in the Appendix below. Prof. Beynon had already been elected in 1966 as the URSI Representative on IUCSTP and he was nominated by the Board as Chairman of the URSI-STP Committee.

5. — In accordance with the Statutes of URSI, the Executive Committee will be invited to give formal approval to the action taken by the Board of Officers.

Appendix

Terms of Reference and Membership of the URSI-STP Committee

1. *Terms of Reference.*

The principal objectives of the URSI-STP Committee are as follows :

1.1. To cooperate with IUCSTP in all matters relating to URSI in the field of solar-terrestrial physics.

1.2. To coordinate the activities of those URSI Commissions which are especially concerned with research in the field of solar-terrestrial physics.

1.3. To deal with all matters referring to the IGY and the IQSY which were formerly considered by the URSI-CIG Committee, including the flow of IGY, IQSY and other data in the field of radio science to the WDCs and the publication of such data.

1.4. To coordinate the particular activities of URSI in the special programmes of research which will be planned by IUCSTP.

1.5. To coordinate and present the views of URSI on the planning of symposia in the field of solar-terrestrial physics.

2. *Membership.*

The membership of the URSI-STP Committee shall be as follows :

(*a*) Chairman (nominated by the Board of Officers)

(*b*) Secretary (nominated by the Chairman)

(*c*) The Chairmen and Vice-Chairmen of URSI Commissions II, III, IV, V and VIII

(*d*) The Chairmen of the specialist Working Groups established by the URSI-STP Committee

(*e*) Members of IUCSTP who are active in URSI.

3. *Working Groups.*

3.1. The URSI-STP Committee may establish Working Groups for the consideration of special questions within the terms of reference of the Committee.

3.2. The membership of the Working Groups may consist partly or entirely of non-members of the Committee.

Composition du Comité URSI-STP et de ses Groupes de Travail
Membership of the URSI-STP Committee and its Working Groups

Composition au 25 juin 1968
Membership on 25 June 1968

Comité URSI-STP
URSI-STP Committee

Président — Chairman : W. J. G. Beynon
J. A. Saxton (Commission II)
W. E. Gordon (Commission II)

C. O. Hines (Commission III)
K. Rawer (Commission III)
H. G. Booker (Commission IV)
J. W. Dungey (Commission IV)
E. J. Blum (Commission V)
C. A. Muller (Commission V)
F. Horner (Commission VIII)
R. Rivault (Commission VIII)
K. Rawer (Groupe de Travail - Ionosphère) — (Working Group on Ionosphere)
G. M. Allcock (Groupe de Travail — Observations synoptiques des Sifflements) — (Working Group on Synoptic Observations of Whistlers)
A. H. Shapley (Groupe de Travail - Centres de Données radio-scientifiques) — (Working Group on Radio Science Data Centres)
R. W. H. Wright (Groupe de Travail - Mouvements ionosphériques) — (Working Group on Ionospheric Drifts)

Secrétaire — Secretary : G. M. Brown, Department of Physics, University College of Wales, Aberystwyth, Cards., United Kingdom.

Groupe de Travail — Ionosphère
Working Group on Ionosphere

K. Rawer
S. Bowhill
W. Dieminger
E. A. Lauter
C. G. Little
W. R. Piggott
A. H. Shapley
R. W. Wright

Groupe de Travail — Observations synoptiques des Sifflements
Working Group on Synoptic Observations of Whistlers

G. M. Allcock
R. Barrington
W. Campbell
D. Clarence
R. Gendrin
R. A. Helliwell
F. Horner
A. Kimpara
E. A. Lauter
Y. Likhter
J. Lokken
M. G. Morgan
J. Mrazek
R. Rivault
V. A. Troitskaya
E. Ungstrup
H. C. Webster

Groupe de Travail — Centres de Données radio-scientifiques
Working Group on Radio Science Data Centres

A. H. Shapley
N. P. Benkova
I. Kasuya
J. A. King

Groupe de Travail — Mouvements ionosphériques
Working Group on Ionospheric Drifts

R. W. H. Wright
Kushneresky
W. Pfister
W. R. Piggott
K. Rawer
A. Spizzichino
K. Sprenger

INFORMAL REPORT ON MEETING OF THE WORKING GROUP ON STANDARDS OF MEASUREMENTS AT RADIO FREQUENCIES

1. In 1965 the Advisory Committee on Electricity (CCE) of the International Committee of Weights and Measures (CIPM) set up a Working Group to consider the part the International Bureau of Weights and Measures (BIPM) should play in the field of measurements at radio frequencies. The Working Group held its second meeting at BIPM, Sèvres, on September 23-25, 1968. Those present were :

F. J. Lehany (NSL, Australia) *Chairman*
J. Terrien (Director, BIPM)
G. Almassy (IRT, Hungary)
H. M. Altschuler (NBS, USA)
A. E. Bailey (NPL, UK, also representing URSI)
H. Bayer (PTB, Federal German Republic)
J. Blouet (LCIE, France, also representing IEC)
A. F. Dunn (NRC, Canada)
G. Giachino (IEN, Italy)
Y. Inoue (ETL, Japan)
G. Leclerc (BIPM)
P. O. Lundbom (RIND, Sweden)
A. Sakuma (BIPM)
A. M. Thompson (NSL, Australia).

2. The Working Group reviewed the progress of the international comparisons of RF power and dielectric parameters listed in Appendix I which had been arranged at its previous meeting in 1965. The Group noted a number of other intercomparisons which had been arranged, largely under URSI sponsorship.

3. The Working Group recommended that the further series of international comparisons of voltage and attenuation listed in Appendix II should be carried out.

4. The Working Group recommended that it should remain in existence to oversee the growing number of intercomparisons, taking into account the following considerations :

(i) RF intercomparisons are of great value in advancing technology and in establishing world-wide standards and tend to be comparisons of techniques rather than of physical embodiments of national standards. They usually involve sending a group of travelling transfer standards round the circuit of a number of laboratories, to be measured by each in turn. They differ, therefore, from the intercomparisons of fundamental electrical quantities which have been carried out at BIPM for many years and a different, less formal, procedure is appropriate.

(ii) There are considerable advantages in carrying out all intercomparisons under BIPM auspices : in addition to providing a focal point for arrangements, BIPM sponsorship is valuable in overcoming customs and export licensing difficulties which have arisen in some cases.

(iii) In addition to the intercomparisons already arranged there are a number of others which will soon be desirable. It is important that arrangements for these should not have to wait until the next meeting of the Working Group. BIPM will be prepared to sponsor further comparisons as soon as laboratories are ready to take part and one of them is prepared to act as pilot laboratory.

(iv) The pilot laboratory for an intercomparison is responsible for making detailed arrangements for the comparison, for sending results of measurements to all participants as soon as they become available, and for eventual publication of the results. It should have great freedom to make these arrangements as it thinks best.

(v) National laboratories may have two distinct reasons for taking part in international comparisons : (*a*) to advance the state of technology, and (*b*) to check their standards (which may be commercial equipment, or not of the highest accuracy) against those of other countries. Both are legitimate, but (*a*) should have priority.

5. The recommendations of the Working Group were subsequently accepted by the CCE and the CIPM.

A. E. Bailey,
Representing NPL and URSI.

Appendix I : Intercomparisons arranged in 1965

1. *Measurement of low powers at 3 GHz :*
   Pilot laboratory : NBS. Other participants : ETL, NRC, DAMW, IMM.
   Status : completed.
2. *Measurement of low powers at 10 GHz (A) :*
   Pilot laboratory : ETL. Other participants : DAMW, NBS, IRT, IMM.
   Status : under way : NRC and IEN subsequently taking part.
3. *Measurement of low powers at 10 GHz (B) :*
   Pilot laboratory : IMM. Other participants : ETL, LCIE, NRC, NSL, PTB, IEN.
   Status : not yet started.
4. *Measurement of dielectric parameters at 10 GHz :*
   Pilot laboratory : NBS (in place of NPL, withdrawn). Other participants : NRC, IMM.
   Status : under way.

Appendix II : New Intercomparisons

1. *Voltage at 1 GHz :*
   Pilot laboratory : NBS. Other participants : NPL, NRC, RIND.
2. *Attenuation at 30 MHz :*
   Pilot laboratory : NSL. Other participants : ETL, NBS, NPL, NRC.
3. *Attenuation in waveguide at 10 GHz :*
   Pilot laboratory : RIND. Other participants : ETL, IEN, LCIE, NPL, NSL, PTB.
4. *Attenuation in coaxial up to 8 GHz :*
   Pilot laboratory : NPL. Other participants : ETL, NBS, NRC, RIND.
5. *Attenuation in waveguide up to 8 GHz :*
   Pilot laboratory : NRC. Other participants : IRT, NPL, PTB, RIND.

SCAR

(Upper Atmosphere Physics Working Group)

An informal meeting of the SCAR Upper Atmosphere Physics Working Group was held in Tokyo on 13 June 1968 during the Tenth Meeting of SCAR.

Among the recommendations included in the Report of the meeting, several are of interest to URSI. It is important to note that these recommendations are provisional pending consideration by SCAR National Committees and formal adoption by the SCAR Executive Committee.

Recommendations

X UAP 1 : The study of many important problems of upper atmosphere physics and of the dynamics of the outer magnetosphere in the Antarctic requires coordinated observations from surface and space vehicles. The UAP Working Group urges the appropriate international organisations as well as national committees on Antarctic Research to discuss these problems and to inform the Secretary of the Group concerning their requirements for the use of space vehicles to assist their observations in Antarctica. The Secretary of the UAP Working Group will contact the convenor of the Group of specialists for the use of space vehicles which has been formed within the framework of SCAR.

X UAP 2 : The UAP Working Group draws the attention of all countries engaged in upper atmosphere physics research in the Antarctic to the urgent necessity for constructing unmanned geophysical stations equipped with telemetric systems wich will enable information collected by these stations to be transmitted via satellites to selected manned stations. SCAR refers this problem to the newly formed group of specialists for the use of space vehicles for their consideration.

X UAP 3 : The UAP Working Group draws the attention of national committees to the fact, that on the 22nd of september 1968 a total eclipse of the sun will take place in the northern hemisphere. The Antarctic stations located in the conjugate area to the region of total eclipse are urged to conduct detailed and uninterrupted observations (geomagnetism, aurora, ionosphere, VLF, cosmic rays, etc.) at least one week before and one week after the day of the eclipse.

X UAP 4 : For the study of the simultaneous auroral particle precipitation pattern on the global scale, the UAP Working Group stresses the importance of the observation of auroral X-rays by long-life polar patrol balloons. Because of the possibility of long-life balloons being carried around Antarctica by the stratospheric great circulation over the continent, the Working Group proposes the establishment of a cooperative network of stations in Antarctica, having the same monitoring equipment, along the circulation route.

The SCAR UAP Working Group notes with satisfaction the joint Japan-USA plan for a series of balloon flights to observe auroral X-rays at Syowa Base and Iceland during mid-January to mid-February 1969. The balloon-borne instruments will carry sodium iodide scintillation counters and will record the incidence of energetic electrons from which the X-rays generate. The balloon-borne instruments will telemeter the temporal and spectral features of the X-ray radiation.

Characteristics of instruments :

detector : NaI (T1) crystal, 2" dia. × 1/2" long ;
energy discrimination : $>$ 25 keV, $>$ 50 keV, $>$ 100 keV, $>$ 200 keV ;
maximum counting rate detectable : $< 5.10^4$/sec ;
background : about 250/sec ($>$ 25 keV) ;
time resolution : $>$ 20 millisecond ;
observation period : possibly from Jan. 15 to Feb. 15, 1969 ;
number of flights : 10 flights ;
ceiling altitude : 8 - 10 millibars ;
floating time : $<$ 50 hours.

X UAP 5 : The present Antartic network of stations for observations of ULF and VLF waves and other connected geophysical phenomena is rather coarse for the precise investigation of the mechanism of generation and the mode of propagation.

Considering the importance of observations concerning solar-terrestrial relationships, the Working Group proposes that an array of stations along a definite geomagnetic meridian be set up extending from the northern to the southern auroral zone. Existing stations might conveniently form part of such arrays which should also include, where possible, conjugate pairs of stations.

IUCAF

REPORT ON THE INTERIM MEETING OF CCIR STUDY GROUP IV
Geneva, September-October 1968

Notes by Secretary General URSI

1. *This Report was circulated to Members of IUCAF as Doc. IUCAF/ 136 dated 30 December 1968.*
2. *The IUCAF documents quoted in the Report formed the basis of the CCIR documents listed below :*

IUCAF No	*CCIR No*
132	*IV/ 25*
133	*IV/122*
128	*IV/128*

3. *Doc. CCIR IV/162 makes additions and amendments to CCIR Report 224-1 (CCIR Oslo 1966 Vol. IV Part 2) and authorises the addition of Doc. IV/25 as Annex 2 to the CCIR Report.*
4. *CCIR Docs IV/25, 122 and 128 are reproduced at the end of this Report.*

INTRODUCTION

Study Group IV of the International Radio Consultative Committee (CCIR) is concerned with the study and description of the technical aspects of Space Communications and Radio Astronomy. The CCIR is not itself concerned with the allocation of radio frequencies, which is the responsibility of the International Telecommunication Union (ITU) of which the CCIR is one of several advisory bodies. To assist the ITU in its work, the CCIR examines on a wide scale all the technical aspects of the radio communication services, including navigational aids, astronomy and space systems. Following such an examination, it reports, among other matters, on the suitability, due to propagation and associated phenomena, of the various parts of the spectrum for different applications and services. In the case of radio astronomy the service required is unique, in that it is conducted by reception only and the study of the natural radiations throughout the radio spectrum from sources in the solar system and the space beyond. For radar astronomy the conditions are somewhat different, since here the principle of radio location by the technique of pulse emission and reception is used.

Organisation of Work

At the opening meeting of CCIR Study Group IV in Geneva, the work was organised by the formation of 6 working groups, the titles and chairmen of which were as follows :

Working Group	*Subject*	*Chairman*
A	Technical Characteristics of communication-satellite systems	W. Klein (Switzerland)
B	Sharing problems for the communication-satellite services	H. Fine (USA)
C	Technical characteristics of space research systems and meteorological satellites	F. Horner (UK)
D	Communication satellite service to aircraft and ships ; and radio-navigation satellites	H. Schultz (Canada)
E	Radio astronomy and radar astronomy	R. L. Smith-Rose (IUCAF)
F	Sub-group on Terminology	M. Thué (France)

The interests of IUCAF are mainly concerned with the work of Group E and, to a lesser extent, with some aspects of Group C. The conclusions of all groups with reference to the associated Questions, Study Programmes and Reports and Recommendations are to be found in the interim report of CCIR Study Group IV, which it is anticipated, will be distributed to National Administrations within the next few months. In the meantime, a summary of the main items of interest to members of IUCAF is given in this report. The actions of the Study Group at this interim meeting will be reconsidered at a further meeting of the Group in 1969, and will then be presented for ratification by the CCIR Plenary Assembly.

Radio and Radar Astronomy

Two meetings of the working group E were held, attended by 10-12 delegates representing the national committees of Canada, France, Japan, United Kingdom, United States of America and USSR together with the CCIR and the International Frequency Registration Board (IFRB). During these meetings all the CCIR Questions, Reports and Recommendations concerning both Radio and Radar Astronomy were considered and revised to date as we deemed necessary. Although no contributions had been submitted in response to Question 2/IV entitled Radar Astronomy, it was agreed that this Question should be maintained for further study.

In the field of radio astronomy, two major reports were brought up to date with the aid of national contributions. The first of these deals with the subject of radio astronomy generally and, apart from minor changes in the main text, a new supplement is proposed under the title "Factors relating to possible interference from VHF television transmissions". The full text of this supplement has already been distributed as Document IUCAF/132. Members of this Inter-Union Commission will wish to study this document in relation to any problems of interference they may encounter particularly in the VHF band (100-1000 MHz).

The OH-Lines in Radioastronomy

The next document (IUCAF/133) covers the draft revision of CCIR Report 397 dealing with "The OH-lines in Radioastronomy". This now forms an up-to-date and well-documented review of the state of knowledge of the emission and absorption properties of the hydroxyl molecule at various frequencies within the approximate range 1,612 to 1,721 MHz. The positions and sizes of some of the sources of this radiation are known to better than one second of arc, and advance which has resulted largely from the improvement in reception techniques in the above range of frequencies. Such improvements are necessary in order that research may be continued with the object of understanding the mechanism by which the OH-molecule is formed in inter-stellar space. In particular, the utmost possible freedom from interference is necessary to pursue a detailed study of the two principal spectrum lines at rest frequencies of 1,665.4 and 1,667.4 MHz. These frequencies are determined solely by the natural resonance properties of the molecules in question and cannot be varied to suit the needs of other users of this part of the radio spectrum. Taking into account the need for comparison observations and the study of Doppler shifts due to the motion of the sources, it is desirable that a band of at least 5 MHz and preferably about 10 MHz, shall be protected from interference to enable radio astronomy to be pursued at each of the above mentioned two frequencies.

Use of Standard Frequency Bands for Radio Astronomy and Space Research

In the current international radio regulations, the guard-bands associated with the standard frequency allocations at 2.5, 5, 10, 15, 20 and 25 MHz are at the disposal of the radio astronomy service with no specific protection from interference caused by services operating in other bands. Furthermore, the bands 10,003-10,005, 19,990-20,010 and 39,986-40,002 MHz are allocated on a secondary basis to the space and earth-space services for research purposes.

In view of the varying proposals that have come to the IUCAF from representatives of URSI and COSPAR, it is suggested that the Inter-Union Commission should evolve a single agreed recommendation on the need of the various standard frequency guard-bands for radio astronomy and space research respectively. This is particularly important since, at the recent meeting of Study Group IV in Geneva, it was recommended that national administrations should give special attention to a revision of the relevant paragraph of CCIR Recommendation No. 134 before the forthcoming Plenary Assembly of CCIR, towards the end of 1969. Reference to the growing interest in radio astronomy using inter-continental baselines was added to this Recommendation.

Radio Propagation Studies using Spacecraft

Starting with a CCIR question, which was originally under the above title, a report, prepared by IUCAF as Doc. IUCAF/128, was presented to the meeting of Study Group IV. During the meeting at Geneva, the title was changed to "Preferred frequency bands for spacecraft-transmitters used as beacons" ; and the IUCAF document formed the basis of the report, which was finally adopted by the Study Group. This contribution emphasised the need for space research experiments involving both Doppler and Faraday-rotation techniques, and for geodetic measurements based on the Doppler effect. For the former measurements, two or more harmonically related frequencies are required between limits of 2 and 200 MHz. The Faraday-rotation measurements can be carried out by observations either on one frequency above 100 MHz or on two transmissions in the VHF band differing in frequency by 1 to 3%.

For geodetic work, it would be advantageous to have assigned a pair of simply related frequencies within the range 150-400 MHz : while for work of the greatest precision, a higher harmonically related frequency is required.

For both the Doppler and Faraday rotation experiments, the transmissions could be accommodated in bandwidths of the order of 0.02 % of the frequency in use.

Protection Criteria for Space Research

There was considerable discussion on the best way of specifying the degree of protection from interference to be afforded to deep-space and manned-space research. No agreement was reached, and it was hoped that a more specific statement on the requirements would be prepared for later consideration by this Study Group.

Plasma Effects

A revised report on plasma effects was prepared. This deals with the influence of re-entry and propulsion plasmas on antenna performance and propagation, and with the influence of natural plasmas on antennas. The findings could influence proposals for allocation of frequencies for Space Research when such plasmas are involved.

Transmissions for Deep Space Research

A new report emphasises the need for very high powers for communicating to spacecraft in deep space. This will be an important consideration when the practicability of sharing frequencies with other services is under review.

Final Note

It has been decided that a World Administrative Radio Conference (WARC) on Space Research and Radio Astronomy will be held, probably early in 1971. There will certainly be a further Study Group IV CCIR meeting in 1969 and a CCIR Plenary Assembly in 1970, and there may be additional meetings in 1970. In view of the WARC, there will be particularly important CCIR meetings at which it will be essential to prepare as much technical data as possible in support of any proposals which may be made for changes in frequency allocations for space research and radio astronomy.

FACTORS RELATING TO POSSIBLE INTERFERENCE FROM UHF TELEVISION TRANSMISSIONS
(CCIR Doc. IV/25-E, 20 May 1968)

1. — Introduction

Because radioastronomy measurements need to be made at reasonably close intervals in frequency, and because large portions of the radio-frequency spectrum are allocated to broadcasting, and are being or will be used for television, it will occasionally be found necessary to operate the two services at frequencies in close proximity. Interference to radio-astronomy may then occur, and several mechanisms need to be considered. The normal spectrum of the television transmission extends outside its nominal band and additional filtering may be needed to reduce the radiated energy in the radioastronomy band to an acceptable level. Normal filtering is accomplished largely in the low-power stages of the transmitter, but additional undesirable components may be generated as a result of non-linear operation of the power amplifier and these would need to be removed by filters operating at high power levels. The dangers of interference are increased when two or more transmitters are operated with the same antenna system, since there may then be intermodulation components.

The radioastronomy receiver will, furthermore, be capable of picking up signals radiated within the television band, if inadequate receiver filters are used. Filters may be needed at the receiving antenna to reduce the voltages received from the television transmissions to a level which ensures that the pre-amplifiers in the receiver do not overload and generate spurious frequency components; additional intermediate-frequency filters are then needed to reduce the residual unwanted received energy to a level which will not degrade the accuracy of the radioastronomical measurements.

All these possible forms of interference can be referred to as "band-edge" interference, the common problem being the design of filters which will adequately suppress the unwanted energy without introducing unacceptable modification, e. g. attenuation or phase distortion, into the wanted signals.

Another form of interference can be caused by harmonic radiation or by the intermodulation of two or more television signals to produce frequency components in radioastronomy bands in other parts of the spectrum. This form will be called "harmonic and intermodulation" interference, although it should be noted that some intermodulation products may be involved in the "band-edge" problem. The problems are generally less severe than those of band-edge interference because the filter requirements are less demanding and because the antennae are likely to be considerably less efficient radiators at frequencies remote from those for which they are designed.

The technical factors leading to these forms of interference are discussed below, together with possible measures for interference suppression. Examples are quoted for the UHF band since particular interest is attached to the use of 606-614 MHz (European television Channel 38, or U.S.A. Channel 37 with part of Channel 36) for radioastronomy in accordance with the radio regulations.

2. — Band-edge Interference

Band-edge interference presents a severe problem to transmissions on European Channel 39 (or on U.S.A. Channel 38) because, with the vision carrier frequency of 615.25 MHz, the fully-transmitted portion of the lower (vestigial) sideband extends downwards by 0.75 MHz, or by as much as 1.25 MHz with CCIR Standards I and L, thus reaching 614 MHz. Below this frequency, the lower sideband is attenuated, but the residual level constitutes a potential source of interference with the nominal radioastronomy band. Although the lower sideband can, if necessary, be well suppressed at low-power levels in the transmitter, it is partly regenerated from the vision carrier and upper sideband by non-linearity in the output stage of the transmitter. Only filters operating at the high-power level, following the transmitter, can improve the overall suppression.

One consequence of the interfering frequencies being close to the vision carrier-frequency is that they will be radiated efficiently from the transmitting antenna. Unless the radioastronomy station is remotely situated from the transmitter there must clearly be a "guard band", for example at the upper end of the 606 to 614 MHz band. This is to allow for the finite slope of the attenuation characteristics of the high-power filters at the transmitter. The width of this guard band depends upon the degree of attenuation required and upon the complexity which is envisaged for the highpower filters, but guard bands of the order of 2 MHz would seem reasonable. The guard band is also necessary to facilitate rejection of the main television signal by the radioastronomy receivers which might need to be designed to be relatively insensitive to frequencies outside the limits 608-612 MHz.

Two problems may arise in connection with the high-power filters installed at transmitters to suppress band-edge interference. First the pass-band attenuation in the region of the vision carrier may be significant (e.g. 1 to 3 dB for high stop-band attenuation and 2 MHz guard band) and this may call for a transmitter power or an antenna gain greater than would otherwise be required. Secondly, phase distortion may be appreciable and affect the quality of the television picture. Although phase correction at low-power levels is possible, the waveform to be handled by the transmitter will then contain overshoots, and this could require a further increase in the power rating of the transmitter if distortion is to be avoided. There is therefore a preference for phase-corrected filters.

A further problem of band-edge interference is associated with the difficulty in predicting its strength. The interference is caused by side-band components of the picture transmission as well as by discrete components derived from the colour sub-carrier and sound signals. The level of interference therefore depends upon the bandwith of the radioastronomy receiver and cannot be uniquely specified as with a single spectral component ; the level also depends upon the picture content and, if integration techniques are adopted at the receiver, upon the duration of a particular picture. As a reasonable guide, the interference can be deduced assuming a 1 MHz receiver bandwidth and certain "quasi-worst" pictures, i.e. pictures which occur fairly frequently and which are most likely to cause interference.

As an example of band-edge interference, take the U. K. 625-line standard (CCIR Standard I) on Channel 39, and assume that a high degree of band-edge suppression has been applied to the modulated signal before the final stage in the transmitter. The signals in the radioastronomy band generated in the final stage (assuming no output filter) will then extend to just below 610 MHz at a level typically about -55 dB relative to the vision carrier, when the measurement is made in a 1 MHz-bandwidth. In addition there will be a narrow-band signal at about 611 MHz, with a colour transmission, and this may reach a level of -42 dB under the quasi-worst picture conditions. An intermodulation product at 609.25 MHz produced as a result of power from the sound transmitter reaching the vision transmitter via the combining unit or diplexer will be at a level of -55 dB, but otherwise the signals over most of the lower half of Channel 38 will be at a level of -80 dB or lower. Since the signal will reach -42 dB only occasionally during the worst picture conditions, and since transmitters often include a simple notch filter at the output to reduce the regenerated colour sideband it seems realistic to take a round figure of -50 dB as a likely relative signal in a typical receiver bandwidth of 4 MHz, when no special filtering is used.

To reduce the levels of out-of-band interference, high-power filters with group-delay correction will be necessary in the outgoing feeders handling the Channel 39 transmissions. Because of the sharp rate of cut-off of these filters, one or two decibels of loss may be unavoidable in Channel 39. In that case, higher-power transmitters would be required. It is probably technically feasible, though expensive, to reduce the out-of-band signal in the radioastronomy band to -100 dB, but greater suppression would probably be impractical.

Suppresion of the out-of-band radiation from a television transmitter to the low levels required for radioastronomy is justified, only if the radioastronomy receiver can reject the energy in the television band to a comparable level. A typical parametric amplifier may start to overload at an input level of 1 μW but it is considered that avoidance of overload is not the main problem. The more difficult problem in general will be to reduce the interference by shaping of the intermediate-frequency passband, since some 110 dB of rejection below the 1 μW input level is required to achieve the measurement sensitivity which is possible in the absence of interference, as indicated in Report 224.

3. — Harmonic and Intermodulation Interference

This type of interference could occur in any band, and in particular could jeopardise measurements in the band 1400-1427 MHz which is exclusively allocated to radioastronomy. The interference will be generated mainly in the output stages of the transmitters. The usual type of output valve for a high-power transmitter is the klystron. Fig. 1 shows a typical arrangement of combining filters when four programmes (each involving a vision carrier, f_v and a sound carrier, f_s) are combined and fed into a common antenna. At some stations the equipment shown in Fig. 1 is duplicated, as a precaution against breakdown, and the two duplicated combined outputs may be split and fed by two feeders to two halves of the antenna.

The second and third harmonics of the carrier frequency may occur at a fairly high level at the klystron output, but transmitters are normally provided with filters (tuned or low-pass) which attenuate all harmonics at the output of the transmitter to at least 60 dB below peak (sync.) power. Carrier intermodulation will also occur when a proportion of the signal from one transmitter breaks through the combining filters to the output circuit of another transmitter. The levels of these terms cannot be predicted accurately but, assuming 30 dB cross-insertion loss between the outputs of all transmitters, it is likely that second- or third-order products involving two vision transmitters will be generated at about -60 dB, those involving two sound transmitters at about -80 dB, and those involving three sound or vision transmitters at about -100 dB relative to peak (sync.) power. Higher-order products in each category would be somewhat lower in level. Many stations may have two separate two-channel antennae rather than a single four-channel antenna but coupling will still occur between transmitters because of the mutual coupling between the antennae. In this case it is reasonable to assume a cross-insertion loss of 40 dB and thus to reduce by 10 dB the levels given above if the intermodulation term involves transmitters connected to the different antennae. Relatively simple additional filters would attenuate these unwanted products, assuming they are not too close in frequency to that of the transmitter. It is current practice in some transmitters to employ harmonic filters of the low-pass type in which case intermodulation products whose frequencies lie above the cut-off frequency will already be suppressed to levels lower than those given above.

The levels discussed in the previous paragraph apply to interference generated in the klystrons. In addition, harmonics and intermodulation products may be generated by non-linearity in the feeders and antennae. Experience in the United Kingdom, when implementing the Band II service, showed that intermodulation products could not be reliably suppressed below about -100 dB relative to the level of the transmitted signals because of this type of non-linearity. Since the results of measurements at multi-programme UHF transmitters are not yet available, it is unwise at the present stage to assume that a greater degree of suppression is feasible in the main antenna feeder at a UHF station. Therefore the addition of further filters at transmitters may only achieve an improvement up to the point where the level of any particular product in the feeders reaches -100 dB relative to peak (sync.) power. Improvement thereafter may not be economically practicable.

In any practical antenna, the gain in horizontal or near-horizontal directions, at frequencies far removed from the design frequency, may be anything from a few decibels to 50 dB below that at the design frequency. It will vary with frequency in a largely unpredictable manner depending upon detailed aspects of the antenna design. Whilst it may later be found that the radiation characteristics of the antenna give a useful reduction of the interference at the majority of stations, it would be rash to rely on this reduction in every case.

Specific examples of harmonic and intermodulation products falling in radioastronomy bands may be mentioned, for the U. K. transmitters using CCIR Standard I. For a Channel 50 transmitter (carrier frequencies F_v = 703.25 MHz vision, and f_s = 709.25 MHz sound) 2 f_v, $f_v + f_s$ and 2 f_s are in the 1,400 to 1,427 MHz hydrogen-line band. With a group of channels such as 21, 24, 27 and 31 radiated from the same site, third order intermodulation products of the $f_1 + f_2 — f_3$ type may fall in the 406 to 410 and 606 to 614 MHz bands. The third harmonic of Channel 21 is in the hydrogen band.

4. — Absolute levels of interference from UHF transmitters

The levels of unwanted components have so far been considered relative to the peak signal of the vision transmitter. As a guide to the absolute levels of interference as a function of distance from the transmitter we may estimate the field strength of the television emission and assume that the interference will be propagated similarly, so that the field strength of the interference remains at the same level relative to the television signal.

Normally a television service is discussed in terms of the field strength at 10 m above ground level. For example it has been estimated from CCIR propagation data that a 1,000 kW (e.r.p.) transmitter with an antenna 300 m high will produce fields exceeding 80 dB above 1 μV/m at 50 km for 1 % of the time. If it were possible to suppress the out-of-band part of the signal to a relative level of -100 dB (i.e. about 50 dB additional suppression at high-power level) the resulting field would be 20 dB below 1 μV/m. The importance of this field would depend on how near to the direction of the transmitter the radioastronomy antenna beam was intended to be used, but even if the gain in the transmitter direction never exceeded -10 dB, relative to an isotropic antenna, the interference level would be up to 10 dB above the CCIR limits (Report 224-1) for continuum measurements for a small percentage of the time. It should be noted, moreover that the mean height of some large radioastronomy antennae is considerably greater than 10 m and a correspondingly larger interfering field may be expected. Depending on the topography, parts of such an antenna could be in a field equal to, or even greater than that in free space, which, at 50 km would be about 25 dB stronger than the field assumed for the 10 m height. It is evident that the possibility of interference needs to be estimated for each path, taking into account the path profile and the size of, and requirements for the radioastronomy antenna.

In the 606-614 MHz band a field of 80 dB above 1 μV/m corresponds to a power at the receiving antennae of -92 dBW if the gain is -10 dB. This is well below the overload point of the preamplifier so the main receiver problem is to reduce the received power from the television band by about 100 dB, by a combination of filtering at radio-frequency and intermediate-frequency to achieve the CCIR limits. This degree of suppression is technically feasible, though probably near the limits of what can be done without introducing other undesirable effects such as phase distortion.

Finally, a similar example can be used to study the effects of harmonic radiation. Assuming that the same field of 80 dB above 1 μV/m is produced by a Channel 50 transmitter at 50 km, having its second harmonic in the hydrogen band, this harmonic might, in normal circumstances, be 60 dB below the fundamental in the transmitter itself. Additional attenuation of about 50 dB would be required to achieve the limit of Report 224-1 with a -10 dB gain receiving antenna. Some of this additional attenuation will be derived from the reduced radiation efficiency of the transmitter antenna, and extra filtering should not be difficult with the wide frequency separations involved. Intermodulation products occurring at frequencies well-removed from the nominal transmitter frequencies should in general be less of a problem than harmonics.

In view of the large number of ways in which interference can be caused, protection of radioastronomy stations in highly developed areas may call for the addition of filters capable of handling the full transmitter output, at several television broadcasting stations. This means that, apart from technical feasibility and cost, the question of organizing checks of the degree of suppression will need consideration.

5. — Conclusions

Band-edge radiation and non-linearity in the equipment at UHF television stations can generate interference in the UHF radioastronomy bands. It is technically feasible, although in some cases expensive, to suppress such interference when it is due to the output stages of the transmitters but an overall limit of -100 dB relative to peak (sync.) power may be set by the occurrence of intermodulation in the feeders and antenna systems. It may not be possible to achieve further useful improvement unless, by chance or by design, the transmitting antenna gain at the interference frequencies is appreciably less than that at the operating frequency. This means, for example that interference fields exceeding a level 20 dB below

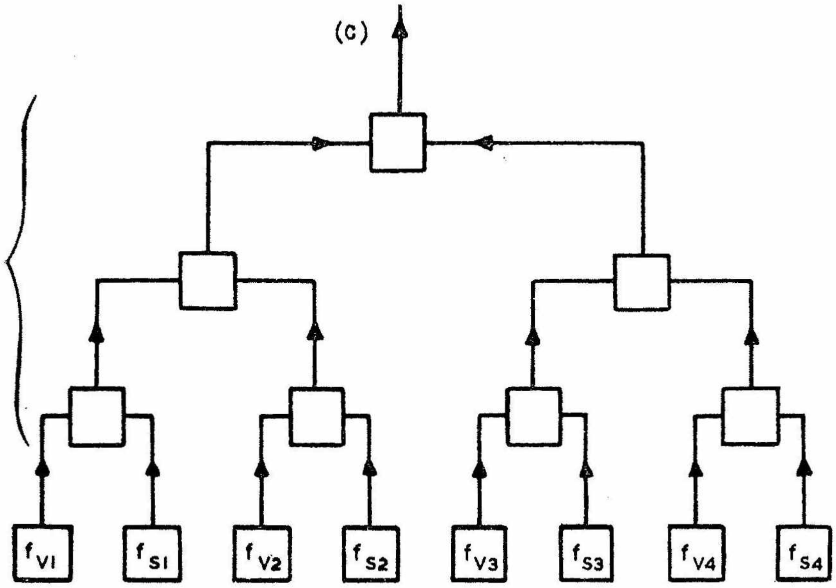

FIG. 1

Typical combining-filter arrangement
when feeding four programmes to a common antenna
Disposition typique avec filtres combineurs, dans le cas où l'on utilise une antenne commune pour quatre programmes différents

(*a*) Transmitters — Emetteurs.
(*b*) Combining-filters — Filtres combineurs.
(*c*) Output to antenna array — Sortie vers le système d'antenne.

1 μV/m at 10 m above ground in the UHF radioastronomy bands may be unavoidable for 1 % of the time at a radioastronomy site situated only 50 km away from a typical high-power UHF television transmitting station. Parts of a large radioastronomy antenna, extending to much greater heights than 10 m, may be in a field nearly equal to that in free space.

In general, band-edge interference introduces more serious technical problems than do harmonic and intermodulation interference in radioastronomy bands well separated from the television frequencies. Special filtering may be needed but in the latter case the design problems will be less difficult. If the out-of-band television signals can be reduced to a relative level of -100 dB, the radioastronomy receivers can be designed to reduce the reception of the main television signals to a similar level.

The examples quoted show that adequate suppression of interference from a transmitter at a distance of 50 km is likely to extend techniques to their limit, if the receiving antenna height is about 10 m. The most sensitive use of higher antennae appears to rely on greater geographical separation or some protection by high ground. On the other hand, some types of observation can be carried out in the presence of interference somewhat greater than the CCIR limits. It may then be feasible to use even a high radio-astronomy antenna at a distance of 50 km from a television transmitter radiating in an adjacent frequency band.

THE OH-LINES IN RADIOASTRONOMY
(CCIR Doc. IV/122-E, 25 September 1968)

1. — Introduction

Radio-frequency spectral lines due to the hydroxyl molecule (OH) were first detected and measured in the laboratory in 1959 [1], and in interstellar space in 1963 [2], when absorption of the radio-frequency radiation from the radio source Cassiopeia A was observed at frequencies (1) corresponding to those of the two principal lines, at 1,665.402 and 1,667.357 MHz. Shortly afterwards, even stronger absorption bands were found from the region of the galactic centre [3, 4, 5], and two expected subsidiary lines, arising from alternative configurations within the OH molecule, were detected, and their rest frequencies determined at 1,612.231 and 1,720.533 MHz [6]. The very much lower intensity absorption line at 1,639 MHz has been detected in the direction of the galactic centre [7]. This line is due to the $0^{18}H$ molecule where the oxygen is the mass-18 isotope of the normal 0^{16}. More recently, investigation of narrow-band emissions from regions of ionized hydrogen in the galaxy [8, 9] has led to the detection of a similar emission from OH [10, 11]. This emission is unexpectedly intense, producing increases in antenna temperature of as much as 150°K, and it has, surprisingly, been found to have a circularly polarized component [12]. A number of the sources of OH emission have now been studied with interferometers, to get more precise positions of the sources [13] and estimates of the angular sizes of the sources [14]. The new technique of "very long baseline" or VLB interferometry, in which baselines of length comparable with the diameter of the Earth are used, have been used to study some OH sources [15] and apparent angular sizes of less than .005 seconds of arc have now been measured. This last tech-

(1) The frequencies in this Report are the rest frequencies for the radiation concerned.

nique, by an equipment improvement which is within the state of our present knowledge, opens up the possibilities of using radio sources of very small angular-size as position references for the location of the observing points on the Earth. Possible uses in measuring earth tides, continental drift, and accurate terrestrial rates of rotation have been predicted [16, 17]).

The discovery of lines due to OH is of great astrophysical significance. The extent by which the observed frequencies are displaced from their rest frequencies by Doppler effects provides direct information about the motions of the gas clouds in which the OH occurs. The anomalies in the line intensities, both in emission and absorption, throw new and unexpected light on the physical conditions in particular regions of our galaxy. The observations also give more information on the structure of and magnetic fields in our galaxy.

2. — THE PROPERTIES OF THE ABSORPTION LINES

The anomalies in the intensities of the lines when observed in absorption continue to pose important problems, since these relative intensities in the observed lines differ considerably from the expected values for a source in thermodynamic equilibrium. For example, the absorption spectrum of Cassiopeia A was examined at the frequencies of the two satellite lines, 1,612 and 1,720 MHz. Whereas both the 1,665- and 1,667 MHz transitions show splitting into two lines, neither the 1,612 nor the 1,720 MHz transition shows any splitting. Furthermore, the absorption at 1,612 MHz is approximately one-half that at 1,665 MHz, instead of one-fifth, as expected. Finally, the observations indicate a small amount of OH emission at 1,720 MHz, but none is detectable at 1,612 MHz. The unusual absorption features and the presence of weak emission have been independently confirmed. It is very difficult to see how any of these observations can be explained in terms of a medium in thermodynamic equilibrium, and these observations are among the many that are still unexplained.

Other absorption anomalies have been found in the spectrum of the galactic centre [4, 5, 6, 18]. For example, the observed ratios of line intensities among the four lines are 1/2.2/2.7/1, whereas the value expected on the basis of thermal equilibrium are 1/5/9/1. It is tempting to try to explain the observed values in terms of a medium exhibiting large attenuation, for which all ratios would approach unity, but this attempt fails. For example, isolated regions near the galactic centre show stronger absorption at 1,665 than at 1,667 MHz, and many regions show unequal absorption at 1,612 and at 1,720 MHz. It seems clear that these observations require the assumption of a non-thermal distribution of the OH molecules among the internal energy states from which the radio lines are derived.

The OH observations in the galactic centre pose problems other than anomalous line-intensity ratios. The OH absorption is very strong and extends over a considerable frequency, or velocity, range as compared to H absorption in the same direction. If the OH profiles for the galactic centre are interpreted in a manner similar to that described for Cassiopeia A, then one derives an OH/H abundance ratio of 10^{-4}, some 10^{3} times the ratio in the direction of Cassiopeia A. However, this value must be used with extreme caution, because any derived values, based upon the observations, must await a full understanding of the mechanism by which OH is formed, is distributed with respect to its internal energy levels, and absorbs and emits radio energy. From the frequency at which the OH absorption occurs one can determine the radial velocity of the OH relative to the sun, and it is found that the OH is moving toward the galactic centre with a velocity of 40 km/s. On the other hand, the H which is associated with the galactic centre is streaming away from the centre with a velocity of 50 km/s. This is a curious situation and may force a revision of our ideas about the physical conditions in the galactic nucleus. It should be emphasized, though, that the observations tell us nothing about the distances to the OH and the H; the concept that they are associated with the galactic centre rests strictly on interpretations of the accumulated evidence.

3. — The emission lines

The observations of the OH emission lines have similarly opened up a new and complex area of astronomical research. Early attempts to detect OH emission were confined to observations at 1,667 MHz because it was thougt this would be the strongest transition, but all attempts gave negative results. When OH was finally discovered in emission at 1,665 MHz, not 1,667 MHz, its properties were so unusual that two out of the first three groups of radio astronomers to observe it did not attribute the line to OH.

Australian observers first observed OH emission in June 1964, when a narrow, intense emission line was detected to the side of an absorption line at 1,665 MHz in the direction of the galactic centre [10]. However, the effect was apparently thought to be an instrumental effect and was not reported at the time. Six months or more later, OH emission was observed by groups at Harvard and Berkeley, with properties so unexpected that the Berkeley radio astronomers thought they had detected an unidentified microwave spectral line ; they nicknamed the line "mysterium" until identification could be established. Although mysterium has now been identified as OH, the name can hardly be called a misnomer in view of the strange properties exhibited in interstellar OH.

From the beginning, OH emission has been characterized by intense, narrow emission lines at 1,665 MHz, with lines of lesser intensity at the other three OH frequencies. Departures by several orders of magnitude from the expected intensity ratios have been noted. Furthermore, the spectrum obtained at one frequency seems to be completely uncorrelated with that obtained at another. This is an extremely difficult phenomenon to incorporate in a theoretical model which attempts to explain the observations.

Another curious fact about the OH emission is its location within the galaxy. It is by no means widely distributed throughout the Milky Way, as is the 21 cm emission of atomic hydrogen, but is found only in isolated positions near "HII regions". An HII region is that region about a hot star where the hydrogen is almost completely ionized. Such regions are closely confined to the galactic equator and are relatively strong radio sources in the continuum wavelengths — that is, the radio emission of HII regions is not confined to a small spectral domain, as OH emission is.

A new OH emission line was recently discovered [23] ; it is due to a transition within an excited energy state of the molecule. Its frequency is thus higher than the ground state frequency. Theoretically, lines were expected at 4,765, 4,750 and 4,660 MHz, but only the 4,765 line was detected.

4. — Polarization of the emission lines

Immediately after intense, narrow-band OH emission was discovered, it was found that the radiation had strong linear polarization [11]. This suggested that the radiating system had a preferred direction associated with it, such as a magnetic field or the direction of incident radiation. The detection of linear polarization also suggested that a search for circular polarization of the received radiation be made, and such polarization was detected forthwith [12, 19], with polarization approaching 100 %. The most obvious interpretation of these observations was the conclusion that the lines were split by the Zeeman interaction of a magnetic field with the magnetic moment of OH. However, observations at all four OH frequencies rule out a simple Zeeman interpretation because of the lack of correlation between the spectrum at one frequency relative to that at another.

5. — The $O^{18}H$ line

The strong OH absorption found in the direction of the galactic centre has made another experiment feasible. All the results discussed above have referred to the abundant isotopic species $O^{16}H$, but the observation of strong absorption suggested the possibility that the isotopic species $O^{18}H$ could be detected. The frequencies of the $O^{18}H$ lines are shifted relative to those of the $O^{16}H$ lines because of mass-dependent effects on the molecular energy levels. Though the $O^{18}H$ frequencies have not been measured in the laboratory, they have been calculated to sufficient accuracy, and their importance to radioastronomy has been pointed out [20]. The terrestrial isotopic abundance ratio O^{18}/O^{16} is 1/490, and if this ratio also applies to interstellar OH, an assumption whose validity is by no means certain, then the lines of $O^{18}H$ should be detectable in the spectrum of the galactic centre at frequencies some 30 MHz lower than those of the $O^{16}H$ lines. This has indeed proved to be the case. The $O^{18}H$ line at 1,639 MHz, corresponding to the $O^{16}H$ line at 1,667 MHz, has been detected in the direction of the galactic centre [7]. The intensity is weak, as expected, and 18 hours of integration were required to produce the results. The observations are consistent with an interstellar isotopic abundance ratio of 1/500 for O^{18}/O^{16}, as observed on Earth, but the conclusion that the ratios agree must be regarded as extremely tentative at this time.

6. — Positions and sizes of OH sources

The positions of a number of the OH sources have been determined to an accuracy of better than one second of arc [13]. The results have shown that an emission source can be a number of very small bright regions separated by angular distances of a few seconds of arc. The angular sizes of the sources themselves have been studied with interferometers of ever-increasing baselines and angular resolutions. First results came with spacings between the antennae of 127 km, or 7×10^5 wavelengths [14] and these showed that one emitting source was less than 0.05 seconds of arc in size.

The technique of VLB interferometry was being started at about this time. In these experiments, two very distant radio-telescopes observe the same source, and work as an inteferometer because the local oscillator or phase reference at each telescope are subsequently carried to a computer and cross-correlated to develop the interference fringes. This technique was shown to work first for continuum observations [21, 22] ; but it now has been extensively applied to OH line studies. As examples of baselines used, the radio-telescopes at Hat Creek (University of California); Lincoln Laboratory (M. I. T. near Boston), National Radio Astronomy Observatory (Green Bank, W. Va.), and Onsala (near Gothenburg, Sweden) have all experimented on OH lines work in pairs. The results show that OH emission sources can be as small as .005 seconds of arc in size. This upper limit may be still further reduced as experiments continue.

If the frequency and phase stability of the VLB experiments can be improved (by the use of hydrogen masers, for example), the technique may be usable for measuring the absolute positions of sources in the sky to better than 10^{-3} seconds of arc. This in turn corresponds to position measures on earth of 3 cm and the possibility of using such measures for a variety of geodetic and geophysical measurements is very attractive [16, 17].

7. — The emission mechanism

The emission line intensities and the very small angular sizes of the sources raise difficult problems in the understanding of the mechanism by which the sources emit. Most attempts to explain the OH observational results have centred around some kind of population inversion of the higher energy levels, whereby the OH medium would be converted into a medium which amplifies rather than absorbs. For amplification to occur. the population of the higher-energy levels — of those defining the radio lines — must exceed that of the lower-energy levels, so that the net effect of the passage of a radio wave through the OH is to induce more transitions from high to low energy levels than from low to high levels. Since transitions from high to low energy levels add energy to the radio wave, and those from low to high levels substract energy, a medium with population inversion will add energy to the radio wave — that is, will amplify the radio wave.

The most obvious reason for attempting to invoke maser action to explain the OH observations is to meet the requirement for explaining the extremely intense lines. The intrinsic temperatures of the lines correspond to temperatures in the range 10×10^9 to 100×10^{9}°K, a circumstance which is highly suggestive of amplification processes because such temperatures exceed, by several orders of magnitude, known physical temperatures. But the intensity of the lines is not the only reason for suspecting maser processes. Extremely narrow lines have been observed, and amplifying processes can lead to a line narrowing, line shapes as well as widths being altered by the amplification. Thus line widths of 600 Hz, corresponding to kinetic temperatures of 5°K, could exist in situations where the line intensities correspond to temperatures between $10^{10°}$ K and $10^{11°}$ K. Furthermore, if the maser mechanism were sensitive to polarization, then the observed radiation might exhibit a large degree of polarization, such as is observed.

Finally, another property of maser processes should not be overlooked. If an OH medium can be brought to a state of amplification, then sources of radiation lying behind it, as viewed from the Earth, or emission of the medium itself, will appear as sources of extremely small angular size. This will be true because of the coherent nature of the amplifying processes, which produces a high degree of directionality in the amplified radiation. If this is indeed happening, then the small angular sizes observed in the interferometric observations may actually be "apparent" sizes rather than true angular sizes. For this reason, the linear dimensions of the OH-emitting regions may be considerably larger than those inferred from the observations.

8. — Techniques

The continuation of this research, and particularly the investigation of the mechanism by which the OH-molecule is formed in interstellar space, will involve further detailed observations using the greatest attainable sensitivity and freedom from harmful interference.

Receivers used to study the OH-lines need to have narrower bandwidths than those used in the observation of the 1,420 MHz line of hydrogen, because the OH molecule, being heavier, has a lower thermal velocity, and correspondingly sharper line features : bandwidths of 1 to 10 kHz are typical. They need, however, to be tunable over an appropriate range, since the lines observed are broadened and displaced in frequency up to several megahertz, as a result of Doppler effects due to relative motions in the line of sight; furthermore, accurate measurement of the shape of the spectral lines requires comparison measurements at adjacent frequencies which are free from the effects of OH-absorption or emission. The overall frequency band technically necessary for detailed study of the two principal lines at 1,665.4 and 1,667.4 MHz, taking into account the requirements or comparison observations and Doppler shifts, is at least 5 MHz and preferably about 10 MHz.

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PREFERRED FREQUENCY BANDS FOR SPACECRAFT-TRANSMITTERS USED AS BEACONS

(CCIR Doc. IV/128-E, 26 September 1968)

1. — Introduction

The frequency bands at present allocated for the space research service have been used mainly to satisfy the need for receiving telemetered scientific and technological data from spacecraft, and for controlling their movements and condition. Radio transmissions between satellites and the earth are also used in research based on the behaviour of the radio waves themselves rather than on the information which they carry as communication links. Some of these activities are described below under three headings. The first two are closely linked in that they depend on the influence of the ionosphere on the radio waves. It is convenient to consider them separately because the objectives and frequency requirements are somewhat different.

The first type of study is referred to as radio propagation, the objective being to determine how waves travel between two points, one at least of which is on a spacecraft. The second is ionospheric research, with the main objective of determining the characteristics of the ionosphere as a physical medium. It will be apparent that radio propagation studies will often yield information on the ionosphere, and conversely ionospheric research will help the understanding of propagation mechanisms. However, the ionospheric research discussed here is based on special techniques which have rather specific frequency requirements.

The third category of research, geodesy and the study of orbits, is based on techniques related to those of the other categories, but the ionosphere is a disturbing influence, and frequencies need to be chosen to minimize its effects.

2. — Radio propagation

At frequencies in the decametric range mainly, long range propagation between ground stations and satellites of low altitude have been observed up to antipodal distances. Il is generally assumed that ducting inside the ionosphere is the important mechanism [1]. However detailed information is lacking and important features such as the exit paths from the duct, leakage, and attenuation need further study. A study of the ducting mechanism is of interest not only for communications with satellites but also for efficient long distance communications on earth by mechanisms without repeated ionospheric and ground reflections. It is therefore important that suitable experiments be made on a sufficiently long time scale and over a large geographical area. Transmissions from a satellite on a suitable selection of frequencies is the best way to allow a great number of earth stations to participate.

As the phenomenon depends in a critical way on ionospheric refraction, a series of frequencies must be used, extending over a large part of the HF range, say 2 - 20 MHz, to take account of the variations of ionospheric electron density with hour, solar cycle, season and geographical position. The lowest of these frequencies, say 2 to 5 MHz, are suitable for rather low satellite altitudes and for high geomagnetic latitudes, while the higher frequencies are preferable for low latitudes and for the study of very long range propagation.

The requirements have been partially met by allocations on a secondary basis in the standard frequency bands at 10, 15 and 20 MHz, and bands at 15.77 MHz and 18.03 MHz. There is an additional technical requirement for frequencies below 10 MHz. It may be noted that the practice of radiating standard-frequency signals at frequencies which are staggered within the allocated bands may lead to increased interference to space research. It is expected that the propagation problems described above, and similar problems, will be a subject of interest to scientists for many years.

3. — Ionospheric research

Ionospheric beacon satellites transmitting at harmonically related frequencies have proved to be powerful tools for the investigation of ionospheric electron content, in particular that of the outer ionosphere. As they can be used by many earth stations simultaneously the information obtained with the relevant techniques provides complementary data to those obtained with top-side sounders. Two techniques have given most useful results.

Observation of the *differential Doppler effect* at two harmonically related frequencies allows separate identification of the modification of waves due to the refractive effect of the ionospheric plasma. Moreover, with a simple electronic device the rather small plasma effect can be directly recorded to a high accuracy [2] [3].

A second technique is the observation of the Faraday rotation of waves transmitted through the ionosphere. The Faraday rotation of the plane of polarization is caused by double refraction in the ionospheric plasma situated in a magnetic field. It is possible to apply this technique in the frequency range of 100 to about 1000 MHz, for example by observing the tracking signals with elaborate equipment to measure the polarization angles to a high degree of accuracy. However, most observations have been made by simpler techniques at lower frequencies, and there will be a continuing need for this type of measurement at many stations all over the world. It should also be mentioned that these observations as a side-product give most valuable information concerning the ionospheric propagation phenomenon of scintillation [4]. For evaluation of the electron content these techniques are based on a count of the number of rotations of the plane of polarization. If this number is large, as is the case with frequencies below 100 MHz, changes of the ionospheric electron content can be determined accurately with simple recording of the output of a receiver. However, with only one transmitted frequency in this lower range, the total number of rotations, and hence the total electron content of the ionosphere, could not be determined. The addition of a second frequency, differing from the first one by only a few per cent, permits the observation of the *differential Faraday effect.* The total number of rotations is then determined by comparing two time-series of nulls and their relative phases. The fractional frequency difference determines the scale-factor relating the total number of rotations to the number of nulls [2] [3]. In typical ionospheric observations a scale-factor of the order of 30 to 100 is convenient; two frequencies differing by 1 to 3 % are therefore technically suitable.

Frequencies usable for both techniques should be high enough to penetrate the ionosphere, but low enough to give appreciable ionospheric refraction effects [5]. In view of the large variations of ionospheric electron density a satisfactory set of frequencies could be in the range from 15 to 60 MHz. One higher frequency is desirable to provide a phase reference with small refraction effects. This higher frequency should not be 80 MHz in view of the allocation to the radioastronomy service of the band 79.75 - 80.25 MHz. Thus a technically suitable series of frequencies for measurements at HF and VHF is :

— three harmonically related frequencies for differential Doppler observations, the two lower ones between 15 and 60 MHz, and one other between 80 and 200 MHz;
— one additional frequency differing by a few per cent from that of the second of the above frequencies for differential Faraday observations.

The allocations at 20 and 40 MHz partially meet these requirements. It would be feasible for the highest frequency of the series to be in the space research band just above 400 MHz, but a lower frequency would be preferable. A frequency of 41 MHz has been used with 40 MHz on a non-interference basis for the Faraday rotation work, but there has been no protection at this frequency for these measurements.

Similar techniques are also used in some experiments using rockets. Frequencies of the order of 1 MHz, for example, are suitable for the study of the lower regions of the ionosphere using Faraday rotation. The D-region can be explored by measuring the fields in the ionosphere from a low frequency transmitter on the ground.

4. — Geodesy

The general problem in the geodetic work envisaged is to establish accurately the relative locations of a satellite and one or more points on earth, at various known times. This information can then be used, for example, to calculate the separations of the earth terminals or to use the satellite motions to calculate the shape of the earth.

Geodetic beacons are used to determine, by the Doppler effect, the radial speed of a satellite as seen from an earth station, and the desire to exploit this technique is likely to continue indefinitely. The varying received frequency is measured in given time intervals (seconds for example) and compared with the transmitted frequency, which must be known accurately so that the difference in frequency can be calculated. Ionospheric (and tropospheric) refraction is a perturbing influence. In view of the high accuracy which is needed, refraction effects must be corrected for ; this is so even if the transmissions are at rather high frequencies at which these effects are small. The most important ionospheric correction can be obtained with the differential Doppler technique, using harmonically-related frequencies as explained above.

At least two sets of frequencies have been used. One system based on multiples of 54 MHz has often been applied, for example in the GECS series with 162, 324 and 972 MHz [6]. It has been reported that interference from other transmitters often occurs on the lowest of these frequencies and that fully satisfactory operations are uncommon. A second system is based on the primary frequency allocations for radio navigational satellites, at 150 and 400 MHz ; these are used by some "Transit" satellites [7]. The frequency ratio 3 : 8 leads to complication of the ground equipment and from this point of view it would be preferable for the geodetic application to be based on a simpler frequency ratio, for example 1 : 2, 1 : 3 or perhaps 1 : 4 or 2 : 3.

5. — The feasibility of frequency-sharing

No information is yet available on the susceptibility to interference of the systems described. It is almost certain that the interference criteria already specified by the CCIR for space research will be satisfactory for these additional applications, and it is possible that less stringent criteria could be acceptable, in view of the narrow bandwidth requirements. A study of these aspects of the problem is required.

6. — Conclusions

A continuing need, for many years, is envisaged for space research experiments involving Doppler and Faraday rotation techniques, and for geodetic measurements based on the Doppler effect. In addition to existing allocations there is a technical need for frequencies between 2 and 10 MHz. Frequencies below 2 MHz are suitable for some types of experiment but no common requirement on a continuing basis is apparent.

For Doppler measurements an additional frequency is required, harmonically related to 20 MHz, preferably a simple multiple and in the range of 80 to 200 MHz. Faraday measurements can be made with elaborate equipment at frequencies greater than 100 MHz, for example those radiated for tracking purposes, but some of the simpler and more widely used techniques require two VHF transmissions differing by 1 to 3 %. Some frequencies can in many cases be common to both Doppler- and Faraday-measurements.

Geodetic work can be carried out to some extent by using the allocated bands for radionavigation satellites, but a pair of frequency bands more simply related than are the present 150 and 400 MHz bands could lead to a simplification of equipment. Furthermore, for work of the highest accuracy an additional frequency, higher than and harmonically related to 400 MHz, is required.

The transmissions used in Doppler and Faraday rotation experiments can be accommodated in bandwidths of the order of 0.02 % of the frequency.

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6. To be completed later.
7. To be completed later.

INTERNATIONAL COLLABORATION

URSI is one of 2,700 international non-governmental organizations which, between them, cover every conceivable facet of human activity where there is something to be gained from international collaboration. There are, in addition, about 300 official organizations established by agreement between governments. The need for closer cooperation on an international scale is illustrated by the fact that the number of international organizations has trebled in the last 20 years and is expected to have trebled again by 1988.

An up-to-date store of information about the 3,000 organizations at present in being is contained in the recently published 12th edition of the well-known Yearbook (1) compiled by the Union of International Associations. The Yearbook is not a mere list of 3,000 titles ; the contents are divided into six sections containing in all 28,000 entries and the system of cross references enables an organization to be traced by its subject or a keyword in its title, by the town or country of its offices, by the names of its principal officers etc.

An essential feature of the life of an active international organization is the opportunity provided at appropriate intervals for the members, or their representatives, to meet and to discuss various aspects of their activities. Such meetings take the form of conferences, symposia, colloquia, congresses, scientific and technical meetings, etc. Only about one quarter of the reports or proceedings of these meetings are distributed through normal commercial channels and it is often very difficult for librarians and others to locate copies of these reports, many of which are circulated in limited numbers.

The first edition of a bibliography (2) of reports of meetings held in the years 1960-1967 has just been published and contains descriptions of the reports of 6,000 meetings of non-governmental and governmental organizations. In addition to the bibliographical entries, which are listed chronologically, there are indexes of authors, subject keywords and titles of organizations.

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(1) Yearbook of International Organizations 1968-1969 (12th edition) 1,200 pages. Price US $24.00.

(2) Yearbook of International Congress Proceedings. Meeting Years 1960-1967 (1st edition) 700 pages. Price US $20.00.

Copies of the two volumes mentioned are available from booksellers, or direct from the publisher :

Union of International Associations,
Dept YB/A
1, rue Aux Laines
Brussels 1, Belgium.

Total Solar Eclipse, 7 March 1970

The path of this eclipse will run from the Pacific Ocean across Mexico, N. Florida, the East Coast of the USA, Nova Scotia and Newfoundland in Canada and will end in the Atlantic Ocean. Dr. Albert E. Belon of the National Science Foundation in Washington has been appointed US Coordinator for the 1970 Eclipse and is cooperating with his counterpart in Mexico Dr. Haro of the National Observatory.

Solar Eclipse 1970 Bulletin B, compiled by Dr. Belon and issued by the National Science Foundation, has recently been circulated to those who intend to make observations during the eclipse. The *Bulletin* contains climatic and other information about local conditions in Mexico and the USA near the eclipse path. Considerable detail is given regarding the numerous experiments planned not only by American groups but by groups from ESRO, France, West Germany, Italy, Japan, Netherlands and the UK.

The National Science Foundation is to be congratulated on the efforts it is making to coordinate the activities of the numerous observing groups and to provide so much advance information in a compact form. The *Bulletin* is to be kept up-to-date by the issue, from time to time, of loose leaves for insertion in the *Bulletin*.

URSI SYMPOSIUM ON ELECTROMAGNETIC WAVES
Stresa, 24-29 June 1968

We have been notified by Professor Boella (Chairman of the Organizing Committee) that the proceedings of the above Symposium will be published in April 1969 in an English issue of *Alta Frequenza.* The programmes of the Sessions and a brief report on the Symposium by Dr. Stumpers were published in *URSI Bulletin* No. 169.

SOLAR AND GEOPHYSICAL EVENTS

One of the main features of the International Geophysical Year (IGY) was the emphasis placed on the study of the relations between the different types of event which take place on the Sun, and the wide variety of terrestrial phenomena caused by or associated with these events. Until the IGY it was difficult, in practice, to investigate such relations because the essential observational data were not available in collected form ; they appeared in periodical observatory reports, not all of which were easily accessible, and in numerous specialised publications.

The suggestion that for the IGY, it would be desirable to collect together as many of the basic data as possible, and to publish them in the form of a chronological list of events, was made by Sydney Chapman, at that time President of the IGY Committee (CSAGI). The resulting Calendar Records for the IGY years, 1957 and 1958, were published in 1962 and 1963 in a volume of *Annals of the IGY* which included also the Record for 1959.

The compilation of these Calendar Records was the responsibility of the International Ursigram and World Day Service (IUWDS). Although CSAGI was terminated in 1958, the parent Unions of IUWDS (IAU and URSI) encouraged the continued preparation of the Record and its distribution on a limited scale. The experience gained by IUWDS during the years 1957-1963 was a valuable asset when the IQSY Committee recommended the continuation and further development of the services provided.

While the IQSY was still in progress, the Calendar Records for 1964 and 1965 appeared in provisional form in successive issues of *IQSY Notes*. They have recently been published in final form in a volume of *Annals of the IQSY* together with the Records for 1960-1963 which had not hitherto been generally available.

In this volume the tabulated data are grouped into blocks each representing 20-day periods. They include magnetic and ionospheric indices of several types, radio and optical observations of solar activity, indices of cosmic radiation intensity, information about the location of solar active regions, etc. To each block there is appended also a set of notes giving qualitative information for particular days which covers magnetic and aurorae activity, noctilucent clouds, and supplementary notes on the tabulated data. By making use of a very compact lay-out, the whole of the Record for each 20-day period is conveniently arranged on two adjacent pages.

In addition to the numerical data based on observations, the volume includes also the planning calendars prepared each year in advance both for the IQSY and the pre-IQSY years, and the warning messages (Alerts), relating to solar and geophysical events, which were disseminated daily by radio to observatories all over the world. This information will be useful to those who wish to make more detailed investigations, because the volume and type of the basic observational data obtained on any given day was determined partly by the provisions of the advance calendar and partly by the nature of the Alert in force on that day.

Also reproduced are the dates of the Retrospective World Intervals (RWI). These were chosen near the end of the IQSY and they represent periods during which solar and geophysical events occurred which seem particularly worth more profound study. Interested research workers are encouraged to pay special attention to the RWI; preliminary analyses of solar and geomagnetic activity during some of them had already been made by Prof. Ballario soon after the end of the IQSY and these were published in *IQSY Notes* Nos 17 and 18 in 1966. It is expected that interdisciplinary studies of the events which occurred during the RWI will shed new light on the problems of solar-terrestrial physics.

In his Preface to the new volume, Mr. Shapley (Chairman of IUWDS) points out that limitations of space preclude the inclusion of comprehensive data in the Calendar Records. Nevertheless it is encouraging to know that, with the publication of the IQSY volume, at least these data and other types of information most likely to be required for many investigations of solar-terrestrial relations during the period 1957-1965 can now be consulted within the covers of only two volumes (1) (2).

RADIO SCIENCE

The journal *Radio Science* was cosponsored by the Environmental Science Services Administration (ESSA) and sold by the Superintendent of Documents, US Government Printing Office up to the end of the 1968

(1) Solar and Geophysical Events 1960-1965 (Calendar Record) (compiled by J. V. Lincoln). *Annals of the IQSY*, Vol. 2, pp X + 297 (The MIT Press, Cambridge, Mass. and London, 1968).

(2a) IGY Calendar Record (compiled by A. H. Shapley and J. V. Lincoln). *Annals of the IGY*, Vol. 16 (Part I), 1-158 (Pergamon Press, Oxford, 1962).

(2b) Calendar Record for the International Geophysical Cooperation. *Ibid.* (Part III), 199-300 (1963).

volume. These arrangements have been terminated and present subscribers will receive refunds from the Printing Office early in 1969.

Beginning with the January 1969 issue, *Radio Science* will be published for the US National Committee of URSI by the American Geophysical Union, with partial support from ESSA during a transition period. The annual subscription rate will be $20.00 for institutions, libraries, and other multiple-use subscribers. For individuals certifying in their order that the journal is for their personal use, the rate will be $10.00. Orders with payment for the 1969 volume should be sent to :

Subscription Department,
American Geophysical Union
Suite 435
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037.

In addition to a change in subscription rates, the transfer of responsibility for publication of *Radio Science* from the Superintendent of Documents, US Government Printing Office, to a private publisher necessitates the introduction of the page charge arrangements customary to most scientific journals. The authors' institutions are requested to pay a publication charge of $50.00 per page. One hundred reprints, without cover, will be supplied free to those paying the publication charge. For those who are not able to pay the publication charge as such, there will be a charge for reprints.

Radio Science will be edited by an editorial board appointed by the US National Committee of URSI. Manuscripts should be sent to :

Professor Sidney A. Bowhill, Editor
Department of Electrical Engineering
University of Illinois
Urbana, Illinois 61801.

CONFERENCE ON ENVIRONMENTAL EFFECTS ON ANTENNA PERFORMANCE

A two-week conference will be held from July 7th to 18th, 1969, in Boulder, Colo., on the subject of radiation of electromagnetic waves from sources in the presence of complex media. The first week will consist mainly of tutorial lectures at an advanced level on the basic theory of radiation in inhomogeneous and anisotropic media. The second week will be devoted to presentations of original work, including applications to communication systems. The Chairman of the Advisory Board is Prof. J. R. Wait, ESSA Research Laboratories, Boulder.

During the first week, for which there will be a registration fee of $150, 22 tutorial lectures will be presented on 15 topics by 8 speakers. The subjects selected for the 10 sessions in the second week include electromagnetic theory ; boundary value problem ; influence of homogeneous half space ; ground screen effects ; antennas in plasma, etc. There will be no registration fee for the second week.

Enquiries should be addressed to the following :

1st week. Prof. S. A. Maley, Electrical Engineering Department, University of Colorado, Boulder, Colorado 80302.

2nd week. Mrs Eileen Brackett, Room 3009, Radio Building, ESSA, Boulder, Colorado 80302.

COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES

The CIRES has been formed on the University of Colorado Boulder campus by agreement between the University and the Environmental Science Services Administration. This Institute is designed to promote research and teaching in solid earth geophysics, oceanography, radio propagation, the physics of the upper and lower atmospheres, and solar terrestrial relationships, and to serve as a centre for multi-disciplinary collaboration of research workers from Boulder and the entire world.

A Visiting Fellowship programme provides funds to enable scientists working in these fields to spend a period of time, normally a year, with CIRES. Further information may be obtained from the Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado 80302, USA.

LOGARITHMIC SCINTILLATION INDEX

The papers by the authors listed in the References on page 24 of *URSI Information Bulletin*, No. 168, will be published in 1969 in *Planetary and Space Science* and not in *Radio Science.*

INTERNATIONAL REFERENCE IONOSPHERE (IRI)

As annonced in *URSI Information Bulletin* No. 169, p. 50, the URSI-STP Committee has established a Working Group charged with the responsibility of preparing an International Reference Ionosphere. The Group will include representatives of COSPAR and Prof. K. Rawer has already been appointed as Chairman. His address is :

Ionosphären-Institut,
7814 Breisach/Rhein,
West Germany.

Prof. Rawer recently sent a circular letter, with a questionnaire, to many of those who are likely to be able to help in the work of the Group. A copy of the questionnaire has been posted with this copy of the Bulletin and Prof. Rawer would be glad to receive completed questionnaires from those who are interested and who are not already in contact with him.

URSI-STP/COSPAR WORKING GROUP ON INTERNATIONAL REFERENCE IONOSPHERE (IRI)

At its September 1968 meeting the URSI-STP Committee set up a new Working Group to prepare an International Reference Ionosphere in cooperation with COSPAR (see : *URSI Information Bulletin* No. 169, p. 50). It is intended to prepare a set of representative profile tables describing the ionosphere in terms of its main physical parameters at a few, selected latitudes. These tables could be used for general orientation, as a basis of estimations needed in theoretical work, and for planning of new experiments. In so far as the neutrals are concerned the tables of IRI should be compatible with the next edition of CIRA which is being prepared at the present time by COSPAR WG IV (Chairman : L. G. Jacchia). In order to avoid the risk of misleading non-specialists, and to show regular variations as well as observed fluctuations, an introductory chapter should precede the tables. This chapter should be fairly detailed but should not include details about chemistry or circulation in the ionosphere.

Meanwhile the Chairman of this new Working Group on IRI has sent out a circular letter to many scientists who are known to be engaged in this field, asking for their cooperation. He has already received quite a few positive answers, but a certain number of replies are still expected. It seems further that not all colleagues who could make valuable contributions have been reached. It is the intention of this note to have the proposal more largely circulated.

Therefore the main items of this circular letter are reproduced (with minor corrections) in the following annexes.

We ask all scientists who could be helpful in this context to contact the undersigned.

Ionosphären-Institut,
7814 Breisach/Rhein,
West Germany

K. Rawer
Chairman,
IRI Working Group.

14 February 1969

Annex 1

Provisional plan for "International Reference Ionosphere"

A. *Introduction*

A1 : Principal processes (descriptive)
- — recombination parameters (summary)
- — solar UV, XUV and X-ray flux (table or diagram)

A2 : Regular variability in time (descriptive)
- — empirical relations, mainly for lower layers (formulae and figures)
- — typical examples of diurnal variations of *fo*F2 and h_MF2 (figures)
- — Fourier-analysis for F2-layer (sample table)
- — model descriptions of the main profile parameters
- — use of M(3000)F2 values for estimating heights

A3 : Irregular and quick changes : irregularities, transitoria, waves and motions, transitorial layers, sporadic-E, winter anomaly (description)
- — occurrence of transitoria (statistics)
- — tidal motions (summary tables or figures)
- — typical sporadic-E N_e-profiles (figures)
- — statistical description of sporadic-E occurrence, and *fo*E*s* (figures and tables)
- — N_e (and ν?) sample profiles for winter anomaly (figures)

A4 : Disturbances : SID and other related flare-effects, earthstorm, polar cap absorption (description)
- — typical SID N_e-profiles (figures)
- — typical auroral layer N_e-profiles (figures)
- — typical polar cap N_e (and N_i ?) profiles (figures)

A5 : Geographic variability (description)
- — solar radiation input (1 or 2 cosχ-maps)
- — empirical relations, mainly for lower layers (formulae)
- — a few (CCIR) UT-maps of median *fo*F2 (world maps)
- — a few (CCIR) UT-maps of median M(3000)F2 (world maps)
- — instantaneous *fo*F2 distribution (regional maps)
- — world wide *fo*E*s* distribution (world maps)

A6 : Geographic range of phenomena related with disturbances (summary)
- — occurrence of auroral types of E*s* (maps)
- — occurrence of polar black-out (maps).

Annex 3

Control sheet (for International Reference Ionosphere)

Please insert "X" in each box for which you have data available and return this sheet with the Questionnaire to Prof. K. Rawer, Ionosphären-Institut, 7814 Breisach/Rhein, West Germany.

		$t1$			$t2$			$t3$		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
	R1									
L1	R2									
	R3									
	R1									
L2	R2									
	R3									
	R1									
L3	R2									
	R3									
	R1									
L4	R2									
	R3									

My data refer to the following characteristics :

Height range .... to .... km (approximate).

Parameters (insert "X" above and/or below)

as input to tables as input for checking	N_e	N_i	T_e	T_i	ν_e	T_n

Your name : ....

Organization : ....

Signature : ....

Annex 2

QUESTIONNAIRE
(for International Reference Ionosphere)

Please delete "yes" or "no"

1. I intend to cooperate in the IRI : yes/no
2. If "yes" under 1, I shall be able to produce data
   - 2.1 for the main tables : yes/no;
   - 2.2 for the introductory chapter : yes/no;
   - 2.3 I intend to participate with the checking : yes/no.
3. If "yes" under 2.1 or 2.2, I could contribute data concerned with :
   - 3.1 the main tables (indicate latitudes etc. using identification system of Annex 3).
     Description : ....

     ....

     ....

     ....

     ....
   - 3.2 the introductory chapter, parts ....
     Description : ....

     ....

     ....

     ....

     ....
4. The data that I can promise
   - 4.1 are almost ready : yes/no ;
   - 4.2 require some more work : yes/no;
   - 4.3 are expected to be ready about .... (date).
5. My correct mailing address is

....

....

....

Signature :

B. *Bibliography*

Books and undamental papers. Special references concerning chemistry and circulation.

C. *Tables*

Height profiles of six parameters, namely : N_e, N_i, T_e, T_i, ν_e, T_n

— for four *latitudes*, characterized by absolute value of magnetic dip :

L1, 10°; L3, 50°-70°;
L2, 15°-35°; L4, auroral zone.

— for three values of *solar activity*, characterized by approximate solar radio noise flux at 2800 MHz (Covington) : R1, minimum (75); R2, medium (150); R3, high (250).

— for two of three *hours*, provisionally :
*t*1, pre-sunrise (end of night);
*t*2, noon;
*t*3, around sunset.
(alternatively for noon and midnight only).

— for three *seasons* :
T1, equinox (March, September);
T2, northern summer (June, July);
T3, northern winter (December, January).

Note : The maximum number of combinations, according to this framework, would be 108. Probably, data would not readily be available for all six parameters over the whole height range, and for each of the 108 cases. It has to be decided later on, for which of the six parameters 108 tables could reasonably be established, and for which of them only some tables could be completed. Any possible combination is indicated as one box on the control sheet (annex 3).

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