Bulletin nº 153 Novembre-Décembre 1965

U. R. S. I.

TABLE DES MATIÈRES — CONTENTS

XV^th GENERAL ASSEMBLY

Scientific Programme

Commission I on Radio Standards and Measurements

The programme of Commission I published in *Information Bulletin*, No. 149 and in the First Announcement issued by the German General Arrangements Committee has been modified as follows :

Date	Title	Subject	Speaker
6 Sept. a.m.	Standard Frequency Transmission	General Review Coordination of UT and AT	J. M. RICHARDSON J. McA. STEELE
p.m.	Velocity of Radio Waves (with Commission VII)	Recent Measurements Velocity of light and electromagnetic theory	R. C. BAIRD
7 Sept. a.m.	Atomic standards of time	Passive standards Active standards	J. BONANOMI M. E. ZHABOTINSKY
8 Sept. p.m.	International Comparisons and Standard Connectors	Review Standard Connectors	J. T. HENDERSON B. O. WEINSCHEL
9 Sept. a.m.	Modern radio measurements	Laser standards	G. BIRNBAUM
12 Sept.	R. F. measurements at frequencies < 19 c/s	Impedance Power Attenuation	I. A. HARRIS
13 Sept.	R. F. measurements at frequencies > 19 c/s	Review Optical techniques	S. OKAMURA

Sub-Commission IV*a* **on Radio Noise of Terrestrial Origin**

The Programme of Sub-Commission IV*a* published in *Information Bulletin*, No. 149 and in the First Announcement issued by the German General Arrangements Committee has been modified as follows :

Date	Title	Speaker
8 Sept. a.m.	Atmospherics I : Characteristics of atmospherics at the source and propagation	Dr. E. T. Pierce
p.m.	Atmospherics II : Atmospheric noise and its influence on communications	Dr. F. Horner
12 Sept. a.m.	Whistlers	Prof. R. Rivault

COLLOQUE INTER-UNIONS SUR LA PHYSIQUE DES PHÉNOMÈNES SOLEIL-TERRE

Annonce préliminaire

L'U.R.S.I., l'U.G.G.I., l'U.A.I. et le C.O.S.P.A.R. organisent en commun un Colloque sur la Physique des Phénomènes Soleil-Terre. Ce Colloque se tiendra à Belgrade au cours de la semaine du 29 août au 2 septembre 1966. Ci-dessous la liste des membres du Comité du Programme :

U.R.S.I. : H. G. Booker et J. A. Ratcliffe.
U.G.G.I. : M. Nicolet et J. G. Roederer.
U.A.I. : C. W. Allen et E. R. Mustel.
C.O.S.P.A.R. : J. W. King.

L'accès au Colloque est ouvert à tous les chercheurs intéressés, qu'ils soient ou non membres de l'une des Unions organisatrices, et n'est pas subordonné à la présentation d'une communication.

Les principaux sujets qui seront traités au cours de ce Colloque sont donnés ci-dessous (des détails complémentaires peuvent être obtenus auprès des membres du Comité du Programme :

— Les émissions de particules solaires et les champs magnétiques interplanétaires.
— L'interaction du plasma solaire avec le champ géomagnétique.
— Les particules énergétiques chargées dans la Magnétosphère.
— La température des particules neutres et chargées dans l'Ionosphère et la Magnétosphère.

Des communications spécialement sollicitées et se rapportant aux différents sujets à discuter lors du Colloque seront présentées par les personnalités suivantes : J. W. Dungey, J. V. Evans, K. I. Gringauz, V. A. Krassovsky, R. Lust, N. F. Ness, T. Obayashi, B. J. O'Brien, E. N. Parker et V. A. Troitskaya.

Les autres chercheurs désirant présenter une communication sont priés d'envoyer au plus tôt possible et *au plus tard pour le 31 mai* 1966, deux exemplaires du résumé de cette communication (n'excédant pas les 300 mots) au Secrétaire du Comité du Programme (Dr. J. W. King, Radio and Space Research Station, Ditton Park, Slough, Bucks., England). Les communications qui seront présentées à Belgrade seront sélectionnées par le Comité du Programme sur la base des résumés ci-dessus mentionnés.

Etant donné qu'un horaire plein est prévu, il ne sera pas possible d'accorder plus de dix minutes pour la présentation des communications autres que celles sollicitées.

Des renseignements concernant l'organisation du Colloque (y compris inscription, logement, etc.) peuvent être obtenus auprès du Président du Comité Organisateur (Dr. Ing. D. Bajic, U.R.S.I. Belgrade Symposium Committee, P. O. Box 356, Belgrade, Yugoslavia). Les frais d'inscription s'élèvent à 12 dollars (U. S. A.) et comprennent le paiement d'un volume qui contiendra les résumés de toutes les communications sélectionnées par le Comité du Programme et sera distribué au début du Colloque.

* * *

Les lecteurs désireux d'obtenir des exemplaires de l'annonce définitive de cette réunion peuvent s'adresser soit à

Ing. Dr. D. Bajic, Président du Comité Organisateur, E.T.A.N./ U.R.S.I., POB 356, Belgrade, Yougoslavie,

soit au

Secrétaire Général de l'U.R.S.I., 7, place Emile Danco, Bruxelles 18, Belgique.

La brochure contient, outre toutes les indications relatives à la réunion, les formulaires d'inscription.

INTER-UNION SYMPOSIUM ON SOLAR-TERRESTRIAL PHYSICS

Brief Interim Announcement

U.R.S.I., U.G.G.I., U.I.A. and C.O.S.P.A.R. are jointly organizing a Symposium on Solar-Terrestrial Physics to be held in Belgrade during the week August 29 to September 2, 1966. The members of the programme committee are :

U.R.S.I. : H. G. BOOKER and J. A. RATCLIFFE.

U.G.G.I. : M. NICOLET and J. G. ROEDERER.

U.I.A. : C. W. ALLEN and E. R. MUSTEL.

C.O.S.P.A.R. : J. W. KING.

Attendance at the Symposium will be open to all scientists interested, whether or not they are members of any of the organizing Unions, and will not be conditional on the presentation of a paper.

The major topics to be covered at the Symposium are listed below (and further details may be obtained from the members of the programme committee) :

— Solar particle emissions and interplanetary magnetic fields.

— The interaction of solar plasma with the geomagnetic field.

— Energetic charged particles in the magnetosphere.

— The temperature of neutral and charged particles in the ionosphere and magnetosphere.

Specially invited review papers dealing with the major different subjects to be discussed at the Symposium have been commissioned and will be read by the following scientists : J. W. Dungey, J. V. Evans, K. I. Gringauz, V. A. Krassovsky, R. Lust, N. F. Ness, T. Obayashi, B. J. O'Brien, E. N. Parker and V. A. Troitskaya.

Other scientists wishing to read papers should send two copies of the abstract (not more than 300 words) to the Secretary of the programme committee (Dr. J. W. King, Radio and Space Research Station, Ditton Park, Slough, Bucks., England) as soon as possible, *but not later than May* 31, 1966. Papers for presentation at Belgrade will be selected by the programme committee on the basis of their abstracts. A full programme is anticipated and it will not be possible to allocate more than ten minutes for the presentation of papers other than the invited papers.

Information about the organization of the Symposium (including registration and accommodation, etc.) should be obtained from the Chairman of the organizing committee (Dr. Ing. D. Bajic, U.R.S.I. Belgrade Symposium Committee, P. O. Box 356, Belgrade, Yugoslavia). The registration fee will be $ 12 (U. S. A.), and this fee will include payment for the book which will contain the abstracts of all papers selected by the programme committee and which will be distributed at the beginning of the Symposium.

Readers wishing to receive copies of the final announcement of the meeting may apply to

Ing. Dr. D. Bajic, Chairman of the Organizing Committee, E.T.A.N./U.R.S.I., POB 356, Belgrade, Yugoslavia,

or to the

Secretary General of U.R.S.I., 7, place Emile Danco, Brussels 18, Belgium.

Besides information on the meting, the booklet contains registration forms.

COMITÉS NATIONAUX

Argentine

BULLETIN

Le Comité National Argentin de l'U.R.S.I. (Comite Radio Cientifico Argentino — CORCA) a publié le premier numéro du *Boletin del Comite Radio Cientifico Argentino.*

Ce Bulletin contient :

A. Un éditorial donnant les buts de l'U.R.S.I. et quelques renseignements sur la création et la façon dont sera présenté le «*Boletin*» :

1. Informations relatives à l'U.R.S.I.
2. Travaux présentés par des scientifiques.
3. Bibliographie.

B. Un bref compte rendu des Journées d'Étude sur la Géophysique Équatoriale (Paris, juin 1964).

C. La composition des Comités Nationaux Mexicain et des E. U. A.

D. L'exposé d'une lettre envoyée par le Prof. Stumpers, Président de la Commission VI, aux Membres Officiels de sa Commission, les consultant sur :

1. Le programme de la Commission VI à l'Assemblée Générale de Munich.
2. Le programme du Symposium de Delft sur la Théorie Électromagnétique.
3. Le titre et le mandat de la Commission VI.

E. Une bibliographie.

Nous souhaitons un grand succès à ce bulletin qui, publié en espagnol, augmentera la diffusion des buts et activités de l'U.R.S.I.

Germany

OFFICIAL MEMBERS

At its last meeting the German National Committee of U.R.S.I. elected the following Official Members for Commissions IV and VI and Sub-Commission IV*a* :

Commission IV : Prof. Dr. G. Elwert, Astronomisches Institut der Universität, 74 Tübingen, Waldhaüser Str. 64.

Sub-Commission IV*a* : Dr. H. Volland, Radio-Sternwarte Stockert der Universität, 53 Bonn, Poppelsdorfer Allee 49.

Commission VI : Prof. Dr. G. Piefke, Institut für Theoretische Elektrotechnik der Technischen Hochschule, 61 Darmstadt, Schlossgartenstr. 2.

Greece

MEMBERSHIP

1. E. Mariolopoulos, Prof. Meteorology, National University, *President.*
2. M. Anastassiades, University Professor, *Vice President A'.*
3. J. Papathanassiou, General Director Greek Telecommunications, *Vice President B'.*
4. A. Lolakis, Technical Director, General Direction Telecommunications, *Secretary General.*
5. A. Polyzopoulos, Brigadeer, Director Signals Section, General Army Staff, *Member.*
6. V. Aslanides, Technical Director, National Broadcasting Institute, *Member.*
7. K. Theophilopoulos, Professor Polytechnical School, Director Greek Telecommunications Organization, *Member.*

Names and addresses of Commission Chairmen of the Greek National Committee

Commission I. — *Radio Measurements and Standards* : V. ASLANIDES, Technical Director National Broadcasting Institute, 7 Rhodori St., Athens 821.

Commission II. — *Radio and Troposphere*: Elias MARIOLOPOULOS, University Professor, National Observatory, Athens.

Commission III. — *Ionosphere* : Michael ANASTASSIADES, University Professor, Athens University, 104 Solonos St., Athens 144.

Commission IV. — *Magnetosphere* : Elias MARIOLOPOULOS, University Professor, National Observatory, Athens.

Commission IV*a*. — *Radio noise of terrestrial origin* : John PAPATHANASSIOU, General Director Telecommunications, 4 Voulis St., Athens 125.

Commission V. — *Radio Astronomy* : Michael ANASTASSIADES, University Professor, Athens University, 104 Solonos St., Athens 144.

Commission VI. — *Radio Waves and circuits* : K. THEOPHILOPOULOS, Professor Polytechnical School, Director Greek Telecommunications Organization, OTE, Athens.

Commission VII. — *Radio electronics* : Asterios POLYZOPOULOS, Telecommunications Brigadeer, 3 Bizaniou St., Synoikismos Papagou, Athens.

Names and addresses of the substitutes of the Commission Chairmen of the Greek National Committee

Commission I : John KAFETZAKIS, Chief Engineer National Broadcasting Institute, Athens.

Commission II : L. KARAPIPERIS, University Professor, Athens University.

Commission III : D. ELIAS, Doctor Physical Sciences, National Observatory, Athens.

Commission IV : L. KARAPIPERIS, University Professor, Athens University.

Commission IV*a* : J. Nicolis, Engineer Greek Telecommunications Organization, OTE, Athens.

Commission V : K. Karoumpalos, Superintendent Electronic Physics Works, Athens University.

Commission VI : N. Karyambas, Chief Engineer Greek Telecommunications Organization, OTE, Athens.

Commission VII : Constantine Fiorakis, Engineer Dipl., Transmission Major, General Army Staff, Athens.

U. S. A.

Symposium on ultrà low frequency electromagnetic fields

BOULDER, COLO., AUGUST 17-20, 1964

The August, 1965, issue of *Radio Science* (Vol. 69 D., No. 8) contains the following papers selected from the large number of manuscripts submitted by the participants at the symposium.

Solar wind and its interaction with the magnetosphere. Ch. P. SONETT.

Schumann resonances. Janis GALEJS.

Earth-ionosphere cavity resonances and the propagation of ELF radio waves. James R. WAIT.

Resonances of the earth-ionosphere cavity observed at Cambridge, England. M. J. RYCROFT.

Experimental results on the dynamics of the F region. W. BECKER. R. RÜSTER and J. KLOSTERMEYER.

Regular oscillations near 1 c/s observed at middle and low latitudes. Lee TEPLEY.

Preliminary results of a micropulsation experiment at conjugate points. Roger E. GENDRIN and Valeria A. TROITSKAYA.

Some characteristics of geomagnetic pulsations at frequencies near 1 c/s. Wallace H. CAMPBELL and Ernest C. STILTNER.

Propagation of hydromagnetic waves in the magnetosphere. Masahisa SUGIURA.

Ionospheric perturbation (the roles played by the ionosphere in geomagnetic pulsations). S. MATSUSHITA.

Effects of induced earth currents on low-frequency electromagnetic oscillations. A. T. PRICE.

Equatorial effects. Rosemary HUTTON.

Interpretation of early magnetic transients caused by high-altitude nuclear detonations. S. L. KAHALAS and P. NEWMAN.

Abstracts of other submitted contributions are listed in the issue of Radio Science.

Papers prepared for the symposium by researchers in Japan have appeared in the *Report of Ionosphere and Space Research in Japan*, Vol. 18, No. 3, 1964.

The issue contains also the following contributions :

A note on the application of pulse compression techniques to ionospheric sounding, by D. C. COLL and J. R. STOREY.

Comments on a paper " Measurements of phase velocity of VLF propagation in the earth ionosphere waveguide " (F. K. STEELE and C. J. CHILTON), by H. F. BATES.

Reply to H. F. Bates' comments, by F. K. STEELE and C. J. CHILTON.

COMMISSIONS AND COMMITTEES

Commission III.

Ionosphere

SATELLITE EXPERIMENTS

(from *C.O.S.P.A.R. Information Bulletin*, No. 26, October 1965)

Description of ionospheric experiments made by Beacon Explorer Satellite 1965-32A.

The ionospheric beacons transmit continuously on 20.005, 40.010, 4.101 megacycles at 250 milliwatts and 360 megacycles at 100 milliwatts, all derived from a common oscillator. About 86 ground stations operated by some 62 scientific groups in 36 countries are receiving these signals and obtaining information on ionospheric electron content and irregularities. Measurements of electron distribution along the line of sight between the satellite and a ground station are made by the Doppler Shift or Faraday Rotation methods. Both methods depend upon the influences that the ionosphere exerts upon the signal sent out by the satellite's radio beacons.

The Doppler Shift Method. One of the characteritics of a signal received from a satellite moving in orbit is that its radio signals are subject to a phenomenon called the Doppler shift. When the satellite moves toward the receiving station, the frequency of the received signals is slightly higher than that sent by the satellite. When the satellite is moving away from the station, the received frequency becomes slightly lower than the transmitted one. The shift of frequency is called a Doppler shift, and varies with both the satellite velocity and electron density. By comparing the Doppler shifts at several frequencies, the electron content between the observer and the satellite can be obtained.

The Faraday Rotation Method. This is a rotation of the plane of polarization of the radio waves that is produced by the waves passing through the ionosphere, whereby the plane of polarization is gradually twisted along a helical path. It is like taking a long, slender curtain and twisting it into a corkscrew shape. This twisting is called the Faraday rotation, and is the result of interactions between the radio waves, the geomagnetic field, and the electrons in the ionosphere. If the number of times the plane of polarization has been rotated between satellite and Earth can be determined, the electron content can be calculated. This is most easily accomplished by measuring the rotation at several frequencies. By using a straight dipole antenna on the ground, a maximum strength signal will be received when the polarization of the incoming radio wave is parallel to it, and a minimum signal will be received when it is perpendicular to the antenna. Variations in the received signal strength may also reveal a patchiness in the ionosphere. The study of such variations should reveal new information on the sources of these localized variations of electron density.

INDICES D'ACTIVITÉ SOLAIRE POUR LA PROPAGATION IONOSPHÉRIQUE

(Extrait du *Journal des Télécommunications*, Vol. 32, n° 10, octobre 1965)

Les tableaux ci-après, contenant les valeurs des indices fondamentaux de la propagation ionosphérique, ont été établis par le secrétariat spécialisé du Comité consultatif international des radiocommunications (C.C.I.R.), conformément à la Résolution 4, l'Avis 371 et le Rapport 246 du C.C.I.R.

Remarque : De nombreux détails sur les indices ionosphériques sont contenus dans une publication récente : *Advances in radio research*, volume 2, éditée par J. A. Saxton (Academic Press, Londres et New York, 1964). Il s'agit de la contribution de C. M. Minnis, intitulée *Ionospheric indices*, pages 1-36, de l'ouvrage en question.

VALEURS OBSERVÉES :

● R_{12} (moyenne glissante sur douze mois du nombre de taches solaires) :

Mois / Année	1	2	3	4	5	6	7	8	9	10	11	12
1964	19	18	15	13	11	10	10	10	10	10	10	11
1965	12	12	12									

● I_{F2} (indice ionosphérique) :

Mois (année 1964).

1	2	3	4	5	6	7	8	9	10	11	12
0(2)*	6(2)*	20(2)*	14(2)*	1(2)*	—3(1)*	1(1)*	—3(1)*	4(1)*	3(1)*	—3(1)*	—4(1)*

Mois (année 1965).

1	2	3	4	5	6	7	8	9
7(1)*	5(1)*	20(1)*	18(1)*	10(1)*	15(1)*	17(1)*	12(1)*	9(1)*

(*) Les chiffres entre parenthèses indiquent le nombre de valeurs de foF_2 qui ne sont pas encore parvenues au secrétariat du C.C.I.R. et dont on n'a donc pas tenu compte dans le calcul de l'indice I_{F2}. Pour plus de détails, voir *Journal des télécommunications* (avril 1964, page 119).

Par rapport aux données contenues dans le Rapport 246 du C.C.I.R., une station de sondages ionosphériques a cessé de fonctionner — celle de Porto Rico (en juin 1963). Les valeurs de I_{F2} contenant entre parenthèses le chiffre (1) sont donc depuis le mois de juin 1963 les valeurs définitives de l'indice I_{F2}. En outre, la station de Fairbanks (College) n'a pas fonctionné pendant la période août-octobre 1963. Pour cette période les valeurs définitives de l'Indice I_{F2} sont celles contenant le chiffre (2) entre parenthèses.

● $\varnothing$ (flux du bruit solaire moyen mensuel) ** :

Mois / Année	1	2	3	4	5	6	7	8	9	10	11	12
1964	74	76	75	73	69	69	67	69	70	73	73	78
1965	78	75	74	72	78	77	74	75	76			

(**) Renseignements obligeamment fournis par le « National Research Council », Ottawa.

PRÉVISIONS POUR LES MOIS A VENIR (1er OCTOBRE 1965) *** :

● R_{12}

Année \ Mois			9	10	11	12
1965			19	20	22	24
	1	2				
1966	26	28				

(***) Renseignements obligeamment fournis par le professeur Waldmeier, Observatoire fédéral de Zurich.

Estimation de l'erreur sur les prévisions de R_{12} : + 10.

● I_{F2} ****

Année \ Mois			9	10	11	12
1965			22	25	28	31
	1	2				
1966	35	(39)				

(****) Renseignements obligeamment fournis par le « Department of Scientific and Industrial Research, Radio and Space Research Station », Slough.

La valeur prévue six mois à l'avance est donnée entre parenthèses.

Estimation de l'erreur sur les prévisions de I_{F2} :

Mois (1965)	9	10	11	12
Maximum	+3	+3	+3	+2
Minimum	—8,5	—11,5	—13	—14,5
Mois (1966)	1	2	3	
Maximum	+1,5	—1	—2	
Minimum	—16	—17	—17,5	

SOLAR INDICES FOR IONOSPHERIC PROPAGATION

(Reprint from *Telecommunication Journal*,
Vol. 32, No. 10, October 1965)

The following Tables, giving values of the basic indices for ionospheric propagation have been prepared by the Specialized Secretariat of the International Radio Consultative Committee (C.C.I.R.) in accordance with C.C.I.R. Resolution 4, Recommendation 371, and Report 246.

Note : A considerable amount of information on ionospheric indices will be found in an article by C. M. Minnis, entitled *Ionospheric indices* on pages 1-36 of the recent publication *Advances in radio research*, volume 2, edited by J. A. Saxton (Academic Press, London and New York, 1964).

PARAMETERS :

● R_{12} (smoothed mean, over twelve months, of the number of sunspots observed) :

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12
1964	19	18	15	13	11	10	10	10	10	10	10	11
1965	12	12	12									

● I_{F2} (ionospheric index) :

Month (year 1964)

1	2	3	4	5	6	7	8	9	10	11	12
0(2)*	6(2)*	20(2)*	14(2)*	1(2)*	—3(1)*	1(1)*	—3(1)*	4(1)*	3(1)*	—3(1)*	—4(1)*

Month (year 1965)

1	2	3	4	5	6	7	8	9
7(1)*	5(1)*	20(1)*	18(1)*	10(1)*	15(1)*	17(1)*	12(1)*	9(1)*

(*) The figures in brackets represent the number of values of foF_2 which have not yet reached the C.C.I.R. Secretariat, and which have not therefore been taken into account in the calculation of I_{F2}. For further details, see the *Telecommunication Journal*, April 1964, page 119.

With regard to the data contained in C.C.I.R. Report 246, one ionospheric sounding station has ceased to operate — Puerto Rico (in June 1963). The values of I_{F2}, that include the figure (1) in brackets are therefore, as from the month of June 1963, definitive values for I_{F2}. Furthermore the sounding station Fairbanks (College) did not operate during the period August-October 1963. For this period the definitive values of I_{F2} are those including the figure (2) in brackets.

● ∅ (monthly mean value of solar noise flux) ** :

Month Year	1	2	3	4	5	6	7	8	9	10	11	12
1964	74	76	75	73	69	69	67	69	70	73	73	78
1965	78	75	74	72	78	77	74	75	76			

(**) Data kindly supplied by the National Research Council, Ottawa.

FORECASTS FOR THE NEXT FEW MONTHS (1 OCTOBER 1965) *** :

● R_{12}

Month Year			9	10	11	12
1965			19	20	22	24
	1	2				
1966	26	28				

(***) Data kindly supplied by Professor Waldmeier, Federal Observatory, Zurich.

Estimated error in forecasts of R_{12} : $+$ 10.

● I_{F2} ****

Month Year			9	10	11	12
1965			22	25	28	31
	1	2				
1966	35	(39)				

(****) Data kindly supplied by the Department of Scientific and Industrial Research, Radio and Space Research Station, Slough.

The figure in brackets is the value forecast six months in advance.

Estimate of the error in I_{F2} predictions :

Month (1965)	9	10	11	12
Maximum	+3	+3	+3	+2
Minimum	—8,5	—11,5	—13	—14,5

Month (1966)	1	2	3
Maximum	+1,5	—1	—2
Minimum	—16	—17	—17,5

Commission V on Radio Astronomy

I.A.U.-U.R.S.I. SYMPOSIUM ON RADIO ASTRONOMY AND THE GALACTIC SYSTEM

Provisional list of subjects and suggested reporters

Asterisks indicate subjects requiring introductions of 1 to 1,5 hours. The reports on the other subjects should take between 30 and 45 minutes. There will then be ample time for discussion and for the presentation of special results.

I. *Interstellar clouds*

(*a*)* Observational data on the structure and motions of interstellar clouds, and on stellar associations (data from observations of the 21-cm line and of optical absorption and emission lines; dark clouds; structures as revealed by luminous clouds; connection with young stars and supernovae)	..........(1)

(1) Subjects I(*a*) and II(*d*) will be introduced by Blaauw, Oort or van Woerden.

(*b*) The problem of molecular hydrogen; OH and other observable radicals or molecules	
Observations	ROBINSON
Theory	SALPETER
(*c*)* General characteristics of clouds and their theoretical interpretation (including clouds dynamics, input and loss of kinetic energy, temperature, etc.)	KAHN
II. *Large-scale distribution and motion of the interstellar gas.*	
(*a*)* Distribution of neutral hydrogen and its systematic motions (spiral structure, rotation curve, overall density distribution, tipping of the outer parts of the layer, etc.) This subject has been dealt with at several previous meetings. I think that at this symposium we should concentrate especially on aspects in which new developments have taken place, such as rotational velocities in and outside the spiral arms (Shane, Burton), arms and other features deviating widely from the galactic plane (P. O. Lindblad, Habing, Gail Smith).	P. O. LINDBLAD
(*b*)* Central region (expanding arms, nuclear part, abundance and localization of OH) It may be that some new theoretical work on the origin of the expanding features could be added by the summer of 1966	KERR
(*c*)* Theories of spiral structure This should be a critical review of all the more important theoretical investigations on this subject.	PRENDERGAST
(*d*)* Systematic motions in high and intermediate latitudes This may become an important new subject, which has not been previously reported in any completeness	.... (1)

(1) Subjects I(*a*) and II(*d*) will be introduced by Blaauw, Oort or van Woerden.

(*e*) H II in the Galactic System and in other galaxies	Mrs Burbidge
(*f*) Comparison between the Galactic System and other spiral galaxies concerning the distribution and motion of atomic hydrogen	Burke
(*g*) Origin of the Galactic System in sofar as it may have influenced the present distribution of the gas This should be confined to a brief sketch	Lynden-Bell

III. *The galaxy as a radio source. Magnetic fields*

(*a*)* Distribution of non-thermal radiation in the Galaxy, its spectrum and its origin. Radio-frequency radiation from other « normal » galaxies (structure in the disk, the radio corona, « spurs » and their possible significance for the general structure of the Galaxy; discussion of the intensity of the extra-galactic background)	Baldwin
(*b*)* Structure of the magnetic field from polarization data (based on observations of polarization of continuous radio radiation from the Galaxy, in particular at short wavelengths; on Faraday rotations and depolarization of the galactic radiation as well as of that from radio sources; and on observations of optical polarization)	van de Hulst
(*c*) Sagittarius A	Lequeux
(*d*) Origin and evolution of cosmic-ray electrons, positrons and other cosmic-ray particles in the Galaxy	Ginzburg, or G. R. Burbidge
(*e*) Significance of X-rays and γ-rays for galactic research	Rossi
(*f*) Theory of the galactic corona	Shklovskii, or G. R. Burbidge
(*g*)* Theory of the magnetic field of the Galaxy	Woltjer

Commission VI on Radio Waves and Circuits

U.R.S.I. SYMPOSIUM ON ELECTROMAGNETIC WAVE THEORY, DELFT, SEPTEMBER 6 TO 11, 1965

The Delft Symposium on Electromagnetic Wave Theory was sponsored by the International Scientific Radio Union, and its Netherlands National Committee, by the Netherlands Electronic and Radio Society, and by the Technological University of Delft.

The opening ceremony was attended by a representative of the Minister of Science and Education, the Mayor of Delft, the Secretary of the College of Curators of the University, the Chairmen of the Departments of Electrical Engineering and General Sciences, Prof. S. Silver and Prof. Ch. Manneback, respectively Vice-President and Treasurer of U.R.S.I. and many participants of the Symposium. After a word of welcome by the chairman, Dr. Stumpers, professor Kuijpers, acting rector magnificus, gave an address on the history of the University and its future. He then officially opened the Symposium. Professor Manneback for U.R.S.I. thanked the University for its co-operation and wished the Symposium every success. After a coffee break Professor Barlow gave his lecture on Millimetre Waves and Optical Waves for Long Distance Telecommunications by Waveguide, and Mr. Kampinsky spoke on : Experimental Evaluation of the results of the Passive Communication Satellite Echo II.

In the afternoon the symposium split in a section on Antenna Theory, chaired by Professor H. L. Knudsen and Professor Roubine, and a section on Propagation in Inhomogeneous Media chaired by Dr. Stumpers. Invited papers were given by Professor Felsen (on Lateral Waves) and by Professor Karbowiak (on Aspects of Propagation in Inhomogeneous Media).

In the evening the acting Rector gave a Reception to the participants and their ladies.

On Tuesday the Section on Antennas continued, moreover we had a session on Propagation in Plasmas, chaired by Professor Cloutier, invited paper by professor Rydbeck (on : Some Wave Propagation Phenomena in Ionized Media), and a session on Underground Waves and Space Waves, chaired by Professor de Hoop, invited paper J. Wait (Terrestrial Waveguides).

The Wednesday was used for a very interesting excursion to the Delta project. The plans for closing the sea arms were discussed and some dikes and sluices were visited. The long boat trip from Hellevoetsluis to Rotterdam gave an opportunity to renew old friendships and have interesting discussions.

On Thursday Professor Timman chaired a session on Boundary Value Problems (invited paper Professor S. Karp). Professor Siforov chaired a session on Millimetre Waves and Optical Waves. Dr. Kay was chairman of the session on Coherence Problems and Modern Optics. In this session Professor Maréchalgav e an invited paper on Wavefront Optics and Professor Picinbono one on Statistical Optics.

Some of these sections continued on Friday. New sections started then on Surface Waves and Wave Beams, chairman Professor Barzilai, invited papers by Professor Oliner (Guided Complex Waves on Slow Wave Periodic Structure) and Dr. Zucker (Aspects of the Theory of Surface Waves). Another section was devoted to Propagation in Nonlinear Media, chairman Professor Siegel. This session had several contributions from U. S. S. R. scientists.

The Saturday was divided between Multiple Scattering and Scattering on Rough Boundaries in one hall and Deterministic Scattering in the other hall of the University. The first session was chaired by Professor Van De Hulst, and invited papers were given by Dr. Twersky (Multiple Scattering of Waves by N-Bodies), and by Professor Saxon (Propagation in Random and Periodic Lattices). The second session was chaired by Professor Marcuvitz, and the invited paper was given by Dr. Weston(Recent highlights in Diffraction Theory).

Shortly before 2 o'clock Dr. Stumpers thanked chairmen, speakers and participants and closed the Symposium.

On Friday night a banquet was organized in the Kurhaus Hotel, attended by many participants and their ladies. Professor Siegel was table president, and Professor Casimir gave the after-dinner speech; in a parable he slightly teased the theoreticians about their prolonged discussions on unit systems. Professor Silver addressed the participants on behalf of the Board of U.R.S.I. Professor Marechal, Knudsen and Siforov spoke on behalf on the foreign participants, and Dr. Stumpers for the organizers.

Apart from the invited lectures 117 contributions were presented at the Symposium. For this reason there were always two sessions simultaneously, but if one so desired all the papers of a section could be followed. The number of registered participants was 264, 64 from the United States, 46 from the Netherlands, 25 from France, 24 from the United Kingdom, 20 from Denmark, 18 from Italy, 18 from Western Germany, 14 from Sweden and 14 from U. S. S. R., Canada, Poland, Norway, Greece, D. D. R., Switzerland, Hungary, Yugoslavia, Australia, Belgium and Finland were also represented.

The main burden of the local organization fell on Professor Timman and more especially on Mr. (rear. admiral ret.) Goossens, who fulfilled his task with good grace and to every one's content.

The transactions of the Symposium will be published by Pergamon Press. It is hoped that all invited papers will be published in full, as well as a selection of the other papers. The remaining papers will be published in abstract. (All participants had received a book of abstracts, one month before the Symposium, and larger summaries or full papers were distributed to the participants.) Professor J. Brown of University College London will act as Editor of the Proceedings.

We had the usual minor difficulties : authors that did not show up; participants, who made reservations and forgot to cancel them, etc.

All things considered, however, it was a very interesting Symposium, with many good scientific contributions, at which many international contacts were renewed and new contacts laid. In this way if fulfilled the main task given to the Symposia of the International Scientific Radio Union, and it was a worthy successor to Copenhague, 1962 and its predecessors.

Dr. F. L. Stumpers.

Bibliography

Commissions II and III.

" The Use of Axograms for the condensed presentation of shortwave propagation data ", by M. Argirović, Radio Engineer, Belgrade, Yugoslavia, *Telecommunication Journal*, Vol. 32, No. 11, Nov. 1965.

COMMISSION III.

" Catalogue of Ionospheric Data ", received up to 30 June 1965 at the Radio and Space Research Station, Slough (World Data Centre C1).

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The Radio Propagation Unit, National Physical Laboratory, Delhi, has published the Scientific Report No. 22 : « Plasma Diffusion in the Ionosphere », by S. CHANDRA.

Abstract. — Equation of continuity is derived for the F region without assuming ambipolar diffusion. It is shown that the commonly employed form of the equation of continuity remains unaltered if the divergence of electron and ion fluxes are equal. It is further shown that the so-called « diffusion term » in the equation of continuity implicitly includes the effect of electric field whatever be its origin. An expression for electric field is derived which is applicable to a situation in which the plasma density and electric potential varies in the vertical direction only.

* * *

The Ionospheric Prediction Service, Australia, is publishing regularly *Hourly values of Ionospheric Characteristics* at the following stations :

Brisbane, 27.5° S, 152.9° E. Frequency range : 1.0 to 16.0 Mc/s.
Canberra, 35.3° S, 149.0° E. Frequency range : 1.0 to 25 Mc/s.
Maroson, 67.6° S, 62.9° E. Frequency range : 0.8 to 20.0 Mc/s.
Norfolk Island, 29.0° S, 168.0° E. Frequency range : 1.0 to 20.0 Mc/s.
Port Moresby, 9.4° S, 147.1° E. Frequency range : 1.0 to 25.0 Mc/s.
Townsville, 19.3° S, 146.7° E. Frequency range : 1.0 to 25.0 Mc/s.
Vaninio, 2.7° S, 141.3° E. Frequency range : 1.0 to 20.0 Mc/s.
Wilkes, 66.2° S, 110.5° E. Frequency range : 0.25 to 20.0 Mc/s.

* * *

Nous signalons à l'attention de nos lecteurs l'article « Établissement d'une formule relative à l'ionisation globale de la couche F_2», par Chaman Lal, publié dans le *Journal des Télécommunications*, Vol. 32, n° 10, 15 octobre 1965.

Résumé. — La moyenne mensuelle des données horaires relatives aux fréquences critiques de la couche F_2 fournies par les stations de sondage ionosphérique peut servir à calculer une moyenne globale ou « planétaire » de la fréquence critique ou de l'ionisation de cette couche. On a étudié ces moyennes mensuelles planétaires $(\Sigma \overline{foF_2})p$ pour la période 1947-1961 et on a constaté que l'ionisation planétaire de la couche F_2 présente une périodicité semestrielle marquée avec des maximas systématiques en avril et en octobre. Une relation simple, de la forme

$$(\Sigma \overline{foF_2})p^2 = K \times F_{10} \times FSA$$

correspond parfaitement aux variations séculaires de l'ionisation planétaire de la couche F_2 au cours de cette même période. Dans cette formule, K est une constante de proportionnalité, F_{10} représente la valeur du flux solaire à 2800 MHz déterminée par Covington, et FSA est le facteur saisonnier d'accroissement dont il est question dans le présent article.

* * *

COMMISSION V.

The Radio Propagation Unit, National Physical Laboratory, Delhi, has published the Scientific Report No. 21 : « A solar radiometer at 2000 Mc/s », by N. V. G. SORMA and M. N. JOSI.

The report describes a radiometer at a frequency of 2000 Mc/s, recently built and installed at the National Physical Laboratory, New Delhi. This instrument is being used for regular measurement of radio flux at a wavelength of 15 cm.

The antenna used is an equatorially mounted parabolic dish of 1.6 meters diameter fed by a circular wave guide. The energy collected by the antenna is taken to a conventional type of broad band mixer in a strip line form using a 1N21F mixer diode. The 30 Mc/s intermediate frequency is first amplified by a low noise transistorized 1F amplifier and then by a high gain post 1F amplifier. The overall bandwidth of the system is 5.3 Mc/s. The rectified signal is further amplified by a D. D. amplifier which drives a pen recorder.

A free space impedence box has been used for the accurate calibration of the system.

* * *

« Report on the Interim meeting of C.C.I.R. Study Group IV at Monte-Carlo, February 1965 », by Dr. R. L. Smith-Rose (see p. 32).

Commission VI.

« Some notes on pulse code modulation », by P. Bronzini, I.F.R.B., *Telecommunication Journal*, Vol. 32, No. 11, November 1965.

SERVICES PERMANENTS

I.U.W.D.S.

CHANGE OF SECRETARY

Copy of a letter from A. H. Shapley to the Members of I.U.W.D.S. Steering Committee and liaison representatives

Dear Colleague :

Mr. Leen de Feiter has asked to be relieved of his duties as Secretary, I.U.W.D.S. Steering Committee, because he plans to spend the year 1966 at Sacramento Peak Observatory. After consultation with Mr. de Feiter, I have invited Dr. P. Simon of Meudon to serve as Acting Secretary until the next meeting of the Steering Committee, presumably at the time of the 1966 U.R.S.I. General Assembly, when the situation of the officers is to be reviewed according to I.U.W.D.S. rules.

Dr. Simon is in immediate charge of the Service d'Ursigrammes at Meudon and has a good knowledge of our activities. He will take over the areas of responsibilities now carried by Mr. de Feiter, except that Mr. de Feiter expects to oversee the publication of the new edition of the I.U.W.D.S. code booklet before his departure for America.

It is impossible to express adequately in a short space the debt we owe to Mr. de Feiter for his contribution to I.U.W.D.S. work over the last five years. We know he will continue to keep contact with the work in his professionnal career and will be available for further counsel.

At the same time we welcome the willingness of Dr. Simon to serve as acting secretary, and count on his assistance in the coming months.

Sincerely yours,
A. H. Shapley
Chairman

November 1, 1965.

* * *

Dr. P. Simon's address is : Observatoire de Paris, Meudon (Seine et Oise), France.

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INTER-UNION COMMISSIONS

Inter-Union Commission on Frequency Allocations for Radio Astronomy and Space Science (I.U.C.A.F.)

RADIOASTRONOMY AND THE C.C.I.R.

Interim meeting of C.C.I.R. Study Group IV at Monte Carlo, February 1965

(Doc. I.U.C.A.F./77 (revised))

At the interim meeting of Study Group IV of the International Radio Consultative Committee (C.C.I.R.) held at Monte Carlo in February 1965, Question 244, entitled « Radioastronomy », was maintained with only minor revisions. The text of this question is reproduced in Appendix I.

Arising from this question two reports were adopted. The first of these, entitled « The OH-lines in Radioastronomy », followed the observation of these spectral lines in 1963 : and the report is attached as Appendix II.

The second is a comprehensive report dealing with the characteristics and factors affecting frequency sharing between radioastronomy and other services; and it is reproduced in full in Appendix III. In its original form, published in 1963, this report included details of the location and characteristics of radioastronomical observatories throughout the world. As already explained in Doc. I.U.C.A.F./73, however, such information is now being collected for transmission to the International Frequency Registration Board.

A Recommendation concerning the « Protection of Frequencies used for Radioastronomical Measurements », which was adopted by C.C.I.R. Study Group IV, has been reproduced in Doc. I.U.C.A.F./76.

In order that the interests of radioastronomers may continue to be safeguarded, and the protection of the assigned frequencies improved, it is desirable that I.U.C.A.F. should co-ordinate any comments or observations on these documents (Appendices I-III) for forwarding to the C.C.I.R. in good time for its next Plenary Meeting in June 1966.

This matter will be placed on the agenda of the next meeting of our Commission (I.U.C.A.F.).

R. L. SMITH-ROSE.
Secretary-General

P. S. — A draft new question entitled : « Frequency Utilisation above the Ionosphere and on the Far Side of the Moon », has been adopted by correspondence and is reproduced as Appendix IV.

APPENDIX I

C.C.I.R. Question 244 Study Group IV

RADIOASTRONOMY

The C.C.I.R.

considering

(*a*) that radioastronomy is based on the reception of signals at much lower power levels than are generally employed in other radio services and, hence, is subject to harmful interference from sources that could be tolerated by many other services;

(*b*) that, for an understanding of the naturally occurring phenomena that produce characteristic line frequencies and the physical processes that result in continuum emission, radioastronomers must observe at both the immutable line frequencies and at several diverse points in the continuum;

(*c*) that the C.C.I.R., in recognition of the above situation, adopted Recommendation 314, « Protection of frequencies used for radioastronomical measurements » at the IXth Plenary Assembly, Los Angeles, 1959;

(*d*) that the Administrative Radio Conference, Geneva, 1959, recognized the radioastronomy service and the cosmic origin of the signals used in this branch of astronomy;

(*e*) that the Radio Regulations, Geneva, 1959, allocated a band at the hydrogen line frequency (1400 to 1427 Mc/s) for the radioastronomy service on a worldwide basis, and provide some further protection for the radioastronomy service on a regional basis, either by other than primary allocation or by footnote;

(*f*) that the Administrative Radio Conference, Geneva, 1959, in its Recommendation No. 32, drew attention to the special case of the radioastronomy service and to the failure of the revised Table of Frequency Allocations to meet fully the stated requirements, urged that observatories be located as remotely as possible from sources of radio interference, and recommended that further consideration be given to the question of frequency allocations for radioastronomy;

(*g*) that the expected expansion of space-communication programmes, noted by Recommendation No. 36 of the Administrative Radio Conference, Geneva, 1959, has occurred;

(*h*) that space communication signals may nullify the partial protection to radioastronomy observations afforded either by remotely located observatory sites or by other regional or more local administrative provisions;

unanimously *decides* that the following question should be studied

1. what are the characteristics of the signal of interest to radioastronomy ? In addition to parameters such as intensity, frequency, bandwidth, polarization, and modulation, or frequency of occurrence, how do the characteristics vary depending on the celestial source, e.g. the sun, planets, extended galactic sources, extragalactic sources with large Doppler shifts;

2. with reference to Article 1, N. 93 of the Radio Regulations, Geneva, 1959, which defines harmful interference as « Any emission, radiation, or induction which endangers the functioning of a radionavigation service or of other safety services

or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with these Regulations », what is a practical interpretation of this definition for the radioastronomy service;

2.1. with reference to para. 1, what are the threshold values of the signal level for there to be harmful interference;

2.2. how are these threshold values modified if reception is via the side lobes only rather than the main beam of the radio-astronomy telescope;

3. what interference levels would typical observatory sites (the site at Green Bank, W. Va. might be taken as a typical remote site, and the Observatory of the University of Michigan of Lincoln Laboratory might be typical of sites in more populated regions) experience in the VHF, SHF and EHF bands, as predicted by means of the best available experimental data and accepted theories on atmospheric scatter, diffraction, and related propagation phenomena, from the following types of sources :

3.1. ground-based transmitters, assumed to operate in accordance with accepted standards;

3.2. airborne transmitters, including both fundamental and spurious emissions;

3.3. aircraft illuminated by ground-based transmitters;

3.4. orbiting devices with active transmitters, considered both with and without directional antenna systems;

3.5. orbiting reflectors, illuminated from the ground, including both « Echo » type satellites and unintentional reflectors such as active satellites, carrier rocket cases, and similar debris; and

3.6. orbiting zones or bands of diffuse scattering elements, illuminated from the ground;

4. what are the general areas of interest in the radio-frequency spectrum to the radioastronomy service, in the light of :

4.1. the Table of Frequency Allocations, 1959; as revised at the E.A.R.C., Geneva, 1963;

4.2. the advent of operational space telecommunication systems ;

4.3. the rapidly improving observational capabilities and techniques now in use and anticipated, such as larger antenna systems, masers, and other forms of improved receivers, and more sophisticated means of handling and analyzing data;

4.4. possible use of higher frequencies than the present limit of 40 Gc/s in the Table of Frequency Allocations; and

4.5. other line frequencies than those listed by the C.C.I.R. in Recommendation 314 ?

Appendix II

The OH-Lines in Radioastronomy

Draft Report (1) relating to C.C.I.R. Question 244 (IV)

Radiofrequency spectral lines due to the hydroxylion OH in interstellar space were first observed in October 1963 [1]; they had been identified in the laboratory in 1959 [2]. The frequency of the principal lines is now well-established to be 1665.402 Mc/s and 1667.357 Mc/s. Following the initial detection in the region of Casseiopeia A, stronger effects were discovered in the region of the centre of the Galaxy [3, 4]. More recently two weaker lines at 1612.2 and 1720.5 Mc/s have been detected [5].

Prior to 1963 the only line that had been detected in radioastronomy observations was that due to atomic hydrogen, at a rest frequency of 1420.4 Mc/s. The discovery of lines due to OH is of great significance, because of the somewhat unexpected light it throws on physical conditions within the Galaxy. The observed intensity of the OH lines relative to that due to atomic hydrogen at 1420 Mc/s suggests that molecular hydrogen may be a great deal more abundant than had been thought. The percentage of gas in molecular form apparently increases rapidly in the vicinity of the centre of our Galaxy and this makes it likely that other molecules are present and may be observable. The ratio of the intensities of the four OH lines so far discovered [5] differs

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(1) C.C.I.R. Doc. IV/139; 24th February 1965.

markedly from the predicted values; the reason is not yet understood but clearly holds valuable information on the physical conditions under which OH molecules are formed in space.

All observations so far made of OH have been of the absorption it produces in the spectra of strong radio sources. Such measurements of the optical depth give the radio of the number of OH atoms in a column of unit area in the line of sight to the excitation temperature of the energy levels involved. It is of fundamental importance, however, that these quantities be determined separately; this could be done by means of emission measurements but no such results are yet available. Observations to date show that antenna temperatures produced by OH in emission are less than 0.05° K; the greatest attainable sensitivity and freedom from harmful interference are therefore required for investigation of the OH lines. (See Report reproduced as Appendix III for discussion of sensitivity of radioastronomy measurements and levels of harmful interference.)

As in the observation of the 1420 Mc/s line of hydrogen, the receiver used to study the OH line must have narrow bandwidth (typically 10 to 25 kc/s) but be tunable over the range covered by the line in order to delineate the line profiles; as observed in the sky, the lines are broadened and shifted by several Mc/s as a result of Doppler effects due to relative motions of various parts of the Galaxy [4, 6, 7]. Furthermore, accurate mesurement of the shape of a spectral line requires comparison observations at frequencies adjacent to but not including the lines themselves. The overall frequency band needed for detailed study of the two principal OH lines at 1665.4 and 1667.4 Mc/s, taking into account the requirement for comparison observations and Doppler effects, is approximately 10 Mc/s. Fig. 1 shows the profile of the absorption due to the 1665 and 1667 Mc/s lines in the direction of the galactic centre as observed with an 18 m radiotelescope in the U. S. A. Observations in Australia using a 64 m radiotelescope show essentially the same features.

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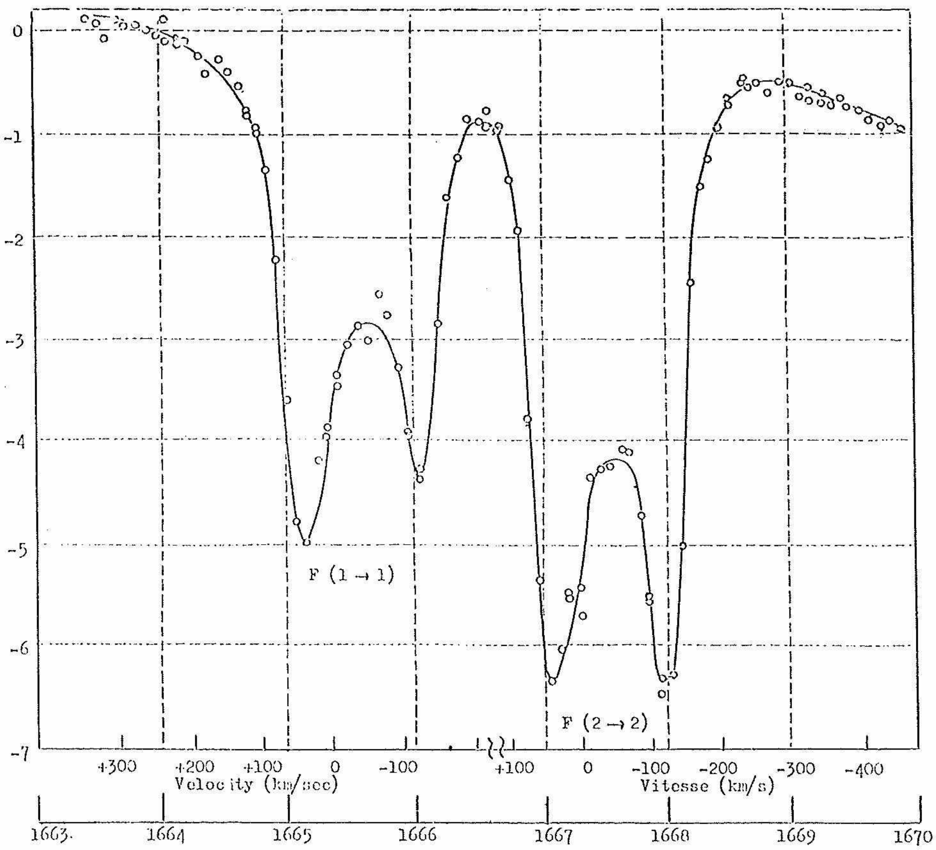
FIG. 1. — OH-absorption spectrum of Sagittarius A showing both principal lines. Each point represents an integration time of 480 s.



Appendix III

Radioastronomy

Characteristics, and factors affecting frequency sharing with other services

Draft Report (1) *on C.C.I.R. Question 244 (IV)*

1. — Introduction.

Radioastronomy and the radioastronomy service are defined in Article 1, Nos. 74, 75, and 75A of the Radio Regulations, Geneva, 1959 (as revised in the Final Acts of the Extraordinary Administrative Radio Conference, Geneva, 1963), as being astronomy based upon the reception of radio waves of cosmic origin. Since it uses receiving techniques only, the radioastronomy service does not cause interference to any other service.

« Radar » astronomy, which involves the transmission of a signal at a high power level and the detection of that signal after reflection from celestial bodies, man-made satellites, or meteor trails, is a quite different service, and is defined in Question 245 (IV).

Radioastronomy began with the discovery in 1932, by Karl Jansky [1], of radio waves of extra-terrestrial origin. The cosmic emissions with which the radioastronomy service is concerned constitute the « cosmic background noise » of communications engineering.

Since Jansky's original observations, remarkable progress has been made in identifying the nature of these emissions, and radioastronomy is now firmly established as an important branch of astronomy. It is a new field of science which is only just being opened up, but it has already made important contributions, for example, to the measurement of atmospheric absorption at radio frequencies; to our knowledge of the composition and nature of the sun, the planets, and interplanetary space and, in particular, of major disturbances in the solar atmosphere which are often forerunners of interruptions to radio communications circuits and of radiation hazards to man in space. Further afield, studies of individual sources over a range of frequencies, and of the « line » emissions at precise frequencies which result from transitions within certain atoms, are providing information basic to our

(1) C.C.I.R. Doc. IV/137; 24th February 1965.

understanding of the physical processes responsible for the emissions, of the physics of plasmas, and of the structure and evolution of galaxies and of the Universe as a whole. The radioastronomy service offers means for studying magnetic fields in distant regions of the Universe, and much of the information it provides is unique in that is is unobtainable by optical or other methods; one if its most spectacular characteristics is the ability to probe even further into the depths of space than is possible with the largest optical telescopes.

In addition to providing new knowledge and understanding of great significance to astrophysics and cosmology, radioastronomy is repaying in a practical way some of the investment of specialized radio techniques that helped to bring it into being. It supplied a major stimulus to the development of maser and parametric amplifier techniques, and hence to an increase, by orders of magnitude, in the sensitivity attainable in radio receivers. It has also made, and is continuing to make significant contributions to the design of large steerable antennae and feed systems.

The cosmic emissions with which the radioastronomy service is concerned are characterized by low power flux levels at the earth and by the absence of modulation, other than random noise. For many sources the best times for observation are dictated by natural phenomena, over which the observer has no control, and radioastronomers are not generally able to observe over any chosen limited time interval. Further the radioastronomer is unable to change the character of the «signal» he wishes to receive; he cannot increase the transmitter power nor code the transmitted signal to increase its detectability. The radioastronomy service is thus extremely susceptible to interference, and to ensure its continued progress there is need for the I.T.U. to provide it with the greatest practicable degree of protection.

2. — Origin and nature of the emissions.

2.1. — The radio waves with which the radioastronomy service is concerned are generated in extraterrestrial sources by three distinct mechanisms :

— thermal emission from hot ionized gas and from solid bodies;

— non-termal processes, mainly synchrotron emission from electrons spiralling in a magnetic field, but including also emission from plasmas (as in the solar atmosphere);

— « line » emission resulting from transitions within individual atoms.

These combine to produce :

A *continuum of radiation*, which extends relatively smoothly over the whole frequency range accessible to observation, upper and lower limits of observation are imposed by the Earth's atmosphere at, roughly, 50 Gc/s and 1 Mc/s respectively.

The continuum is composed of a background together with numerous small « bright » regions, the discrete radio sources. The background shows a general distribution over the whole sky with a broad maximum in the direction of the galatic centre, together with a ridge of intense emission around the galactic equator (the Milky Way), showing a marked maximum in the direction of the centre.

The discrete sources, often referred to as radio « stars », are, with the exception of the Sun, not stars but radio « nebulae ». They are distributed over the sky, those near the Milky Way region usually belonging to our Galaxy and those remote from this region generally being galaxies external to our own.

« *Line* » *emission* which, though occurring at the source at one or more precise frequencies determined by the transitions involved, is observable over a band of frequencies as a result of Doppler shifts due to relative motions in the line of sight.

Intermittent emission (« bursts »), of durations which may vary from seconds to hours. They are most intense in the HF and VHF bands, and those from some disturbances in the solar atmosphere may vary progressively in frequency, from high to low, during their lifetime. Those so far detected originate in localized areas on the Sun, a few other stars, and the planet Jupiter.

2.2. — *Continuum radiation and discrete sources.*

The discovery of radio sources and the bulk of current knowledge about their nature and distribution, and of the processes responsible for the radio emission from them, has come through observations of the continuum radiation, made at a limited number of frequencies at the lower end of the band transmitted by the ionosphere. Observations of intensity need to be made at a number of frequencies to determine the characteristic « spectra » of sources, but, because the distribution of continuum radiation with frequency is relatively smooth, observations of this kind do not need to be made at specific or closely adjacent frequencies. Bands spaced within each octave of the radiofrequency spectrum are satisfactory.

For determining the size of certain of the radio sources, high angular resolution is necessary; some of these sources are not resolvable by existing antenna systems, and it is only by observing their occultation by the Moon that limits to their sizes have been determined. The existence of « quasi-stellar » objects, which are extremely powerful radio emitters situated at enormous distances from our Galaxy, has opened up a completely new chapter of cosmology. Here again the observations require a series of bands separated at intervals of about one octave, with protection on a world-wide scale because of the reflecting power of the Moon.

The bands made available to the radioastronomy service in accordance with the final Acts of the E.A.R.C., Geneva, 1963, in general meet these requirements so far as frequencies are concerned, except that in most cases they are either shared with other services or have footnote status only. Freedom from harmful interference at the level required for observations of the highest sensitivity is, therefore, often not achieved.

2.3. — « *Line* » *radiation.*

Observations of « line » radiation came somewhat later in the history of radioastronomy, the first to be discovered (1951) being that due to neutral atomic hydrogen [2], at a rest frequency of 1420.4 Mc/s. In 1963 a second line (a doublet) was discovered due to the hydroxyl ion OH, when absorption was observed in the spectrum of the radio source Cassiopeia A [3] from lines whose rest frequencies were determined at 1665.4 and 1667.4 Mc/s. Absorption due to OH has since been studied in some detail in the spectrum of the radiation from the galactic centre. (See Appendix II) OH has not so far been detected in emission.

Studies of the neutral hydrogen line at 1420 Mc/s have provided, and are continuing to provide, new knowledge about the distribution and motion of interstellar hydrogen, and thus about the mass distribution and the relative proportions of gas and stars in different parts of our own Galaxy, and in external galaxies. Observations of OH are at a preliminary stage but indicate that the proportion OH to H is unexpectedly high in the vicinity of the centre of our Galaxy. Studies of « line » emissions thus provide information which is often unique and of the most basic significance to astrophysics and cosmology; for example the detailed distribution of neutral hydrogen and OH cannot be observed by optical methods.

The investigation of line emission (or absorption) is one of the most difficult and challenging fields in radioastronomy. Reception techniques of the highest attainable sensitivity, often involving long integration times, are required; consequently, freedom from harmful interference is necessary. It is required over a band of frequencies wide enough to include broadening of the original emissions due to Doppler effects, together with a band of comparable width for comparison or reference purposes adjacent to that containing the line.

2.4. — *Bursts.*

The Sun is the outstanding source of short-period emissions; at metre wavelengths, the level of some bursts may exceed that of the thermal radiation from the Sun's disk by a factor of at least 10^6 [4]. This has led to a search for « burst » emission from some relatively nearby stars of a class known as « flare » stars, which show occasional short-period variations in brightness : in several of them coincident increases in radio and optical brightness have been detected.

High intensity bursts are also received from the planet Jupiter [5, 6]. These are observed sporadically in the frequency range 5 to 30 Mc/s.

3. — Classes of observations

3.1. — Radioastronomy observations can be broadly divided into two classes :

Class A observations are those in which the sensitivity of the equipment is not a primary factor. They are often used in the study of those cosmic emissions which are of relatively high intensity. Many of the solar, Jupiter, riometer, and scintillation observations fall into this class; continuity is a primary factor for these observations.

Class B observations are of such nature that they can be made only with advanced low-noise receivers using the best available techniques : long integration times and wide receiver bandwidths are usually involved. The significance of these observations is critically dependent upon the sensitivity of the equipment used in making them.

3.2. — The sensitivity of receivers used for class B observations and the levels of harmful interference are discussed in Annex 1. Some of the basic measurements in the radioastronomy service are those of the absolute intensity of emissions originating in the outer fringes of the Universe : for these and many other radioastronomy observations the presence of unwanted signals can produce misleading or erroneous results. Because the levels of interference that can be tolerated are so very low it is often impracticable to measure them with conventional monitoring equipment; it is difficult to measure them with a very sensitive radioastronomical receiver unless it is used with a high-gain antenna. Some typical calculations are given below.

It is noted from Recommendation 11A of the Final Acts of the Extraordinary Administrative Radio Conference, Geneva, 1963, that further consideration to the provision of improved frequency allocation for radio astronomy is to be given at the next Ordinary Administrative Radio Conference (1).

4. — DETAILS OF RADIOASTRONOMY OBSERVATORIES.

Appendix 1A (Section F) of the Radio Regulations (as revised in the Final Acts of the Extraordinary Administrative Radio Conference, Geneva, 1963) describes the information on observatories and on the observations in progress or planned, which Administrations should furnish to the I.F.R.B. for incorporation in the Master International Frequency Register (2). It is understood that this information will be published by the I.T.U. from

(1) See Doc. I.U.C.A.F./54, Appendix III.

(2) Doc. I.U.C.A.F./73 includes a letter which has been sent to a large number of radio astronomers requesting their co-operation in supplying this information.

time to time in the form outlined in the revision of Appendix 9 of the Regulations (List VIIIA).

5. — Sources of interference.

The following notes describe some of the more probable causes of interference which may occur (particularly to Class B observations) even at an observing site chosen to minimize interference. Some of these will be significant even in bands allocated exclusively to the radioastronomy service on either a local or a more extensive basis.

5.1. — Terrestrial stations within about 100 km are very likely to cause interference if operated in a band shared with radioastronomy. If they operate at lower frequencies, harmonic radiation can cause interference if it is not suppressed at the source. Unwanted sideband radiation from high-power transmitters can have appreciable energy in an adjacent radioastronomy band. Adequate suppression of both harmonic and unwanted sideband radiation at the transmitter is technically possible provided that sites are chosen with care. In meteorological conditions leading to anomalous tropospheric propagation, the distance from which interference can be caused by ground transmitters is likely to be increased to several hundred kilometers but these conditions will occur only infrequently in most parts of the world. At VHF, interfering signals can be received occasionally by ionospheric propagation.

5.2. — Some transmitters carried by aircraft and spacecraft are likely to cause interference at fundamental or harmonic frequencies, but adequate suppression of harmonic radiation is technically possible.

5.3. — Reflections from aircraft are likely causes of harmful interference in a shared band even when the terrestrial transmitter is distant, and the possibility of interference by reflections from low-orbit satellites also exists. A single reflecting body will be effective for only a short time and the interference problem will depend on the density of the air or space traffic.

5.4. — For certain types of radioastronomical measurements in shared bands, reflections of terrestrial transmissions by the Moon can cause serious interference. The Moon is of great importance to radioastronomy for two main reasons. The first, and more important, is that because both the shape and the motion of the Moon are known, the observation of lunar occultations of radio sources provides the most accurate available method for determining their angular positions and, in some instances, their sizes. Occultation of a particular radio source by the Moon will occur only at long intervals and it is important that there should be no harmful interference at these times. The second use of the Moon is as a calibration source, because its effective temperature over a range of frequencies is accurately known.

In both applications the main beam of the radio telescope is directed at the Moon and the observations are, therefore, particularly susceptible to interference by signals reflected from the lunar surface. Illumination of the Moon by terrestrial transmitters, either intentionally or otherwise, in frequency bands used by the radioastronomy service can thus cause harmful interference; occultation measurements have already been prevented on many occasions by radar pulses reflected from the Moon.

5.5. — It has been reported [7] that belts of orbiting dipoles, if sufficiently dense to be used as reflectors for an operational communications service, may lead to harmful interference to radioastronomy in bands shared with services using high-power transmitters, even if these bands are well separated from the resonant frequency of the dipoles.

5.6. — Incoherent scattering of high-power transmissions by free electrons in the ionosphere is a further potential source of interference but is at present less important than the sources already discussed.

6. — LEVELS OF HARMFUL INTERFERENCE AND FACTORS AFFECTING FREQUENCY SHARING.

6.1. — Interference to the radioastronomy service may be of two kinds : one is readily apparent and may interrupt or prevent the observations; the other, perhaps even more harmful to the progress of radioastronomy, involves interfering signals at such low flux levels that they cannot be detected at the time of the observation nor, in many cases, during the analysis of the data. This latter type of interference can lead to misleading or invalid conclusions.

6.2. — Because of the noise-like character of cosmic emissions, the inherent uncertainty in a radioastronomy measurement is set by fluctuations of the total noise, both desired and undesired. These fluctuations can be expressed in terms of an equivalent r.m.s. temperature fluctuation, ΔT_e, defined in the Annex. A level of harmful interference to a Class B radioastronomy measurement is reached when the unwanted signal flux incident upon the antenna is sufficient to increase the operating noise temperature by a significant fraction of ΔT_e. If the radioastronomy service is to secure the advantage of low-noise receivers, the level of interference must not introduce an error of more than 10 % in the measurement of flux density. For example, the flux density of a continuous unwanted signal must contribute less than 0.1 ΔT_e; alternatively, an unwanted signal equivalent to ΔT_e must not exist for more than 10 % of the observation time.

6.3. — The levels of co-channel interference which are harmful to a Class B radioastronomy observation can be obtained from Table I of the Annex by taking account of the gain of the receiving antenna in the direction of the interference. To calculate the level of interference from a specific unwanted signal, we require knowledge of the antenna pattern and the direction of arrival of the signal. Many radioastronomical observations are performed by using a single antenna, usually a parabolic reflector having characteristics similar to those of earth-station antennae used in communication-satellite systems when the diameters, expressed in wavelengths, are similar. However, at the longer wavelengths used in radioastronomy it is in most cases impracticable to use antennae with correspondingly large diameters, and consequently these are more susceptible to interference received through the side lobes. Furthermore, some experiments involve the use of interferometers in which the individual antenna elements have relatively low gain. Such antenna assemblies may nevertheless have high gain in a number of areas forming a coherent pattern over the whole sky. For example, in a direction in which each antenna of an assembly is effectively isotropic, the combined gain may be equal to the number of antennae. The example which follow refer to a highly directive parabolic antenna, but it should be borne in mind that an interferometer will require a greater degree of protection unless its individual elements are highly directive.

6.4. — For the usual case of unwanted signals entering via the far side lobes of the antenna, we may assume that the gain of the best receiving antennae at centimetre wavelengths is —10 db relative to an isotropic antenna. Since the gain of the main beam and the nearby side-lobes will normally be more than 30 or 40 db, unwanted signals from these directions will be harmful at correspondingly lower levels. As a numerical example, Table I shows that, for typical continuum observations at 2.7 Gc/s, radioastronomy measurements may be rendered invalid by unwanted flux levels above —167 db (W/m^2) incident upon the far sidelobes of the radio telescope. It is immediately evident that, for line-of-sight transmission, interference from a single transmitter could be intolerable at enormous distances, even for transmitters of moderate power. In this example, a one-watt transmitter with an omnidirectional antenna could interfere at a distance of 70.000 km.

6.5. — The curvature of the earth provides some protection against such levels of interference if the transmitter is on the earth. However, energy will be propagated over large distances by tropospheric scatter and other mechanisms. For example, at 500 km a 2.7 Gc/s signal propagated by tropospheric scatter would frequently be only 70 db below free-space intensity; at these times a 700 W transmitter at this distance, with an omnidirectional antenna, could cause harmful interference. Other propagation mechanisms, though more erratic than tropospheric scatter, may result in even more severe interference. These include reflections from sporadic E ionisation and from meteor trails at meter wavelengths and scattering of microwaves by heavy rain. Reflections from aircraft and artificial satellites are effective over even greater distances, their importance increasing with the number of such objects.

As an illustration we may take 100 m^2 as the scattering cross-section of a large aircraft, and assume that the aircraft is equidistant from the transmitter and radioastronomy observatory. With the aircraft flying at a height of 12 km the horizon distance is 450 km and we ask under what conditions can harmful interference be propagated to the horizon. At 408 Mc/s, for example, it is realistic to assume that the far lobes of the receiving antenna are equivalent to an isotropic antenna; the minimum effective radiated power to cause harmful interference is then 6 kW. The range at which aircraft-reflected interference can be harmful is thus limited primarily by the horizon distance, i.e. 450 km for an aircraft height of 12 km. This can mean that interference from a transmitter as far away as 900 km from the radioastronomy observatory could be harmful.

We must also consider scattering from artificial satellites. Here the horizon distance is greatly increased and the satellite will be within the simultaneous line of sight of a vast area of the earth. The scattering cross-section is perhaps a factor of 100 below that of an aircraft, but this will be more than counterbalanced if, because of the high angle of elevation of the satellite, it appears in the near side lobes of the radioastronomy antenna. As mentioned earlier, these may have gains greater than 30 db. However, with a narrow beam antenna, a satellite would be in the beam or near side lobes for a very short time and, as in other interference problems, this would need to be taken into account in determining the severity of the interference.

Reflections from the Moon are especially likely to be a source of serious interference to occultation and calibration observations, in which the main beam of the antenna is necessarily directed at the Moon. For purposes of illustration the effective cross-section of the Moon may be taken to be $10^{11} m^2$. Then, an occultation observation at 408 Mc/s made with a radio telescope of 45 db gain (beamwidth approximately 1^{o}), using a bandwidth of 2 Mc/s and an integration time of 2 s, will suffer harmful interference if a total power of only 3400 watts is radiated from isotropic antennae located on the moonlit hemisphere of the earth.

6.6. — *Harmonics.*

Up to this point, it has been assumed that the transmitter is operating at a frequency within the receiver bandwidth. It is well known that the technical ability to control the transmitte- frequency and to design receivers with great selectivity has provided a fundamental basis for present radiocommunications. To explore the protection this offers to radioastronomy let us assume that the transmitter is operating at a sub-harmonic of the radioastronomy receiver and that the harmonic suppression is 80 db. From the illustrative example given for the line-of-sight situation, even with this degree of suppression at the transmitter, there may be harmful interference at separation distances of the order of

100 km, for the conservative case of isotropic antennae at both transmitter and receiver.

6.7. — *Some conclusions on frequency sharing.*

In view of the very low levels at which interference has been shown to be harmful to the radioastronomy service it is concluded that :

6.7.1. — Because of the nature of the phenomena observed in radioastronomy, only under special conditions will it be feasible to devise timesharing programmes between radioastronomy and others services operating on the same frequencies.

6.7.2. — If relatively high power is beamed at the Moon, or at artificial satellites, or if lower power is beamed at aircraft closer to the ground stations, the signal picked up through side-lobes of the radioastronomy antenna may cause interference, if the transmitter frequency corresponds to the reception band in use by the radioastronomy service.

6.7.3. — Considering the large areas of the earth visible to a satellite or the Moon, administrative actions to protect the radioastronomy service will need to be on a world-wide (or, at least, regional) basis; a single Administration acting independently cannot cope with the general problem.

6.7.4. — It is not feasible for the radioastronomy service to share frequencies with any other services in which direct line-of-sight paths from the transmitters to the observatories are involved.

6.7.5. — Until harmonic suppression much greater than 80 db is provided in transmitter designs, services employing high transmitter powers will cause interference, if assigned to operate within the line-of-sight at frequencies sub-harmonically related to those employed by the radioastronomy service.

6.7.6. — To obtain maximum usefulness of his equipment, the radioastronomer should place his observatory at a site remote from centres of population and protected from unwanted radiations to the greatest extent possible by the surrounding terrain. While such a site will in no way provide protection from interfering radiation at the desired frequency reflected or scattered into the antenna beam, it will provide a significant degree of protection, particularly from radiation of frequencies other than those intended for reception to which the receiver may nonetheless be sensitive.

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ANNEX

Levels of harmful interference to radioastronomy observations of class B

1. — SENSITIVITY CRITERIA.

The extra-terrestrial « signal » detected in any radioastronomical observation is a broadband noise, and is superimposed on other noise which is unavoidably produced in the receiver system itself, or is collected by the antenna from the sky, the ground and the earth's atmosphere. These different noise sources are incoherent, and therefore add to give a total power P which fluctuates in time in accordance with the normal statistical properties of random noise. The root mean square fluctuation of P about its mean value is given by

$$\Delta P = \frac{P}{\sqrt{2\ Bt}} \qquad (1)$$

where B is the receiver bandwidth and t is the total time of the observation, called the integration time.

The power is usually expressed in terms of an operating noise temperature T_e according to the equation :

$$P = kT_eB \text{ watts} \qquad (2)$$

where k is Boltzmann's constant (1.38×10^{-23} J/°K), T_e is in degrees absolute (°K) and B is in c/s. The root mean square fluctuation of T_e

$$\Delta T_e = \frac{T_e}{\sqrt{2\ Bt}} \qquad (3)$$

with t in seconds

From (1) and (3), it follows that ΔP or ΔT_e may be taken as a measure of the sensitivity of the power or temperature determination in Class B observations. The equations show that improved sensitivity is obtained by using wide bandwidths and long integration times. The bandwidths used for continuum measurements are usually as wide as is practicable (e. g. 10 to 20 Mc/s), the main limitation being the need to avoid interference from transmitters in adjacent bands. For the study of the fine structure of lines in the spectrum, arising from molecular emission or absorption in various parts of the Galaxy, receivers of much narrower bandwidth may be used, down to a few kc/s. However to allow for Doppler shifts the receiver frequency must either be swept over a much wider bandwidth, or alternatively must include many narrow-band channels. Furthermore, provision must be made for simultaneous reference measurements in an adjacent band and, for the reasons given above, this should be wide enough to provide an accurate standard of reference.

The operating noise temperature is made up from a number of components, which correpond to the several sources of noise which contribute to P. It can be expressed as

$$T_e = T_a + T_{eff} \qquad (4)$$

where T_{eff} is the component due to the receiving system referred to the antenna terminals and T_a that entering via the antenna.

The value of T_{eff} for many current receiving systems is about 200° K or lower, depending on frequency. In the most advanced apparatus in use at a few observatories it is of the order of 20° K, and the use of such highly sensitive receivers is increasing.

The minimum antenna temperature T_a (in the absence of solar noise) results from the collection of noise from cosmic sources and the terrestrial environment.

2. — Cosmic noise.

The flux density of radio-frequency radiation from the celestial sphere is dependent on frequency and on direction or position in the sky. In Tables 1 and 2 of this Annex, minimum antenna temperatures are listed for the series of frequencies at which there are allocations for the radioastronomy service. Cosmic noise is the main factor leading to the large variations in antenna temperature as a function of frequency.

3. — Noise from the terrestrial environment.

Contributions to the antenna temperature from the relatively warm environment are unavoidable. They are not significant at the lowest frequencies in the range considered, by comparison with that from cosmic noise. At the higher frequencies present knowledge suggests that by good design the contribution of thermal noise from the ground to the temperature of a paraboloid antenna can be reduced to the order of 10° K, except when the antenna is directed at low elevation angles, and this value has been adopted provisionally, where significant, in compiling the tables. Figures in column 2 in each table therefore include this allowance for ground noise. At the two highest frequencies an allowance has also been made for noise associated with absorption in the atmosphere.

4. — Sensitivity.

From (1) and (3) it is seen that the accuracy of measurement is increased by using large integration times and these may range up to several hours or even days or weeks. In the calculations leading to Tables 1 and 2, an integration time of 2000 sec. has been assumed. Then from (3) and (4),

$$\Delta T_e = \frac{T_a + T_{eff}}{\sqrt{4000\ B}}\ {}^{\circ}K \qquad (5)$$

For example if $T_{eff} = 200^{o}$ K and B = 10 Mc/s (continuum measurements).

$$\Delta T_e = (5 \times 10^{-6})T_a + 0.001^{o}\text{ K}$$

While with the same receiver temperature and B = 10 kc/s (line frequency measurements).

$$\Delta T_e = (1.6 \times 10^{-4})T_a + 0.032\ ^{o}\text{K}$$

Values of sensitivity ΔT_e are given in the Tables. These values are representative of the potential (interference-free) sensitivity of the best observations currently being made.

5. — Levels of harmful interference.

Harmful interference occurs when the unwanted signal flux impinging on the antenna is so great that the operating noise temperature is increased by an amount comparable with ΔT_e. If the radioastronomy service is to secure the advantages of low-noise receivers, the interference should not introduce an error of more than 10 % in the measurement of ΔT_e.

The level of harmful interference can therefore be expressed as a power input ΔP_H, measured at the antenna terminals, given by :

$$\Delta P_H = 0.1\ kB(\Delta T_e).\text{watt}$$

or if expressed in db relative to 1 watt

$$\Delta P_H = -238.6 + 10 \log B + 10 \log (\Delta T_e)\ \text{dbW}.$$

Values of ΔP_H are given in the Tables.

The harmful interference can also be expressed in terms of the power flux incident at the antenna, either in the total bandwidth or as a flux density S_H per c/s bandwidth. For convenience, the values are given for an antenna having a gain, in the direction of arrival of the interference, equal to that of an isotropic antenna (which has an effective area of $c^2/4\pi f^2$, where c is the speed of propagation and f the frequency). Appropriate allowance must be made when the gain has some different values. Values of $S_H B$, in db relative to $1 W/m^2$, are derived from ΔP_H by adding

$$20 \log f - 38.6\ \text{db}$$

where f is in Mc/s. S_H is then derived by substracting 10 log B to allow for the bandwidth.

Finally the interference may be expressed as a field-strength E_H in the total bandwidth. This is given by

$$E_H = (Z_0 S_H B)^{\frac{1}{2}}$$

Where Z_0 is the impedance of free space, 377 ohms.

In decibels relative to 1 μV/m, E_H is derived from $S_H B$ by adding 145.8 db.

TABLE 1. — *Sensitivity* ($\triangle T_e$) *of typical continuum measurements and flux density* (S_H) *which causes harmful interference*

Frequency f Mc/s	Minimum antenna tempe-rature (1) T_a °K	Receiver Tempe-rature T_{eff} (2) °K	Typical Bandwidth B Mc/s	Sensitivity ΔT_e °K	Minimum harmful power input ΔP_H dbW	Level of signal causing harmful interference (isotropic antenna) (3)		
						Power flux		Field strength E_H db (μV/m)
						$S_H B$ db (W/m²)	S_H db [(W/m²) (c/s)⁻¹]	
20	32 000	200	0.1	1.6	—186	—199	—249	—53
40	6 200	200	0.1	0.32	—193	—200	—250	—54
80	1 000	200	1	0.02	—196	—196	—256	—51
150	200	200	2	0.0045	—199	—194	—257	—48
327	40	100	2	0.0016	—204	—192	—255	—46
408	26	100	2	0.0014	—204	—190	—253	—45
610	16	100	8	0.00065	—201	—184	—253	—39

1 420	10	20	27	0.00009	—205	—180	—254	—35
1 665	10	20	4	0.00024	—209	—183	—249	—37
2 700	10	20	10	0.00015	—207	—177	—247	—31
5 000	10	20	10	0.00015	—207	—171	—241	—26
10 680	12	20	20	0.00011	—205	—163	—236	—17
15 350	18	100	50	0.00026	—197	—152	—229	— 6

(1) Noise from the ground has, provisionally, been assumed to increase the antenna temperature by 10°K.

(2) Referred to antenna terminals.

(3) For an antenna of power gain G (db) in the direction of any unwanted signal, reduce all values by G.

(4) Typical for a single channel of a multi-channel or tunable receiver. Total band required is much greater (see Section 1 of this Annex).

General Note : An integration time (or total time of observation) of 2000 sec is used throughout. For longer integration times the minimum detectable power flux will be lower and the unwanted signal will be harmful at correspondingly lower levels. For example, with a time of observation of ten hours the relevant figures in the Tables should be reduced by 6 db.

Table 2. — *Sensitivity* (ΔT_e) *of typical lines measurement and flux density* (S_H) *which causes harmful interference*

Bandwidth 0.01 *Mc/s* (4)

Frequency f Mc/s	Minimum antenna temperature (1) T_a °K	Receiver temperature (2) T_{eff} °K	Sensitivity ΔT_e °K	Minimum harmful power input ΔP_H dbW	Level of signal causing harmful interference (isotropic antenna) (3)		
					Power flux		Field strength db (μV/m)
					$S_H B$ db (W/m²)	S_H db [(W/m²) (c/s)⁻¹]	
327	40	100	0.02	—216	—204	—244	—58
1420	10	20	0.005	—222	—197	—237	—51
1665	10	20	0.005	—222	—196	—236	—50

(1) (2) (3) (4) See footnotes table 1, page 57.

Appendix IV

Draft new question (adopted by correspondence 1965)

Frequency utilization above the Ionosphere and on the far side of the Moon

The C.C.I.R.,

Considering

(*a*) that some radioastronomical and other scientific experiments are difficult, and perhaps impossible, to carry out on the surface of the earth;

(*b*) that the advent of spacecraft has already permitted scientific observations to be made from vantage points above the ionosphere, and that further developments will enable experiments to be carried out in the relatively quiet environment on the far side of the moon;

(*c*) that in addition to line-of-eight communication links for scientific and other purposes between the earth and spacecraft, it may be necessary to establish links between spacecraft above the ionosphere and between a station on the far side of the moon and another station either on or visible from the earth;

(*d*) that at frequencies below the critical penetration frequency of the ionosphere the region above the ionosphere is relatively isolated from terrestrial noise and communications signals;

(*e*) that the far side of the moon provides an even greater degree of isolation from terrestrial radiation at all radio frequencies;

(*f*) that optimum utilization of frequencies above the ionosphere and on the far side of the moon requires better undestanding of the shielding effects.

Decides that the following questions should be studied :

1. what attenuation of terrestrial radio signals occur when they travel through the ionosphere to the region beyond, and how does this attenuation vary with frequency, zenith angle, time of day, season of the year, phase of the sunspot cycle, and the location of the source of the signal;

2. how does the geometrical shielding of the moon vary as a function of frequency, angular distance from the limb of the moon toward the centre of the far side and distance above the surface of the moon;

3. what are the preferred means and routes for communicating between

   (*a*) a station on the far side of the moon and a station just above the ionosphere;

   (*b*) a station on the far side of the moon and an earth station;

   (*c*) two spacecraft above the ionosphere;

4. in what frequency regions would radioastronomical measurements carried out :

   (*a*) on a station above the ionosphere,

   (*b*) on the far side of the moon

   have marked advantages compared with observations from the surface of the earth ?

FREQUENCIES IN USE AT RADIOASTRONOMY OBSERVATORIES

(Doc. IUCAF/83)

Doc. I.U.C.A.F./73 comprised a letter addressed to members of Commission 40 (Radio Astronomy) of the I.A.U., seeking their co-operation in the supply of information to the International Frequency Registration Board (I.F.R.B.) in accordance with the requests of the International Telecommunication Union (I.T.U.), Geneva. Under the Final Acts of the Extraordinary Administrative Radio Conference (E.A.R.C.) of the I.T.U., Geneva 1963, full particulars of the observatories were requested in the form of Appendices of Doc. I.U.C.A.F./73.

The following table shows the response received at the end of November 1965, and gives a summary of the information received from various countries.

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class	
			A	B
Australia	C.S.I.R.O. Sydney	Culgoora, N. S. W.	158.5	80
		Culgoora, N. S. W.	5 to 2000 (swept)	
Australia	C.S.I.R.O. Sydney	Parkes, N. S. W.	—	153 408 610 960 1 405 1 410 1 420 1 665 2 650 5 000 473 1 400
Australia	University of Sydney	Molonglo, HOSKINSTOWN N.S.W.	These could be A or B	111.27 408

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class	
			A	B
		Fleurs, St. Marys N.S.W.	These could be A or B	14.15 20 30 48 85 726.5 1 423
Tasmania	C.S.I.R.O. and R.C.A., N.Y.	Bothwell	2.1	—
	University of Tasmania	Llanherne	—	0.004 (4 kc/s)
Tasmania	University of Tasmania	Llanherne	—	18.5 24.5 28.0 40.0 *20.0 to 40.0 *18.0 to 20.0 *20.0 to 200

		Sorell		*Spectrum Analysers 9.6
Canada	Dominion Radio Astrophysical Observatory	Penticton	10.030 22.250	408 1 413.5 2 695
Canada	National Research Council	Algonquin	22.5—20 to — 117.5—bands 74 2 830 2 770	1 400 2 800 3 200 6 600 10 690 13 500 31 250
Canada	Queen's University	Kingston, Ontario	—	146 222 858
France	Observatoire de Paris-Meudon	Nançay	169 408 9 150	408 610 1 413 2 695 4 995 10 690

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	B
Germany	Heinrich Hertz Institute of German Academy of Science (D.D.R.)	Berlin-Adlershof	3 453 3 487 9 456 9 522	775— beginning in 1966
Germany	Heinrich Hertz Institute of German Academy of Science (D.D.R.)	Aussenstelle, Neustrelitz	557 — beginning in 1966 1 457 1 523 1 967 — 2 033 9 106 9 172	
Italy	Bologna University	Bologna	—	408
Japan	University of Kyoto	Kyoto	300	—
Japan	University of Niigata	Niigata	500	—
Japan	National Science Museum	Tokyo	6 440 6 560	—

Japan	Radio Research Laboratories	Kashima	—	1 666
				4 170
	Radio Research Laboratories	Hiraiso	201	
			500	
Japan	Nagoya University	Toyokawa	1 000	2 695
			2 000	4 995
			3 690	9 415
			3 810	15 375
			4 000	
			2 000	
			4 000	
			4 995	
			9 340	
			9 460	
			9 415	
Japan	University of Tokyo	Nobeyama	25	
			38	
			58	
			74	
			114	
			160	
			227.5	
			408	
			612	
			2 695	
			4 995	
			15 375	

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	B
Japan	University of Tokyo	Mitaka	227.5	
			326	
			408	
			612	
			800	
			300-800 (spectral receiver)	
			2 695	1 420.4
			10 690	1 666
			19 320	2 695
			19 380	4 995
			31 340	10 690
			31 460	19 350
Poland	N. Copernicus University	Piwnice	32.5	
			127	2 Antenna Systems
			327	
United Kingdom	University of Manchester	Jodrell Bank	—	151.5
				408

				610 1 420 1 400-1 425 1 664.4-1 668.4 2 695 4 995 10 690
United Kingdom	University of Cambridge	Cambridge		13.05 26.5 (or 26.3) 38.0 81.5 151.5 408 610 1 413.5 2 695 4 995
U. S. A.	University of Texas	Austin, Texas	35 000 70 000 94 000 140 000	

Country	Administration	Location of Observatory	Frequencies in Mc/s in use for Observations in Class A	Frequencies in Mc/s in use for Observations in Class B
U. S. A.	Stanford University	Stanford California	3 292.4	425 2 926 3 074 3 213 3 343 3 470 10 690
U.S.A.	Ohio State University	Delaware, Ohio	—	1 415
U. S. A.	California Institute of Technology	Bigpine, California	—	74 611 960 1 420 1 665 2 840 10 690

U. S. A. (*continued*)	Massachusetts Institute of Technology	Haystack, Tyngsboro, Mass.	—	1 420 1 610 ⎫ 1 666 ⎬ OH line 1 720 ⎭ 5 000 8 000 15 500 35 000
U. S. A.	University of Colorado	Boulder, Colorado	8.927 17.985 36.1 7.6 to 41	
U. S. A.	Harvard University	Radio Astronomy Station, Fort Davis, Texas	63 (25-100 sweep)	210 (100-320 sweep) 920 ⎫ 980 ⎬ 5 000 ⎭

I.Q.S.Y.

IVth I.Q.S.Y. Assembly and Symposium: London, 17-22-July 1967

PRELIMINARY ANNOUNCEMENT

The President of the Special Committee for the I.Q.S.Y. has accepted the invitation of the Council of the Royal Society to hold the IVth (and final) I.Q.S.Y. Assembly and Symposium in London from 17-22 July 1967.

The Ist (Paris, 1962) and IInd (Rome, 1963) I.Q.S.Y. Assemblies were concerned entirely with drafting the programme of observations to be made in the different disciplines during 1964 and 1965, and with making various administrative arrangements. At the IIIrd (Madrid, 1965) Assembly, it was possible to review very briefly some of the work which had already been carried out and a few of the results obtained since January 1964. The opportunity was taken to consider also the desirability of continuing, from 1966 onwards, a coordinated inter-disciplinary research programme in those disciplines of geophysics in which the effects of solar radiation are important.

The IVth (London, 1967) Assembly will be the last in the series. It will be devoted almost entirely to a Symposium during which invited speakers will review the principal scientific results and conclusions of the I.Q.S.Y., as far as it will be possible to do so less than two years after the end of the operational phase of the programme. It is hoped that some time will be available also for the presentation of short papers dealing with recent new or important results. The principal review papers and the additional papers presented at the Assembly, and also those accepted but not actually presented verbally, will be published in 1968 in several volumes of *Annals of the I.Q.S.Y.*

The main topics to be included in the 1967 Symposium will be: meteorology; geomagnetism and earth currents; aurora and airglow; ionosphere; solar activity; cosmic radiation and geomagnetically trapped particles; aeronomy. In view of the great importance of space vehicles as a means of obtaining data in all these branches of geophysics, space research is also listed as one of the I.Q.S.Y. disciplines. However, in planning a scientific review of the I.Q.S.Y., it seems preferable not to isolate the results obtained using space vehicles from those obtained using other methods. This will be achieved by devoting an appropriate part of each of the other discipline reviews to descriptions of results obtained using space research techniques. For this reason, the reviewers in each of the different disciplines will be encouraged to include, in their papers, surveys of all important conclusions and results, irrespective of whether these were obtained by measurements made at ground observatories or in space vehicles.

The I.Q.S.Y. Committee is aware that, in 1967, several other international meetings will take place at which certain aspects of solar terrestrial physics may be discussed. With the cooperation of the organizers of these meetings, it is expected that arrangements will be made which will avoid any major overlap in the material presented at the I.Q.S.Y. Symposium and at any symposia organized by other bodies.

I.Q.S.Y. Notes

Issue No. 15 of *I.Q.S.Y. Notes* (December, 1965) contains the following main items :

— Message from the President of the Special Committee for the I.Q.S.Y. New Year 1966, Prof. W. J. G. Beynon.

— Second International Symposium on Equatorial Aeronomy

Recommendations

Publication of the proceedings (in *Report on Equatorial Aeronomy* (Nov., 1965) and in *Annales de Geophysique* (March and June, 1966)

Further information on the publications :

S.I.S.E.A. Report

C.N.A.E. — Sao Jose dos Campos, Sao Paulo, Brazil

— Total eclipse of the Sun — November 1966

— World data centre catalogues — General Information

— Conference on the activity of comets, Kiev, 1-3 November 1965.

— Inter-Union Symposium on Solar-Terrestrial Physics, Belgrade, 1966 — Interim Announcement

— C.O.S.P.A.R. — Vienna 1966 — Programme
— IVth I.Q.S.Y. Assembly and Symposium, London, July 1967 — Preliminary Announcement
— The current trend in solar activity — Provisional data for January — September 1965
— The Soviet Non-magnetic ship « Zarya »
— Bibliography for the I.Q.S.Y.
— World Days Programme
— I.U.W.D.S. International Geophysical Calendar for 1966
— Abbreviated Calendar Record — May-June 1965
— I.Q.S.Y. Programmes of participating Committees
— I.Q.S.Y. participating Committees

I.Q.S.Y. Participating Committees

(1) Addresses (Secretary or Convener).
(2) Names of responsibles for ionospheric investigations.

Argentina.

1. Comision Nacional para el E.I.S.Q. : Coronel A. A. LUCHETTI, Cabildo 381, Buenos Aires.
2. Ing. D. V. PADULA-PINTOS.

Australia.

1. Dr. R. G. GIOVANELLI, National Standards Laboratory, University Grounds, City Road, Chippendale, N.S.W.
1. Prof. H. C. WEBSTER.

Cuba.

1. Prof. Lucano NILO BLANCO, Comision Nacional de la Accademia de Ciencias, Capitolio Nacional, La Habana.
2. Ing. J. B. ALTSCHULER.

Finland.

1. Mr. C. SUCKSDORFF, Finnish Meteorological Office, Helsinki.
2. Dr. J. OKSMAN.

Germany.

1. Dr. G. LANGE-HESSE, Max-Planck Institut für Aeronomie, 3411 Lindau/Harz, Postfach 20.
2. Prof. Dr. W. DIEMINGER.

1. Dr. A. P. MITRA, National Physical Laboratory, Hillside Road, New Delhi 12.

Ireland.

1. Mr. J. BYRNE, 44 Upper O'Connel Street, Dublin.

Italy.

1. M. GIORGI, Consiglio Nazionale delle Ricerche, Piazzale delle Scienze 7, Roma.
2. Prof. M. BOELLA.

Japan.

1. Y. AONO, Radio Research Laboratories, Kokubunji, Tokyo.
2. Y. AONO.

Republic of Corea.

1. SANG BOK HAHN, College of Liberal Arts and Sciences, National University, Seoul.

Pakistan.

1. Mr. SIBTE NABI NAQVI, Director, Pakistan Meteorological Service, Karachi 3.
2. Mr. SIBTE NABI NAQVI.

South Africa.

1. Mr. O. A. VAN DER WESTHUIZEN, Science Cooperation Division, C.S.I.R., PO Box 395, Pretoria.
2. Prof. N. D. CLARENCE
   Prof. J. A. GLEDHILL
   Mr. R. W. VICE.

Thailand.

1. Vice-Amiral Sanit VESA-RAJANANDA, R. T. N., Meteorological Dept., Office of Prime Minister, Bangkopi, Bangkok.

United Kingdom.

1. Dr. D. C. MARTIN, Executive Secretary, The Royal Society Burlington House, Piccadilly, London W1.

2. Prof. W. J. G. BEYNON.

U. S. S. R.

1. S. Z. KRICHEVSKY, Soviet Geophysical Committee, Molodezhnaya 3, Moscow B-296.
2. N. V. BENKOVA.

COMITÉ INTERNATIONAL DE GÉOPHYSIQUE C.I.G.

Future of the C.I.G.

We quote the following parts of the proceedings of the Sixth meeting of C.I.G. as published in the I.U.G.G. *Chronicle*, No. 61, October 1965.

« The President said that at the 10th General Assembly of I.C.S.U. the functions of C.I.G. had been reduced to the completion of the *Annals of the I.G.Y.* and the supervision of the W.D.C's. He said that the *Annals* would be completed during the course of 1965 and after that the C.I.G. would still have an important role to play in maintaining the efficient functioning of the W.D.C's. Under its original constitution there were also other opportunities for C.I.G. to make contributions to international geophysics, particularly in the preliminary discussion and introduction of new international interdisciplinary programmes. He drew attention to the fact that the I.Q.S.Y. Committee would be dissolved in the summer of 1967 and suggested that it was necessary to have an international body for co-ordinating certain interdisciplinary programmes in the post-I.Q.S.Y. period.

During the course of the I.Q.S.Y. Meeting, the need for such a continuing body had been discussed both in open plenary session and by all the disciplinary working groups. The general conclusion on all sides was that either C.I.G. or some similar I.C.S.U. body should continue. There was strong feeling that the title « International Committee for Geophysics » (C.I.G.) was a good title and should be maintained. It was felt that a continuation of the title would also probably facilitate the acquisition of funds by national bodies. It is clear too that data interchange should continue after I.Q.S.Y. and that much of the present W.D.C. structure is desirable and should be continued. Mme Troitskaya said that there was a strong feeling in the U. S. S. R. that observations should be continued on a reduced scale and that all the services participating in I.Q.S.Y. should continue in future years, since it is extremely difficult to start again once a service has been interrupted. The Soviet geophysicists thought an organization to ensure long term cooperation in geophysics was absolutely essential.

The President proposed an interim holding group for C.I.G. consisting of the Bureau, together with the W.D.C. representatives, which would be charged with the consideration of proposals for the constitution of a long-term C.I.G., which would become effective after the dissolution of the I.Q.S.Y. Committee.

It was suggested that this would, in fact, differ little from continuing the C.I.G., particularly if no further meetings of C.I.G. were called during the period up to the dissolution of the I.Q.S.Y. Committee. It was generally agreed that a long-term Committee of this sort should have the responsibility, originally given to C.I.G. in its constitution, of discussing proposals for new inter-disciplinary programmes in geophysics. Mr. Fournier d'Albe said that in principle, U.N.E.S.C.O. would be willing to support an international body for planning and co-ordination of research programmes and for the collection and analysis of data in Geophysics. Dr. Fedorov said that the U.N.E.S.C.O. Office of Oceanography of the I.O.C. would certainly be willing to support the World Data Centre mechanism.

The President stated that any long term body should have a regular source of income. A grave weakness of the existing C.I.G. was that it had no source of income whatever but had lived on its capital. He also thought that it was highly desirable for such an International Committee to have a properly established paid Secretariat. The great success of the I.Q.S.Y. administration had proved this point very conclusively.

The Treasurer of I.C.S.U. said that two possible ways of obtaining funds were, (*a*) to appeal to the national members of C.I.G. and (*b*) to appeal to I.C.S.U. He said that although a large number of new I.C.S.U. Committees are being established, it might be possible to obtain grants for 1966 and 1967. He suggested that C.I.G. make a formal request to the I.C.S.U. Executive Committee at its meeting in Munich on 5-7 April, 1965.

The C.I.G. decided to recommend to the Executive Committee of I.C.S.U. that for the present C.I.G. remain in being, and that in the next year or so a plan be prepared for a revised long-term C.I.G., and that this plan be drafted by the present C.I.G. Bureau and W.D.C. representatives acting in consultation with I.C.S.U. and other interested bodies. The Committee agreed to seek a grant from I.C.S.U. to cover the expenses of a meeting of the above planning group in 1966 or 1967.

Appointment of a new secretary

Dr. C. M. Minnis has been appointed as Secetary of C.I.G. in succession to Mr. G. R. Laclavère. The structure of the C.I.G. will be reviewed before the end of 1967 and this appointment is only for this interim period. Dr. Minnis continues to be Secretary of the I.Q.S.Y. Committee and his address is still 6 Cornwall Terrace, London N. W. I.

I.G.Y. — I.G.C.

Ionospheric Characteristics

The Research Department, All India Radio, New Delhi has issued No. 4, 5 and 6 of « Ionospheric Observations during the International Geophysical Year 1957-1958 and the International Geophysical Co-operation 1959 ».

Those issues contain the ionospheric characteristics over Tiruchirapalli respectively from April to June 1958, from July to September, 1958, and from October to December, 1958.

I.C.S.U.

I.C.S.U. Publications

The I.C.S.U. Abstracting Board (17, rue Mirabeau, Paris 16e, France) has issued a « Tentative List of Publications of I.C.S.U. Scientific Unions, Special and Scientific Committees and Commissions for the year 1964 ».

C.O.S.P.A.R.

The Optical Tracking of Satellites

A special issue of *C.O.S.P.A.R. Information Bulletin* (No. 25, Oct. 1965) contains a « Manual for the establishment of an optical tracking station » edited by W. De Graaf and C. de Jager with the cooperation of members of C.O.S.P.A.R. Working Group I.

The following chapters are dealt with in the Manual :

Chapter I. — *General Introduction.*

1. Introduction — A. G. Massevitch (1961); F. L. Whipple (1956); B. G. Pressey.
2. Illumination and visibility of satellites — G. Veis (1963).
3. Predictions, generalities — G. Veis (1963).
4. Predictions; mathematical formulae — W. Pachelski (1963).
5. Some general remarks on timing — K. Fea (1965).
6. Star charts — K. Fea (1965).
7. Signaux horaires — (1865).
8. Addresses of Satellite Prediction Centers — (1965).

Chapter II. — *Visual Observations.*

1. The uses of visual observations — D. G. King-Hele (1965).
2. Optical aids to observation — K. Fea (1965).
3. Moonwatch stations and observations of re-entry of satellites — G. Veis.
4. Individual visual observations — D. G. King-Hele (1965).
5. Theodolites (general review) — G. Veis (1963).
6. Une méthode d'observation spéciale avec le théodolite adapté Wild T3 — M. Bielicki.
7. Improving the accuracy of visual observations — A. G. Massevitch.
8. Visual satellite tracking using a shutter — V. I. Belenko.

CHAPTER III. — *Photographic Observations.*

1. General remarks on photographic observations — G. VEIS (1963).
2. Photographic plates and films — Smithsonian Astrophysical Observatory (1963).

3.1. Non-Tracking cameras — G. VEIS (1963).

3.2. A 60-cm F/1 field flattened camera — J. HEWITT

4.1. Tracking cameras — G. VEIS (1963).

4.2. Description of a simple tracking camera — D. A. RICHARDS (1961).

5. Camera mounts — Smithsonian Observatory (1963).
6. Camera shutters — Smithsonian Astrophysical Observatory (1963).
7. Timing — Smithsonian Astrophysical Observatory (1963).

8.1. Operations — Smithsonian Astrophysical Observatory (1963).

8.2. Reduction of plates and correction to the observations — G. VEIS (1963).

8.3. Determination of Equatorial positions of the negative by the method of « three triangles » — J. F. LATKA (1965).

9. Optical tracking of cosmical rockets — A. G. MASSEVITCH.

CHAPTER IV. — *The Observing Station — Smithsonian Astrophysical Observatory.*

1. Selection of sites
2. Buildings.
3. Emergency power supply.
4. Darkroom.
5. Logistics.
6. Personnel.

Information Bulletin No. 26

C.O.S.P.A.R. Information Bulletin, No. 26, October 1965, contains the following main items :

— Summarized Report on the Eighth Meeting of C.O.S.P.A.R.

— Announcement of the Ninth Plenary Meeting of C.O.S.P.A.R. and Seventh International Space Science Symposium, Vienna, May 10-19, 1966.

— Report on the Second International Symposium on the Use of Artificial Satellites for Geodesy, Athens, April 1965.

— Inter-Union Symposium on Solar-Terrestrial Physics (brief interim announcement).

— The Ranger Lunar Missions.

— Initial Scientific Interpretation of Mariner IV Photography.

— Certain untypical effects noticed in radio observations of artificial earth satellites, by J. GRYCAN.

— Survey of satellites and space probes.

— Scientific satellites launched by the U. S. A. continuously emitting radio signals as of July 6, 1965.

— Detailed satellite experiments : Solar Radiation Satellite 1965-16D, Beacon Explorer Satellite 1965-32A, Meteoroid Detection Satellite 1965-39A, Interplanetary Explorer Satellite 1965-42A, Manned Gemini Spacecraft 1965-43A.

I.U.G.G.

International Association of Geomagnetism and Aeronomy (I.A.G.A.)

SYMPOSIA

We have been informed that the following I.A.G.A. symposia have been tentatively agreed upon through the 1970 period

1967 « Aurora and Geomagnetic Storms », to be held in Oslo just prior to the XIV General Assembly. The Norwegian Academy of Letters and Science has issued a formal invitation for I.A.G.A. to hold this symposium in Oslo.

1967 « Recent Developments in Geoelectric and Geomagnetic Instrumentation ». Dr. E. Thellier agreed to be the convenor. Dr. S. K. Runcorn will be asked to be secretary. To be held as a part of the XIV General Assembly in Basel, Switzerland.

1967 « Conjugate Points Experiments », Madame V. A. Troitskaya is to be the convenor. Dr. R. Schlich will be asked to be the secretary. To be held as a part of the XIV General Assembly.

1968 « A Description of the Earth's Magnetic Field », Washington D. C., was suggested as the location.

1969 « Secular Change », France was suggested as the location.

1969 « Chemical Aeronomy », Brussels was suggested as the location.

1970 « Geocorona and Magnetospher », U. S. S. R. was suggested as the location.

1970 « Solar-Terrestrial Relationships in Selected Special Events ».

Commission VII will hold a Symposium on « Laboratory Measurements of Airglow », as a part of their XIV General Assembly Programme.

INTERNATIONAL ASTRONAUTICAL FEDERATION

XVIIth International Astronautical Congress

MADRID, SPAIN — 1966

FIRST CALL FOR PAPERS

Papers are being sought for the XVIIth I.A.F. Astronautical Congress to be held in Madrid, October 9-15, 1966.

The International Astronautical Federation is composed of technical societies around the world dealing with the advancement of astronautics.

The Congress is held annually and papers from numerous nations participating in space flight development are presented.

The program is determined by an International Program Committee in cooperation with the Bureau of the I.A.F.

All persons desiring to present a paper must submit a summary of from 500 to 800 words, in triplicate, before May 15, 1966, to the Chairman of the Technical Committee responsible for the subject area into which the paper falls. The Session Chairmen for 1966 will be announced in a further communication, together with instructions for authors.

The eligibility of a manuscript does not depend upon whether or not the author is a member of one of the societies adhering to the I.A.F.

Papers will be evaluated by the Session Chairmen with the aid of reviewers. Authors will be notified of the acceptance of their papers before July 15, 1966.

A. — GENERAL SESSIONS.

These sessions cover essentially the field of technical problems related to space flight and to the sciences that constitute its background (1). Only original papers should be submitted.

(1) Results of pure scientific interest which have no bearing on the art of space flight, even when obtained by means of space laboratories, should preferably be proposed to specialized scientific meetings.

General Sessions include :

1. Propulsion.
2. Astrodynamics (including the theoretical aspects of guidance and control).
3. Guidance, control and tracking (technical aspects).
4. Physical problems of re-entry.
5. Systems design.
6. Application satellites (communication satellites, meteorological satellites, etc...).
7. Bioastronautics and life support systems.

B. — SPECIAL SESSIONS.

1. Lunar International Laboratory — Life Sciences Research and Lunar Medicine (Second Symposium, organized by the International Academy of Astronautics; invited papers only).
2. Astronautics in Education (Second Symposium, organized by the I.A.F. Education Committee).
3. Space Law (IXth Colloquium, organized by the International Institute of Space Law).

International program committee

Chairman : P. CONTENSOU, Office National d'Etudes et de Recherches Aérospatiales (France).

Members :

W. BOLLAY, Aeronautics and Astronautics Department — Stanford University (U. S. A.).

O. GAZENKO, U. S. S. R. Academy of Sciences (U. S. S. R.).

K. Y. KONDRATIEV, University of Leningrad (U. S. S. R.).

L. NAPOLITANO, Institute of Aerodynamics — University of Naples (Italy).

Ex officio : Members of the I.A.F. Bureau.

BIBLIOGRAPHIE

Union Internationale des Télécommunications

Carte des Stations Côtières— L'Union Internationale des Télécommunications a publié la 9e édition de la « Carte des Stations Côtières ouvertes à la correspondance publique ou participant au service des opérations portuaires ».

Cette édition comprend une carte-index et 10 feuilles se répartissant comme suit :

Feuille 1 : Europe septentrionale.

Feuille 2 : Europe occidentale.

Feuille 3 : Méditerrannée.

Feuille 4 : Afrique, Inde, etc.

Feuille 5 : Mer de Chine, Archipel des Indes orientales.

Feuille 6 : Océanie.

Feuille 7 : Amérique du Nord orientale.

Feuille 8 : Amérique du Nord occidentale et Alaska.

Feuille 9 : Amérique du Sud.

Feuille 10 : Calotte polaire, du pôle nord au 60° de latitude nord.

La couverture de cet atlas comporte le titre de la carte dans les cinq langues officielles de l'Union; il en est de même pour les explications et la légende. Toutefois, afin de réduire le prix de revient dans toute la mesure du possible, les noms des pays sur les différentes feuilles ne figurent qu'en français.

Le prix de vente a été fixé à 5.— francs suisses l'exemplaire; ce prix comprend l'emballage et les frais de port pour envoi par la poste ordinaire dans le monde entier.

Commission Electronique Internationale

Publication 34-1*A* : *Première édition.* — Complément à la Publication 34-1 (1960). Recommandations pour les machines électriques tournantes (à l'exclusion des machines pour véhicules de traction). Irrégularités de la forme d'onde.

Publication 68-2-17 : *Première édition.* — Essais fondamentaux climatiques et de robustesse mécanique applicables aux matériels électroniques et à leurs composants. 2e partie : Essais — Essai O : Etanchéité.

Publication 175 : *Première édition.* — Ventilateurs électriques de table à courant alternatif et régulateurs de vitesse associés.

Publication 65 : *Deuxième édition.* — Règles de sécurité pour les appareils électroniques et appareils associés à usage domestique ou à usage général analogue, reliés à un réseau.

Publication 92-6 : *Deuxième édition.* — Installations électriques à bord des navires. 6e partie : Appareillage d'installation, éclairage, batteries d'accumulateurs, appareils de chauffage et de cuisson, communications intérieures, paratonnerres.

Publication 92-5 : *Première édition.* — Installations électriques à bord des navires. 5e partie : Transformateurs pour énergie et éclairage, redresseurs à semiconducteurs, génératrices (avec moteurs primaires associés) et moteurs, propulsion électrique, navires citernes.

Publication 184 : *Première édition.* — Méthodes de spécification des caractéristiques relatives aux transducteurs électromécaniques destinés aux mesures de chocs et de vibrations.

Publication 180 : *Première édition.* — Sections nominales et composition des âmes circulaires en cuivre des conducteurs et câbles isolés au caoutchouc ou au polychlorure de vinyle, de tension nominale ne dépassant pas 750 V.

Publication 188 : *Première édition.* — Tableau de caractéristiques pour lampes à décharge à vapeur de mercure à haute pression.

Publication 197 : *Première édition.* — Fil de connexion à haute tension avec isolation à combustion lente pour utilisation dans les récepteurs de télévision.

Ces publications sont en vente au Bureau Central de la C.E.I., 1, rue de Varembé, Genève, Suisse.

BIBLIOGRAPHY

International Telecommunication Union

Map of Coast Stations. — The International Telecommunication Union has published the 9th edition of the « Map of Coast Stations open to public correspondence or participating in the port operations service ».

The new edition of the map consists of a card-index and 10 sheets as follows :

Sheet 1 : Northern Europe.
Sheet 2 : Western Europe.
Sheet 3 : Mediterranean.
Sheet 4 : Africa, India, etc.
Sheet 5 : China Sea, East Indies.
Sheet 6 : Oceania.
Sheet 7 : Eastern North America.
Sheet 8 : Western North America and Alaska.
Sheet 9 : South America.
Sheet 10 : Polar cap, from the North Pole to latitude 60° North.

The name of the map appears on the cover of the atlas in the five official languages of the Union, as do the explanations and legend. To keep production costs to a minimum, however, the names of countries are shown on the sheets in French only.

The sale price is 5.— Swiss francs per copy, including the cost of packing and carriage by ordinary mail to any address.

International Electrotechnical Commission

Publication 34-1*A* : *First edition.* — Supplement to Publication 34-1 (1960). Recommendations for rotating electrical machinery (excluding machines for traction vehicles). Irregularities of waveform.

Publication 68-2-17 : *First edition.* — Basic environmental testing procedures for electronic components and electronic equipment. Part 2 : Tests — Test Q : Sealing.

Publication 175 : *First edition.* — A. C. electric table type fans and regulators.

Publication 65 : *Second edition.* — Safety requirements for mains operated electronic and related equipment for domestic and similar general use.

Publication 92-6 : *Second edition.* — Electrical installations in ships. Part 6 : Accessories, lightning, accumulator (storage) batteries, heating and cooking appliances, internal communications, lightning conductors.

Publication 92-5 : *First edition* — Electrical installations in ships. Part 5 : Transformers for power and lightning, semiconductor rectifiers, generators (with associated primemovers) and motors, electric propulsion plant, tankers.

Publication 184 : *First edition.* — Methods for specifying the characteristics of electro-mechanical transducers for shock and vibration measurements.

Publication 180 : *First edition.* — Nominal cross-sectional areas and composition of circular copper conductors for rubber or polyvinyl chloride insulated cables and flexible cords with a rated voltage not exceeding 750 V.

Publication 188 : *First edition.* — Schedule for high-pressure mercury vapour lamps.

Publication 197 : *First edition.* — High-voltage connecting wire with flame retarding insulation for use in television receivers.

These publications are on sale at the Central Office of the I.E.C. at the usual terms.

Imprimé en Belgique

14153 — Imp. VAILLANT-CARMANNE, S. A.
J. François, directeur, 4, place St-Michel, Liège