

INTERNATIONAL SCIENTIFIC RADIO UNION

MEETING IN SYDNEY

THE tenth general assembly of the International Scientific Radio Union (I.S.R.U.) was held in Sydney during August 11–21, 1952, followed by a visit, reception by the Commonwealth of Australia Government, and closing ceremonies at Canberra during August 22–23. This was followed by a two-day meeting of the Mixed Commission on the Ionosphere, also in Canberra, at which matters of common interest to the Union and the corresponding International Astronomical and Geophysical Unions were discussed. The proceedings of this Mixed Commission will be reported separately. Furthermore, advantage was taken of the presence of a number of British radio scientists to hold a meeting in Sydney of the Commonwealth Specialist Conference on Radio Research.

The assembly of the International Scientific Radio Union was attended by some seventy delegates representing fourteen countries, and by a large number of Australian scientific workers and engineers who, as observers, were interested in being present at the first meeting of an international scientific union to be held in Australia. The general organization of the work of the Union under seven Commissions, and the constitution of the British delegation have been given previously¹. This article presents a general description of the Sydney meeting and a summary of the proceedings of the various Commissions.

Measurements and Standards

The president of Commission 1 of the Union, Dr. J. H. Dellinger (United States), made an introductory statement on the progress of international work in the field of standards and measurements, and this was followed by two sessions of the Commission: the first on frequency and impedance measurement, under the chairmanship of Prof. M. Boella (Italy); and the second on power and special receiver measurements, under Dr. R. L. Smith-Rose (Great Britain). Twenty-eight papers, of which eleven were reports from national committees, were available and were considered according to the subject-matters of these sessions. Of great interest was a paper by C. J. Grebenkemper and J. P. Hagen (United States) which described the results of measurements on resonant cavities at very low temperatures, 1–3° K., in an investigation of superconductivity in metals at microwave frequencies. For a tin-plated resonator, the Q -value increased from 5×10^4 to more than 10^6 as the temperature was reduced to the values mentioned. A discussion took place on the use of this technique for studying skin-effect in different metals, and on the influence of surface finish on the results.

Several papers dealt with various aspects of measuring power at ultra-high frequencies. These included a description by A. L. Cullen (Great Britain) of the radiation pressure method of measuring 10–60 W. at wave-lengths of 3 and 9 cm., and an account of a micro-calorimeter by A. C. Macpherson (United States) for the absolute measurement of a power of 1–15 mW. at a wave-length of 9 cm. A novel method of calibrating field-strength measuring

equipment was described by H. E. Dinger and W. E. Garner (United States), in which the calibrating voltage from a signal generator is applied across the gap in the shield surrounding the loop antenna.

At the close of its work, Commission 1 confirmed its previous resolutions concerning the study of reception of standard-frequency transmissions and time signals, and the international comparison of methods of measuring power at radio frequencies. Also, mainly as a result of a paper by Dr. L. Essen (Great Britain), the following resolution was put forward and adopted by the general assembly of the Union: "As a result of investigations made in recent years by several different methods, it is recommended that the following value of the velocity of electromagnetic waves in vacuum be adopted for all scientific work: $299,792 \pm 2$ km./sec."

Troposphere and Wave Propagation

Under the presidency of Dr. C. R. Burrows, Commission 2 held four meetings at which some fifty papers and reports were discussed, dealing principally with the subjects of very-short-wave propagation both over optical paths and to distances beyond the horizon, and with the influence of meteorological conditions on this propagation. Particular note was taken of the requests made at the Geneva meeting (1951) of the International Radio Consultative Committee (C.C.I.R.) for co-operation in the study of tropospheric wave propagation in view of the importance of short radio waves (all wave-lengths less than 10 m.) in the development of broadcasting, television and communications generally. Results of the observation of fading on centimetre wave-lengths made in New Zealand, Sweden and the United States for distances up to about 100 km. were described and discussed, and it was generally agreed that it is difficult in many cases to explain the depth of fading in terms of the variations of the refractive index modulus over the whole path. Dr. J. B. Smyth (United States) emphasized the need for obtaining and studying micro-meteorological data, and claimed that in this way the main characteristics of radio-wave propagation over distances up to more than 100 km. could be predicted with a considerable measure of agreement with the experimental results.

Among the resolutions adopted by this Commission were recommendations that the scattering of radio waves by fluctuations in the lower atmosphere should be studied in different countries, with particular reference to the dependence of this scattering on latitude, climate and terrain. The statistical characteristics of fluctuations in atmospheric refractive index should also be explored, making use of recent developments in micro-meteorological measuring technique. In addition, it was recommended that at all frequencies above 30 Mc./s. research should be directed towards establishing a better understanding of the correlation between readily available synoptic meteorological data and radio propagation characteristics. While the Union takes all possible steps to ensure that national meteorological authorities are aware of the need of radio scientists for aerological observations, it has specially asked the Joint Com-

mission of the International Geophysical Year (1957-58) to take into consideration the needs of radio meteorology when planning its programme of meteorological measurements.

Ionosphere and Wave Propagation

Sir Edward Appleton presided over the sessions of Commission 3, which had about one hundred documents before it relating to various aspects of research on the ionosphere and the propagation of waves over a wide range of frequencies. A discussion on "Movements in the Ionosphere" was opened by Dr. G. H. Munro (Australia)², followed by Dr. W. J. G. Beynon and Profs. L. G. H. Huxley and L. Manning among other speakers. It was clear that there is considerable interest in the study by radio methods of regular and irregular movements in the ionosphere. Knowledge of these movements is rapidly accumulating and is of great interest from the point of view of upper-atmospheric meteorology.

One of the most interesting topics discussed concerned the effective conductivity of the atmosphere. At the second session of the Commission, papers were presented by Drs. W. G. Baker and D. F. Martyn (Australia)², with additional contributions by Prof. T. G. Cowling and K. Hirono, all of whom showed how, in spite of the presence of the earth's magnetic field, the conductivity could reach a magnitude of the order required in the theory of geomagnetism. This was followed by a discussion on "Ionospheric Storm Phenomena", opened by Dr. Martyn³ and continued by Sir Edward Appleton and others. This subject is of considerable interest not only to scientific workers interested in relating ionospheric disturbances to other geophysical phenomena, but also to the radio engineers who are seeking reliable forecasts on the progress of ionospheric storms around the world, so that they may anticipate the considerable interruption of communication circuits which accompanies such storms.

Considerable interest was also aroused in a discussion, opened by J. C. W. Scott (Canada), on the propagation of very-high-frequency radio waves over distances of the order of 1,000-1,500 km., by way of scattered reflexions in the ionosphere. The relationship between scattering at normal and at grazing incidence was emphasized, and it was pointed out that, for frequencies exceeding the normal maximum usable frequency, the reflexion coefficient may be determined by a very thin layer rather than by a general increase in ionization. Reference was made to the observations taken in Great Britain, Australia, New Zealand and the United States on the scattering of very-high-frequency radio waves due to the incidence of meteors in the ionosphere. It appears that meteor showers add to a fairly constant level of meteoric activity which is always present at a height of about 110 km., the diurnal variation resulting from such showers being much more marked in the winter than in the summer months, at any rate in the southern hemisphere.

A discussion on wave-interaction was opened by Mr. R. A. Smith (Australia), deputizing for Prof. V. A. Bailey, who was prevented by illness from being present, and was continued by Dr. M. Cutolo (Italy), Prof. L. G. H. Huxley (Australia) and Mr. J. A. Ratcliffe (Great Britain). This was followed by a presentation by Dr. R. A. Helliwell (United States) of some papers dealing with an investigation of the characteristics of the ionosphere at a frequency of 150 kc./s. and the corresponding propagation of low-

frequency waves. Some of this work was concerned with a study of turbulence in the lower region of the ionosphere and with stratification in the sporadic-E layer.

The following resolutions were formulated as a result of the deliberations of Commission 3: a world-wide study of movements in the ionosphere should be made; attention should be given to the method of measuring ionospheric absorption using galactic noise signals; attention should be given to the study of auroræ by the radio-echo method and to the effects of auroræ on galactic noise radiations; there should be an extended study of the development and morphology of ionospheric storms; and experiments should be made in all parts of the world on the propagation of very-high-frequency waves by ionospheric scattering.

International Geophysical Year

In 1950 the Mixed Commission on the Ionosphere put forward a proposal for a Third International Polar Year to be held during 1957-58, the previous Polar Years having been held during 1882 and 1932-33. Subsequent discussion had made it clear that the former emphasis on the polar nature of the project would need modification, since observations in tropical latitudes are now also of great interest. Accordingly, it has been agreed to change the title to "International Geophysical Year 1957-58"; and during the Sydney meeting the International Scientific Union established its own committee, under the chairmanship of Sir Edward Appleton, to advise on all aspects of radio work during this year. The Union also suggested that each country should establish a Geophysical Year Committee.

In connexion with proposals made for a new world determination of longitude during the Geophysical Year, a sub-commission of the Union, under the chairmanship of Prof. M. Boella, was appointed to study the propagation time of radio signals over long distances, and to collaborate with the International Union of Geodesy and Geophysics and with the International Astronomical Union.

Terrestrial Atmospherics

In the absence of Prof. H. Norinder (Sweden) the meetings of Commission 4 were presided over by Mr. J. A. Ratcliffe (Great Britain) and were chiefly devoted to discussions on the wave-forms and mean level of atmospherics, and on the characteristics from which the interference to different types of communication system can be determined. On the first subject, Dr. R. Rivault (France) pointed out that the wave-form of atmospherics received over the same distances depend to some extent upon the geographical location of the lightning strokes from which they arise. Mr. Ratcliffe gave an account of recent work on 'whistling atmospherics' and of a tentative theoretical explanation of these. Dr. R. A. Helliwell (United States) said he had recorded such 'whistlers' simultaneously at two places about 1,500 km. apart.

On the measurement of the general level of atmospheric noise, the meeting agreed with the recommendation by the International Radio Consultative Committee to continue to use the subjective method of measurement due to H. A. Thomas until an objective method is in use and is found to be satisfactory. In this connexion, it was opportune that Mr. H. E. Dinger (United States) described the American plans for a world-wide measurement of

atmospheric noise by an objective method at some fifty stations to be installed during the next two years. In the meantime, it was urged by the chairman that measurements in the high-frequency range by the subjective method should be resumed in Australia and New Zealand; and attention was directed to the British plans to extend the world survey to lower frequencies. Mr. F. F. Gardner (Australia) gave an account of noise measurements made on a frequency of 2 Mc./s. at a place remote from sources of man-made interference. He said that by day the only noise measured was that corresponding to the thermal noise from the ionosphere, while at night the prevailing noise arose from man-made sources in a city 50 km. away. Mr. Dinger stated that at high latitudes noise due to precipitation is very important and can interrupt traffic for several hours on frequencies between 18 kc./s. and 18 Mc./s. In addition, interference is often associated with storm clouds even when there is no actual precipitation.

Concerning the future, it was agreed that at the next general assembly of the Union discussions would be held on the following topics: wave-forms and propagation of atmospherics; meteorological aspects of atmospherics; world-wide 'noise surveys'; and atmospherics as a source of interference to communication systems.

National committees were asked to encourage research in these subjects, and in particular to endeavour to provide an answer to the following question posed by the International Radio Consultative Committee: "What are the most easily measured characteristics of terrestrial radio noise from which the interference to different types of communication system can be determined?" Finally, the Commission recommended that, during the International Geophysical Year, three lines of work should be undertaken: measurements, of a high standard, of the radio noise at as many places as possible, including the polar and auroral regions; observations of the wave-forms of atmospherics, including 'whistlers', at several places, including the equatorial and polar regions; and optimum use to be made of organizations set up for the location of thunderstorms and lightning flashes.

Radio Astronomy

Commission 5 formerly defined its scope by the title "Extra-terrestrial Radio Noise"; but at the general assembly in Zurich during 1950 it was renamed as the Commission on Radio Astronomy, and its scope was extended to include such subjects as meteors and the moon when observed by radio techniques, as well as the investigation of radio emissions from the sun and stars. The meetings of this Commission in Sydney were of particular interest in view of the large amount of research in this field which has been conducted in Australia during the past few years under the auspices of the Commonwealth Scientific and Industrial Research Organization. The visit of the Union provided a most valuable opportunity for the research workers in this field in the northern and southern hemispheres to discuss their experiences and results.

At the first of four sessions, Mr. W. N. Christiansen (Australia) described observations of solar radiation made on a wave-length of 21 cm. (frequency 1,420 Mc./s.) using a linear array of thirty-two parabolic reflector aerials along an east-west line some 240 m. long. The radiation diagram of this system com-

prised lobes 3'-arc wide and 1.5° apart; and a continuous record was obtained as the sun passed through several lobes. The observations showed the presence of disturbed areas on the sun, closely associated with sunspots and persisting for one or two revolutions of the sun. The distribution of radiation across the disk was deduced: this showed limb-brightening corresponding to a coronal temperature of 2.5×10^6 °K. Dr. J. L. Steinberg (France) reported observations made on solar eclipses on wave-lengths of 178 m. and 3 cm., and these could only be explained on the assumption that the solar corona was not circularly symmetrical. These results were confirmed by other observers on various frequencies between 225 and 10,000 Mc./s., and in most cases there was evidence of limb brightening. Dr. F. G. Smith (Great Britain) described interferometric measurements of the distribution of brightness across the sun on four wave-lengths between 60 cm. and 7.9 m. in an attempt to determine the distribution of temperature in the corona. It was shown that no simple model of the solar atmosphere can explain results on these wave-lengths, it being difficult to interpret the observed radiation from regions at two or three times the solar radius from the centre of the disk.

At the second session, which, like the first, was presided over by Dr. D. F. Martyn, a discussion on the dynamics of ionized media was opened by Prof. H. S. W. Massey (Great Britain), followed by contributions by Dr. Martyn, by Drs. K. C. Westfold and J. H. Piddington (Australia) and by Dr. N. Herlofson (Sweden). Some of the particular problems considered were the nature of modes in a plasma and the setting-up of oscillations with consequent radiation from plasma. It was shown that reflexion from dense meteor trails when the electric vector is not along the trail is not fully understood.

The subject of the third session was interstellar gas, and at this meeting Dr. H. I. Ewen (United States) described his work on the reception of the line radiation at 1,420 Mc./s. originating in the neutral hydrogen atoms in the galaxy. The frequency and intensity of the line were shown in the early experiments to depend on the direction of the observation. Mr. Christiansen and Dr. C. A. Muller (Netherlands) described their investigations of the variations of frequency and of the deductions which could be made about the movements of the emitting portions of the galaxy.

At the last session, Dr. B. Y. Mills (Australia) surveyed the techniques which have been used for the observation of discrete sources of cosmic radio waves. Observations made in Sydney on a frequency of 100 Mc./s. show that the more intense radio stars are concentrated towards the galactic plane. R. Hanbury Brown (Great Britain) reported results obtained on a frequency of 160 Mc./s., in which a source was discovered near the position of the supernova observed by Tycho Brahe; other sources were tentatively identified with clusters of extra-galactic nebulae. Dr. J. G. Bolton (Australia) described an extension of the sea interferometer experiments, and a new instrument for determining azimuth. He has been able to show that the angular diameter of some radio stars can be resolved.

Among the thirty-three documents distributed to this commission were several reports from national committees which present useful surveys of the very rapid progress made in recent years in this general field of radio astronomy.

Waves, Circuits and Electronics

The interests of Commission 6 are considered to cover such fields as theory of information; theory of non-linear oscillations; linear circuit theory; and diffraction theory, antennae and wave-guides. Various working parties were set up at Sydney to report on progress in these fields, and national committees were recommended to give serious consideration to a number of matters relevant to the theory of information and its practical application to communication matters in which the International Radio Consultative Committee had expressed particular interest.

Three sessions of the Commission concerned with electronics were held, at the first of which new developments in vacuum tubes were discussed, while the second dealt with such subjects as the dielectric properties of solids, the thermionic constants of metals and the electrical properties of thin films. The final session dealt with the fundamentals of gas discharges, the interaction of electromagnetic waves with plasma, and the radiation of micro-wave noise from gas discharges.

Publications

Hitherto the proceedings of the General Assemblies of the Union have been published with the detailed texts of all documents. On the present occasion, the executive committee of the Union decided to discontinue the publication of the individual papers, which are either incomplete summaries of the papers presented at the sessions or are papers which are or will be published in the recognized scientific journals. A more useful objective to be pursued is to publish additional special reports on selected radio topics, and to make these universally available. Two such reports have already been published, one on "Solar and Galactic Radio Noise" and the other on "Tidal Phenomena in the Ionosphere"; and a third, on "The Dynamics of Ionised Media", is in the press. Among the subjects proposed for future reports are ionospheric storms, radio investigation of meteors, ionospheric wave interaction, interstellar hydrogen, discrete sources, and the distribution of radio brightness on the solar disk.

Officers

At the closing meeting of the general assembly, the following officers were elected: *Honorary presidents*, Sir Edward Appleton, Dr. J. H. Dellinger and Dr. B. van der Pol; *President*, Father P. Lejay; *Vice-Presidents*, Dr. C. R. Burrows, Dr. D. F. Martyn and Prof. B. D. H. Tellegen; *Treasurer*, Prof. C. Manneback; *Secretary General*, Col. E. Herbas; and *Chairmen of Commissions*, (1) Dr. R. L. Smith-Rose, (2) Dr. C. R. Burrows, (3) Sir Edward Appleton, (4) Mr. J. A. Ratcliffe, (5) Dr. M. Laffineur, (6) Dr. L. C. von Atta, and (7) Prof. G. A. Wootton. Delegates of the Union were also appointed to serve on various other international organizations.

In addition to the scientific meetings described above, the delegates participated in an extensive programme of technical visits and social events which displayed both the intention and the ability of their Australian hosts to make the occasion as instructive and pleasant as possible. The University of Sydney, the National University at Canberra, the Commonwealth Observatory at Mt. Stromlo, the various laboratories and field stations of the radio and

electrical divisions of the Commonwealth Scientific and Industrial Research Organization were all visited, as well as some of the laboratories and works of firms in the associated industry. On such occasions, chiefly at week-ends, when no formal business sessions were on the programme, all the delegates were provided with excellent opportunities for enjoying the beautiful scenery around Sydney and farther afield in New South Wales. The hospitality shown by the Commonwealth Government and by private organizations and individuals has left a memorable impression of this visit to the only continent which lies wholly in the southern hemisphere.

R. L. SMITH-ROSE

¹ *Nature*, 170, 152 (1952).

² See *Nature*, 170, 1090 (1952).

³ See *Nature*, 171, 14 (1953).

PLANKTON OF THE BENGUELA CURRENT

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DURING the two surveys of this area in 1950 that yielded the hydrological results described in a recent article by Currie¹, extensive plankton collections were made. Preliminary sorting of the zooplankton material is not yet complete—in addition to its being nearly as rich as that of polar waters in quantity, it is much more diverse in quality—and a greater expenditure of time than that required for this phase of the work on material from most other regions is therefore unavoidable. Moreover, the full value of the material can only be assessed when specialists working independently on the various groups have completed their reports. At this stage, therefore, only major features of group-distribution, rendered clear by the preliminary work on material from the first survey, have been considered.

With the phytoplankton we can already proceed much further. In dealing with it, a conservative choice of method was necessitated by practical considerations (to be stated in the main report), and our estimations for all stations on both surveys are now complete. These were made by Hensen methods from 100–0 m. hauls of the Gran net. When plotted logarithmically, they seem adequate to show up the grosser quantitative differences; for it was found that the concentrations of phytoplankton in this area were such that, whether dealing with important individual species, groups or grand totals, a 50 per cent alteration of values assigned to the contours in either direction made but little difference to their position on the chart. Moreover, scores of individual species, only one or two of which can be cited here, showed distributional patterns in good agreement with the hydrological features. The latter were, of course, quite independently assessed.

Close similarity to the conditions off Lower California in 1941, as described by Sargent and Walker², working from W. E. Allen's counts, is evident. They found a succession of three "plankton elements" in a large eddy of the upwelling current, with *Chaetocerids* predominating in the richest, most recently upwelled and coldest water, and a sparse warm-water element offshore. This last, however, was in the oldest surface water from the eddy, not in a distinct, more oceanic,