40. COMMISSION POUR LES OBSERVATIONS RADIOELECTRIQUES

PRÉSIDENT: M. WOOLLEY.

MEMBRES: MM. Appleton, Blackett, Bolton, Burrows, Mme Carpenter, MM. Denisse, Greenstein, Harang, Hey, Khaikin, Laffineur, Lovell, McKinley, Martyn, Millman, Mitra, Nicolet, Pawsey, J. R. Pierce, Rakshit, Ratcliffe, Reber, Rydbeck, Ryle, Shklovsky, Williamson.

Commission 40 of the I.A.U. has not yet had an opportunity to meet, and its activities have been as yet confined. A communication has been received from the corresponding Commission of another Union (Union Radio Scientifique Internationale) suggesting a list of terms and definitions for general use. This document has been circulated to individual members of our Commission and it is proposed to discuss it when our Commission meets.

Reports on recent developments in the various scientific matters which fall into the province of our Commission, for which I am indebted to the kindness of Drs J. G. Bolton, P. M. Millman and J. L. Pawsey, are given below.

GALACTIC NOISE

Dr J. G. Bolton reports as follows:

The pioneer discovery in galactic noise was made in 1931 by K. G. Jansky, who working on a frequency of 20 Mc./sec. found a strong distributed source of extra-terrestrial radiation. This radiation was strongest when his aerial system was directed towards the centre of the galaxy but could be detected at all points along the galactic equator.

The spatial distribution of this radiation has since been studied by a number of workers over a range of frequencies from 9·5 to 480 Mc./sec. Such work, however, has generally been severely handicapped by the low resolving power of the aerial systems available and much fine detail has probably been missed. In 1946 a second fundamental discovery was made by J. S. Hey, S. J. Parsons and J. W. Phillips who found that the radiation from a small area in the constellation of Cygnus showed short period fluctuations in intensity. From the similarity between the Cygnus fluctuations and the rapid variations in the high level of radiation associated with active sunspots they suggested that the fluctuations might originate in a discrete source such as a star. It is now known that the fluctuations are of atmospheric origin.

Later J. G. Bolton and G. J. Stanley, using interference technique, were able to demonstrate the existence of a 'point source' in this region and also found a number of other point sources. Their interferometer consisted of a single aerial situated on a high cliff overlooking the sea. The sea acted as a reflector and interference took place between the direct and reflected rays—the path length between the two rays gradually increasing as a source rose above the horizon. From the interference patterns it was possible to determine roughly the position of the source and place an upper limit on its angular width. This work has been continued by Bolton, by Ryle (Cambridge) and Mills (Sydney) using interferometers consisting of two aerials spaced along East–West lines and by Hanbury Brown (Manchester) using a single but highly directive aerial. At present over one hundred point sources are known but only a few have been studied in detail and positioned with reasonable accuracy. No visible counterparts have been found for the most intense sources in Cygnus and Casseopeia but suggested identifications for three of the others are the Crab Nebula and the extragalactic nebulae M87 and NGC 5128. If the latter identifications are correct these nebulae must be far more powerful radiators than our own Galaxy or the Andromeda Nebula from which R. Hanbury Brown and H. Hazard find radiation comparable to that which our own Galaxy would give if placed at the same distance.

Some years ago attempts were made to explain the general background of noise in terms of free-free transitions in the ionized interstellar gas. However, experimental

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evidence such as the radio frequency spectrum of the noise, the high intensity at the lower frequencies and the low concentration of the noise distribution to the galactic plane has led to the rejection of this hypothesis. Interstellar matter may be expected to make important contributions only in certain regions close to the galactic plane. No doubt influenced by the discovery of point sources in ever increasing numbers, theorists now favour a 'stellar' origin. On the basis that the general background of noise represents the diluted radiation of a distribution of *radio stars* and that the nearer ones may be identified with the known point sources, densities of between one in a hundred and one in a thousand of normal stars have been suggested. Little can be said at present on the large-scale distribution. However, it appears that the more intense sources lie close to the galactic plane. A definite association of the point sources with the general background may be proved by investigation of noise spectra. It is also important to establish whether the point sources are in fact starlike, for the present upper limits to their angular diameters (ranging from 90″ in the case of the Cygnus source to 30′ for some of the less intense) are far in excess of similar stellar dimensions and do not preclude the possibility of their being nebulae.

In 1935 Jansky wrote: '... This fact leads to the conclusion that the source of these radiations is located in the stars themselves or in the interstellar matter distributed throughout the Milky Way ...' Whatever the mechanism of the radio noise it may be assumed that the distribution of the source of this radiation throughout the Galaxy is representative of the distribution of matter. On present evidence there seems to be little absorption of radio-waves in the Galaxy—certainly nothing comparable to the vast dust clouds which lie close to the galactic plane hiding the central regions from the visual astronomer. Thus though the radio astronomer has as yet no yardstick of distance he may be able to infer from the observed distribution of noise important structural features of the Galaxy.

Solar Radio-waves

Dr J. L. Pawsey reports as follows:

Radio-waves emitted by the Sun were first recognized in 1942 in the course of investigations related to military radar. Strangely enough there were two independent discoveries of two entirely distinct components of solar radio-waves. In the centimetre wavelength range Southworth of the Bell Telephone Laboratories identified steady thermal radiation of an intensity corresponding to black body radiation from the solar photosphere at a temperature a few times the optical (6000° K.) value. On wavelengths of a few metres Hey of the English Operational Research Group identified a peculiar type of interference observed on radar equipment during the presence of an exceptionally large sunspot as due to radiation from disturbances on the Sun. The intensity exceeded the black body value many thousandfold.

These observations were published at about the end of the war in 1945 and since then extensive observations have been carried out in a number of laboratories. The present state of knowledge of solar radio-waves is broadly as follows. The intensity observed at any wavelength is highly variable, short-period increases of seconds' duration and bursts being conspicuous features. It is fairly clear that the emission is due to a number of distinct components due to different physical causes. The principal components now recognized are:

(1) A background due to thermal emission from the gases of the whole solar atmosphere.

(2) *Outbursts*. Violent brief increases (duration minutes) associated with solar flares. The polarization of the radiation (in the intense stage) is random and the source generally moves outwards from the vicinity of the flare with a velocity of the order of 1000 km./sec.

(3) *Noise Storms*. Protracted increases observed on metre wavelengths (duration days) associated with large sunspots. The polarization is normally circular and the source is usually in a single small region high in the corona over a large sunspot.

(4) A slowly varying component observed on decimetre wavelengths (e.g. 3–50 cm.) of amplitude of the order of the thermal background. The source is normally in a number

of small regions, some of which are over sunspots, and the radiation shows traces of circular polarization.

Considerable progress has been made in the interpretation of these phenomena. The background is now generally accepted as due to thermal radiation arising at electron-proton collisions in the solar atmosphere. The theory is understood and the region of origin is in the high corona at metre wavelengths but falls with decreasing wavelength to the mid-chromosphere in the centimetre range. The observations in conjunction with optical ones have already been applied to the derivation of electron temperature and density distribution in the solar atmosphere. There is now strong evidence that outbursts often originate in the explosive ejection of particles of the nature of those which, when they pass towards the Earth, cause aurora and magnetic storms. Consequently, the radio observations should be capable of providing valuable evidence concerning the genesis of such phenomena.

It has recently been suggested that the slowly varying component originates in thermal radiation from coronal concentrations, i.e. regions of excess electron density and temperature (e.g. up to 10^7 °K.). If this hypothesis is confirmed, valuable information about such regions should become available. The last component, neise storms, along with other minor components not mentioned here, have not received a satisfactory explanation in terms of known solar phenomena.

In addition, the mechanism of origin of the more intense components, including noise storms and outbursts, is not established. The measured intensities, corresponding to brightness temperatures of 10^9 °K. commonly and up to 10^{16} °K. in an extreme case, and the rapid variations cannot be reconciled with a simple thermal origin. The suggested mechanisms fall into two groups, the one involving mass motions of electrons and ions (electric currents) and the other radiation from electron-ion collisions where the electrons have high energies derived from electric fields.

From the progress in the six years since research in the field of solar radio waves commenced it seems certain that radio measurements should take a major place in two aspects of solar physics; firstly in the study of physical conditions in the undisturbed solar atmosphere where radio and optical techniques are already playing complementary roles, and secondly in the study of disturbances in the outer atmosphere where the present lack of a single optical observation of the actual source of a major radio disturbance constitutes a challenge to astronomers.

References

SOUTHWORTH, G. C. Microwave Radiation from the Sun. *J. Frank. Inst.* **239**, 285–97, 1945, and erratum issued with **241**, no. 3 (March 1943).

HEY, J. S. Solar Radiation in the 4–6 Metre Radio Wavelength Band. *Nature*, **157**, 47–8, 1946.

The Moon

The Moon has the distinction of being the only astronomical body which has been studied both by means of the echo technique and by means of its naturally emitted, thermal, radio-frequency radiation. Nevertheless the information derived so far is trivial relative to that concerning the Sun and Galaxy. As a result of echo experiments on wavelengths of 3 and 15 m. it appears that there is no previously unknown matter between us and the Moon which seriously obstructs radio waves but that the terrestrial ionosphere presents a greater impediment than is expected on current models. The surface of the Moon has also been shown to be 'rough' at these wavelengths.

Naturally emitted radiation on a wavelength of about 1 cm. has been studied and it appears to be simple thermal radiation from the solid surface of the Moon. The intensity was used to derive the mean lunar surface temperature and its variation over the lunar day. These values disagree with similar temperatures previously derived from infra-red observations. The radio temperatures showed a lesser range and a difference in phase.

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This was explained as being due to the different depths of origin, the infra-red being from the surface and the radio a little below the surface and hence subject to less violent fluctuations from day to night. Further, the phase difference between the radio and the infra-red variations was shown to be incompatible with heat transfer in a homogeneous medium but consistent with the existence of a thin surface layer of high thermal insulation. It was suggested that this layer is in fact present and consists of a thin layer of dust lying over the lunar surface.

The most obvious use of the echo technique is to determine distance to the Moon with high precision. This has not yet been attempted because in the past experiments insufficient power was available to permit accurate distance measurement.

R. v. d. R. Woolley
President of the Commission

APPENDIX

1. Terminology and Notation in Radio Astronomy

The attention of those interested in the activities of Commission 40 is directed to a letter and report received from the president of Commission V, U.R.S.I.* Since this communication will be considered at the next meeting of Commission 40, the following preparatory comments are offered at this time.

(*a*) The quantities and symbols defined in Table I are the definite recommendations of Commission V, U.R.S.I. They do not conflict with general astronomical practice and are extensively used in radio astronomy. The definition of the sense of rotation of polarized radiation is in general use throughout the field of radio-wave propagation. It does not seem wise to restrict the term 'apparent temperature' to the case of the sun, though that has been its chief use so far.† Preferably, the apparent temperature should be defined by the relation,

$$T_s = \frac{\int T_b \, d\Omega}{\int d\Omega} = \frac{S}{\Omega},$$

where T_b is the brightness (see Table I), $d\Omega$ is an increment of solid angle and the integration is over the whole of the contributing parts of the object. With T_s as the general notation for the apparent temperature, T_d still may be used, as in Table I, for the important and special case of the sun where Ω is the solid angle of the visual disk.

If these definitions and notations are acceptable, I.A.U. Commission 3 should be notified.

(*b*) The Commission V report contains an extensive list of 'Generally Accepted Terms and Special Terms Used by Some Authors' These are qualitative terms used to define phenomena and they illustrate the descriptive difficulties, both linguistic and

* Letter to Dr R. v. d. R. Woolley from Dr D. F. Martyn, printed in *U.R.S.I. Information Bulletin*, No. 67, p. 19 (English edition), Jan.–Feb. 1951.

Report of the Sub-Committee on Terminology (*Proceedings of the General Assembly U.R.S.I.*) held in Zürich from 11–22 September 1950, **8**, part 1, pp. 406–12.

Rapport du Sous-Comité pour la Terminologie et les Unités (*Recueil des Travaux de l'Assemblée générale*) tenue à Zürich du 11 au 22 Septembre 1950, **8**, 1re Partie, pp. 426–34.

These U.R.S.I. publications have a limited distribution. Copies of the pertinent material may be obtained, when otherwise unavailable, by applying to the Office of the Secretary, I.A.U., Sterrewacht, Leiden, The Netherlands.

† It is common practice to assign apparent solar temperatures on the arbitrary basis of a half-degree solar diameter. This is not desirable when the relative precision of measurement throughout a year approaches 6% or better.

observational, which now exist in radio astronomy. 'It would therefore be premature to attempt to standardize these yet, but it would be unfortunate if later authors should create confusion by using these terms with different meanings.' Commission 40 should encourage the development of a consistent and uniform descriptive terminology for radio astronomy.

TABLE I

Symbol	Quantity (per unit frequency band in each case)	Unit	Corresponding temperature expression unit (° K.)
S	Flux density	(Watts) (m.)$^{-2}$ (cyc./sec.)$^{-1}$	Apparent temperature of sun (T_d)
B	Brightness	(Watts) (m.)$^{-2}$ (cyc./sec.)$^{-1}$ (steradian)$^{-1}$	Brightness temperature (T_b)
P	Available power	(Watts) (cyc./sec.)$^{-1}$	Equivalent aerial temperature (T_a) (of an aerial)

The sense of rotation of a circularly, or elliptically, polarized wave will be defined as 'right-handed' if the electric vector in a plane fixed in space and parallel to the wave-front rotates clockwise when viewed in the direction of propagation, i.e. with the source behind the observer. The opposite sense of rotation is 'left-handed'

(*c*) An alternate terminology for radiation concepts is suggested in Appendix I of the Commission V report which does not seem in any way desirable. Both new terms and terms already in use in photometric literature are proposed for introduction where current practice is well established and satisfactory in astrophysics and radio-wave propagation. The absence of the bandwidth dimension, (cyc./sec.), is unfortunate. Though units such as the (watts) (m.)$^{-2}$ (cyc./sec.)$^{-1}$ are dimensionally redundant,* yet they have found very wide use just because of their functional clarity and propriety in radio astronomical measurements. Lastly, it is suggested that the CGS and the MKS systems are equally acceptable. This is contrary to long established practice in electronics, radio-wave propagation and radio astronomy.

2. DESIGNATION OF DISCRETE SOURCES

Appendix II of the Commission V report suggests a procedure for the official designation of discrete sources. Official action should be taken on this matter because the number of discrete sources is well over sixty at the present time and a large increase can be expected in the near future. Furthermore, early difficulties with the observational techniques have been overcome to such an extent that one may place considerable confidence in the reality of most of the reported objects and in their positions. Thus it would be most appropriate if Commission 40 were to draw up specific recommendations for a suitable method of naming the discrete sources and were to designate a sub-committee to supervise the official classification of the known objects and the new ones as they appea· Such recommendations should be communicated to Commission V, U.R.S.I., and a general agreement sought.

Two schemes are now in use for naming discrete sources. Scheme (*a*) divides the sky into twenty-four equal areas. Objects are designated according to the whole hours of their right ascension and by the order of their discovery within the particular lune. Scheme (*b*), the oldest arrangement, employs the abbreviations of the names of the constellations in which the object is located followed by a capital letter giving the order of discovery within that particular constellation. Appendix II of the Commission V report suggests a third method in which the abbreviations of the names of the constelations are followed by a number. As an example of these three designations we have, in order,

19·01, Cyg A, Cyg. (1).

* The dimensions of flux density can also be given as (joules) (m.)$^{-2}$.

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The primary function of a systematic naming scheme is to give the position of any source in a catalogue where more complete data are to be found along with references to other tabulations. The designation should be brief, easily interpreted, easily remembered and widely acceptable. The naming of celestial objects by constellations is traditional and a great many of those trained in the tradition know the location of the constellations and their relation to the galactic centre. This is hardly true for most of those now engaged in performing the radio observations. Consequently and because of the desirability of general agreement on some system at an early date, two additional schemes are proposed here, as follows:

Scheme (X) designates each source by five characters where the first two give the whole hours of the right ascension, the third is N or S, the fourth gives the tens of degrees of declination and the fifth indicates the order of official classification within each co-ordinate mesh.

Scheme (Y) is derived from a practice sponsored by the I.A.U. for the naming of an ever increasing number of variable stars. Here, **19·01**, or **Cyg A**, being the first *radio* discrete source found in Cygnus, would be **R1 Cyg**.

Table II was assembled to present a unified summary of the observational data on discrete sources in the literature at the present time. The various methods of classification just discussed are illustrated in the table. Order of discovery was generally ignored and, with the (Y) designations, it was not intended that the internal organization by right ascension should become a precedent. Because of the size of the probable errors of some of the source positions, scheme (X), with its 432 subdivisions, leaves the designation of some two dozen objects presently uncertain. Scheme (Y), with 89 subdivisions, leaves five objects presently uncertain. The situation is similar with schemes (a) and (b) now in use. Because this list of discrete sources is the result of essentially preliminary observations with new techniques, the number of uncertain designations in any of these systems should decrease to an insignificant number in the next few years.

3. World-wide Radio Survey of Solar Activity

At the 1950 Zürich assembly of U.R.S.I., Commission V appointed a sub-committee, under the chairmanship of A. H. de Voogt,* to report on continuous observation of the solar radio emission by a chain of observatories. This sub-committee is proceeding with the establishment of a continuous patrol on 200 and 3000 Mc./sec. but it is seriously handicapped by the lack of stations in the following approximate areas—Southern California or Mexico, Hawaii, India and North Africa. To improve the general level and uniformity of observing and reporting procedures, this sub-committee has arranged a monthly exchange of data among nine observatories which operate on fourteen or more frequencies between 60 and 3750 Mc./sec. Many of these same observatories also contribute data to the *Quarterly Bulletin on Solar Activity*.†

For several years and at the cost of considerable effort, Dr C. W. Allen has been editing a large body of solar radio observations for publication in the *Quarterly Bulletin on Solar Activity*. The recent and rapid developments in radio-observing techniques and the increase in the number of regular observers are producing an immense volume and variety of data. Not all of these can be included in the *Quarterly Bulletin*. Also, the long delay between the availability of some of the data and their appearance in the *Quarterly Bulletin* tends to delay public discussion of all the data.

* Engineer-in-Chief, Chief Radio Service P.T.T., 6 Scheveningsweg, The Hague, The Netherlands.

† Contributing to both the *Quarterly Bulletin* and the U.R.S.I. exchange are observatories at Canberra and Sydney (Australia), Cambridge (England), Paris and Marcoussis (France). Appearing only in the *Quarterly Bulletin* are Ottawa (Canada), Byfleet (England), Cornell (U.S.A.). Participating only in the U.R.S.I. exchange are Nera (The Netherlands), Mitaka, Osaka and Toyokawa (Japan). This list was compiled from *Quarterly Bulletin*, No. 91, and with the help of A. H. de Voogt, and is certain to be out of date by September 1952.

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So far, there has been no general discussion of the intrinsic quality of much of the routine data being collected and of their possible relative value. It is imperative that all concerned be on their guard against the merely prolific and conservative aspects of modern, semi-automatic, data-taking apparatus. While a certain amount of standardization is desirable in solar radio observation and, perhaps, badly needed at the present time, yet care must be used to prevent premature or accidental standardization.

For these reasons, Commission 40 should make some arrangements for the evaluation of the whole problem of solar radio observation and the publication of the radio data, consulting such interested bodies as I.A.U. Commissions 10 and 11 and establishing a close liaison with Commission V, U.R.S.I.

4. Bibliography

For some time, there has been a limited, private distribution of a world-wide bibliography of radio astronomy. A recent edition of this work* appeared under the title 'Bibliography of Extraterrestrial Noise, Issued as Part of the Report of Commission V to the IXth General Assembly (1950) of the International Scientific Radio Union' Interested persons not yet aware of this useful reference should communicate with the editor.

A bibliographical item which would be useful to those working in the field of solar-terrestrial relationships would be a summary of current organizations and publications, government or private, which are wholly or in a large part devoted to the systematic collection and/or publication of observations and predictions of solar, ionospheric, geomagnetic, auroral activities, etc. Perhaps such a source list could be provided by the I.C.S.U. Mixed Commission on Solar and Terrestrial Relations.

In so far as they are not connected with regular astronomical observatories, radio astronomical observatories should be encouraged to make brief annual reports of their activities, perhaps publishing them in a manner similar to the annual observatory reports in the *Astronomical Journal.*

5. Co-operative Investigations

There are a number of investigations which commend themselves highly at the present time and which, because of the geographical positions of some of the possible observers, may require an unusual degree of co-operation. The following are particularly worth mentioning. Should any of these or similar investigations be under way, it would be to the general interest to make known an informal résumé of the work in hand.

(a) *Complete Isophotal Maps*

Isophotal maps of the entire celestial sphere are needed over a range of frequencies. They should be corrected for the effects of the stronger discrete sources and a maximum of precision should be aimed for in those aspects of the data which can be used for determining the first and second moments of the distributions.

(b) *Standard Sequences*

The spectra of the galactic and extra-galactic radiations are of paramount importance. Absolute intensity measurements are difficult to perform with high accuracy Several observatories, cross-checking each other, could set up standard spectral sequences of discrete sources and selected areas. The standard, selected areas should be chosen for their general uniformity of brightness. With such easily available, comparison objects, a greatly increased spectral accuracy would be obtainable for the entire sky with only relatively simple radio telescopes.

* Compiled and edited (with full abstracts) by Dr M. E. Stahr-Carpenter, Dept. of Astronomy, Cornell University, Ithaca, N.Y., U.S.A.

(c) *Systematic Atmospheric Refraction*

The systematic, as well as the erratic, refraction of the Earth's atmosphere needs to be known with precision for use in the accurate determination of the positions of discrete sources. This work recommends itself particularly to those who are fortunate in their geographic positions with respect to the stronger discrete sources.

(d) *Eclipses and Occultations*

There are many partial lunar eclipses of the Sun which may be of importance to radio astronomy but which are not even roughly calculated. Under certain circumstances, partial radio eclipses where the Moon comes no nearer than a degree to the limb of the Sun may provide useful coronal data.

In a similar way, as pointed out by Machin and Smith,* coronal eclipses of a strong discrete source may provide information on the structure of the corona.

Lunar occultations of discrete sources may be used in two ways. First, an occultation of a known source will provide a fundamental check on the radio position and on the width of source. Second, large single antenna systems can be used for the sensitive discovery of discrete sources merely by tracking the Moon for systematic, short periods over the next few years. In a Saros, the Moon occults about 10% of the sky many times over.

C. L. SEEGER,
D. A. MACRAE,
R. E. WILLIAMSON,
H. C. VAN DE HULST

* Machin, K. E. and Smith, F G. *Nature*, **168**, 599 (6 October 1951).

Table II

Discrete Radio Sources

(For References and Notes, see end of Table)

	Source designations: Proposed (X)	Proposed (Y)	Others(1) (a)	Others(1) (b)	R.A.(2) h. m. s.	± m. s.	Dec. ° ′	± ° ′	Technique(3)	Approximate galactic(4) Lat.°	Long.°	Flux(5) density × 10⁻²⁶ W/m.² (c./s.)	Refs.	Notes(6)
1	00N31	R1 And	00·01	...	00 42	± 6	38	±5	*M*	−24	90	4	*a*	M31
2	01N31	R1 Tri	01·01	...	01 25	± 5	30	±3	*M*	−31	101	8	*a*	M33
3	01N41	R2 And	01·02	...	01 09	± 3	43 15	±1	*M*	−18	96	4·5	*a*	
4	02N31	R2 Tri	02·02	...	02 25	± 3	35 30	±2	*M*	−22	113	5	*a*	
5	02N41	R3 And	02 01	...	02 16	± 3	44 15	±2	*M*	−14	107	6	*a*	
6	02N42	R1 Per	02·03	...	02 45	± 3	45 15	± 45	*M*	−11	112	4	*a*	
7	03S31	R1 For	...	For-A	03 11		−36		*L*	−57	204	20	*b*	
8	03N41	R2 Per	03·02	...	03 12	± 3	43 45	± 30	*M*	−10	117	9·5	*a*	
9	03N42	R3 Per	03·03	...	03 58	± 1 30	41	±1 30	*M*	− 7	125	4·5	*a*	
10	03N71	R1 Cam	03·01	...	03 50	±20	75	±1	*M*	+17	102	14	*a*	
11	04N21	R1 Tau	04·01	...	04 28	± 1	25	±2	*M*	−14	141	33	*a* }	(7)
12	04N22	R2 Tau	...	Tau-C	04 38		28		*L*	−10	140	30	*b* }	
13	04N31	R1 Aur	04·02	...	04 56	± 2	33	±1 30	*M*	− 4	139	12·5	*a*	
14	04N32	R4 Per	04·03	...	04 10	± 2	35 45	± 30	*M*	− 9	131	10·5	*a*	
15	05S41	R1 Pic	...	Pic-A	05 18		−44		*L*	−33	217	30	*b*	
16	05S31	R1 Cae	...	20–1949	05 01		−36		*L*	−35	205	20	*b*	
17	05N21	R3 Tau	...	Tau-A	05 31 00	± 30	22 01	± 07	*L*	...	...	...	*g* }	
				Tau-A	05 31 20	± 30	22 02	± 08	*L*	...	...	...	*c* }	
				Tau-A	05 31 30		22 01		*L*	− 4	150	185	*b* }	NGC-1952, (M1), (8)
			05·01	...	05 31 37	± 10	22 10	± 20	*M*	− 4	152	125	*a* }	
			05·01	...	05 31 34·5	± 03	22 04	± 05	*M*	...	...	...	*e* }	

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18	05N22	R4 Tau	...	Tau-B	05 32		24		*L*	− 3	151	60	*b*	
19	05N31	R2 Aur	05·02	...	05 02	± 3	37	±2	*M*	− 1	137	10	*a*	
20	06N31	R3 Aur	06·01	...	06 17	± 2	33	±2	*M*	+10	148	8·5	*a*	
21	06N41	R1 Lyn	06·02	...	06 57	± 3	47 30	±1 30	*M*	+23	137	3	*a*	
22	07N41	R3 Lyn	0·702	...	07 35	± 4	42	±2 30	*M*	+28	145	3	*a*	
23	07N51	R2 Lyn	07·01	...	07 19	± 3	51	±1	*M*	+27	134	4	*a*	
24	08S41	R1 Pup	...	Pup-A	08 18		−42		*L*	− 2	227	30	*b*	
25	08N11	R1 Cnc	08·02	...	08 48	± 2	18	±5	*M*	+36	177	7·5	*a*	
26	08N31	R5 Lyn	08·03	...	08 22	± 3	36	±1 30	*M*	+36	154	4	*a*	
27	08N41	R4 Lyn	08·01	...	08 08 00	± 15	48 15	± 30	*M*	+35	139	10	*a*	
28	08N51	R1 UMa	08·04	...	08 51	± 2	53	±1	*M*	+41	132	2·5	*a*	
29	09S01	R1 Sex	...	Sex-A	09 55		− 5		*L*	+38	214	20	*b*	
30	09N31	R1 LMi	09·02	...	09 32	± 6	39	±2	*M*	+50	152	3·5	*a*	
31	09N41	R2 UMa	09·01	...	09 16	± 4	47	±1	*M*	+46	140	5	*a*	
32	09N51	R3 UMa	09·03	...	09 57	± 2	56 30	±1 30	*M*	+50	124	3·3	*a*	
33	10N41	R4 UMa	10·01	...	10 00 30	± 30	43 15	±1	*M*	+55	144	7·5	*a*	
34	10N42	R6 UMa	10·02	...	10 50	± 3	44 15	±2	*M*	+63	136	3·5	*a*	
35	10N51	R5 UMa	10·03	...	10 33	± 4	56	±1	*M*	+54	120	3·3	*a*	
36	11N11	R1 Leo	...	15–1948	11 52		17		*L*	+74	223	10	*b*	
37	11N31	R7 UMa	11·01	...	11 03	± 3	39 45	±1	*M*	+67	143	6	*a*	
38	11N41	R8 UMa	11·03	...	11 43	± 3	44	±2	*M*	+70	122	3	*a*	
39	11N61	R9 UMa	11·02	...	11 48	± 4	64	±3	*M*	+53	99	5	*a*	
40	12N11	R1 Vir	...	Vir-A	12 28 06	± 37	12 41	± 10	*L*	...	...	...	*g*	NGC-4486, (M87), (11)
				Vir-A	12 28 06		12 41		*L*	+74	260	125	*b*	
			12·01	...	12 28 25	± 10	12 55	± 20	*M*	+74	259	105	*a*	
			12·01	...	12 28 18	± 03	12 37	± 10	*M*	...	...	...	*e*	
41	13S41	R1 Cen	...	Cen-A	13 22 20	± 60	−42 37	± 08	*L*	...	...	...	*g*	NGC-5128
				Cen-A	13 22 20		−42 37		*L*	+20	274	185	*b*	
42	13N31	R2 CVn	13·02	...	13 40	± 2 30	38	±1 30	*M*	+74	42	3	*a*	
43	13N41	R1 CVn	13·01	...	13 26	± 4	48	±3	*M*	+68	69	3·5	*a*	M51
44	14N51	R10 UMa	14·01	...	14 01	± 2	51	±2	*M*	+62	62	7·5	*a*	M101
45	14N52	R1 Dra	14·02	...	14 59	± 3	58	±1 30	*M*	+51	61	4	*a*	

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TABLE II (*continued*)

	Source designations				R.A.(2)		Dec.		Tech-nique(3)	Approximate galactic(4)		Flux(5) density $\times 10^{-25}$ W/m.^{2} (c./s.)	Refs.	Notes(6)
	Proposed		Others(1)											
	(*X*)	(*Y*)	(*a*)	(*b*)	h. m. s.	± m. s.	° ′	± ° ′		Lat.°	Long.°			
46	15N31	R1 Boo	15·03	...	15 01	± 2	36	±3	*M*	+59	24	4	*a*	
47	15N51	R2 Dra	15·02	...	15 29	± 5	55	±1 30	*M*	+49	54	4·5	*a*	
48	15N71	R1 UMi	15·01	...	15 00	± 2	70	±1	*M*	+44	74	9	*a*	
49	16N01	R1 Oph	...	Her-A	16 50		5		*L*	+26	351	20	*b* }	
			16·01	...	16 49	± 4	7	±9	*M*	+28	353	30	*a* }	
50	16N31	R2 Her	16·03	...	16 24	± 1	38	±1 30	*M*	+43	27	7	*a*	
51	16N41	R1 Her	16·04	...	16 08	± 2	40	±4	*M*	+46	30	3·5	*a*	
52	16N61	R3 Dra	16·02	...	16 01	± 4	66 30	±1	*M*	+41	66	7	*a*	
53	17N61	R4 Dra	17·01	...	17 03	± 6	63 30	±1 30	*M*	+36	60	5	*a*	
54	18S11	R1 Ser	...	Ser-B	18 11		−15		*L*	− 1	343	20	*b*	
55	18N01	R2 Ser	...	Ser-A	18 43		5		*L*	+1½	5	30	*b*	
56	18N41	R3 Her	18·02	...	18 00 00	± 30	47 30	± 30	*M*	+27	42	8·5	*a*	
57	18N42	R5 Dra	18·03	...	18 27	± 3 30	47 45	±1	*M*	+22	43	7·5	*a*	
58	18N81	R6 Dra	18·01	...	18 40	±10	80	±1	*M*	+28	79	9·5	*a*	
59	19N41	R1 Cyg	...	Cyg-A	19 58 47	± 10	41 47	± 07	*L*	...	...	...	*f* }	
			...	Cyg-A	19 58 14		40 36		*L*	+4½	44	1250	*b* }	
			19·01	...	19 57 46	± 05	40 30	± 07	*M*	+ 4	44	1350	*a* }	(9), (10)
			...	Cyg-A	19 57 37	± 06	40 34	± 03	*M*	...	...	1500	*d* }	
			19·01	...	19 57 45·3	± 01	40 35	± 01	*M*	...	...	...	*e* }	
60	19N51	R7 Dra	19·02	...	19 01	± 4	57 30	±1	*M*	+20	55	3·8	*a*	
61	23N51	R1 Cas	23·01	[Cas-A]	23 21 12	± 10	58 32	± 04	*M*	− 2	80	2200	*a* }	(10)
			23·01	...	23 21 12	± 01	58 32·1	± 00·7	*M*	...	...	...	*e* }	

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(*b*) Stanley, G. J., Slee, O. B. *A.J.S.R.* A**3**, 2, pp. 234–50, 1950.

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Notes

(1) See references (*a*) and (*b*).

(2) Epoch 1950 (to sufficient accuracy). With increasing accuracy of measurement, it would be convenient if all observations were reported to the same epoch.

(3) *L*, primary technique uses Lloyd's mirror arrangement; *M*, primary technique uses the meridian interferometer.

(4) Galactic co-ordinates not given in references were computed in Leiden.

(5) Measurement frequencies and estimated errors in flux density are as follows:

Reference:

(*a*) 81 Mc./sec.: a nominal 15% for absolute flux densities and 5–10% for relative flux densities. (Private communication from M. Ryle.)

(*b*) 100 Mc./sec.: estimated 10% for stronger sources to 50% for very weak sources. This reference also gives approximate spectra in range 40–160 Mc./sec. for sources 19N41, 05N21, 12N11, 13S41.

(*c*) 100 Mc./sec.:

(*d*) 97 Mc./sec.: 20%.

(*e*) 81 and 210 Mc./sec.:

(*f*) 100 Mc./sec.:

(*g*) 100 Mc./sec.:

(*h*) 81 Mc./sec.:

(6) The tentative identifications shown are those of the respective authors. Where no co-ordinate errors are listed, see the references for maps and descriptive material. Where attempts have been made to determine the source diameters (refs. *b*, *d*, *f*, *h*), the upper limits appear to have been uniformly set by the instrumental resolution. Multiple entries for several sources are given which are results of essentially the same observers. This is done to show additional information and the consistency of the observations. Presumably, the latest observations with a given technique are the most reliable.

(7) Probably the same source but listed separately here because the difference in right ascension is larger than the estimated errors.

(8) 05N22, or Tau B, appears to be awkwardly placed with respect to the measurement of 05N21, or Tau A, by observers (*a*) and (*e*). The influence of weak, nearby sources on determination (*e*) is estimated to be less than a maximum of 2 sec. in right ascension.

(9) No polarized component has been found in the flux of 19N41; estimated accuracies of polarization measures are 3 and 5% for references (*d*) and (*h*) respectively. From (*d*), the upper limit of the angular width of the source is one minute of arc.

(10) For determination (*e*), the influence of weak, nearby sources is estimated to be less that ¼ sec. in right ascension.

(11) For determination (*e*), the influence of weak, nearby sources is estimated to be less than 2 sec. in right ascension.

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Report of meeting. Monday, 8 September 1952

PRESIDENT: Prof. R. v. d. R. WOOLLEY.

SECRETARY: Prof. M. NICOLET.

The President invited M. Laffineur to give the resolutions taken by Commission V of U.R.S.I. at its last meeting in Australia. He invited the members of the Commission and other astronomers present to comment on the proposals or to make suggestions.

Finally. the following recommendation was adopted:

The Commission recommends that U.R.S.I. be asked to arrange working co-operation between three members of the I.A.U. (to be nominated by the Executive Committee) and the existing sub-commission of U.R.S.I., Commission V, for the purpose of naming radio-stars and of giving advice on all matters concerning the work of Commission 40 and U.R.S.I., Commission V, which may arise between meetings of the International Unions.

Several members gave short accounts of their recent work on radio-electric observations and on radio-sources.

M. Ryle, 'An investigation of the structure of the outermost layers of the solar corona by observation of the occultation of a radio star'

M. Ryle, 'The determination of the accurate positions and angular diameters of two intense radio-stars'

P M. S. Blackett, 'Measurements at Manchester of the angular diameter of the Cassiopeia and Cygnus radio stars'

W Baade, 'The radio sources in Cassiopeia and Cygnus'

After these lectures, the President closed the session of Commission 40.

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