NRAO ONLINE 51

Pawsey, an Astronomy Internationalist, Radio Astronomy's Recognition and Acceptance 1945 to 1960[1]

In 1948, radio astronomy could hardly be said to have made any extensive impact on the world's optical astronomers.[2]

> However, by 1956 Schklovskii wrote :
> ... However diverse, however singular may be the methods of astronomical research, however little they may resemble one another, it must always be kept in mind that they are but branches of one and the same venerable old tree. Radio astronomy is valuable above all because it materially enriches our understanding of the Universe. However, in order to interpret the results of radio-astronomical research, it is absolutely essential to make use of the data of optical astronomy. Only very close cooperation and interdependence between optical and radio astronomy can lead to genuine progress. One must always remember that radio astronomy has not sprung up from a desert; that, over the long years of development of optical astronomy, there has accumulated an immense store of information on the physical nature of the various celestial objects.

Pawsey continued this theme in 1957:[3]

> We observe by radio things which are invisible optically so that we obtain new clues to the nature of the universe. And I scarcely need to remind you, in the detective story which is science, clues add up non-linearly: two and two can add up to more than four.

As the Australians established their prominence in the post war era, Pawsey was very aware of the isolation of the Australian group from the broader community. He was also concerned that radio astronomy would need to be accepted as an important component of astronomy and effectively integrated into the optical astronomy community. The fact that the first radio astronomers in these years were radio physicists who had a background in ionospheric research and later in WWII radar was an initial handicap. Pawsey took immediate steps to close this gap. In 1946, he established close contacts with C.W. "Cla" Allen at the Commonwealth Solar Observatory at Mt Stromlo in Canberra. A major goal of the 13-month overseas trip in 1947-1948 (Chapter 17) was to meet astronomers of all types in North America and Europe.

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[1] This text is related to Chapters 17, 14 and 38 among others.
[2] Edge, D. O., and Mulkay, M. J. (1976). "Astronomy transformed. The emergence of radio astronomy in Britain." New York: Wiley,, quoting Shklovskii in English translation, Potnis, 1960.
[3] Pawsey: 1957 Matthew Flinders lecture 2 May 1957

In January 1950, Pawsey gave one of the concluding papers at an Australian URSI meeting in Sydney organised by the Australian National Committee on Radio Science (ANCORS). He detailed "Proper Fields for Radio Astronomy"- a description of new lines of investigation, revealing "new knowledge". Pawsey pointed out that new features of the universe could now be investigated at radio wavelengths. For the first time, the low density portions of the interstellar medium could be explored. The purpose of this presentation was to explain to colleagues in Australia his vision of the connection between the new radio astronomy and classical astronomy. Pawsey was convinced that the new science would provide "new knowledge" about the universe: "The use of radio waves in astronomy is a recent addition to astronomical techniques. Its value will depend on differences in generation and propagation between radio waves and light which permit the observation of phenomena by radio waves which were not detectable optically."

Pawsey's overseas trip 1947-1948

During his long overseas trip of 13 months in 1947-1948 (Chapter 17), a major goal was to become an ambassador for the new field of radio astronomy. In 1948, Pawsey along with Ginsburg and Ryle had invented the new term "radio astronomy", replacing the earlier terminology "cosmic noise" and "solar noise". Sullivan has written in *Cosmic Noise* page 423:

> But *noise* (meaning radiation characterized by random fluctuations) was a misleading technical term and hardly attractive or descriptive. Nor did it suggest more than a weak link to the sky and to astronomy.

See, ESM_17.2.pdf the for details of the invention of this new terminology.

Australian radio astronomers were convinced they would need to assert their scientific independence; they were no longer a branch of British science. They had shown their own scientific initiative in WWII and continued down this path in the post war era. Perhaps a contributing factor to the rationale for the Pawsey visit in 1947-1948, was the surprising claim by the British in February 1948 that the Australians should not present their own data at the upcoming Stockholm General assembly of URSI 12 to 23 July 1948.

On 24 February 1948, C.R. Oatley of the Engineering Laboratory of the University of Cambridge wrote a remarkable letter to Fred White (CSIR Executive Officer, Melbourne). On behalf of

Smith Rose of URSI in the UK (from the National Physical Laboratory, Teddington), Oatley wrote White[4]:

> I enclose the two copies of letter which I have just received from Smith Rose. It is I believe self-explanatory.
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> **As far as I can gather the Dominions do not usually send representatives to the URSI meetings, although Bowen was present for part of the time in Paris, two years ago [1946].** (our emphasis)[5] Can you please arrange for someone to let us have a short note about work on radio measurements carried out in Australia during the past two years[6].

Fortunately for the Australians, White seems to have ignored the request of Oatley and in July 1948 Pawsey and Martyn presented the Australian results at URSI. Pawsey sent a self-congratulatory letter to Bowen at the end of the Stockholm meeting, on 12 August 1948 (NAA, C3830, F1/4/Paw1): "Martyn and I, to put the matter rather bluntly, attempted to put Australia on the map, and I think we were fairly successful." And indeed, they were! Martyn was elected Chair of URSI Commission V - Radio Astronomy, Pawsey became Secretary and the 1952 URSI General Assembly was held in Sydney on the invitation of Martyn. At subsequent, URSI General Assemblies no attempts were made by the British to block or even discourage any Australian participation.

In the US, Canada and Europe, Pawsey presented the exciting results obtained by the RPL group since the war to a number of astronomy groups: Cambridge and Manchester in 1948, followed by extensive visits to Europe (Netherlands, Sweden and Norway), as well as the IAU in Zurich and URSI in Stockholm (Chapter 17). During this visit to the UK, he also endeavoured to establish collaborations with Cambridge colleagues in metre wave solar research, an attempt which failed (NRAO ONLINE 60, and NRAO ONLINE 20). One radio "star" collaborations did succeed, with the determination of the structure of Cygnus-A by the groups at Jodrell Bank,

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[4] NAA, C3830, C6/2/2.

[5] In 1946, Bowen tried to attend the URSI in Paris, the first URSI since the pre WWII, 1938 meeting in Venice. His attendance at the Paris meeting was only partly successful. He had to catch a plane to the US ("rigid timetable to catch an aircraft to the US") and could only spend the first three days of the one-week conference in Paris. The solar noise session was after Bowen departed. "I was therefore unable to give a talk and was asked to communicate a summary for inclusion in the report of the meeting." NAA C3830, C6/2/1.

[6] Smith Rose had asked others to present summaries of work in the Americas (Dellinger of the National Bureau of Standards in Washington, D.C) and three colleagues from France, Sweden and Italy to summarise the work by European groups.

Cambridge and Sydney. This result was published at Christmas 1952 in *Nature* (Chapter 21, papers by Hanbury Brown, Jennison and Das Gupta--Jodrell Bank, Mills--CSIRO Sydney, and Smith--Cambridge).

However as shown in Chapter 19, the attempted three-way collaboration in the determination of the ionospheric cause for radio star scintillations failed. There was a joint publication by Cambridge (Smith, F.G. (1950). "Origin of the fluctuations in the intensity of radio waves from galactic sources: Cambridge observations." *Nature* 165, no. 4194: 422-423) and Jodrell Bank (Little, C. G., and Lovell, A. C. B. (1950). "Origin of the fluctuations in the intensity of radio waves from galactic sources: Jodrell bank observations." *Nature* 165, no. 4194: 423-424), but no participation of the Australians. Again in 1951 (Chapter 21, attempts at collaboration between Sydney and Cambridge to determine the position of Cygnus A did not succeed. The Cambridge position was published by Smith (Smith, F. G. (1951). "An accurate determination of the positions of four radio stars." *Nature 168,* no. 4274: 555-555) preceding Mills.

The International Scientific Unions – URSI and IAU[7]

Already in 1932 Karl Jansky had presented his evidence for radio emission from the galaxy at a US URSI meeting and, in the post-war era, radio astronomy was enthusiastically included in the international URSI meetings. At the URSI General Assembly of 1946 in Paris, Appleton, who was a long-term president of URSI, established a sub-committee on radio noise of extra-terrestrial origin which hosted a few radio astronomy presentations. Between 1936 and 1946 van der Pol of the Netherlands had established the concept of Commissions for the different research areas. In 1948, at the Stockholm General Assembly, the sub-committee on radio noise became Commission V – radio astronomy with David Martyn of Australia as chair until 1953. Radio astronomy was, of course, a major high light of the URSI 10th General Assembly in August 1952 in Sydney, hosted by the Chair of Commission V, Martyn. At that time Pawsey was the Secretary of Commission V and Ron Bracewell was the chair of the Local Organising Committee.

The introduction of radio astronomy into the International Astronomical Union (IAU) had a complex history summarised by Edge and Mulkay, 1976 *Astronomy Transformed* (AT), p. 60--61. The IAU had its first post war international meeting in 1948 in Zurich; the previous meeting been a decade earlier, Stockholm 1938. In 1948, before the General Assembly, there was a short meeting of the Joint Commission on Solar and Terrestrial Relations (Commission 10) with some discussion of solar noise research. As Edge and Mulkay pointed out (AT, 1976, p. 60): " In 1948, radio astronomy could hardly be said to have made any extensive impact on the world's optical astronomers."

[7] Based on Edge and Mulkay p 59-67 AT, Sullivan, W. T., III. (2009). Cosmic Noise: A History of Early Radio Astronomy. Cambridge University Press, Cambridge, UK, p 432-434, and archive material from the NAA

The next IAU General Assembly was delayed[8] from 1951 to 1952, eventually taking place in Rome some weeks after the URSI meeting in Sydney in August 1952. Before this time, the IAU Executive Committee in Stockholm in September 1950, proposed a new IAU Commission (40) for radio astronomy. Richard Woolley of the Commonwealth Observatory at Mt Stromlo was made the chair of Commission 40. There were 26 members, including Pawsey, Bolton, Martyn and Woolley from Australia. The choice of Woolley as chair was linked to his involvement in solar research in IAU Commission 10 and the IAU executive would have been more comfortable with a traditional optical astronomer in this role. However in retrospect this was a very ironical choice given Woolley's later disdain for radio astronomy (Chapter 24, . his dismissive comments at a public lecture in 1954: "...[In] a gathering of astronomers it was not considered decent to mention radio astronomy."

Under the chairmanship of Woolley the new Commission 40 was moribund with little activity and there was no meeting of Commission 40 at the 1952 General Assembly. Woolley may well have been uneasy in this position as Commission 40 chair. From the IAU Executive Minutes (IAU President B. Lindblad) from 4 to 6 September 1951, Paris (a year before the Rome IAU), the minutes read:

> Professor Woolley, President, Commission 40, wishes to resign. It was decided that if Prof Woolley insists that he wishes to resign, Dr J.L. Pawsey, Australia, be asked to function as Acting President.

However, Pawsey was not informed of this decision for over a year! The minutes continued:

> It was further decided to hold a Symposium on Radio Astronomy, and the following organizing Committee was appointed: Van de Hulst (Chairman), Hagen, Laffineur, Lovell and Pawsey. It was decided to explore the possibility of holding this Symposium in connection with the URSI General in Australia in August,1952.

This proposal evolved into the 1955 IAU Symposium on Radio Astronomy held at Jodrell Bank (Chapters 26 and 35-36) with no meeting in 1952 in Sydney.

Pawsey becomes Chair of IAU Commission 40 – Radio Astronomy, 1952-1958

In October 1952, a realignment of the two radio astronomy commissions (URSI Commission V and IAU Commission 40) occurred. David Martyn of Australia had been the chair of Com V from

[8] Originally, a General Assembly was planned for 1951 in Leningrad, postponed due to cold war tensions of the early 1950s. The GA of Rome in 1952 was the replacement congress.

1950 to 1954; he was succeeded by Marius Laffineur (from Paris) as Chair from 1954 to 1957. Pawsey had been Secretary of Com V of URSI during the period up to 1952.

Laffineur, a radio engineer and former avid amateur astronomer, had become the Chief of Radio Astronomy at the Institut d' Astrophysique in Paris, within a few years of obtaining a PhD. He met Pawsey at the URSI meeting in Sydney in August 1952.

Surprisingly, Pawsey had not been officially informed by the IAU of his appointment as the President or even Acting President of Commission 40. Pawsey only received the news in a second-hand manner a year later!

A few months after the URSI conference in Sydney, October 1952, Pawsey received an unexpected letter from Marius Laffineur (letter not located in the archive).

Pawsey replied to Laffineur on 30 October 1952:

> Thank you for your letter of congratulations on [my] being Chairman of Commission 40 of IAU. [letter from Laffineur not located in the archives] Your letter is the first confirmation of this, although I know I was nominated for the position. I hope that you and I can make a success of the two Radio Commissions in URSI and IAU. I am very pleased to have you as my "opposite member" because I believe that we can cooperate very effectively.

Laffineur was Chair of URSI Com V from 1954 to 1957, Pawsey Chair of IAU Comm. 40 from 1952- 1958

Pawsey's selection to chair Commission 40 of the IAU represented a turning point in the appreciation of the role of radio astronomy by the astronomy community. A delicate interplay between the IAU and URSI began. Radio astronomy was already established in URSI and the presence in the IAU was stimulated by Pawsey's active leadership from 1952 The official response from the IAU indicated that URSI was still playing the lead role. The IAU Transactions for the 1952 meeting (published in 1954) reported:

> Commission 40 of the IAU has not yet had an opportunity to meet, and its activities have been as yet confined. [Woolley's role had indeed been minimal.] A communication has been received from the corresponding Commission [V] of another Union [URSI] suggesting a list of terms and definitions for general use…

> The Commission recommends that URSI be asked to arrange working cooperation between three members of the IAU… and the existing sub-commission of URSI, for the purpose of naming radio stars and giving advice on all matters…. which may arise between meetings of the International Unions… [9]

With this bureaucratic language, the IAU was asking for URSI's help to move forward. As Pawsey transitioned from URSI to the IAU, he provided strong leadership for six years from 1952. In the next IAU in Dublin in 1955, Commission 40 was a major presence.

The issue of naming radio stars would normally be a role for the IAU, but it was confounded by the large position errors, sometimes even the constellation was wrong; often there were major disagreements on which sources were real. These were issues that required the technical expertise which could only be provided by URSI.

The next step in this process was made by URSI in 1954 at The Hague meeting when it was announced that Pawsey, under IAU auspices, would publish a list of known radio sources "whose existence and position are regarded as reliably known." (URSI report of 1954 General Assembly). Bolton was chair of the URSI committee which would produce a list of sources. The committee members were Bolton, Hanbury-Brown, F.G. Smith and B. Mills. The paper with this list was submitted to *Monthly Notices of the Royal Astronomical Soceity*, but rejected on 14 May 1954! (Edge and Mulkay, AT page 429): "the Council of the UK Royal Astronomical Society (which was dominated by optical astronomers) decided that the Monthly Notices was not a suitable place for the publication of such a list". Pawsey then submitted the paper to the US Astrophysical Journal on 2 August 1954 which published the paper in January 1955, "A Catalogue of Reliably Known Discrete Sources of Cosmic Radio Waves". List one contained the most reliable sources, eight sources with errors ranging from 15 arc sec (Cygnus A right ascension) to 1 degree (Puppis A). The famous sources such as Cygnus A and Cas A were in this list. In list number two were sources with poorer positional accuracy, with errors in the range a few arc min to a degree; a total of nine sources (eg Sgr A and Orion A). List 3 is a heterogeneous collection of 21 sources with large positional uncertainties at the degree level. In summary, although the existence of this list solved the IAU naming impasse, its success was limited and it was largely ignored. The three lists are discouraging as viewed by modern standards.

[9] A joint URSI-IAU committee which was formed in 1960 called IUCAF (The Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science), became very influential and has played a major role in the protection of the radio frequency spectrum for radio astronomy and space science.

The position based naming convention proposed ("IAU Number") was, for example, the case of Cygnus A: 19N4A, signifying 19 hours of RA, northern declination, at 40 deg declination and a serial letter (eg A was the first source in the particular region of the sky). This convention did not survive, but the coordinate-based successor was eventually to become the accepted IAU standard and with minor modifications is still in use for all extragalactic objects. The 3C catalogue published in 1959 was the first reliable large-scale catalogue of the northern sky but it used sequential numbering (3C1 to 3C471) ignoring the proposed IAU standard. These names became the de-facto convention. It was not until the publication of the Parkes catalogue in the 1960s, that an IAU endorsed position-based name was finally accepted. The naming convention was of the form PKS 1934-63 where the telescope is Parkes, 1934 is the hours and minutes of right ascension and -64 the declination. (epoch 1950)

In 1955, the role of Pawsey as the president of Commission 40 became apparent at the IAU in Dublin. His introductory statement for the Com 40 report at Dublin (IAU Transactions, (Transactions of the IAU, vol 9, 1957, p. 563) promotes the complementary roles of URSI and the IAU, the radiophysicists and astronomers:

> Since its birth in 1932 with Jansky's discovery of cosmic radio waves, radio astronomy has developed sufficiently to permit an assessment of its place in astronomy. It is now clear that radio observations can supply important information not available optically so that the combination of radio with optical observations is indispensable in furthering our understanding of the Universe… But it is only recently that trained astronomers have begun to play an effective role in the science. The early discoveries were made by Australian and English radiophysicists; we are now at the stage where experienced astronomers, especially from the USSR, the USA and Holland, are making major contributions, particularly in interpretation. Radio astronomy, if it is to develop properly, must depend on a blending of radio invention and astronomical insight.

The full text of the Pawsey report for Commission-40 for the IAU in Dublin in 1955 is given in NRAO ONLINE 28. Pawsey's insight to the future of Commission 40 became clear in this 24-page report.

Pawsey's theme was taken up by Laffineur, in his Presidential address to URSI Commission V in 1957 (Boulder, Colorado URSI, at the end of his term as Chair of Commission V). His statement shows enthusiasm for evolving complimentary roles with the technical developments in radio astronomy being the primary role of URSI commission V:

> The radio engineers who founded this new branch of astronomy have in many cases become expert astronomers: on the other hand, astronomers have been quick to recognize its importance and have assimilated our techniques with immense possibilities .... New chapters in astronomy have been written which are of such interest that the subject of technique which led to their development is taking second place. This evolution is normal, logical and welcome ....
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> Commission V ought to play the part of a moderator .... I have reached the conclusion that we should emphasize the development of instruments, aerials, receivers and methods of observation. We shall also discuss the effects of the media to be traversed by the radiation, and finally, in spite of all, certain results are to be considered, preferably from the point of view of the comparison of different methods. Theories of the mechanism of radio-frequency emission in ionized media will also be discussed. All these fields of research are in the domain of URSI, while programmes of observation, results in general and their cosmological implications belong to Commission 40 of the IAU….

The conflict between radio and classical astronomy

Edge and Mulkay (Astronomy Transformed, chapter 2) explore the interactions and conflicts between radio and optical astronomers in the 1950s and argue that this was reflected in the tension between the two international scientific unions (URSI and IAU). However, we feel that the views/perceptions of Edge and Mulkay were unduly biased by the situation in the UK which was quite different from that in other countries. As already noted, the Australian isolation made it imperative for Australia to develop strong links with both the optical and international communities. In Australia, unlike the UK and the US, there was no existing powerful optical astronomy community; collaborations were quite natural, with little sense of competition. Pawsey, in particular, was extremely pro-active in developing these links and committed significant resources to his own travel and to enable other members of the Australian radio astronomy group to travel overseas. By contrast, Ryle in Cambridge, who was already surrounded by astronomers, had no need or inclination to build up such linkages.

From the perspective of Pawsey and Laffineur the division of roles between IAU and URSI was quite natural and complementary. Edge and Mulcahy have misrepresented Pawsey's role – for example, they comment that at the Moscow IAU in 1958, Pawsey was reluctant to make a bid for "intellectual leadership in the new field of radio astronomy" (quoted from Edge and Mulkay, AT, p. 64) as he seemed to predict that the need for Commission 40 would disappear in the

future. Pawsey began his Com 40 report from the Moscow IAU (Transactions of the IAU vol 10, 1960 p. 594:.

> The Radio Astronomy Commission has a peculiar role to play in the IAU because of the rapidity with which its techniques are developing into diverse fields in astronomy. These developments pose a problem in transmission of ideas between radio experimenters and astronomers who are each experts in their fields. This problem is accentuated by the fact that a large proportion of those contributing to radio astronomy have been trained as physicists or engineers and not as astronomers. There is need to inform astronomers of the fields in astronomy to which radio is contributing or can contribute, and to provide clear statements on the experimental and the interpretative uncertainty in the available results. Similarly, there is need to inform radio astronomers of relevant aspects of astronomy with which they may not be adequately familiar … As radio techniques become familiar in astronomy it is to be expected that radio observations will progressively be absorbed in the fields of the various other Commissions, and the field of Commission 40 may narrow towards a consideration of problems which are peculiar to the use of radio techniques …

In a prescient manner, Pawsey had correctly predicted that radio observations would be absorbed in many other IAU Commissions. The relevance of Commission 40 did not diminished in the following 60 years, as Commission 40 remains one of the larger IAU commissions.

Edge and Mulkay continued (AT, p 64)

> Undisturbed by the prospect of this professional vanishing trick, Pawsey outlined a policy of specialized symposia.[10] His notion of a selective symbiosis between radio technique and astronomical wisdom, self-effacing as it may seem, was clearly to the taste of many radio astronomers. Indeed, a modus vivendi was emerging that has, at least, survived the sixties. In 1960, URSI Commission V passed a resolution that cleared the air and also restored some specifically astronomical objectives to its remit.

However, this pattern has survived well into the 21th century. Commission 40 (renamed Commission B4 after the IAU restructuring in 2015) has continued as a vibrant component of

[10] The 1955 Jodrell Bank Symposium (sponsored by the IAU. IAU Symposium No.4: Radio Astronomy 1957, Editor van de Hulst) and the 1958 Paris Symposium sponsored by URSI and the IAU (*Paris Symposium on Radio Astronomy*, 1959, edt-Bracewell) were successful examples of conferences that highlighted radio astronomical research in a wide variety of fields.

the IAU while Commission J (the new Commission V) of URSI remains a forum for the discussions of astronomical techniques and the relevant astrophysics. Sullivan p434 draws an interesting parallel with ionospheric physics. As noted by Gilmor (1986, p.108 "Federal Funding and Knowledge Growth in Ionospheric Physics, 1945-1981" in *Social Studies of Science*, vol. 16) in ionospheric research there is a complimentary relationship between URSI which covers "technology and radio wave propagation" and the International Union for Geodesy and Geophysics (IUGG) for the "science".

Matthew Flinders Lecture 2 May 1957- JL Pawsey

Pawsey was awarded the first Matthew Flinders Medal and Lectureship by the Australian Academy of Science in 1957. He used the opportunity to emphasise the additions that radio astronomy had brought to astronomy in the post war era. Some brief details are presented here; the full text of his lecture is presented in NRAO ONLINE 29 (Matthew Flinders Lecture). Pawsey pointed out:

> Radio astronomy is simply astronomy using radio waves for the observations. The discovery that radio waves as well as light can be used for observing the heavenly bodies has given us a new tool for use in studying the universe. In many cases we observe, by radio, things which are invisible optically so that we obtain new clues to the nature of the universe. And I need scarcely remind you that, in the detective story which is science, clues add up non-linearly: two and two can add up to more than four.
>
> The radio waves emitted by the sun and other astronomical bodies are the same kind of waves--electromagnetic waves--as light but the millionfold difference in wavelength carries with it radical differences in emission, in propagation, and in capabilities for reception.

In summary we can see that Pawsey not only played a key role in establishing radio astronomy as a vibrate new component of the IAU, but he also had a huge influence on the broader acceptance of radio astronomy as part of the greater international astronomical community.