History of the Department of Physics at UWA

Issue No. 10: "Early Research in Solar Radio Astronomy"

Presented by John L. Robins

Introduction.

When considering the early research undertaken in the Department, it is interesting to note some work on Solar Radio Astronomy carried out by Dr S.E. Williams over a three-year period from 1946 to 1948. These observations were among the first of that kind conducted within Australia.

This research is another illustration of just how far back in the history of this Physics Department one can trace the interest in astronomy. (See also the report on the Wallal Expedition to study the 1922 eclipse of the sun, in Issue 9.)

The material presented here is an abridged version of a comprehensive 32-page article on solar radio astronomy in Australia, with only those sections that refer to the work of the WA group being included. It briefly describes the most significant observations of the Western Australian group and shows how this work fitted into the framework of other related research within Australia.

To enhance the readability of this historical report, the many references cited in the original article have been omitted, other than those of the WA group. However, readers who are interested in the scientific content, rather than the pure historical narrative, can consult the original published paper or contact me directly (see address in the Introduction to this History website).

Sources.

The report presented below is made up of extracts from pages 35, 50, 51 and 53 of an article "The Genesis of Solar Radio Astronomy in Australia" by W. Orchiston, B. Slee and R. Burman, *Journal of Astronomical History and Heritage*, Vol. 9(1), pp 35-56, 2006.

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Extracts from an Article (in *Journal of Astronomical History and Heritage*, Vol. 9(1), pp 35-56, 2006.)**:**

The Genesis of Solar Radio Astronomy in Australia

Wayne Orchiston
Centre for Astronomy, James Cook University
Townsville, Queensland 4811, Australia.

Bruce Slee
Australia Telescope National Facility,
PO Box 76, Epping, NSW 2121, Australia.

and

Ron Burman
School of Physics, University of Western Australia,
Crawley, WA 6009, Australia.

Abstract: In late 1945, O.B. Slee at RAAF Radar Station 59 near Darwin and staff from the CSIRO's Division of Radiophysics in Sydney were involved in Australia's first investigation of radio emission from the Sun. After WWII, the Sydney radio astronomers were joined by small independent groups based at the Commonwealth Observatory, Mt Stromlo, and in the Physics Department at the University of Western Australia, in Perth. Between 1946 and 1948, these young scientists made an important contribution to international astronomy, heightening our understanding of solar physics and the relationship between sunspots and solar radio emission.

[Section] 4 University of Western Australia [Pages 51,52]

It is not widely known that a small group at the University of Western Australia in Perth was active in solar radio astronomy in 1946-1948, even though attention was drawn to the group's work in papers published by Burman*and Burman and Jeffery*, and this research is mentioned in Robertson's* history of the Parkes radio telescope and in the Haynes et al.* history of Australian astronomy.

The project was set up by Dr Sydney E. Williams, a Lecturer in Physics with a background in optical astronomy at the Commonwealth Observatory, following a seminar on radar held at the Radiophysics Laboratory, Sydney, in January 1946. At the end of April 1946 Williams installed a 75 MHz Yagi and receiver on the flat roof of one of the buildings on campus in suburban Perth. In a letter to Pawsey, Williams* describes how

> We made a Yagi (dismountable for portability) on a wooden polar axis with synchronous motor drive. Matching aerial to coaxial and receiver has so far been done simply by fiddling with the dipole and director lengths till we got the best polar diagram and sensitivity. We are using simply milliameter but soon will have a film camera recorder on the oscillograph.

For two years, Williams, assisted by three Honours (fourth-year) students, P. Hands, E.

Denton and P.M. Jeffery, carried out studies of solar bursts and enhanced levels of solar emission using this Yagi, and an example of one of their chart records is reproduced here [Figure omitted]. The focus was on temporal variations in the intensity of solar radio emission, correlations with sunspots, solar flares and ionospheric radio fadeouts, and the shapes of short pulses of radiation.

This research resulted in an editorial note [by] Williams and Hands[1], and two letters in *Nature* [by] Williams[2,3] and a full-length paper in the *Journal of the Royal Society of Western Australia* [by] Williams[4], which was based on a lecture presented to that Society. There were also unpublished papers given by Williams at the 1946 and 1947 ANZAAS Congresses*. Of particular note, in the context of the present study, is the fact that the four papers by the Perth group comprise 33% of all observation-based papers on Australian solar radio astronomy published during the interval 1946-1948*.

Williams ended these radio astronomical investigations in 1948, and later returned to optical astronomy[#]. [In reviewing the Western Australian work in 1992] Burman and Jeffery* conclude that "Although the work was noticed internationally, its influence on the course of radio astronomy seems to have been slight ..." They also note that "Probably the main innovation introduced by the Perth group was the analysis and interpretation of the time decay of the pulses ..." We shall look more closely here at that aspect of the work*.

Sydney E Williams (1919 – 1979)

The third of the Nature papers, a brief letter by Williams entitled "Shape of Pulses of Radio-frequency Radiation from the Sun", seems to have been the only one of the four Perth papers to have had any direct influence on contemporaneous radio astronomers. The paper, based on some 400 hours of observations, was aimed at examining the tails of pulses for exponential decay, as an indication of the decay of the source when it is no longer subject to the influence of an exciting agency, or of the decrease in influence of that agency. Filmed records of a vibration galvanometer output of detected radio bursts were used. There were 99 single pulses, lasting a few seconds each, that were considered to be sufficiently clear of others to indicate a faithful record of the variation of the power from the source: 78 of the 99 had a peak at least 25% above background and a sufficient length of falling slope for significant measurements to be made. Of these, 58 were found to be very probably exponential, 11 less probably so, 4 probably not so and 5 definitely not [Figure showing typical curves is omitted].

Williams' table binning the half-lives (time for the power to reduce to half) of the 58 exponential tails shows them to range over 0.4 - 2.2 seconds, with a distribution peaking in 0.8 - 1.2 s. A second table lists the half-lives of 30 of these 58 pulses that occurred either consecutively or within a short interval. (The intervals listed are mostly 30 s, but 5 minutes for one sequence of 6 pulses.) From this table, Williams* noted that "Although it might be assumed that pulses closely connected in time come from the same region and should therefore show similar half-value times, the results given above do not offer firm support for such a hypothesis." The paper concludes with the remark that no success had been obtained in attempts to interpret the rising portions of the pulses in terms of exponential functions.

[Section] 6 Concluding Remarks [In part, page 53]

The birth of solar radio astronomy in Australia occurred towards the end of WWII, soon after news of secret war-time detections by radar units in England and New Zealand reached Sydney, and between October 1945 and December 1948 major advances were made in the study of 'solar noise'. Initially these involved wartime radar antennas and receivers, but Yagis and other types of antennas specifically dedicated to solar (and non-solar) radio astronomy soon emerged. This instrumentation was used at wide-ranging frequencies to investigate emission from the quiet and the 'radio-active' Sun. Of special interest were flux levels at different frequencies; the various types of burst emission; locations of emitting regions and their association with photospheric features and magnetic fields; and emission mechanisms.

While much of this research was accomplished by staff in the CSIRO's Division of Radiophysics, it is important to remember that initially two other small research groups, at the Commonwealth Observatory (Mt Stromlo) and the University of Western Australia (Perth), were active in solar radio astronomy. To illustrate their contribution, we should note that of the twelve Australian research papers reporting observations of solar radio emission made in 1945-1947, the [CSIRO's Division of Radiophysics] scientists contributed exactly half, the Mt Stromlo group two and those from the University of Western Australia, four. In addition Martyn (from Mt Stromlo) published three theoretical papers. However, Williams' research on solar radio emission ceased in 1948 and Mt Stromlo's involvement ended just three years later, leaving the growing [CSIRO's Division of Radiophysics] group as the sole Australian participants. December 1948 therefore is an appropriate chronological point at which to end this paper.

* Reference omitted. Most references have been omitted to facilitate the readability of this historical account. For reference details, please refer to the original publication or contact the Presenter of this History series.

In addition to his interest in astronomy, Dr. Williams also pursued physics research in the field of vacuum spectroscopy from about 1952 onwards. However, in later years, prior to his retirement as an Associate Professor in 1975, he again concentrated on optical astronomy and supervised the construction, in the Physics Department workshop, of a 16-inch reflector optical telescope which was housed and operated at the Perth Observatory in Bickley.

[1] Williams, S.E. and Hands, P., "Abnormal solar radiation on 75 megacycles". 1946, *Nature*, 158, 511.
[2] Williams, S.E., "Solar radio-frequency noise fluctuations and chromospheric flares". 1947, *Nature*, 160, 708.
[3] Williams, S.E., "Shape of pulses of radio-frequency radiation from the Sun". 1948, *Nature*, 162, 108.
[4] Williams, S.E., "Some observations of solar radio-frequency radiation". 1948, *J. Roy. Soc. West. Aust.,* 34, 17.

[**Presenter's Note:** A spectrohelioscope was constructed in the Physics Department Workshop for this project. In a private note, John Budge has confirmed that the construction of this instrument was one of the early tasks assigned to him soon after he started work as an apprentice in the Workshop in 1947.]

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