Summer lecture 1964

# Notes for Lecture on History of Radio Astronomy at NRAO

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| YEAR | EVENT |
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| 1894 - 1900 | Sir Oliver Lodge tried to detect radio radiation from the sun. Did not succeed due to interference and lack of receiver sensitivity. |
| 1931 - 1932 | Karl G. Jansky detects extragalactic emission at 20 Mc/s (14.6 meters). Attributes radiation to 1) a disk-like distribution of radio sources, 2) a different class of sources than the sun, since he didn't detect the sun, and 3) the cause was attributed to thermal agitation of charged particles with an effective temperature of about 15,000°K |
| 1936 | Arakawa in Japan finds a hissing noise accompanying sudden fadeouts at 4-20 Mc/s. The first evidence for the presence of solar non-thermal emission. |
| 1938 | Heightman observes a smooth, hissing sound at frequencies of 20 Mc/s and higher. More evidence for solar non-thermal emission. |
| 1940 | Grote Reber maps the sky at 160 Mc/s, finds lower intensities than Jansky, but has better resolution. Finds emission reaches a maxima near the galactic center in agreement with Jansky, but also finds subsidiary maxima, particularly in the direction of Cygnus. First possible observation of Cygnus A, but not so recognized at that time. |
| 1942 | Hey in England detects the sun in conjunction with war effort. Used Army radar at 55-80 Mc/s, found emission to be correlated with the presence of a large sunspot on the disk of the sun. Simultaneously, Southworth at the Bell Telephone Labs in New Jersey detects the sun -- the quiet component -- at 10,000 Mc/s and at 3000 Mc/s a few weeks later. Their reports are classified and will not be made public until after the war. |
| 1943 | Reber independently detects the sun at Wheaton, Illinois, at 160 Mc/s. He publishes the first paper concerning the detection. |

1944 — H. C. van de Hulst in Leiden predicts the 1420 Mc/s line of neutral hydrogen.

1945 — Dicke and Beringer detect the moon at 24,000 Mc/s.

1946 — Pawsey, Payne-Scott and McCready correlate solar radio noise with sunspot activity.
Circular polarization of solar radio emission (non-thermal) is detected.
The first radar echoes are received from the moon. Work was done almost simultaneously by the Signal Corps Labs at 111 and 120 Mc/s and by Bay in Hungary at a higher frequency.
The first application of interferometry in radio astronomy by Ryle and Vonberg, using a spacing of 140 $\lambda$ at Cambridge. They find the angular size of the solar emitting regions to be less than 10 minutes of arc.
Appleton and Hey point out the non-thermal character of solar emission.
Hey, Parsons and Phillips find short periods, irregular fluctuations at 64 Mc/s (5 m) from an intensity maximum in Cygnus.
The angular size of the source is found to be less than two degrees.

1947 — The 218-foot fixed antenna at Jodrell Bank is completed.
Hey, Parsons and Stewart find transient echoes from meteors that originate from the E-layer of the ionosphere. They determine the first meteor velocities.

1948 — Bolton and Stanley find that the angular diameter of Cygnus A is less than 8 minutes of arc.
Ryle and Smith discover Cassiopeia A. At the end of the year, ten radio sources are known.

1949 — Piddington and Minnett study the variation in lunar thermal emission with phase of the moon.
Cambridge and Jodrell Bank workers show the intensity variations of discrete radio sources at meter wavelengths to be ionospheric in origin.
Bolton, Stanley and Slee discover Taurus A, Virgo A, Hercules A, and Centaurus A.

1950 — First external galaxy is detected by Hanbury Brown and Hazard (M 31).
Ryle, Smith and Elsmore publish the first Cambridge catalogue of radio sources -- 50 sources. The 1C catalogue.
The first parametric amplifier is built in the laboratory.
Alfvén and Herlofson first suggest that synchrotron radiation may be of importance to the understanding of the non-thermal emission from many discrete sources.

1951 Ewen and Purcell at Harvard discover the neutral hydrogen line predicted by van de Hulst. Confirmation comes within three months by observers at Leiden and Sydney.
F. G. Smith determines the first precise (by optical standards) positions of bright sources. He finds that they have negligible parallaxes.

1952 Brown and Hazard detect Tycho's supernova 1572.

1953 Shklovskii suggests that the Crab Nebula is a synchrotron emitter.
Mills constructs the Mills Cross.
Jennison and das Gupta find Cygnus A to be a double source.

1954 The first MASER is constructed by Gordon, Zeiger and Townes.
Kerr first detects 21 cm emission from an external galaxy -- the Magellanic Clouds.
Cyg A and Cas A are optically identified by Baade and Minkowski.
Williams and Davies first detect the 21 cm line in absorption.
Baldwin and Dewhirst discover the SN remnant IC 443.

1955 Burke and Franklin at DTM discover non-thermal bursts of radiation at 22 Mc/s from the planet Jupiter.
The first planetary detection.
The second Cambridge catalogue (2C) is published, containing 1936 sources, many of which are spurious.
The 85-foot dish at Leiden begins operation.

1956 Mayer, McCullough and Sloanaker first detect thermal emission from Venus, Mars and Jupiter, using NRL equipment at high frequencies. NRL detects polarization from the Crab Nebula.
The 60-foot antenna at Harvard begins operation.
Rishbeth at CSIRO observes the first lunar occultation (IC 443).
Heeschen first detects neutral hydrogen emission from a cluster of galaxies -- the Coma Cluster.

1957 The 250-foot dish at Jodrell Bank begins operation.
The spiral arms of the Milky Way are completely mapped for the first time by the Leiden and Sydney observers using the 21 cm line.

1958 Drake and Ewen detect Saturn and a planetary nebula at 8000 Mc/s.
The first radar echoes from Venus are obtained at Lincoln Labs.
The first MASER is used in radio astronomy by Alsop, Giordmaine, Mayer, and Towens at NRL.

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| 1958 (continued) | Sloanaker at NRL detects enhanced radiation from Jupiter at 10 cm.<br>Coates at NRL makes the first observations at wavelengths less than 8 mm.<br>The 85-foot NRL antenna is completed.<br>The first Mills, Slee, Hill catalogue of southern hemisphere sources is published.<br>Westerhout completes the first detailed study of HII regions. |
| 1959 | The first trans-Atlantic communication is made via the moon. Eshleman, et al, at Stanford first detect the sun by radar at 25.6 Mc/s.<br>The CalTech twin 90-foot antennas are completed.<br>The 22 meter dish at Lebedev (USSR) is completed. Surface accuracy permits it to be used at 8 mm.<br>The Cambridge 3C catalogue is published.<br>Suggestion is made by Drake and Hvatum that enhanced decimeter radiation from Jupiter is due to van Allen Belt around Jupiter. |
| 1960 | Morris and Berge observe Jupiter's van Allen Belts at 31 cm at CalTech.<br>Jodrell Bank workers achieve 2" of arc angular resolution of discrete radio sources using interferometry.<br>A detailed investigation at 21 cm of the galactic center region is completed by Oort and Rougoor at Leiden.<br>Sandage finds the optical counterpart of the source 3C 48 to be a 16th magnitude point object.<br>Minkowski optically identifies 3C 295 with a galaxy having a redshift of 0.46 the velocity of light. |
| 1961 | General polarization of galactic background is found by Leiden and Cambridge groups.<br>Hogbom and Shakeshaft and Heeschen find Cas A flux density to decrease at the rate of about one percent per year.<br>Howard and Barrett detect and measure radio emission from Mercury at 3-4 cm wavelength.<br>The Parkes 210-foot dish is completed.<br>The first flare star observations are made by Lovell at Jodrell Bank and by Slee at CSIRO.<br>Five "quasi-stellar" radio sources are now known.<br>The first large scale study of brightness distributions is made at CalTech. |
| 1962 | First Mercury radar contact is made by Kotelnikov in the USSR at 700 Mc/s.<br>The 300-foot antenna at Green Bank is placed in operation. |
| 1963 | The 1000-foot fixed dish in Arecibo is completed.<br>Barrett, Meeks, Weinreb and Henry discover the OH |

1963 (continued)

line at 1665-1667 Mc/s (MIT, Lincoln Labs). Confirmed by groups in CSIRO, Berkeley and Harvard.
Zeeman splitting of the HI line is detected, showing the presence of a galactic magnetic field with strength about 25 microgauss.
Mars is first detected by radar at JPL at 2388 Mc/s.
Schmidt finds the quasi-stellar sources to be galaxies with very large redshifts.