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OLOF RYDBECK AND EARLY SWEDISH RADIO ASTRONOMY: A PERSONAL PERSPECTIVE[1]

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Abstract: The spectacular development of radio astronomy in Europe and Australia in the period soon after WWII was mostly propelled by 'amateur' scientists motivated by a spirit of adventure. Totally untrained in astronomy, these pioneers were necessarily courageous and highly individualistic. Each of the leaders was 'a character', and often larger than life. And among these personalities there was none bigger than Olof Rydbeck of Sweden. He was already well known for his studies of electromagnetic theory and the invention and fabrication of devices for ever higher frequencies. He was one of the pioneers in the study of the ionosphere, and had built powerful sounders and also detectors for meteor trails. The creation of the Onsala Radio Observatory was entirely due to his efforts.

Keywords: Olof Rydbeck, Onsala Radio Observatory, Würzburg antennas, H-line

1 INTRODUCTION

A crude paraphrasing of the development of radio astronomy immediately after the end of WWII could be *'Engineers with instruments of warfare looking for something to do with them.'* In England and Australia the pioneers were all radar specialists who understood how to build directional antennas and sensitive receivers (Lovell, 1983; Sullivan, 1988). When they pointed their gadgets skywards, they discovered extraordinary things and overnight expanded the known Universe, so to speak (Sullivan, 1984). In the United States, the group that was intimately involved in developing electronics for warfare and trying to use it for astronomy later was based at the Naval Research Laboratories (Haddock, 1983). The difference was that unlike the other two groups, they were using the very high frequency end, which was the region of their expertise.

It is an interesting fact that on a visit to NRL the father of Australian radio astronomy, Joe Pawsey, told them they were wasting their time because the important messages were all at low frequencies. They had the good sense to ignore his advice, and went on to make equally interesting and important discoveries. The point I want to make, and which is true in some sense even today, is that one really does not know about the astrophysical mechanisms that may be operating up there, to predict the frequency and the strength of signals we could expect to receive on Earth. Pulsars, discovered twenty-five years after the period I am talking about, and molecular masers even later, are good examples.

2 OLOF RYDBECK

Sweden being a neutral country was not involved in any activity related to World War II. But its radio astronomy pioneer, Olof Rydbeck,[2] had several attributes in common with his counterparts from the warring nations. He was a great expert in electronics, as adept at using radar as any of them, and equally ignorant about astronomy. He had written a definitive paper on the theory of the travelling wave tube, built several of them, and was a celebrated pioneer in the use of radar for studying the ionosphere and aurorae.

Rydbeck was an authority on electron tubes and was always trying to invent better ones. My first job with him was to work on a frequency-multiplying concept he called the rotatron, in which a rotating electron beam went through an anode with a ring of holes and produced pulses on the next anode.[3]

Returning to radio astronomy pioneers, there was one who knew nothing about radio, even less about radar, but everything about astronomy, who had no radio telescope but wanted one to do a specific research project. And unlike all the other pioneers I mentioned, he knew what frequency was the right one for his purpose. Jan Oort wanted to unravel the structure of the Galaxy, with a radio spectral line from interstellar hydrogen. As everybody knows, the line was first detected in 1951 (Ewen and Purcell, 1951), and launched the era of radio spectroscopy in astronomy. But not many know that Rydbeck's first attempt to get funding to build a 21cm receiver was in 1950, a year before the detection of the line. He knew about van de Hulst's 1945 paper and Shklovsky's 1949 paper (presumably translated from the Russian). His proposal, which was rejected, was to use such a receiver on a Würzburg German radar antenna of 7.5 meters diameter, exactly as Oort and company were planning to do.

3 ESTABLISHING THE ONSALA RADIO OBSERVATORY

Rydbeck had seized upon the idea of obtaining abandoned Würzburgs as the way to realize his dream of setting up a first-rate radio observatory despite having limited funds. These ex-radar antennas could work at high frequencies and came complete with mountings, all for little or no money. But where to find them? The determined character that he was, Rydbeck undertook an expedition, and he drove a Chalmers University station wagon all the way from Naples along the coasts of France, Belgium and Holland looking for these antennas. He heard that three had been rescued from the Channel coast and were at Meudon Observatory in Paris. He went to see them and was told that there were none in Belgium, but that two had been rescued in Holland, at least one of which was at Kootwijk (see Figure 1). This photograph was taken in 1950, and shows part of the radio telescope that a few years later did all that spectacular first mapping of the Galactic neutral hydrogen (see Westerhout, 2002). It was at Kootwijk that Rydbeck

learned that there were five large Würzburg antennas in very remote places on the Norwegian coast (e.g. see Figure 2), erected with the labour of prisoners of war.

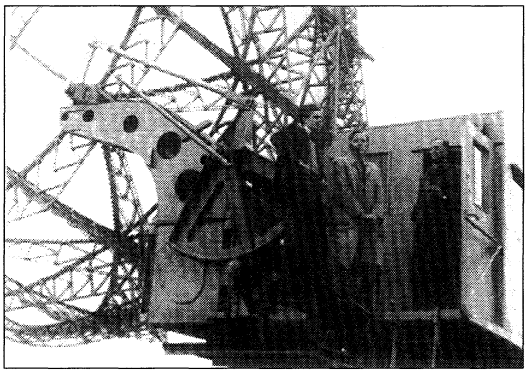

Figure 1: The receiver cabin and part of the Würzburg antenna at Kootwijk, Netherlands (after Rydbeck, 1991).

This was the chance Rydbeck had been looking for, and the political exercise of getting the consent of the authorities in the Norwegian government was the sort of thing he was expert at. He stressed the role that Chalmers University had played in educating Norwegian students, highlighted the good science that could be done with these old antennas which would otherwise only have scrap value, and successfully negotiated the token price of 300 crowns for each of them.

The physical exercise of demounting these 17 ton assemblies (Figure 3), all in relatively inaccessible locations, dragging the pieces down the mountains to the coast, loading them on lighters, and shipping them by sea to Gothenburg, is a saga that Rydbeck actually had nothing to do with. He was away in the U.S.A. in June 1950, when this feat was carried out in less than a month by staff from the laboratory's workshop. These were people I got to know and work with when I came to Sweden several years later. In recording this amazing operation in his autobiography, Rydbeck (1991) graciously notes that the speed and success of the whole exercise in part may have been due to the absence of their Professor breathing down their collective necks!

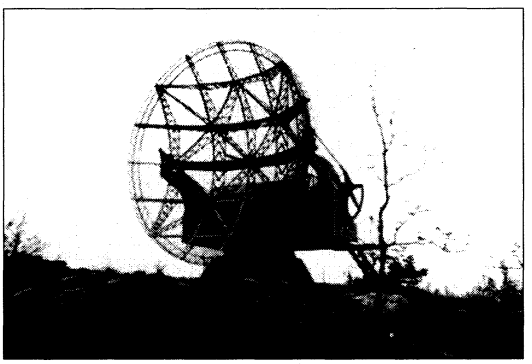

Figure 2: One of the abandoned Würburg antennas located on the remote Norwegian coast (after Rydbeck, 1991).

In a process that began in the late forties and ended only around the mid-fifties, Chalmers University of Technology in Gothenburg acquired a substantial plot of land on the picturesque peninsula of Råö (see Figure 4), the benefactor being Herbert Jacobsson (Figure 5) who had contributed to many such good causes in the course of his career. Unfortunately he did not live to participate in the formal opening there of the Onsala Radio Observatory in 1955.

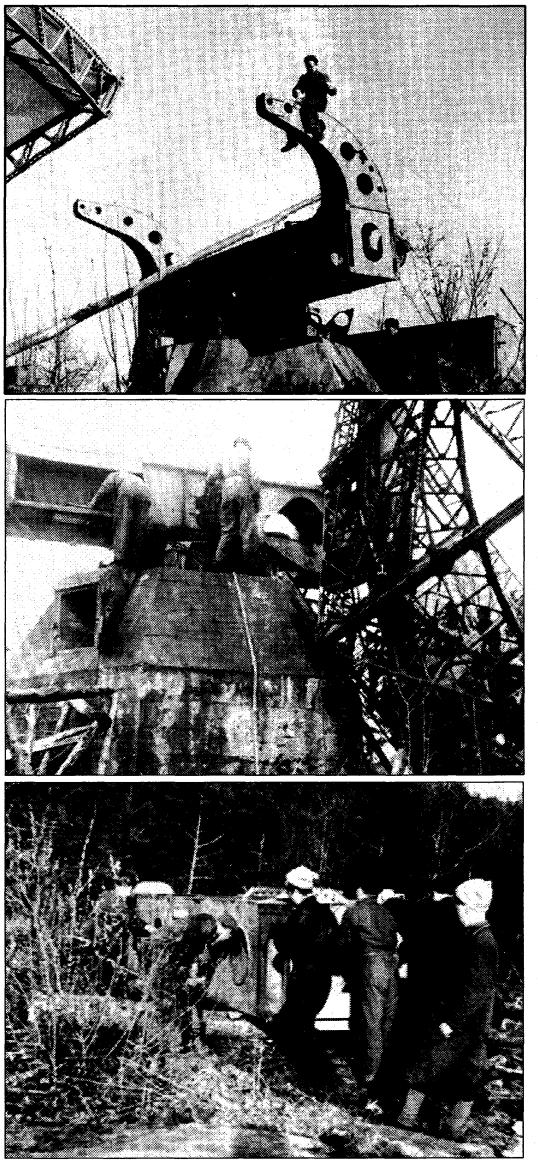

Figure 3: Three photographs showing the dismantling of one of the Norwegian Würzburg antennas (after Rydbeck, 1991).

The intervening years were apparently the worst economically, with no money even to set up the radio telescopes that had been brought from Norway, almost for free. Another benefactor in the form of Axel Wennergren (Figure 6), the inventor of the monorail concept, then came to the rescue and enabled the Würzburgs to be erected (Figure 7).

Not all of the five Würzburg antennas that had been brought in pieces from Norway were restored to original status, or could be, because of the state of the reflectors.

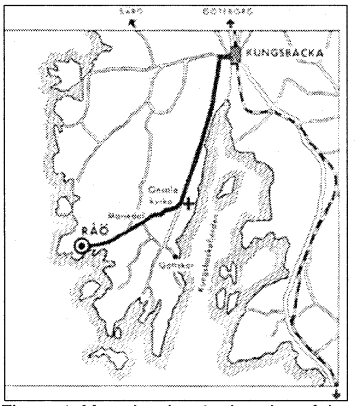

Figure 4: Map showing the location of the Onsala Radio Observatory (cross) and nearby Råö (after Rydbeck, 1991).

Figure 5: Herbert Jacobsson, who donated land near Råö to the University so the Onsala Radio Observatory could be established (after Rydbeck, 1991).

Figure 6: Axel Wennergren (right foreground), the benefactor who funded the erection of the Würzburg antennas at the Onsala Radio Observatory (after Rydbeck, 1991).

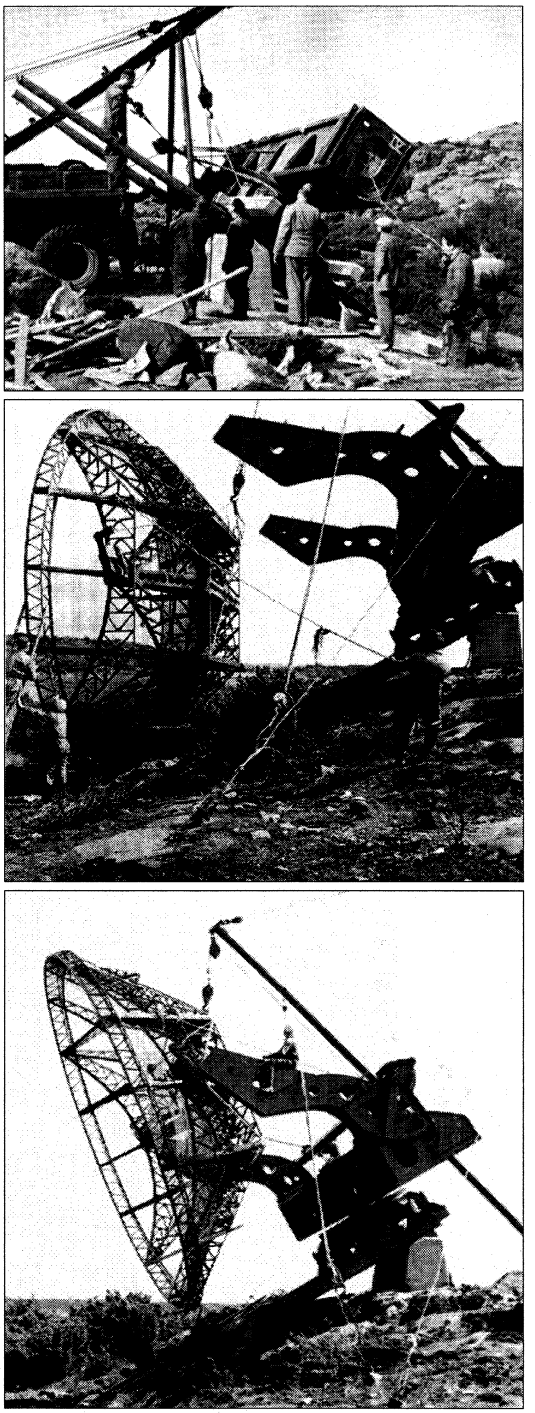

Figure 7: Three photographs showing erection of one of the Würzburg antennas at the Onsala Radio Observatory (after Rydbeck, 1991).

Two of the mounts were erected with a vertical axis as in the original configuration for radar use, but without the paraboloidal reflector. Instead two towers were mounted on the horizontal beam from which hung a gigantic array of dipoles working at 150 MHz (Figure 8). With an impressive area of about 135 square meters and equipped with cascode amplifiers,

the low-noise system of those days, this provided good sensitivity for several investigations. A very important early study of ionospheric scintillation using one of these antennas was by Torleiv Orhaug (Figure 9), who observed Cygnus A for several years and discovered new phenomena associated with the ionosphere.

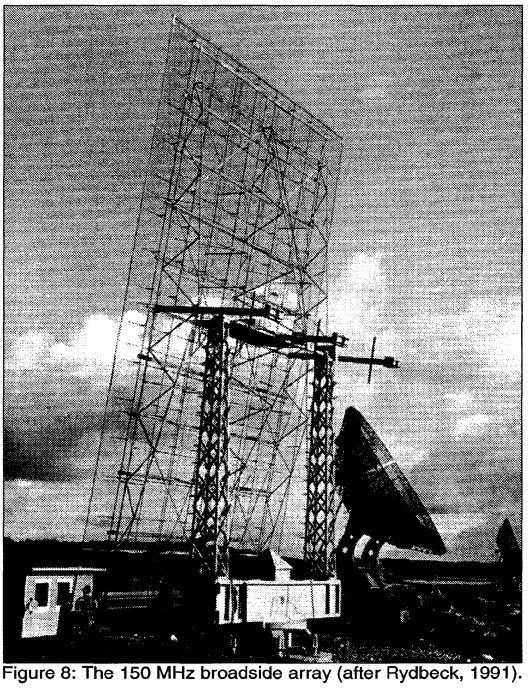

Figure 8: The 150 MHz broadside array (after Rydbeck, 1991).

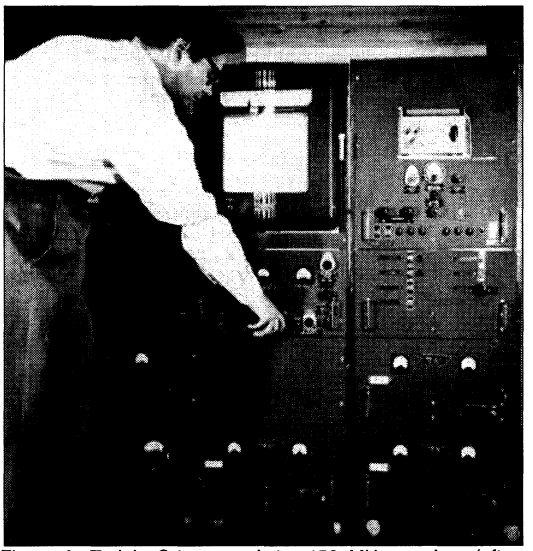

Figure 9: Torleiv Orhaug and the 150 MHz receiver (after Rydbeck, 1991).

The Würzburg antenna with the best reflecting surface was mounted on a tilted (equatorial) axis and just called # 1; it is shown in Figure 10. This was the antenna intended for 21cm line observations and for which Sverre Eng, a Norwegian who had graduated from Chalmers University in 1953, was appointed to build a receiver (Figure 11). The first profiles were obtained in late 1955, and in his autobiography Rydbeck (1991) laments that it was a dream delayed by four years due to limited financial resources. The famous Dutch papers on the spiral structure of the outer part of the Galactic system (van de Hulst, Muller and Oort, 1954) and the rotation of the inner part of the Galaxy (Kwee, Muller and Westerhout, 1954) had appeared in print more than a year earlier. With the altazimuth-mounted Kootwijk telescope that had to be moved by hand every few minutes, the structure of the Galaxy, its differential rotation, and the coordinates of its poles and Centre had been established by observations over the period between when the Würzburgs had landed in Gothenburg and the first spectra were obtained with Eng's receiver. But even worse, the receiver was not stable enough to produce good measurements, and Eng decided to leave Sweden and go to California. Rydbeck also heard that Oort had succeeded in getting money for a larger 25-meter dish, which would be installed in Dwingeloo in the course of the following year.

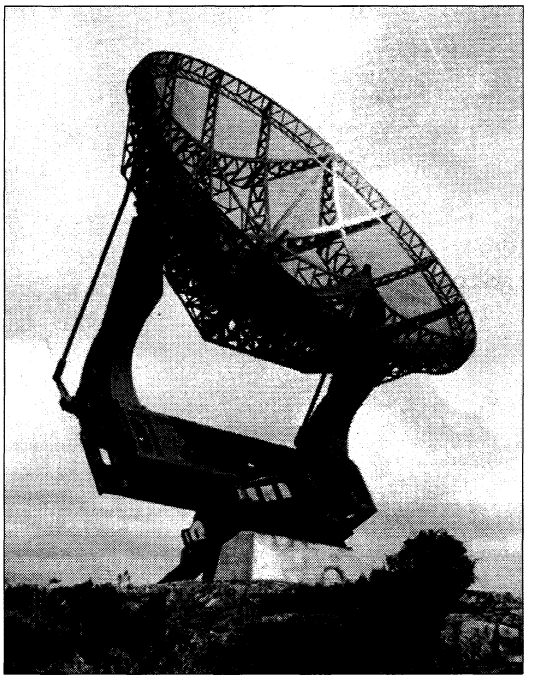

Figure 10: The #1 Würzburg antenna at the Onsala Radio Observatory, which was used for H-line investigations (after (Rydbeck, 1991).

Given these circumstances, one can imagine Rydbeck's depressed state of mind in late 1955 which was when I came to Sweden, ran out of money, and tried to see him to ask if he could give me a temporary job in his laboratory so that I could save money for further travels. In hindsight, it is no surprise that he did not want to see me, and he sent word that the laboratory had no job to offer, and he was reluctant to pay wages to an unqualified Indian to do a job he had no training to do who turned up unexpectedly at his door. At the time, I did not know there was any hydrogen in the sky, and I did not really care ... I was not looking for a career in astronomy, just some money in order to keep travelling. Despite all this, he found a job for me!

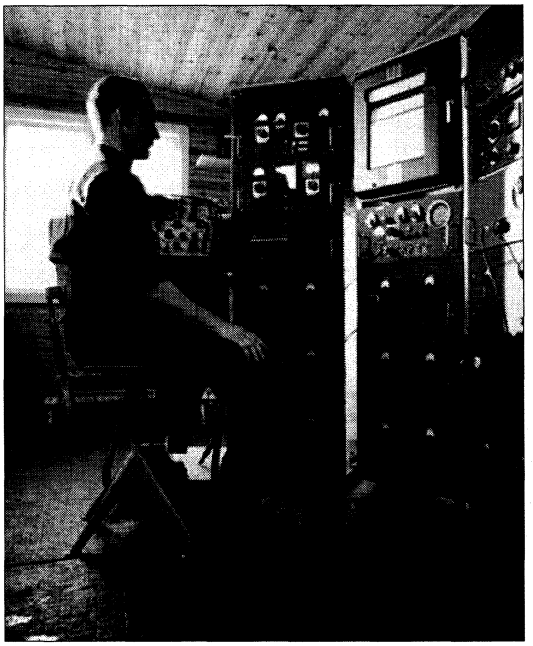

Figure 11: Norwegian-born Sverre Eng and the first H-line receiver at the Onsala Radio Observatory (after Rydbeck, 1991).

4 THE H-LINE RECEIVER

Rydbeck must have been desperate, because after I had spent a month or two in the tube lab he asked me to build a new hydrogen-line receiver. Fortunately there were two others in the radio astronomy team who could help, Ellder, who had made measurements with Eng's receiver, and Höglund, who had been interested in astronomy since childhood.[4] The three of us proceeded to build the receiver (see Höglund and Radhakrishnan, 1959), all five racks of it, which consumed 2 kilowatts of power that helped to keep the hut warm in winter. Today, each of these chassis could be replaced by a chip, but remember this was in the vacuum tube era. I did in fact build one transistor into the machine that I claim was the first in any radio astronomy receiver. As soon as the receiver started to work I decided to follow Eng's lead and go west, as the U.S.A. seemed the only place where I could earn enough money to buy a sailing yacht before I became too old to handle it. Meanwhile, Bertil Höglund, like a good astronomer, justified the effort we had all put in and used the H-line receiver to make thousands of measurements of the Anti-centre region of our Galaxy (Höglund, 1963), interpreting them in terms of the dispersion orbit theory of Lindblad. This was one of several valuable contributions in his doctoral thesis.

5 CONCLUDING REMARKS

In his book, Rydbeck (1991) states that his decision to build a new hydrogen-line receiver was to gain confidence in receiver development that would be essential for the Observatory's future, and that this was a wise decision. As a result of long-term association with Charlie Townes, the search for molecules was something else that was always on his mind, and the need for sensitive receivers to find them (see Figure 12).

Figure 12: Olof Rydbeck with his first ruby crystal, which he used to make a maser in order to look for molecules (after Rydbeck, 1991).

This short paper simply provides a personal perspective on my short stay at Chalmers University of Technology and the Onsala Radio Observatory. New larger radio telescopes were acquired at the Observatory following these early pioneering efforts (Figure 13), and much valuable research was carried out there. An excellent account of all this is contained in Rydbeck's (1991) autobiography.

Figure 13: Olof Rydbeck and the Onsala 25m antenna that was shared with the Skandinaviska telesatellit kommitten.

6 NOTES

1. An earlier version of this paper was presented in one of the Historic Radio Astronomy sessions at the 2003 General Assembly of the IAU in Sydney.
2. Olof Rydbeck was born in Greifswald, Germany, in 1911, and after moving to Sweden completed an electrical engineering degree at the Kungliga Tekniska Högskolan. He then carried out post-graduate research at Harvard, and in 1940 completed a doctoral thesis on the ionospheric reflection of radio waves. He returned to Sweden in 1945, accepting a Chair in 'Radioteknik' at Chalmers University of Technology in Gothenburg. He subsequently held chairs in 'Elektronik' (1948-1963) and 'Teoretisk Elektronfysik' (1963-1979) at Chalmers University. Rydbeck has been described as

> ... an engineer, physicist, spectroscopist, geophysicist – he was even interested in cosmology, but above all he was a man who got things done. He will be remembered as a pioneer, a builder of instruments and a man of ideas. He was also a man of great general knowledge which he often liked to demonstrate ... Olof was a man with a sense of humour; he was a great character. (Obituary, 1999).

He was the father of Swedish radio astronomy, and died on 27 March 1999.

3. I was paid next to nothing at this time, and concluded that Rydbeck did not hesitate to use cheap labour to get the job done.

4. I remember that at this time there was a clock on the table in the receiver hut that was always showing the wrong time, which irritated me. I was about to reset it one day when Höglund stopped me and explained that it was keeping sidereal time, something else I had not heard about before!

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