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Author: Elbers, Astrid
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CONCLUSION

Since the early twentieth century, Dutch astronomy has been preoccupied with one simple question: What is the structure of the Milky Way? Answering this question, however, was a different story. Firstly, the Dutch cloudy climate severely hindered (optical) astronomical observations. And secondly, the largest part of the Milky Way was inaccessible for observations at optical wavelengths because of the extinction of the light by interstellar dust. Astronomers had already resigned themselves to the fact that their question might never be answered.

And this is where radio astronomy entered the picture. Throughout this book, you could read the answers to the questions we asked in the beginning: How can we explain the quick and remarkable success of Dutch radio astronomy? How did the astronomers manage to raise the necessary funds for these expensive projects? Which strategic alliances did they forge in order to safeguard their projects? How did they deal with the new and unfamiliar kind of instrumentation? To what extent did they collaborate or interact with other groups abroad? Why did the Dutch focus on Galactic radio astronomy, whereas in most other countries the focus was on solar radio astronomy?

A decisive moment in the history of Dutch radio astronomy was when at the end of 1940, the Leiden astronomer Jan Hendrik Oort read an article by Grote Reber, an electronic engineer from Chicago, in the Astrophysical Journal. Reber had been able to detect radio radiation from the Galaxy with a self-made telescope and he had studied how the intensity of radio emission changed with position in the sky and wavelength. Oort immediately realised that radio radiation could be vital for astronomical research: as radio waves were not hindered by earthly clouds and by interstellar dust, it was an ideal means to answer the question of the structure of the Milky Way.

Although Reber’s work was of crucial importance for early Dutch radio astronomy, it was hardly known outside the Netherlands. Much more important were wartime developments in military radio and radar electronics. As the technologies of radar installations and radio telescopes were closely linked, this is not surprising. During the war, radar workers – mostly engineers and physicists – were confronted with interference, in the first place mostly from radio radiation from the Sun. Some of them wanted to explore this further after the war. Hence, the first radio astronomy groups consisted mainly of engineers and physicists with a background in wartime radar research. The Dutch group was anomalous in this respect.

This anomalous beginning of Dutch radio astronomy had several profound consequences. First of all, Dutch (radio) astronomers were not familiar with the new kind of instrumentation: they lacked the technical background to build radio telescopes, a disadvantage that would prove to be an advantage in the end. It forced them to conclude strategic alliances with industrial partners such as Philips, the PTT and the KNMI. These partners were willing to cooperate for several reasons: in Philips, several people of NatLab had a personal interest in (radio) astronomy (although the company as a whole showed little interest), the PTT was interested in possible spin-offs in telecommunication and the KNMI hoped the research would give them a better insight in weather conditions. In the end, these relations yielded the astronomers much more than the necessary technical know-how. First of all, in the beginning of 1948, the PTT made one of the Würzburgs at their transmitting station in Kootwijk available to the Dutch astronomers for studies of Galactic radiation. So the first radio telescope in the Netherlands was actually a ‘present’ from the PTT.
And there was more. In the context of Dutch post-war politics, science – and especially ‘pure science’ - came to be seen as a key factor in rebuilding the country, as its applications would stimulate the economy. Of course, industrial partnerships entailed promises of possible applications and hence they made it easier to obtain government funding.

However, when Oort and his colleagues tried to get the large radio telescope in Dwingeloo funded, it became clear that more was needed than industrial partners and promises of possible spin-offs. When in 1949 the plan for ‘a large radio telescope with a dish of 25 m’ was presented to the national funding organisation ZWO for the first time, it was not approved. The main reason was that in Kootwijk, no significant observations had yet been made, so why should another expensive instrument be built? It was only after the Dutch detection of the 21-cm hydrogen line in May 1951 that the definitive plan for the large radio telescope was approved. Apparently, only then was ZWO really convinced that the Dutch could indeed play a vital role in this new discipline.

Nevertheless, despite the industrial partnerships, the favourable post-war context and the breakthrough of the detection of the 21-cm hydrogen line, it remains remarkable that such an expensive project as the large radio telescope was approved rather easily. Two additional reasons can be mentioned here. First of all, in the whole radio astronomical project, only a handful of people were involved and also ZWO was still in an embryonic stage. Hence, in the application procedures people were often judge and party at the same time. Moreover, the fact that in the Netherlands radio astronomy was initiated by optical astronomers also assured that there was no ‘gap’ that needed to be bridged between the communities of optical and radio astronomers. Unlike in other countries, Dutch radio astronomers were no astronomical novices, prone to astronomical blunders. Hence, they were immediately taken seriously by optical astronomers. Even more: the astronomical community in the Netherlands was so small that radio astronomers and optical astronomers were to a large extent the same persons and not each other’s competitors.

The anomalous beginning of Dutch radio astronomy also influenced the early radio astronomical research itself. Worldwide, the vast majority of radio astronomical research during or immediately after the war was radio astronomy of the Sun. That was because during the war radar workers had often been confronted with interference by radio radiation from the Sun. Dutch astronomers, on the other hand, focused on Galactic radio astronomical research, which was a continuation of their pre-war research by means of a new technology.

Over time, international influences and international collaboration strongly diminished the influence of the Dutch peculiar start. However, the American radio astronomer Erickson once described the conception of the Westerbork telescope in the 1960s, as ‘clearly developed by optical astronomers’.

The above illustrates that in the beginning of the 1950s, Dutch academics, people from industry and government officials were clearly convinced of the importance of radio astronomy and of the vital role their country could play in it. However, this did not mean that this new field already enjoyed the acceptance of the broader public. Although the astronomers had put in a lot of ‘popularisation’ efforts and regularly dealt with the press, they met with a lot of resistance when they chose the village of Dwingeloo (Drenthe) as the location for their telescope. Nevertheless, construction started in 1954 and the 25-m telescope was inaugurated in April 1956.

As soon as the first observations with the telescope in Dwingeloo were made, ideas came up to build an even larger and better instrument. This was to become the radio telescope in Westerbork,
inaugurated on 24 June 1970. The reason for the new plans was that higher resolving power was needed to keep up with the recent developments in radio astronomy. The Dutch chose a cross shaped interferometer, a choice that was to a certain extent ‘shaped’ by its international counterparts, as cross interferometers were constructed in several countries those days. By means of the hiring of foreigners - such as the Australian Christiansen, the Swedish Högboom and the American Erickson - Oort brought the worldwide expertise in radio telescopes into Holland.

From the beginning, it was estimated that this cross-shaped interferometer would be so expensive that the Dutch government would not provide funding. To share the costs, an international partner was needed. Therefore, in 1958, the Dutch chose the Belgians as their partner, a choice that marked a continuity with the history of Belgian-Dutch relations. However, what seemed to be the beginning of a successful common project, was in fact the start of several years of frustration, tensions and ultimately the decision of Belgium to withdraw from the project in June 1966. There are several reasons for this.

First of all, in Belgium and the Netherlands astronomical traditions had diverged since the beginning of the twentieth century. In the Netherlands, since the days of Kapteyn Milky Way structure and stellar dynamics – in which radio astronomy would later make great contributions - had become the main objectives of astronomical research. In Belgium, these research topics were negligible.

Another great stumbling block between the two countries was the different way in which they dealt with ‘internationalisation’. Since the late nineteenth century, Belgium had been one of the most internationalised European countries. Dutch science, on the other hand, was remarkably little internationalised in the period concerned. And although Dutch astronomy can to a certain extent be considered an exception in this general picture - Dutch astronomers did collaborate and interact with groups abroad - also in this field the international orientation differed very much from that of the Belgians. In the Netherlands, it had a much more pragmatic character: each project was individually studied to determine whether it would benefit from international cooperation or not. ‘Internationalisation just because science had to be international’ – an attitude that prevailed in Belgium - was not the attitude of the Dutch. Hence, for the Belgians, further internationalisation of the radio telescope project was a conditio sine qua non, while this was definitely not the case for the Dutch.

Another problem was that the radio astronomical project was too much of a ‘pure science’ project for the Belgians. This rhetoric of pure science had at the end of the 1950s been long outdated in Belgium. In Belgium, applications and industrial benefits came first. In the proposals for the radio telescope project, the promises about technological implications were much too vague. This is also the reason why the Belgians were much more eager to cooperate in space research, as this offered their industry several beneficial contracts. Besides, (Earth-based) astronomy in general was no longer a government priority in Belgium. This can partly be explained by the absence of technological opportunities, but also by the fact that with the reform of Belgian science policy around 1960, the Belgian government wanted special attention to be paid to other fields such as molecular biology, space research and human genetics. The field that absorbed by far the biggest share of government funding, however, was – as in the Netherlands – nuclear research. The fact that astronomy was no longer a priority in Belgian science policy, is also one of the reasons why the handling of the project was sometimes slow and negligent. And last but not least: around 1960,
Belgian science policy was – unlike in the Netherlands – already highly bureaucratized, which made an expeditious handling of the matter impossible.

In 1965, a breakthrough seemed to have been reached, as the Belgian government had officially decided to participate. However, the next year the Belgians suddenly withdrew because of the developments in a completely different Belgian-Dutch project that was running at the time: the Antarctic expeditions. At the end of June 1966, a Dutch delegation announced in Brussels that the Dutch government had decided not to provide funding for an Antarctic expedition in 1967. As both projects were inextricably linked in the eyes of the Belgians - although in reality they had nothing to do with each other – the Belgians announced their withdrawal from the radio telescope project the month after.

The withdrawal of the Belgians forced the Dutch to simplify the design of the radio telescope. However, as this was already the fourth design in a row, this was nothing exceptional. These decisions were often motivated by other than scientific considerations. The reasons to modify the first design were the disappointingly high cost, the fact that there were no guarantees that a channel near 75 cm was going to be allocated to radio astronomy and the fact that the design had little flexibility for changing to other wavelengths. Therefore, a second design was developed. In the beginning of 1963, however, the resolving power of one minute of arc did not seem high enough anymore. At the end of the 1950s - when the first ideas for the telescope arose - a resolution of 1' was considered to be very high, but in 1963 this resolution was outdated. Hence, an entirely new design was proposed by Högbom in the summer of 1963. The telescope would no longer be cross-shaped, but it would be a linear east-west array of telescopes that would make use of Earth-rotation aperture synthesis. This telescope could offer a resolution between 10" and 20". Soon, however, new complications arose. Because of the troubled relations with the Belgians, the Dutch started thinking about continuing alone. This meant of course that the project should be much cheaper. In January 1964, Muller therefore proposed a new design, a simplification of the previous one.

When it came to choosing a location for the telescope, the difference with the Dwingeloo period is striking. In Dwingeloo, the astronomers met with resistance. In the location where the Westerbork radio telescope was built - the forestry of Hooghalen – some serious obstacles needed to be overcome before the construction of the telescope could take off: a road had to be closed, a farm and a military shooting range had to be removed, and several Ambonese families had to be moved. The ease with which Oort got this all done, testifies to his prestige and to the fact he had a great influence on decision making in the Dutch government, as well as - more in general - to the prestige radio astronomy had gained by the mid-1960s.

Nevertheless, not everything went smoothly. Notwithstanding the radical simplification of the eventual design, the telescope remained one of the most expensive Dutch scientific projects. And there were two financial problems. First of all, the Belgians were always late with their payments. This problem, however, was easily overcome by yearly advance payments of ZWO. The second problem was more difficult to handle. Dutch government budgets had been tightening since the mid-1960s. Government austerity was also felt by ZWO. As a result, grant application procedures became more and more strict.

The plans for the Westerbork radio telescope were made at a time when cosmology and ‘source counts’ were hot topics in radio astronomy. Hence, it is not surprising that the main research goal
was to use radio source sizes and radio source counts to study cosmology. However, although this was even one of the justifications for building the radio telescope in Westerbork, in the end, this observational programme would be curtailed. Reasons were that around 1970 it had become clear that the relevance of the investigation of extragalactic radio sources for cosmology was disappointing. Moreover, the resolution of the WSRT proved to be rather insufficient to study topics like the angular size-redshift relation. This big difference between what was originally envisaged and what was actually carried out is not so unusual: the entire process of planning, designing and constructing the telescope, took almost twelve years. In the meantime, scientific research progressed. Nevertheless, this did not prevent the observational programme from being enormously diverse: giant radio galaxies were mapped, research was done on neutron stars, on the continuum radiation of spiral galaxies, on clusters of galaxies etc.

The period 1940 – 1970 may well be called the ‘Oort period’ in Dutch radio astronomy. The radio telescopes in Kootwijk, Dwingeloo and Westerbork are inextricably linked to the name of Oort. However, we should not forget that Dutch radio astronomy would never have been so successful without engineers such as Muller and Hooghoudt. This ‘public effacement’ of the engineer is a general feature of the historiography of early radio astronomy. In the case of the Netherlands, this is not too surprising. Unlike in other countries, in the Netherlands the research programme was entirely developed by astronomers and it was a purely astronomical one. The telescope was not used for other, e.g. defence related, purposes in which the engineers could have a say. So in the Netherlands, engineers had a subordinate role, although a crucial one. Oort remained the driving force behind everything. It is not exaggerated to say that it was especially thanks to Oort that the Dutch radio astronomical group was one of the five major groups in the post-war decade.

If we should summarise Oort’s character in one word, we can say his was a very dominant personality. He knew very well how to exploit the peculiar post-war situation in which large budgets were made available for science. At the same time, Dutch science policy was not well developed yet, which left ample opportunity for talented and ambitious scientists such as Oort. Without any engineering background, Oort and his colleagues succeeded in invading the unknown territory of radio astronomy and in turning their efforts very quickly into a success story. In this the small but influential network they had established with people from industry, politics and government was crucial.

The smaller the field, the more influence dominant personalities such as Oort and small networks can have. And Dutch radio was a small field in the period 1940-1970. That it began as a small field, was not exceptional however. Everywhere radio astronomy started as ‘Little Science’. Even in countries where its first practitioners had a background in the big-science setting of war laboratories, the first radio astronomy groups were small groups working with modest resources and using adapted war equipment.

What was special in the Netherlands, however, was that radio astronomy remained small for quite a long time. In the making and, afterwards, the using of the radio telescope in Dwingeloo, only a handful of people were involved. Moreover, Dwingeloo was an exclusively Dutch affair: it was a matter of Dutch astronomers, engineers and construction companies. Besides the fact that this telescope was an expensive instrument, the organisational structure around it can certainly not be called Big Science. At first sight, the setup of the huge and extremely expensive radio telescope in Westerbork seems completely different. However, a closer look reveals that the similarities with the previous period are striking: although the number of people involved in the making of the
radio telescope in Westerbork was much larger than in the Dwingeloo case, the organisational structure was initially about the same. Westerbork, too, was a truly Dutch project: although for a few years there was a cooperation with Belgium, the project again became a national Dutch project after the failure of this cooperation. This had something to do with the Dutch mentality (a pragmatic attitude towards internationalisation), but even more with Oort’s personality: Oort always wanted to work alone. Despite very fruitful relations with the Australians on the Westerbork telescope, he never agreed to a formal cooperation. Summarising, we can say that in 1970 Dutch radio astronomy had still many little-science characteristics.

It was not only Dutch radio astronomy that was very small, Dutch national science policy too was still a small-scale undertaking in the 1950s and the beginning of the 1960s. ZWO was only founded in 1950, while in most other countries these organisations were a typical interwar product. Moreover, the reforms in the national science policies that had taken place in several European countries since the early 1960s at the instigation of the OEEC/OECD only took place about a decade later in the Netherlands. Hence, while in other countries – the Belgian example is illustrative - science policy had already evolved into a huge bureaucratic undertaking, this was anything but the case in the Netherlands. This in turn meant that in the Netherlands, things could still be arranged in the typically Dutch style: it was sufficient to have a chat with the right person to get something done. Very often, people were also judge and party at the same time. This meant of course that arrangements could be made very quickly, while in many other countries, things were slowed down by bureaucracy.

Around 1970, however, the Dutch radio astronomical scene underwent a complete metamorphosis.1 Oort retired. His disappearance from the scene created a power vacuum that could not be filled immediately. Several potential successors were proposed, but none of them was available at the moment: Oort saw Adriaan Blaauw as the most suitable candidate, but Blaauw became the general director of ESO in the same year 1970. Henk van de Hulst and Kees de Jager, two other potential successors, were too busy in space research. Then there were Lodewijk Woltjer and Maarten Schmidt, but these had good positions in the USA, at Columbia University (New York) and Caltech (Pasadena, CA) respectively, and they did not want to come back to the Netherlands. Finally, Harry van der Laan was appointed to the chair of Oort. Van der Laan was a 34-year old lecturer who was born in Groningen and raised in Canada. He got his PhD in radio astronomy in Cambridge in 1963 and in 1967 he came to Leiden at the instigation of Oort. Van de Hulst in turn succeeded Oort as the director of Leiden Observatory.

It was not only in radio astronomy, but in Dutch astronomy in general that there were extensive changes in personnel around 1970. Historian David Banke even talks about a ‘leadership crisis’ in Dutch astronomy (Banke, 2014, p. 35).

These changes in Dutch astronomy around 1970 in turn, were to a large extent related to broader developments. First of all, around 1970 the rapid economic growth of the 1950s and 1960s came definitively to a halt. In 1973-1974, there was the oil crisis. This meant that the exponential growth of research budgets was really over now. Moreover, in this context of economic hardship, Dutch society became more and more critical towards huge amounts of government money spent on

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1 Historian David Banke recently wrote an article that focusses on these profound changes in Dutch astronomy and Dutch science policy after 1970, see: Banke, D., Sterrenkunde na Oort. De veranderende bestuurscultuur in wetenschap en universiteit in de jaren zeventig en tachtig, in: BMGN – Low Countries Historical Review, 1 (2014), pp. 25-54.
‘useless’ science. Oort, who had been used to get what he wanted without strictly following the procedure, had many difficulties to adapt to this. This led to a serious conflict between Oort and Bannier, the latter blaming Oort for the authoritarian way in which he led SRZM.

At the same time, the democratisation of higher education made an end to the authoritarian position of professors. More specifically, in 1971 a law was passed to reform the administration of the Dutch universities, the so called ‘Wet Universitaire Bestuurshervorming’. This meant that from then on, university administrators were elected and not only professors, but employees and students were represented in the university administration (Baneke, 2014, p. 36).

The administrative reforms also affected radio astronomy. Under the new leadership of Van der Laan, a huge reorganisation of SRZM began. It was a process that took several years and that strengthened the central administration of SRZM. This reorganisation, however, did not always go smoothly. One of the most painful episodes was the departure of Muller. Muller was a typical person of the previous generation: like Oort, he wanted to run the whole show and did not like other engineers to have a say in the job. This kind of attitude, however, was an anomaly in the new era. At the end of 1970, Muller received an honourable discharge. It was time for a new generation to step forward.