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## CHAPTER II: THE LONG WAY TO DWINGELOO

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From the very first days of Dutch radio astronomy, the idea arose to build a large radio telescope with a dish of 25 m. In this chapter, we explain how this idea became reality after several years. Questions we will address are: how did the Dutch radio astronomers finally convince ZWO that funding this expensive telescope was worth the effort? How did they come to choose Dwingeloo as the most suitable location? Did they try to 'sell' their telescope project to a broader public and if so, how did they do that?

Furthermore, we put the Dutch community of radio astronomers in an international perspective. Was cooperation or competition - or maybe both - the dominant feature of the relations between the different radio astronomical groups?

Not only did the community of early radio astronomers cross national boundaries, it also crossed disciplinary boundaries. Not only (radio) astronomers, but also radio technicians and especially engineers made vital contributions to the field. Hence, the question we must address is: what was the perception - both at the time and in historiography - of the role of the engineer?

Last but not least, we place early Dutch radio astronomy in a Cold War perspective. The general picture of the USA as the world leader in matters of science during the early Cold War is still maintained. As we will see, Dutch radio astronomy offers us the possibility to moderate this picture.

The very first thing that needed to be done before any other substantial action could be undertaken, however, was uniting all the Dutch radio astronomers in one foundation to enable an efficient coordination of the research. So let us first take a look at the creation of the National Foundation for Radio Astronomy.

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### 2.1 A NATIONAL FOUNDATION FOR RADIO ASTRONOMY

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As early as 1945, the idea to create a national institute for radio astronomy was launched. That this idea did not come from an astronomer, but from Bakker from Philips NatLab, has remained unnoticed until now:

A few days ago, I [Bakker] got a report of Dr. Houtgast, in which the foundation of an 'Institute for Sun and Ionosphere' is proposed. It is also worth considering the foundation of a national institute for radio research in the ionosphere and the 'cosmic noise'.<sup>1</sup>

However, it took until shortly after the observations with the Kootwijk telescope had started before the astronomers really felt the need for an efficient organisation and coordination of their research. Then, Oort and Minnaert judged it the right moment to create the National Foundation for Radio Astronomy ('Stichting Radiostraling van Zon en Melkweg' or SRZM)<sup>2</sup>. It was formally established on 23 April 1949, but had been informally active since the autumn of 1948. In article

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<sup>1</sup> Bakker to Oort, 5 October 1945, University Library Leiden, OA, 251.

<sup>2</sup> Sometimes, the English acronym 'NFRA' is used instead of 'SRZM', but SRZM is much more common.

2 of the founding charter we read that the aim of the foundation was ‘the promotion and the execution of research into short-wave radiation from outer space. Its activities are exclusively in the scientific domain.’<sup>3</sup>

Oort and Minnaert carefully selected the board of SRZM: academe, industry and public utilities were represented. During the first years it consisted of Oort (chairman), Van de Hulst (lecturer at Leiden Observatory since 1948), Minnaert (director of the Utrecht Observatory), Houtgast (Utrecht Observatory, assistant of Minnaert), Stumpers (engineer at Philips NatLab), Rinia (member of the board of Philips NatLab), Veldkamp (KNMI), De Voogt (PTT) and Vening Meinesz (KNMI). New members of the board were officially appointed by the science section of the KNAW (Royal Netherlands Academy of Arts and Sciences) on the advice of the board of SRZM.<sup>4</sup> From this, however, it should not be concluded that the KNAW had a huge influence on early Dutch radio astronomy. As the KNAW always followed the advice of the board of SRZM, the appointment of the new members was in reality merely a formality. Besides, the KNAW had no further influence on the policy of SRZM (Van Berkel, 2011, p. 331). This negligible role of the KNAW in radio astronomy was nothing exceptional. The changing relationship between science and the government after the Second World War and the founding of ZWO had seriously threatened the role of the KNAW in matters of science (Van Berkel, 2011, p. 175).

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## 2.2 OORT’S STRATEGY OF MAXIMAL EFFICIENCY

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It may seem odd that Oort did not invite people from the other astronomical Dutch institutes to join SRZM. However, as he was a headstrong person who always wanted to arrange things as quickly as possible with as few parties as possible, this is not so surprising. Even Pieter van Rhijn, the director of the Kapteyn Laboratory (the astronomical laboratory of the University of Groningen) and former supervisor of Oort was not informed in any way of Oort’s plans. Obviously, he reacted rather upset when he heard that SRZM had asked for a grant of Dfl 200 000 from ZWO for the construction of ‘a very large instrument for the research of radio waves from Sun and Milky Way’<sup>5</sup>. Van Rhijn thought it was only natural that the other Dutch institutes would participate:

Would it not be possible that the new instrument be managed not by a single institute, but by a board consisting of representatives of all Dutch astronomical and meteorological institutes and that all Dutch astronomers could work with the instrument?<sup>6</sup>

One might expect that Oort was bothered by Van Rhijn’s implicit criticism on the fact that he had ignored the other institutes and that a subsequent letter with a clear invitation from Oort to join SRZM would follow. However, a rather odd and vague answer followed:

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<sup>3</sup> ‘het bevorderen en doen uitvoeren van onderzoekingen van de korte-golfstraling die van buiten de aarde komt. Haar werkzaamheden liggen uitsluitend op wetenschappelijk terrein.’ Founding charter of SRZM, 23 April 1949, OA, 263.

<sup>4</sup> Founding charter of SRZM, Article 3, 23 April 1949, OA, 263.

<sup>5</sup> Van Rhijn to Oort, 2 December 1949, OA, 149f.

<sup>6</sup> ‘Zou het niet mogelijk zijn, dat het nieuwe instrument wordt beheerd niet door 1 instituut, maar door een bestuur bestaande uit vertegenwoordigers van alle Nederlandse astronomische en meteorologische instituten en dat alle Nederlandse astronomen met het instrument zouden kunnen werken?’ Van Rhijn to Oort, 2 December 1949, OA, 149f.

I am a bit surprised that I have never told you about the Radio Foundation. Apparently, we see each other too infrequently even to discuss the most important things. (...) Personally, I would be very glad if other astronomical institutes than Utrecht and Leiden would actively participate. (...) As you will see, for the moment only the observatories of Utrecht and Leiden are represented on the board, because these, as we thought, were the only directly interested parties.<sup>7</sup>

Understandably, Van Rhijn was not entirely happy with this answer. As he knew it would take several years before the instrument was ready, he assured Oort he would come back to the issue on a later date and that he would then probably ask him to include a representative of the Kapteyn Laboratory on the board of SRZM.<sup>8</sup>

Indeed, about three years later, the correspondence on this matter was resumed. Van Rhijn was close to retirement and as he felt insecure about the future of the Kapteyn Laboratory, he thought it was useful to explore new directions for his institute. Radio astronomy could be an option. Therefore he asked Oort whether from then on, he could be present at the meetings of the board of SRZM.<sup>9</sup> But Oort refused. He answered that 'the board believes that it is undesirable to expand even further'.<sup>10</sup> Van Rhijn in turn, did not stop there. In an angry letter, he wrote that he thought it was 'incorrect that the director of the Kapteyn Laboratory was excluded from the decisions concerning the development of radio research'.<sup>11</sup> Too much centralisation would be detrimental for Dutch astronomy, according to Van Rhijn:

If the practice of astronomy is strongly developed at one institute, compared to the others, the danger is that when prosperity is declining in the Netherlands, the smaller institutes are abolished. (...) As yet, for Groningen I do not see another possibility for astronomical work independent from foreign institutes than radio research. One has the great advantage here that the climate is no obstacle.<sup>12</sup>

Finally, Oort agreed to propose Van Rhijn as a member of the board of SRZM. The other members approved this proposal and Van Rhijn's membership was officially approved by the KNAW in the

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<sup>7</sup> 'Het verwondert me een beetje, dat ik je nooit over de Radio-Stichting verteld heb. Wij zien elkaar veel te weinig blijkbaar om zelfs de belangrijkste dingen te overleggen. (...) Persoonlijk zou ik het erg toejuichen indien ook andere astronomische instituten behalve Utrecht en Leiden hier actief aan wilden deelnemen. (...) Zoals je zien zult, hebben op het ogenblik in het bestuur alleen de Sterrewachten te Utrecht en Leiden zitting omdat deze, naar wij dachten, de enige direct geïnteresseerden waren.' Oort to Van Rhijn, December 1949, OA, 149f.

<sup>8</sup> Van Rhijn to Oort, 30 December 1949, OA, 149f.

<sup>9</sup> Van Rhijn to Oort, 24 November 1952, OA, 149f.

<sup>10</sup> 'is het bestuur bepaald van mening dat het ongewenst is het nog omvangrijker te maken dan het reeds is.' Oort to Van Rhijn, 29 November 1952, OA, 149f.

<sup>11</sup> 'onjuist (...) dat de directeur van het Kapteyn Laboratorium van de beslissingen omtrent de ontwikkeling van het radio-onderzoek is uitgesloten.' Van Rhijn to Oort, 15 December 1952, OA, 149f.

<sup>12</sup> 'Indien men de beoefening van de sterrenkunde aan 1 instituut zeer sterk tot ontplooiing brengt vergeleken bij de andere, dan dreigt het gevaar, dat men bij verminderde welvaart in Nederland de kleinere instituten opheft. (...) Voorlopig zie ik voor Groningen geen andere mogelijkheid voor sterrenkundig werk onafhankelijk van buitenlandse instituten dan radio-onderzoek. Men heeft hierbij het grote voordeel, dat het klimaat geen belemmering vormt.' Van Rhijn to Oort, 15 December 1952, OA, 149f.

beginning of 1953.<sup>13</sup>

Oort's behaviour may not be the epitome of collegiality, but from the point of view of efficiency, it was certainly understandable. Oort was not per se opposed to the appointment of 'outsiders' in the board of SRZM. In 1951, for example, he agreed to appoint the Belgian astronomer P. Swings, as he thought the latter could make valuable contributions to the project. Indeed, radio astronomy had also recently started in Belgium and with some Belgian astronomers, especially Swings, the Dutch had good relations (see also Chapter III). It was unclear, on the other hand, how the Kapteyn Laboratory, Van Rhijn in particular, could further Dutch radio astronomy. Therefore, the Dutch (radio) astronomer Hugo van Woerden, a retired professor of the University of Groningen and former member of the board of SRZM can understand Oort's reaction:

Van Rhijn was ill for several years during and after the Second World War (...). He had had tuberculosis and remained weak until the end of his life in 1960. My fellow students in Leiden (...) and I were already discussing in 1952/1953 who would be his successor after his retirement. Van Rhijn was rarely at the meetings of the NAC [Nederlandse Astronomen Club]. I think Oort respected Van Rhijn's scientific contributions, but at the same time, he thought he did not undertake many new things. Without doubt, Oort was convinced that Van Rhijn could not make a substantial contribution to the work of SRZM, because he had no staff available that could throw itself into radio astronomy, and because he had too little energy for managerial work.<sup>14</sup>

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### 2.3 STARTING RESEARCH IN KOOTWIJK: THE HIRING OF HOO

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One of the first things the newly founded SRZM needed to do was hire a radio engineer. The board of SRZM discussed the issue with professor Gorter of the Kamerlingh Onnes Laboratory. They decided that Hoo, a student-assistant at the Kamerlingh Onnes Laboratory would be a suitable person. At the Laboratory, he had already adapted a surplus American radar receiver to make it suitable for doing astronomical research in the 21-cm hydrogen line.<sup>15</sup>

Hoo was hired in late 1948, but soon there were doubts about his competence. Already in the spring of 1949, it was said that a second experienced radio engineer should be appointed for about six months, to work together with Hoo. The Englishman Martin Ryle was contacted to this end. At that moment, Ryle led a radio astronomy group at the Cavendish Laboratory of Cambridge University. In 1946, he had constructed a radio interferometer with some colleagues, so he had

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<sup>13</sup> Oort to Van Rhijn, 26 January 1953, OA, 149f.

<sup>14</sup> 'Van Rhijn is jarenlang ziek geweest tijdens of na de Tweede Wereldoorlog (...). Hij had tuberculose gehad en bleef zwak tot het eind van zijn leven in 1960. Mijn medestudenten in Leiden (...) en ik bepraatten in 1952/53 al wie hem na zijn emeritaat zou opvolgen. Van Rhijn verscheen zelden bij bijeenkomsten van de NAC. Ik denk dat Oort respect had voor Van Rhijns wetenschappelijk werk, maar wel vond dat hij weinig nieuws ondernam. Ongetwijfeld had Oort de overtuiging dat Van Rhijn geen wezenlijke bijdrage aan het werk van SRZM kon leveren, omdat hij geen personeel had dat zich op de radiosterrenkunde zou kunnen werpen, en ook te weinig energie had voor bestuurlijk werk.' Personal communication of Van Woerden to author, 7 December 2012.

<sup>15</sup> Minutes of the board meeting of SRZM of 26 October 1948, SA.

ample experience with the instrumentation.<sup>16</sup> However, Ryle refused as he 'had no time'. (It was probably a little unrealistic of the Dutch to think that Ryle himself, by then already a rising star in British radio astronomy, would come over to the Netherlands to do this job.) He also had no assistants available.<sup>17</sup>

Half a year later, still no second radio engineer had been found. The doubts about Hoo increased. At that time, he was still a student with a provisional appointment. The question was whether he was good enough to get a permanent position afterwards. According to De Voogt of the PTT, who regularly controlled Hoo's work, Hoo 'lacked the flair for the experiment'.<sup>18</sup> Although there was a consensus that Hoo was enthusiastic and diligent, it was agreed upon that he needed to be supervised. So it was decided that he should write a work report for Oort every month, and that an instrument maker of De Voogt would assist Hoo.<sup>19</sup>

Finally, at the beginning of 1950, a second radio engineer to help Hoo was found: G. de Bruin.<sup>20</sup>

Hoo and De Bruin had only started to work together for a few months, when a disaster struck: on 10 March 1950 a fire broke out in the observation cabin of the radio telescope at Kootwijk. For SRZM, the consequences of this fire were 'disastrous, because of the loss of work and valuable instruments'.<sup>21</sup> Virtually all the equipment was burned and a lot of private belongings of Hoo and De Bruin too. Of course, things needed to be repaired as soon as possible. The construction of a new receiver was the most important. The idea was that Hoo and De Bruin would carry out this task at Philips NatLab, supervised by Stumpers. The new receiver would differ from the old one in some aspects, the most important of which was the possibility of high frequency amplification in the new receiver.<sup>22</sup> The management of Philips NatLab, however, did not want Hoo and De Bruin in their laboratory, but it was agreed that Philips itself would construct the receiver for SRZM.<sup>23</sup>

As the competence of Hoo was doubtful from the beginnings, SRZM had announced a vacancy for the position of leading engineer at SRZM in early 1950. But as mentioned above: finding good engineers was hard. In September 1950, only three candidates had applied: Hoo himself, Bruin (not to be confused with *De Bruin*!) and Muller.<sup>24</sup> It was immediately agreed that Hoo was not suited for the job. Muller and Bruin, on the other hand, were both very strong candidates. Bruin was an engineer at the Zeeman Laboratory, a laboratory for high-energy physics at the University of Amsterdam. There, he was the assistant of the well-known Bakker, former physicist at Philips NatLab (see Chapter I). Muller was engineer, and assistant at the electronics department of Delft Polytechnic.<sup>25</sup> Eventually, the choice fell on Muller, who was hired in late 1950.<sup>26</sup> With the hiring of Muller, Dutch radio astronomy embarked on an era of success.

In historiography on early radio astronomy, there is some disagreement on the role of the fire in

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<sup>16</sup> Ryle's contributions to radio astronomy, especially to interferometry and aperture synthesis, will be discussed in detail in Chapter IV.

<sup>17</sup> Minutes of the board meeting of SRZM of 23 May 1949, SA.

<sup>18</sup> Minutes of the board meeting of SRZM of 1 November 1949, SA.

<sup>19</sup> Minutes of the board meeting of SRZM of 1 November 1949, SA.

<sup>20</sup> Minutes of the board meeting of SRZM of 17 January 1950, SA.

<sup>21</sup> Minutes of the board meeting of SRZM of 21 March 1950, SA.

<sup>22</sup> Minutes of the board meeting of SRZM of 21 March 1950, SA.

<sup>23</sup> Minutes of the board meeting of SRZM of 23 May 1950, SA.

<sup>24</sup> Minutes of the board meeting of SRZM of 12 September 1950, SA.

<sup>25</sup> Minutes of the board meeting of SRZM of 12 September 1950, SA.

<sup>26</sup> Minutes of the board meeting of SRZM of 23 October 1950, SA.

Kootwijk. First we need to say that the real cause of the fire has never been ascertained. Hoo's own account goes that when the door to the hut had been closed, a piece of wire had fallen of a workbench, causing a short circuit in one or more lead batteries below (Sullivan, 2009, p. 406). Concerning the consequences of the fire, on the other hand, most authors claim that it caused serious delays in the Dutch observations. Sullivan, on the other hand, holds an anomalous view in this. He says that the fire in fact hastened the eventual detection of the 21-cm hydrogen line (see below), because it hastened the replacement of Hoo (Sullivan, 2009, p. 414). But this is not correct. First of all, Hoo was never *replaced* by someone else. He held a temporary position as radio engineer at SRZM as part of his studies. Of course, if he would have proven to be very competent, he could later have been appointed in a permanent position as leading radio engineer of SRZM. However, it became clear very soon that Hoo's work was rather disappointing. Therefore, already at the board meeting of 17 January 1950 – almost two months before the fire - it was decided to announce a vacancy for the position of a leading radio engineer as soon as the budget to pay the engineer was approved by ZWO.<sup>27</sup> Besides, it took almost a year before a competent engineer – Muller – was found, so it can hardly be said that his appointment hastened the job. For several months – until Hoo's position ended – they collaborated. Moreover, Van Woerden (who had been involved in Dutch radio astronomy from the very beginning) and Strom, former astronomer at ASTRON (Netherlands Institute for Radio Astronomy), have pointed out that because of the fire, many months of development were lost (Strom and Van Woerden 2006, p. 5). It is of course impossible in hindsight to give a definite answer to the question 'who would have been the first if the fire had not happened'. And for the historian, it is perhaps not even the most interesting question to ask. However, we think it is absolutely true that the fire seriously delayed the early observations as a great deal of development was lost and consequently observations came to a halt for several months. On the other hand, there is good reason to assume that the role of the fire in this story is negligible: as will be explained in the following section, the Dutch lacked a key element for the detection of the line.

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#### 2.4 MULLER AND THE QUEST FOR THE 21-CM HYDROGEN LINE

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In December 1950, the new 21-cm receiver was ready at Philips and was transported to Kootwijk, so the quest for the 21-cm hydrogen line could be resumed. Although there was general agreement that Muller was a very competent engineer, he did not succeed in detecting the line. The problem was that something crucial was missing and he had to wait until a solution came from ... Harvard.

In the same period, in the USA there was a quest for the 21-cm hydrogen line too. At Harvard, at the end of the 1940s, physics student H.I. Ewen wanted to find a suitable topic for his PhD research in physics. After his advisor E.M. Purcell had discovered a paper by the Russian astronomer I.S. Shklovsky – which said that the hydrogen line should be relatively easy to detect (Shklovsky, 1948) – Ewen decided to build a radiometer to detect this interstellar hydrogen (Stephan, 1999, p.8).

As mentioned above, most of the early radio research was not done by 'real' astronomers, but by physicists and engineers with a background in wartime radar research. This was also the case at Harvard. Both Ewen and Purcell had a background in the war research. In 1944, Purcell had interrupted his work at Harvard to head the Fundamental Developments Group at the MIT

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<sup>27</sup> Minutes of the board meeting of SRZM of 17 January 1950, SA.

Radiation Laboratory. There, he directed investigators in projects related to radar research and development. Ewen for his part had been an airborne-radar officer whose duty was to fly anti-submarine patrols in and around the English Channel. He had learned how to assemble and repair complex equipment with whatever facilities were at hand.

Early in 1951 it so happened that Henk van de Hulst – at that time a lecturer at Leiden University – was spending a few months at Harvard College Observatory, where he had been appointed a visiting professor, to give a course in radio astronomy. It is unclear whose initiative it was to get Van de Hulst to Harvard, but it was probably Bart Bok's. After Bok's efforts to get Reber's 1940 paper published in the *Astrophysical Journal*, he continued to follow the developments in this field closely. He set up a research programme in radio astronomy in 1952 and from 1953 onwards, he taught radio astronomy at Harvard, as he wrote to Oort: 'This Fall I am teaching the Radio Astronomy course that was initiated by Henk van de Hulst two and half years ago.'<sup>28</sup>

It is noteworthy that as early as 1950-1951 – despite the 'gap' between optical astronomers and radio astronomers – a course in radio astronomy was given to Harvard astronomy students. Moreover, the course was then called 'radio astronomy'. Probably, this was one of the earliest uses of the term.<sup>29</sup>

Shortly after Van de Hulst's arrival, he had learned of the 21 cm effort of Ewen and Purcell. Subsequently, collaboration between Ewen and Purcell and Van de Hulst began. Van de Hulst used his astronomical knowledge to help Ewen and Purcell with their endeavours. He said that the line might be considerably wider than the one measured in the laboratory. This was because the hydrogen in different parts of the Galaxy might be moving at a considerable range of velocities relative to the Earth. So the emission might be Doppler-broadened (i.e. covering a wider frequency range) over a band many kilohertz wide. Ewen adapted his equipment accordingly. On the other hand, Van de Hulst studied Ewen and Purcell's receiver techniques (Stephan, 1999, pp. 12-14). Ewen and Purcell's radiometer was based on the switching principle of Dicke. The so-called 'Dicke switch' was invented by the American physicist Robert Henry Dicke, when he was working in the radar industry in the Second World War. The Dicke switch repeatedly (and very rapidly) alternates the input of the receiver between an antenna and a constant-temperature load resistor. This is not so much to eliminate noise, as to eliminate the effects of receiver gain fluctuations<sup>30</sup> during a measurement. In a letter of 8 March 1951, Van de Hulst wrote to the Dutch group about this frequency-switching scheme, which was the key novel element for the engineer Muller (Sullivan, 2000, p. 250).

From then on, things proceeded quickly. In Harvard, Ewen managed to detect the hydrogen line on 25 March 1951. In the Netherlands, the first hints of the line came on 11 May, followed by the confirmation several nights later. Oort communicated the news enthusiastically to Van de Hulst in Harvard:

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<sup>28</sup> Bok to Oort, 6 October 1953, OA, 151c.

<sup>29</sup> 1950-1951 Harvard University, Astronomy 241b, radio astronomy. Final. June, 1951, VdH, 37. In 1950, Minnaert also used the word 'radio-astronomy' in his 'Report on Dutch research on radio-astronomy in 1948-1950' for the 9<sup>th</sup> General Assembly of the URSI in Zürich in 1950, VdH, 37.

<sup>30</sup> The 'gain' is the ability of an amplifier to increase the power or amplitude of a signal from the input to the output.

Dear Henk, I have just received a call from Muller at Kootwijk, saying that he has observed the 22-cm line<sup>31</sup> tonight in the vicinity of Sagittarius! He estimated the strength of the same order as Ewen said.<sup>32</sup>

At the end of June 1951, further confirmation came from Australia. It is noteworthy that F. Kerr, a staff member of the Radiophysics Laboratory in Sydney (where microwave radar equipment was developed during the war), was spending a year at Harvard studying astronomy in 1950-1951. He was there at the moment of the line detection, and Purcell suggested that he cable the result to Australia. There, no attempt to look for the line was being undertaken at the time. However, upon receipt of Kerr's cable by Pawsey, a programme was immediately started. The necessary equipment was assembled. The professor of physics and engineering W.N. Christiansen and his assistant J.V. Hindman detected the line after only six weeks (Kerr, 1984, p. 138).

It appears that Purcell and Ewen were really looking for at least one confirmation of the detection before publishing their result. Once the confirmation by the Dutch was there, it was decided to try to have the two papers published in the same issue of Nature. Purcell wrote to the editors of Nature:

Our first results were communicated privately to Professor van de Hulst and Professor Oort of the Leiden Observatory. We have just learned that our findings have been subsequently confirmed by observation there. The purpose of this letter is, therefore, to suggest that it might be appropriate if both communications (...) were to appear in the same issue of NATURE. Our results were also communicated to the Radio Physics Division of the Commonwealth Scientific and Industrial Research Organization in Australia. (...) It is possible, therefore, that you will receive still a third communication on this subject, from the Australian laboratory.<sup>33</sup>

The first papers from the Harvard and the Leiden groups were published in Nature in 1951, with a short cable from the Australian group as an addendum.

The differences between the Leiden and the Harvard group are strikingly obvious in the papers in Nature. The article by Ewen and Purcell was written as an experiment in interstellar microwave spectroscopy, whereas the article by Muller and Oort was a study of the structure of the Galaxy (Sullivan, 2000, p. 254). As Ewen and Purcell wanted to explore the physics of the hydrogen atom, they concentrated on the opacity and the physical state of the hydrogen gas. For example, they summarised:

We have made rough theoretical estimates of the efficacy of various processes through which energy is exchanged between the hydrogen hyperfine levels and the other thermal reservoirs in the interstellar matter-plus-radiation complex. (Ewen and Purcell, 1953, p. 356)

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<sup>31</sup> The Dutch often referred to the line as the 22 cm line, even though its wavelength was known to be 21.1 cm

<sup>32</sup> Oort to Van de Hulst, 17 May 1951, VdH, 37.

<sup>33</sup> Purcell to the Editors of Nature, 14 June, 1951, VdH, 37.

The emphasis of Muller and Oort was on the line widths and the Doppler shifts (shifts in frequency) and what they revealed about the location of the gas. This in turn could tell them something about the structure of the Galaxy (Muller and Oort, 1951).

The differences between the Leiden and the Harvard papers illustrate that the questions researchers asked – even when studying the same topic (the 21-cm hydrogen line) – were strongly influenced by their background and previous activities.

It is worthwhile to mention that from the questions for the final exam in radio astronomy in June 1951, it becomes clear that Van de Hulst must have told his Harvard students about the Dutch plans to build a radio telescope with a dish of 25 m, as the main part of the exam was about this radio telescope. Students were asked to give their ideas on the instrumentation and possible research programmes:

Plans have been made to construct a parabolic antenna of 25 meter diameter with a surface of wire screen reflecting waves of 10 cm and longer. The antenna will be able to move in two coordinates. Before appropriation of the funds a well-considered program of expected research problems has to be submitted. You are invited to submit such a program. Discuss solar and galactic and possibly other problems; freely use any data that are now available from observation with smaller equipment. Give sample estimates of beam width and antenna gain, where needed. Indicate clearly the type of result expected from each suggested problem and its impact on problems of classical astronomy or other fields of science. Finally try to state what programs deserve priority and how long it will take to complete them.<sup>34</sup>

This relative openness concerning the Dutch plans, however, did not prevent a huge amount of (international) competition, as we will see.

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## 2.5 FUNDING, BUILDING AND INAUGURATING THE RADIO TELESCOPE

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The detection of the 21-cm hydrogen line was not only important from an astronomical point of view; it was also instrumental in obtaining a ZWO grant for the construction of a large radio telescope.

Remember that the first time the astronomers asked for funding for this telescope was in 1945 (see Chapter I). In that year they asked the government a grant of Dfl 100 000. This amount, however, was as large as the government's total budget for scientific instrumentation and consequently the request was turned down.

The first time a plan was presented to ZWO was in 1949. Werkspoor had made an estimate of the price tag: the construction would cost around Dfl 200 000, which was about 16% of the ZWO-budget for 1950 (see above). Financial support was *not* possible in that year and the astronomers received only Dfl 5850 for 'research on short wavelengths originating from interstellar space, as

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<sup>34</sup> 1950-1951 Harvard University, Astronomy 241b, radio astronomy. Final. June, 1951, VdH, 37.

well as those that are emitted by the sun'.<sup>35</sup> One of the reasons for this refusal was, indeed, the poor progress of the Kootwijk observations. This was illustrated by the words of Bannier, the director of ZWO, who was present at a meeting of the Dutch astronomers in September 1949. At that meeting, Bannier expressed his doubts on whether the technical and astronomical experiences with the small dish were already such that it would be justified to build a large dish.<sup>36</sup> After all, in the autumn of 1949 the astronomers had not yet succeeded in detecting anything significant at all.

In addition to this, however, Bannier mentioned that it was impossible for the provisional organisation to decide on such a huge amount of money. The astronomers had to wait until ZWO was officially installed. This argument sounds a bit odd, as it was obviously no problem for the provisional board to give a larger budget to the Foundation for Fundamental Research on Matter ('Fundamenteel Onderzoek der Materie' or FOM), the Dutch national foundation for nuclear physics, founded in May 1946. In 1947, ZWO distributed its total budget of Dfl 571 550 over twelve projects. FOM received Dfl 257.500 (Reinink, 1950, p. 59) which means that it consumed almost half (!) of the annual budget. For at least a decade, FOM continued to consume yearly on average fifty per cent of the annual budget of ZWO. To compare: SRZM received about ten per cent of the annual budget of ZWO, which meant it was in a respectable second place in matters of funding.<sup>37</sup> Obviously, the Dutch government gave higher priority to nuclear physics in the early Cold War context, although in the Netherlands, it was exclusively used for peaceful purposes.

In August 1951—about three months after the detection of the 21-cm line of 11 May — a definitive plan was presented to ZWO. The estimated cost was much higher than the previous estimate of 1949: the construction would cost Dfl 436 000 (Kersten, 1996, p. 98). However, the project was approved and it was decided to finance the building of the telescope in three stages from 1951 until 1953.

When we take a closer look at the funding process, this sudden success is not so surprising. Several people once again were judge and party at the same time. A ZWO ad hoc advisory committee of five people was appointed by the board to judge the plan. Among its members were the physicists G. Holst – former physics professor of Leiden University and director of Philips NatLab – and Vening Meinesz, head of the KNMI. Not surprisingly, they advised positively on the project.<sup>38</sup> In their argumentation, they stressed the great scientific value of the project. While the Dutch cloudy climate was unsuitable for optical astronomical observations, the Dutch could play a vital role in radio astronomy. With this new instrument, the Dutch would—in their own country—be able to have a significant influence on this new field of astronomy. The research would also have positive effects on related disciplines such as telecommunication and development of knowledge about the ionosphere. The project was of extraordinary importance for the education of scientific researchers and technicians. They would learn how to work very precisely and because of the interdisciplinarity, they would become familiar with problems of other disciplines. In other countries, there were no plans to build such a 25-m dish and so Dutch radio astronomy would stay

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<sup>35</sup> 'voor onderzoek van de kortegolfstraling, die uit de interstellaire ruimte komt alsmede van die, welke door de zon wordt uitgestraald', Annual report ZWO, 1950, p. 41.

<sup>36</sup> Minutes of the board meeting of SRZM of 20 September 1949, SA.

<sup>37</sup> Annual reports ZWO, 1950-1960.

<sup>38</sup> Minutes of the board meeting of SRZM of 30 October 1951, SA.

at the international top (Kersten, 1996, pp. 98–99).<sup>39</sup> So from this line of argument it becomes clear that a rhetoric of practical applications and technical spin-offs was still highly relevant.

In the beginning of the 1950s, the network of people that put radio astronomy on the agenda was still very small: only a handful of astronomers, some people from industry and from the government were involved and ZWO was also still a very small organisation. Paradoxically, it was exactly this smallness that contributed to the early success of Dutch radio astronomy. Because of the small number of people involved, overlapping memberships were the rule rather than the exception so that people were often judge and party at the same time. In such a small network, ‘friendship’ between the protagonists could be a crucial factor. That an apparently trivial factor such as friendship can play an important role in the establishment of a new scientific field has been demonstrated already several times (see for example Michaelson, 1993). Historian Klaas Van Berkel also recognises that friendships and dominant personalities can play decisive roles, but only in fields which are still very small, such as Dutch radio astronomy:

In a relatively small field, dominant personalities can distinguish themselves more easily than in more extensive, multi-hued fields. Oort’s achievements – his scientific work as well as his diplomatic talents – were exceptionally important for Dutch astronomy, and would not have been possible within a large field such as physics (...). (Van Berkel, 2004, p. 350)

Van Berkel is indeed right in stressing that the smaller the field, the more influence dominant personalities can have. On the other hand, Oort was anything but a ‘diplomatic’ person. It has already been illustrated how dominant and even uncollegial he could actually be. But because he was embedded in a small network of people who knew him personally and were well acquainted with his scientific achievements, this hardly mattered: in the Netherlands, Oort almost always got what he wanted. However, when it came to collaboration with other countries – and hence with people that were outside his network – the situation was completely different. The collaboration that was established with Belgium in the late 1950s for the building of the radio telescope in Westerbork (see Chapter III) ultimately failed. It becomes clear that in Belgium Oort absolutely did not get the credit that he received in the Netherlands.

As mentioned before, Werkspoor estimated the cost of the telescope to be Dfl 436 000. Hence, this was also the amount ZWO made available. Over time, however, the total cost increased. In the beginning of 1953, Werkspoor handed in a new estimate of no less than Dfl 586 720.<sup>40</sup> In an accompanying letter, the company explained:

Much to our regret, the amount of this offer is considerably higher than that of the estimate we gave you on 4 May 1951 [which was Dfl 436 000]. This increase of the estimate is almost exclusively due to important changes in the construction which seemed to be necessary in order to meet the requirements of the servo mechanism.<sup>41</sup>

But the astronomers were not pleased. According to them, it was clear that ‘several entries calculated unnecessarily generously by Werkspoor could be lowered by better calculation and

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<sup>39</sup> Unfortunately, we were unable to find the original text of the committee.

<sup>40</sup> Werkspoor to Houtgast, 15 January 1953, SA, NWO.

<sup>41</sup> Werkspoor to Houtgast, 16 January 1953, SA, NWO.

simplification of the construction'<sup>42</sup> Werkspoor agreed to make a revision. In consultation with the astronomers, several entries were adapted. For example, it was agreed upon that the foundation could be of a lesser quality.<sup>43</sup>

In October 1953, Werkspoor's price estimate had gone down from Dfl 586 720 to Dfl 530 000. But at the same time, a new problem arose: the estimated delivery time had gone up from ten months to one year and a half.<sup>44</sup> New negotiations between the astronomers and Werkspoor took place, which led again to a lowering of the cost to Dfl 490 810 in the beginning of 1954. It was said, however, that this would go up again with Dfl 15 000 the next year, because of the pay rise.<sup>45</sup>

Dfl 490 810 was of course still higher than the original estimate of Dfl 436 000, the grant ZWO had reserved for the project. Fortunately for the astronomers, the increased cost was no problem for ZWO. The decision had been taken and ZWO realised that there was no going back. Hence, on 4 March 1954, SRZM received the permission of ZWO to give the tender to Werkspoor.<sup>46</sup>

The delivery contract of Werkspoor followed on 18 March 1954.<sup>47</sup>

Construction started, but very soon, new delays arose. As Werkspoor's drawing office was understaffed, a delay of four months had arisen in the machinery. Moreover, the delivery of several components – for example the large gear wheel - was delayed too. The astronomers started to panic, as they knew there were plans in some other countries too to construct large radio telescopes and they absolutely wanted to be 'the first'.<sup>48</sup>

And things only got worse. On 19 July 1955, SRZM received a letter of Werkspoor in which an additional delay of four months was announced. On top of this, the delay was announced much too late in the astronomers' eyes. The latter agreed to react 'immediately and in strong words'.<sup>49</sup>

Fortunately, all's well that ends well. The telescope was ready at the date when the inauguration was planned. Initially, it was said that the inauguration date would be 18 April 1956 and that the telescope would be opened by 'the Minister' (probably the Minister of Education, Arts and Sciences) by means of a 'push a button'.<sup>50</sup> However, Her Majesty Queen Juliana informed the astronomers she wanted to open the telescope *herself* on 17 April 1956,<sup>51</sup> and so it happened. Or at least, so it seem to happen so. An amusing anecdote is that, at the time of the inauguration, the automatic steering system of the telescope was still unfinished and the button pushed by Juliana was not connected. What actually happened when the Queen pushed the button, was that a bell rang in the control room, after which an SRZM employee manually

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<sup>42</sup> 'verschillende door Werkspoor onnodig royaal berekende posten door betere calculatie en door vereenvoudiging van constructie verlaagd kunnen worden', Minutes of the board meeting of SRZM of 3 February 1953, SA.

<sup>43</sup> Minutes of the board meeting of SRZM of 3 February 1953, SA.

<sup>44</sup> Minutes of the board meeting of SRZM of 27 October 1953, SA.

<sup>45</sup> Minutes of the board meeting of SRZM of 2 February 1954, SA.

<sup>46</sup> Minutes of the board meeting of SRZM of 16 March 1954, SA.

<sup>47</sup> Contract of Werkspoor, 18 March 1954, SA, NWO.

<sup>48</sup> Minutes of the board meeting of SRZM of 14 September 1954, SA.

<sup>49</sup> 'onmiddellijk en in krachtige termen', Minutes of the board meeting of SRZM of 19 July 1955, SA.

<sup>50</sup> Minutes of the board meeting of SRZM of 17 January 1956, SA.

<sup>51</sup> Minutes of the board meeting of SRZM of 14 February 1956, SA.

steered the telescope. For a moment, it was even steered in the wrong direction, but this mistake was quickly corrected (Gerding et al., 2009).



**FIGURE 2. The radio telescope in Dwingeloo (Leiden Observatory Archives)**

For a few months, the radio telescope in Dwingeloo would be the biggest radio telescope in the world. One would expect that this fact received a lot of media attention. However, compared to the number of articles that appeared in August-September 1953 when the plans for the radio telescope became public and protest arose (see also below), the media coverage of the inauguration was small. A quick search in the Dutch National Library's database of historical newspapers<sup>52</sup> revealed that only four newspapers reported this inauguration. This brings us to the question how the astronomers dealt with the press and with 'the general public'. But first let us take a look at how a suitable location for the telescope was chosen.

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<sup>52</sup> <http://kranten.kb.nl/> (accessed on 22 January 2013). This database contains over 1400 newspapers, 1152 of which cover the period 1940-1945.

## 2.6 IN SEARCH OF A LOCATION FOR THE LARGE RADIO TELESCOPE

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*Plotseling werd een deel van de Spiegel zichtbaar boven de bomen: een reusachtig staketsel van vijftientig meter doorsnee, een transparante parabool van grauw staal, in de landelijke omgeving zo detonerend als een vloek in een preek.*  
Harry Mulisch, *De ontdekking van de hemel*

The telescope was built in Dwingeloo, but the question remains of course which elements determined the choice of this location. As we will see, it was only after several years of carefully weighing the pros and cons of several locations and after a lot of negotiations that this location was finally considered the best.

As cooperation with the Belgians was considered for a while and the Belgian astronomer P. Swings was appointed to the board of SRZM in 1951, the initial plan was to build the 25-m telescope on the Belgian-Dutch border near the nature reserve of the Benedictine Abbey 'Achelse Kluis'.<sup>53</sup> In the context of Belgian-Dutch cultural cooperation (see also Chapter III) SRZM contacted the Dutch government to ask the Belgian government to keep this area free from possible sources of interference (such as cars, motorcycles etc.). There were also rumours that in the near future, a military airport would be located to the south of the city of Neerpelt (Belgium). Swings contacted the Belgian military authorities about this matter, but as military secrets were involved here, the authorities were reluctant to give information.<sup>54</sup> It was decided that if military activity in the area would be too much of a problem, a completely different location in Veenhuizen in the province of Drenthe (in the north of the Netherlands) would be considered.<sup>55</sup> This meant of course that the idea of constructing the telescope on the Belgian-Dutch border was given up.

Over time, it became more and more obvious that the location of Achelse Kluis was unsuitable. Although not many details were given, further contacts between Swings and the Belgian military authorities revealed at least that a lot of military activity was planned in the area around Achelse Kluis.<sup>56</sup> The Dutch Military Aviation Authority also discouraged this location<sup>57</sup>.

So in the fall of 1952 it was decided that Veenhuizen was definitely the best location, as it would remain free of interference for a long time.<sup>58</sup> But the enthusiasm quickly waned, when the astronomers heard of existing plans for the construction of a main road between Assen (Drenthe) en Oosterwolde (Friesland), a road that would cross Veenhuizen. The astronomers contacted the provinces of Drenthe and Friesland, but neither was inclined to change the plans. Moreover, the southern part of the area seemed to be owned by private mining companies.<sup>59</sup> It was at this moment that the 'Kraloër veld'<sup>60</sup> near the village of Dwingeloo (Drenthe) - where the telescope would ultimately be built - was taken into consideration as a possible location for the first time. This was a nature conservation area. The state owned the area, but it was managed by the Forestry

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<sup>53</sup> Minutes of the board meeting of SRZM of 27 November 1951, SA.

<sup>54</sup> Minutes of the board meeting of SRZM of 12 February 1952, SA.

<sup>55</sup> Minutes of the board meeting of SRZM of 18 March 1952, SA.

<sup>56</sup> Minutes of the board meeting of SRZM of 27 May 1952, SA.

<sup>57</sup> Minutes of the board meeting of SRZM of 24 April 1952, SA.

<sup>58</sup> Minutes of the board meeting of SRZM of 2 October 1952, SA.

<sup>59</sup> Minutes of the board meeting of SRZM of 3 March 1953, SA.

<sup>60</sup> I.e. the 'Kraloërheide'

Commission ('Staatsbosbeheer'). So this was a very quiet region that would be free from interference for a long time and hence it was considered to be perfect. However, the astronomers themselves were in doubt whether it could be justified to 'spoil' such a beautiful area.<sup>61</sup>

Indeed, with the choice of Dwingeloo as a possible location, the real trouble only began.

Huge resistance came from the village administration. On 24 August 1953, the city council of Dwingeloo voted almost unanimously against the construction of the radio telescope in Dwingeloo. This decision was widely reported in the media. The astronomers were very upset that they were in no way informed by the council and that they had to read about the decision in the newspapers. They were also convinced that, if the mayor – who had discussed the plans with the astronomers – would have informed the council, the attitude of the council would not have been so negative:

We regret that the mayor has been of the opinion that confidentiality had to be maintained. The unfamiliarity with the efforts of the Foundation has without doubt caused the council to overestimate the disadvantages and to disregard the positive side.<sup>62</sup>

The village council and the inhabitants of Dwingeloo too were not happy with this secrecy. Mayor Stork had not informed them in any way and they only knew about the plans through 'all kind of rumours that are circulating'.<sup>63</sup>

The council was especially worried because of the need of a large interference free area surrounding the telescope. According to the council, this would have the following consequences:

- (a) The farmers would suffer severe restrictions when doing their jobs. For example, the use of motorised machinery would be forbidden and electric fences around the pastures would not be allowed.
- (b) Part of the road between the village of Lhee and the city of Hoogeveen had to be displaced, which implied a fragmentation of several agricultural plots.
- (c) Tourism would seriously diminish, because the nature reserve would be spoiled by a 30-m tower with a mirror of 25 m diameter. Moreover, the area would be difficult to access, as cars and motor cycles would be hindered.<sup>64</sup>

In its opposition, the village council found a partner in the Society for the Preservation of Nature Monuments ('Vereniging tot Behoud van Natuurmonumenten'). Being a green lobby group, it is not surprising that the Society for the Preservation of Nature Monuments was against the construction of a radio telescope in a nature reserve. The Society for the Preservation of Nature

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<sup>61</sup> Minutes of the board meeting of SRZM of 3 March 1953, SA.

<sup>62</sup> 'Betreurd wordt dat de burgemeester gemeend heeft geheimhouding te moeten betrachten. De onbekendheid met het streven van de Stichting heeft de raad ongetwijfeld de nadelen te zwaar laten wegen en de positieve kant over het hoofd doen zien.' Minutes of the board meeting of SRZM of 8 September 1953, SA.

<sup>63</sup> 'allerlei geruchten die er gaan', in: Dwingelo laat zich niet dwingen. Protestmotie tegen het plaatsen van radiotelescoop. Belemmeringen gevreesd voor landbouw en vreemdelingenverkeer, in: *De Waarheid*, 25-8-1953.

<sup>64</sup> Dwingelo laat zich niet dwingen. Protestmotie tegen het plaatsen van radiotelescoop. Belemmeringen gevreesd voor landbouw en vreemdelingenverkeer, in: *De Waarheid*, 25-8-1953.

Monuments was founded in 1905. In a propaganda leaflet of 1906, the society made its goals explicit:

(...) the preservation of special parts of the Dutch soil and special animals, plants and ecological communities that live in the Netherlands, as well as important remains of prehistoric human activity, which threaten to disappear because of the expansion of culture or other causes (...).<sup>65</sup> (Quoted in Roenhorst, 2007, p. 183)

In a report of 24 August 1953, the society concluded that the location near Dwingeloo 'did not satisfy the requirements of SRZM'. This was in the first place due to the presence of several nearby roads. But Oort replied that these roads were either little used or located at a sufficient distance from the telescope. Furthermore, although the society presented no less than sixteen alternative locations for the telescope, all of them were entirely unsuitable. Often, there was too much interference because of nearby roads, but more important was that about half of the alternatives were located on the coast. And constructing a radio telescope near the sea was absolutely impossible according to the astronomers. First of all, the heavy winds would demand a heavier construction which in turn would increase the cost considerably. Moreover, sea wind and sea salt would severely corrode the apparatus.<sup>66</sup>

Fortunately for the astronomers, not all the reactions were that negative. The trade association ('Handelsvereniging') of Dwingeloo, for example, thought Dwingeloo would greatly benefit from the construction of the radio telescope: as a lot of people would like to see this gigantic telescope, tourism would – despite the traffic regulations – greatly increase, the association believed. This would be beneficial to shopkeepers, craftsmen, guesthouse owners etc.<sup>67</sup>

But more important was that the provincial and the national governments too supported the plan. In June 1953, the executive council of the province of Drenthe, wrote to the Government Service for the National Plan ('Rijksdienst voor het Nationale Plan'):

The construction of a radio telescope (...) to the north of the Kraloërheide (...) is considered to be favourable (...). From a scenic point of view, the radio telescope will be a rather disturbing element; on the other hand we should not forget that the presence of the installation is a much better guarantee for the preservation of the nature reserve in its present state than anything we could obtain until now.<sup>68</sup>

Here, we see a very strong new argument in favour of the construction of the telescope: the telescope would be one of the best guarantees for the preservation of the nature reserve. Indeed,

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<sup>65</sup> '(...) het behoud van merkwaardige deelen van den Nederlandschen bodem, merkwaardige in Nederland levende dieren, planten en levensgemeenschappen, alsmede belangrijke overblijfselen van voorhistorische menschelijke werkzaamheid, welke door uitbreiding der cultuur of andere oorzaken dreigen verloren te gaan (...)'

<sup>66</sup> Oort to the executive committee of the Society for the Preservation of Nature Monuments, 29 September 1953, SA, NWO. (The society report itself of 24 August 1953 could not be found.)

<sup>67</sup> Radiospiegel opent grootse perspectieven voor Dwingeloo, in: *Friese Koerier*, 31-8-1953.

<sup>68</sup> 'Plaatsing van een radiotelescoop (...) wordt langs de Noordrand van de Kraloërheide (...) gunstig geacht. Landschappelijk bezien zal de radio-telescoop een enigszins storend element opleveren; daarnaast dient niet uit het oog te worden verloren, dat de aanwezigheid van deze installatie een veel betere waarborg biedt dan tot dus verre kon worden verkregen voor de handhaving van het natuurgebied in de huidige vorm.' The executive committee of Drenthe to the Government Service for the National Plan, 3 June 1953, SA, NWO.

because of the necessity of a large interference-free zone, the nature reserve had to be kept in its original state.

The Department of Waterways and Public Works ('Rijkswaterstaat') – responsible for the safe flow of traffic and the national water system – was rather neutral. As the department was aware of the objections against a location in Dwingeloo, it proposed the Wadden Islands, in the north of the country, as an alternative. This suggestion was communicated again to the Government Service for the National Plan, which in turn communicated it to the astronomers. The astronomers, however, rejected this, mainly because of the problem of corrosion.<sup>69</sup>

The Government Service for the National Plan ('Rijksdienst voor het Nationale Plan') – to whom the executive council of Drenthe and the Department of Waterways and Public Works communicated their advices - was responsible for environmental planning. It had an advisory function towards the government. It was founded in May 1941 as a service of the Ministry of Internal Affairs. In 1945, it came under the administration of the Ministry of Public Works and Reconstruction, from 1947 onwards called the Ministry of Reconstruction and Public Housing. The service had an important say in the administration of nature reserves. In 1942, it started to list the recognised nature reserves. Since 1950 this list had evolved into a national plan for nature protection and outdoor recreation. The service often used the list to oppose 'undesirable' planning developments, initiated by local governments, companies and private persons (Blom, Jansen and Van der Heide, 2004, p. 7). This, however, did not mean that this service was per se hostile towards industrial, scientific or other initiatives. On the contrary, it had to reconcile the different interests in the first place.

After the Government Service for the National Plan had consulted several parties involved (the astronomers, the executive councils of Friesland and Drenthe and the Society for the Preservation of Nature Monuments) and after it had listened to the Department of Waterways and Public Works and the advice of several independent engineers, the standing committee ('vaste commissie') of the service advised the Minister of Reconstruction and Public Housing that 'it had found no reason to suggest to you a proposal to object to the work in question'<sup>70</sup>. It further explained why the telescope had to be built in the Netherlands, preferably in Dwingeloo:

One should set great store by the scientific importance of the construction of this installation in the Netherlands, also with regard to the preservation of the leading position of our nation in this field. (...) Although the damage to the (...) nature reserve is to be regretted, at the same time the preservation of this area in its present state is rather advanced than endangered by the presence of this installation and the associated requirements for quiet in the surrounding area.<sup>71</sup>

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<sup>69</sup> Minutes of the board meeting SRZM of 24 July 1953, SA; Government Service for the National Plan to the Minister of Reconstruction and Public Housing, 28 July 1953, SA, NWO.

<sup>70</sup> 'geen aanleiding wordt gevonden U een voorstel tot het maken van bezwaar tegen het onderhavige werk in overweging te geven.' Government Service for the National Plan to the Minister of Reconstruction and Public Housing, 28 July 1953, SA, NWO.

<sup>71</sup> 'Het wetenschappelijk belang van de stichting der onderhavige installatie in Nederland moet zeer hoog worden gewaardeerd, mede in verband met behoud van de voorsprong van ons land op dit gebied (...). Hoewel de schade voor (...) het natuurgebied uiteraard moet worden betreurd, wordt overigens handhaving van dit gebied in zijn huidige staat door de aanwezigheid van de installatie en de daaraan verbonden eisen

On 5 August 1953, the Minister of Reconstruction and Public Housing in turn communicated to the Minister of Education, Arts, and Sciences that – following the advice of the Government Service for the National Plan – he had no objections against the construction of the radio telescope in Dwingeloo. The latter communicated this decision to Bannier, the director of ZWO, who in turn communicated this decision to the astronomers. The fact that the government was on the side of the astronomers, meant that they were now completely ‘free’ to choose this location.<sup>72</sup>

Some other meetings followed with the Forestry Commission - which did not object to the arrival of the telescope -, the Ministry of Agriculture and Fisheries – which had to give formal permission to build the telescope on the grounds of the Forestry Commission -, the Ministry of Education, Arts, and Sciences, and the Society for the Preservation of Nature Monuments. It was ‘generally agreed’ that Dwingeloo was the best place to build the telescope.<sup>73</sup>

On a meeting on 24 November 1953, SRZM engineer B. G. Hooghoudt (see below), together with the Society for the Preservation of Nature Monuments, the Forestry Commission and the Provincial Planological Service of the province of Drenthe agreed about the precise location of the telescope. It had to be in the most western part of the area, as this was the furthest away from roads.<sup>74</sup>

From the fall of 1953 onwards, the Forestry Commission let the astronomers use the grounds.<sup>75</sup> But a formal agreement still had to be concluded. The Forestry Commission proposed to give the land on a long lease for an annual amount of Dfl 893.<sup>76</sup> Bannier, however, tried to get the most out of the deal and asked the Ministry of Education, Arts and Sciences whether it would be possible to give the land for free. His reasoning was that SRZM was entirely dependent on the state through ZWO.<sup>77</sup> This Ministry forwarded the question to the Minister of Agriculture and Fisheries.<sup>78</sup>

It was a nice try, but unfortunately for the astronomers, the Ministry of Agriculture and Fisheries did not agree to give the land for free, because:

By doing that [giving the land for free] we would create a precedent for many other useful projects. Moreover, the expenses of the aforementioned Foundation [SRZM] are covered by a subsidy of the Dutch Organisation for Pure Scientific Research and as a matter of fact, the free provision of land would be a second subsidy at the expense of the Forestry Commission.<sup>79</sup>

Then Bannier tried something else: he asked the Minister of Education, Arts and Sciences whether he could urge the Minister of Agriculture and Fisheries to lower the lease amount. However, the

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voor de rust in het omliggende terrein eerder bevorderd dan in gevaar gebracht.’ Government Service for the National Plan to the Minister of Reconstruction and Public Housing, 28 July 1953, SA, NWO.

<sup>72</sup> Bannier to Cramer, commissioner of the Queen in the province of Drenthe, 21 September 1953, SA, NWO.

<sup>73</sup> Minutes of the board meeting of SRZM of 27 October 1953, SA.

<sup>74</sup> Minutes of the board meeting of SRZM of 22 December 1953, SA.

<sup>75</sup> Minutes of the board meeting of SRZM of 27 October 1953, SA.

<sup>76</sup> The inspector of the Forestry Commission to Hooghoudt, 21 June 1954, SA, NWO.

<sup>77</sup> Bannier to the Minister of Education, Arts and Sciences, 20 August 1954, SA, NWO.

<sup>78</sup> The Minister of Education, Arts and Sciences to the Minister of Agriculture and Fisheries, 22 September 1954, SA, NWO.

<sup>79</sup> The Minister of Agriculture and Fisheries to the Minister of Education, Arts and Sciences, 2 November 1954, SA, NWO.

Minister of Education wrote that he could not possibly do that, as the lease amount of Dfl 893 was already very low.<sup>80</sup> Eventually, Bannier and the astronomers agreed to the situation.

It is striking that the Society for the Preservation of Nature Monuments continued to raise problems even after the astronomers had formally acquired the land on long lease. As late as 1958, two years after the inauguration of the telescope, the society continued to ask the astronomers to make the presence of the radio telescope less visible in the landscape. In their board meeting of 18 June 1958, for example, the astronomers discussed a proposal of the society 'to paint the telescope green'. This, however, was impossible, as the colour green absorbs warmth, which would make the temperature in the observation room rise too much.<sup>81</sup> Four months later, the society asked *again* – this seems to have been the last time – that the telescope would be masked as much as possible. Muller wrote back that 'this matter has our full attention'<sup>82</sup>, but nothing was ever undertaken in this respect.

That there was a lot of opposition against the construction of the telescope had to do with several factors. Some people (especially farmers), for example, saw their jobs threatened. But from our point of view, the opposition illustrates in the first place that radio astronomy was still a very young field that was not yet accepted by the general public. As will be seen in Chapter IV, it was completely different in the late 1960s when the radio telescope in Westerbork was built.

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## 2.7 POPULARISATION AND RELATIONS WITH THE PRESS

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In the early post-war period, science popularisation in the Netherlands was still at a low ebb, compared to, for example, the USA, Britain and France. In the 1950s, Dutch science was still in its 'ivory tower' to a large extent. In the middle of this decade, however, academics started to worry about the lack of social esteem of science. (Dalderup, 2000, p.172). Indeed, in the Netherlands as in the rest of the world, critical voices were raised about the moral status of some kinds of scientific research. Sometimes, these critical voices came from *within* the scientific community itself. A well-known example was the foundation of the Pugwash-movement ('Pugwash Conferences on Science and World Affairs') in 1957 as a consequence of the release of the Einstein-Russell Manifesto on 9 July 1955. This manifesto called for a conference to assess the dangers of weapons of mass destruction. The first conference was held in July 1957 in Pugwash, a small village in Nova Scotia (Canada) and was attended by twenty-two scientists from ten countries (Rabinowitch, 1958). Besides the concern about weapons of mass destruction (which were only nuclear weapons at that time), there was also a growing concern about the consequences for the environment of the large-scale application of new technologies in the late 1950s (Dalderup, 2000, p. 171).

It was in this context that, in 1957, in the Netherlands an interuniversity committee (the 'Bender Committee') called for 'a systematic promotion of good relations with those groups in society on which the university is dependent on to a certain extent, and gaining trust'<sup>83</sup> (Dalderup, 2000, p.172). In practice, this led to the appointment of the first university science information officers

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<sup>80</sup> Woltjer of the Ministry of Education, Arts and Sciences to Bannier, 2 February 1955, SA, NWO.

<sup>81</sup> Minutes of the board meeting of SRZM of 18 June 1958, SA.

<sup>82</sup> Minutes of the board meeting of SRZM of 21 October 1958, SA.

<sup>83</sup> 'het op systematische wijze bevorderen van goede betrekkingen met die groepen in de maatschappij waarvan de universiteit in zekere mate afhankelijk is, en het winnen van vertrouwen.'

(‘wetenschapsvoorlichters’), who were to inform the public about the research that was going on. It is noteworthy that, at that time, the initiatives concerning ‘science and the public’ were explicitly directed at the *appreciation* of science: there was a strong belief that if people understood science, they would appreciate it. This was not only the case in the Netherlands. The American professor of science communication Bruce Lewenstein, for example, showed that in the USA, in the period 1945-1960, the term ‘public understanding of science’ became equated with ‘public appreciation of the benefits that science provides to society’ (Lewenstein, 1992).

As will be illustrated in Chapter III, the Netherlands were not only late with coordinated initiatives for science popularisation. In comparison with other countries, they were late with a science policy in general. This was very different from for example Belgium, where there was already a very well-developed science policy in the 1950s (with special councils, (inter)ministerial committees etc.). This difference between the two countries created tensions in the radio astronomical cooperation that was set up for several years. In the Netherlands, it was not until the late 1960s that the first initiatives for a Dutch science policy were taken (Dalderup, 2000, p. 173).

This lack of a national Dutch effort for science popularisation was in sharp contrast with the efforts the Dutch astronomers *themselves* made to inform the public about their research. As a matter of fact, Dutch astronomers had already been great popularisers since the days of the nineteenth-century Leiden astronomer Frederik Kaiser. Nowadays, Kaiser is especially remembered for his foundation of a new observatory in Leiden in 1860, but beside that, he was also a famous populariser of astronomy. In 2011, a special issue of the journal *Studium* was dedicated to Frederik Kaiser on the occasion of the restoration of his observatory. In several contributions, Kaiser’s efforts to bring astronomy closer to the public through the writing of popular astronomical works were highlighted. Kaiser’s popular writings can be roughly divided into three categories: publications in general cultural or popular scientific journals, translations and adaptations of other – mostly German – books, and of course his own popular books and leaflets (Van Lunteren, 2011, p. 30). The number of popular works Kaiser wrote was enormous. To give an example, in the first eight years after his appointment as director of Leiden Observatory in 1837, he completed no less than 50 (!) publications (Zuidervaart, 2011, p. 17).

One of the reasons why Kaiser undertook this effort was – as he said himself – the following: by means of enhancing the population’s knowledge about astronomy, he wanted to create social support for astronomy – a discipline that was rather neglected in the Netherlands (Van Lunteren, 2011, p. 40). Without doubt, he succeeded in this aim. Because of his stream of popularising books and articles, Kaiser himself created ample social support for his observatory. In the Dutch newspaper *Handelsblad* of 10 February 1851, a review appeared of Kaiser’s book *On the history of the discovery of the planets* (‘De geschiedenis der ontdekking van planeten’). This review was accompanied by an – anonymous – call on ‘the rich people in Amsterdam, Rotterdam, Middelburg and elsewhere’<sup>84</sup> (Zuidervaart, 2011, p. 19) to bring together about Dfl 10 000 for the foundation of a new observatory, equipped with new instruments. This initiative was the beginning of a series of actions that finally led to the foundation of the observatory (Zuidervaart, 2011, p. 19).

And the Dutch astronomers maintained their reputation as famous popularisers. Marcel Minnaert, for example, published many popular works in astronomy and physics – for example his three-volume work *De natuurkunde van ‘t vrije veld* (‘The physics of the open air’)- and he also actively

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<sup>84</sup> ‘de veelvermogenden in Amsterdam, Rotterdam, Middelburg en elders’.

supported several popularisation initiatives. In these efforts, he continually emphasised that popular publications had to be *high quality* publications, preferably written by *professional* astronomers. This is proven e.g. by his work for the foundation for amateur astronomers MACRO ('Meervoudig Centrum Ruimtewaarnemingen en Onderzoek'), which issued a monthly journal with the same name. Minnaert was often asked to review the articles before publication. He was often very critical in his comments. An illustrative example is the following. At the beginning of 1969, the director of MACRO had received two contributions – one about the Sun and one about cosmic radiation – from a Belgian amateur astronomer, a certain G. Janssens, which he sent to Minnaert for revision.<sup>85</sup> Minnaert discouraged publication, as the articles were 'superficial and poorly written with several flaws'<sup>86</sup>. And he continued:

It is clear that you have a serious shortage of collaborators that are real astronomers. A man who has a small telescope and who has read a few popular books is not yet capable of writing a decent article on astronomy.<sup>87</sup>

As a result, Janssens's articles were not published.

Minnaert also tried to pass his ideas on science popularisation on to his students. De Jager is a famous example. He was very active in the Dutch Association for Meteorology and Astronomy (see above) – an amateur association – of which he was also president for a while. Minnaert's biographer Leo Molenaar said: 'His students propagated the values of his 'school': they (...) invariably strove for the popularisation of astronomy and physics in society.'<sup>88</sup> (Molenaar, 2003, pp. 403-404).

Minnaert's efforts for science popularisation seem to have been a very memorable aspect of his versatile career. Following Minnaert's death, the Dutch journalist Gerton van Wageningen published two articles in the newspapers *Nieuw Utrechts Dagblad* and *Het Parool* on 28 October, 1970 entitled: *Professor Minnaert: fighter for the popularisation of astronomy* ('Prof Minnaert: strijder voor popularisering sterrenkunde').

Another aspect of the popularisation of astronomy was the relation with the press. Around 1950, when the astronomers tried to get a ZWO grant for the large radio telescope, strict guidelines were developed for dealing with the press. This was especially pressing after a small incident had taken place in January 1950. In one way or another, rumours about the plans for the large radio telescope had come to the ears of journalist Idenburg, working for the Dutch newspaper *Het Vrije Volk*. Idenburg had asked Bannier for some information about the possible grant for this project. Next, he made a phone call to Minnaert, after which he visited the radio telescope in Kootwijk behind the astronomers' backs. Finally, a meeting took place at Utrecht Observatory with Idenburg, Minnaert and Houtgast. Minnaert insisted that Idenburg should hold up publication at least until the next board meeting of SRZM on 17 January 1950. Idenburg did so. It even seems that in the

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<sup>85</sup> The director of MACRO, A.C. Sabelis, to Minnaert, 8 February 1969, MA, 838, Box 8, Folder 1.

<sup>86</sup> Minnaert to Sabelis, 13 February 1969, MA, 838, Box 8, Folder 1.

<sup>87</sup> 'Het is wel duidelijk dat U groot gebrek heeft aan medewerkers die echt sterrekundigen zijn. Een man die over een klein kijkertje beschikt en een paar populaire boeken gelezen heeft, is nog niet in staat een behoorlijk artikel over de sterrenkunde te schrijven.' Minnaert to Sabelis, 13 February 1969, MA, 838, Box 8, Folder 1.

<sup>88</sup> 'Zijn leerlingen droegen de normen en warden van zijn 'school' uit: ze (...) zetten zich steevast in voor de popularisering van de sterrenkunde en de natuurwetenschap in de samenleving.'

end, he never published this article, as we could not find it in *Het Vrije Volk* of early 1950. Nevertheless, at the meeting of 17 January, the matter was thoroughly discussed. Minnaert insisted that clear guidelines should be developed for dealing with the press. He thought that the very first radio astronomical results that were obtained with the radio telescope in Kootwijk should not be made public yet, as research was still in an embryonic stage. When the results appeared in the newspapers, there was a reasonable chance that their importance would be overemphasised. People might then get the impression that the astronomers were trying to 'force' a grant from ZWO. Only when the astronomers judged it the right time for publication should a press release be given to the press agency ANP ('Algemeen Nederlands Persbureau'). Minnaert's point of view got the support of De Voogt and Van der Wijck of the PTT and Veldkamp of the KNMI, who were strongly opposed to the appearance of 'uncontrolled messages' in the media. At the same time, it was said that it was impossible – and also undesirable – to prevent publication in general. Therefore, it was concluded that from then on each newspaper article about the Dutch radio astronomical research should be censored *before* publication.<sup>89</sup>

Nevertheless, these guidelines for dealing with the press were often re-negotiated. It even seems that after they were made, they were easily forgotten. Indeed, at the board meeting of 23 October 1950, we read: 'Following the visit of a reporter to the Observatory of Utrecht (...) it is desirable to develop guidelines concerning the provision of information to the press.'<sup>90</sup> Then, a rather halfhearted decision was taken: in the future, the astronomers would only generally inform ANP. This meant that individual journalists could be sent away. However, each board member of SRZM was free to follow this guideline or not.

At the beginning of 1953 when construction of the large radio telescope came closer, it was decided that no press release should be sent to ANP until there was enough information available about the construction, the price, the location etc. A premature press release had to be avoided, as this could give way to all kinds of rumour and speculation.<sup>91</sup> It was not until in March 1954 that the press release was issued. At the board meeting of 16 March, it was decided this should be done after the delivery contract of Werkspoor had arrived.<sup>92</sup> As we mentioned before, this happened on 18 March 1954. So a press release to ANP was issued a few days later. Subsequently, an article appeared in *Het Vrije Volk* on 25 March, in which we read:

Werkspoor in Amsterdam is going to construct a new radio telescope with the enormous diameter of 25 metres. The installation, which will be completed in 1955, will be located on a moorland in the municipality of Dwingelo<sup>93</sup>. The order for the construction of this apparatus, which is going to cost Dfl 700 000, is given by the board of the foundation "Radio Radiation of the Sun and the Milky Way". The radio telescope consists of a parabolic reflector with a diameter of 25 metres. For the coating, wire mesh is going to be used, which in the wavelength range of 10-100 cm reflects equally well as the mirrors that are

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<sup>89</sup> Minutes of the board meeting of SRZM of 17 January 1950, SA.

<sup>90</sup> 'Naar aanleiding van het bezoek van een verslaggever aan de Utrechtse Sterrenwacht (...) is het gewenst richtlijnen vast te stellen betreffende voorlichting aan de pers.' Minutes of the board meeting of SRZM of 23 October 1950, SA.

<sup>91</sup> Minutes of the board meeting of SRZM of 16 January 1953, SA.

<sup>92</sup> Minutes of the board meeting of SRZM of 16 March 1954, SA.

<sup>93</sup> At the time, 'Dwingeloo' was sometimes written as 'Dwingelo'.

used for optical waves.<sup>94</sup>

The reference to a price tag of Dfl 700 000 is somewhat surprising, as in the delivery contract of Werkspoor (see above) an amount of only Dfl 490 810 was mentioned, which would nevertheless increase by Dfl 15 000. It remains unclear whether the astronomers themselves mentioned this much higher amount – and if so, *why* they did that – or whether this was done by the press agency or the newspaper. (In any case, no reaction from the side of the astronomers followed about a ‘mistake’ in the article.)

The attitude of the Dutch astronomers towards the media can be summarised in one word: *paternalistic*. The above makes it clear that the astronomers wanted full control about what information was made public at what time. By doing this, they obviously thought the general public would take a positive attitude towards the project. This was not exceptional. As said before, it was a feature of the *Zeitgeist* that it was believed that ‘public understanding of science’ would automatically lead to ‘public appreciation of science’. However, the astronomers were far from succeeding in controlling the media. The articles that appeared based on press releases that were issued by the astronomers themselves were generally low-impact articles. The aforementioned article in *Het Vrije Volk* of 25 March 1954, for example, was a short article, with merely some superficial factual information that appeared on page seven of the newspaper. A quick search in the Dutch National Library’s database of historical newspapers<sup>95</sup> indicated that there was no other newspaper either that reported this information (or at least: none of the newspapers that is included in the database). This was in sharp contrast with e.g. the articles that appeared in August–September 1953, after the city council of Dwingeloo had voted against the construction of the radio telescope. Another quick search in the Dutch National Library’s database of historical newspapers showed that no less than twelve articles covered this event. In the *Friese Koerier* of 31 August 1953, it was even front-page news. So this news was of a much higher impact, notwithstanding the fact that these articles appeared without the astronomers even knowing about it.

Besides informing the newspaper media about their project, the astronomers also did something else to inform the general public about the radio telescope: they made a documentary film. In early 1954, the board of SRZM agreed that the making of a documentary film about the construction of the large radio telescope was ‘very worthwhile’.<sup>96</sup> ZWO, Werkspoor and the Leiden amateur film maker Herman Kleibrink - who was employed at Leiden Observatory as observer/photographer - were contacted. Initially, it was decided that the film would be about 20 minutes long. Werkspoor itself possessed filming equipment and was willing to lend it to the astronomers to reduce the costs. The total cost was estimated at Dfl 2000, a budget that was asked from ZWO as an ‘extra subsidy’.<sup>97</sup> Filming began in the summer of 1954.<sup>98</sup> In the spring of 1955, it became clear that a

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<sup>94</sup> ‘Werkspoor te Amsterdam gaat een nieuwe radiotelescoop bouwen met de enorme doorsnee van 25 meter. De installatie, die in 1955 zal worden opgeleverd, wordt geplaatst op een heideterrein in de gemeente Dwingelo. De opdracht voor de vervaardiging van dit apparaat, dat f 700.000 zal kosten, is gegeven door het bestuur van de stichting “Radiostraling van Zon en Melkweg.” De radiotelescoop bestaat uit een parabolische reflector met een doorsnee van 25 meter. Voor de bekleding wordt gaas gebruikt dat voor het golflengtegebied van 10-100 cm, waarmee men gaat werken, evengoed reflecteert als de voor lichtgolven gebezigde spiegels.’ *Het Vrije Volk*, 25 maart 1954.

<sup>95</sup> <http://kranten.kb.nl> (accessed on 22 December 2012).

<sup>96</sup> Minutes of the board meeting of SRZM of 16 March 1954, SA.

<sup>97</sup> Minutes of the board meeting of SRZM of 27 April 1954, SA.

<sup>98</sup> Minutes of the board meeting of SRZM of 9 July 1954, SA.

film of 40 minutes was preferred over one of 20 minutes. This, however, also meant that the cost more than doubled: an additional budget of Dfl 2050 was needed and obtained.<sup>99</sup>

The film was finished in late 1957 and was entitled *De Bouw van een Radiotelescoop* (The Construction of a Radio Telescope). Today, one can still watch it on the website of ASTRON.<sup>100</sup> It explains *why* the telescope had to be built, *how* it was built, and what kind of research could be done with it.

The film was regularly shown in secondary schools, companies, community colleges etc.<sup>101</sup> The press was very enthusiastic about it. A journalist of the Dutch newspaper *De Tijd* even called it ‘the first popular-scientific film about astronomy that has been made in the Netherlands’.<sup>102</sup> It is not certain whether this film was really ‘the first’ Dutch popular-scientific film about astronomy, but in any case – like all kinds of science popularisation - in the late 1950s popular-scientific films and television programmes were indeed still scarce in the Netherlands. This situation would remain the same for decades. To give an example: in 1978-1979, out of a total of 3000 hours of broadcasting on Dutch television, only 10 (!) were dedicated to science programs. In Belgium, this was 110 hours out of a total of 2800 broadcasting hours in the same period (Dalderup, 2000, p. 175).

In hindsight, it is very hard to say whether, and if so, to which extent the 1950s attempts of the Dutch astronomers to bring astronomy closer to the ‘general public’ really helped Dutch radio astronomy forward. We do not have examples available where we can clearly pinpoint the effect of popularisation. The counterfactual question on what would have happened if there had been no popularisation, seems also impossible to answer. What we know for sure is that *De Bouw van een Radiotelescoop* did not bring about a more positive attitude of the general public towards the *building* of the telescope, as it was only shown *after* the opening of the telescope. Hence, it had mostly a legitimising function.

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## 2.8 THE FIRST RADIO ASTRONOMICAL RESULTS

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While the radio telescope in Dwingeloo was built, observations in Kootwijk were in full swing and remarkable astronomical results were obtained. From July 1952 to August 1955- the few years of its scientific use – the Kootwijk dish was used almost exclusively for hydrogen-line studies of the Galaxy (Strom and Van Woerden, 2006, p. 7). The first – and maybe also the most remarkable survey – was the one of the spiral structure of the Galaxy. In June 1952, people from SRZM and some Leiden students started the survey. Van de Hulst did the reduction of the data by hand (a very laborious procedure), initially alone, later with the help of two PhD students (Westerhout, 2002, p. 29). A quick analysis of the first results allowed Oort to derive locations of hydrogen

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<sup>99</sup> Minutes of the board meeting of SRZM of 31 May 1955, SA.

<sup>100</sup> <http://www.astron.nl/about-astron/history/footage/historic-footage> (accessed on 26 December 2012).

<sup>101</sup> Wetenschappelijke nieuwsgierigheid verfilmd. Cineast geeft populaire les in sterrenkunde, in: *De Tijd*, 12 April 1958.

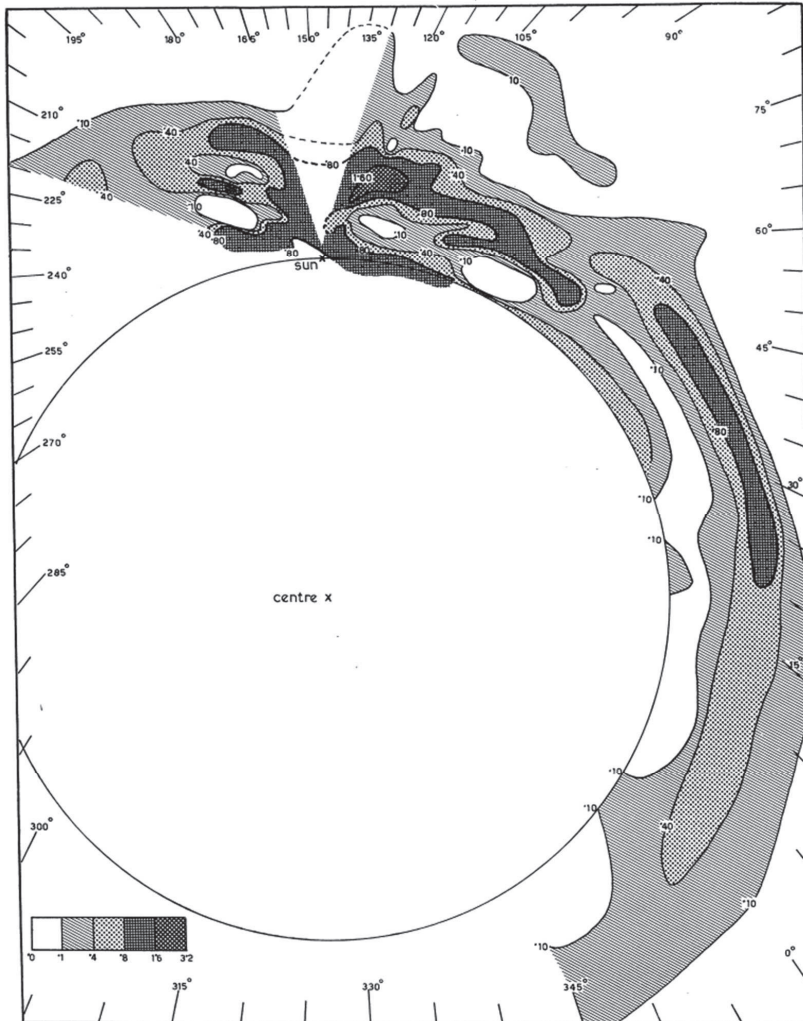
<sup>102</sup> ‘(...) de eerste populair-wetenschappelijke film over sterrenkunde, die ooit in Nederland werd gemaakt.’ Wetenschappelijke nieuwsgierigheid verfilmd. Cineast geeft populaire les in sterrenkunde, in: *De Tijd*, 12 April 1958.

concentrations in the Galactic Plane (the most dense part of the galactic disk). These locations gave him hints of *spiral arms*.

In 1953, Van de Hulst was invited to give the Halley Lecture at Oxford University about this research on the Milky Way. In his talk, he did not hesitate to emphasise how important these results were:

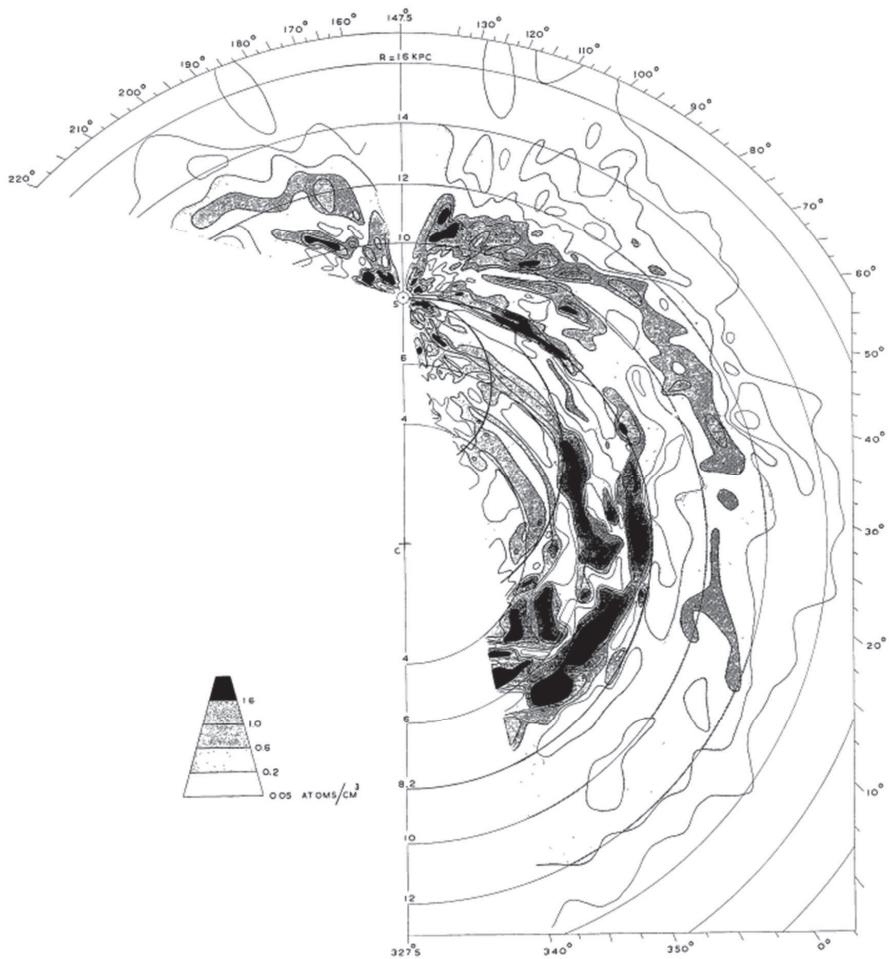
It is not necessary to emphasize the importance of these investigations: they stand out against the hopes and desires of several generations of astronomers. To observe the spiral arms in our own galaxy has been the distant aim of many researches. (Van de Hulst, 1953, p. 138)

The first results of the survey were published by Van de Hulst, Muller and Oort in 1954. It is in this article that the well-known HI (neutral hydrogen) map of the Galaxy, showing the spiral structure, was published for the first time (later, many other versions of this map appeared).



**FIGURE 3. Contour map of hydrogen density in the galactic plane (Van de Hulst, Muller, and Oort, 1954, p. 146)**

The first survey was completed in June 1953. A second one was started in November 1953 and finished in August 1955 and aimed at a three-dimensional mapping of the Milky Way. Reduction of the data was this time mainly done by the PhD student Gart Westerhout. In a 1957 article, Westerhout published the following map of the hydrogen distribution:

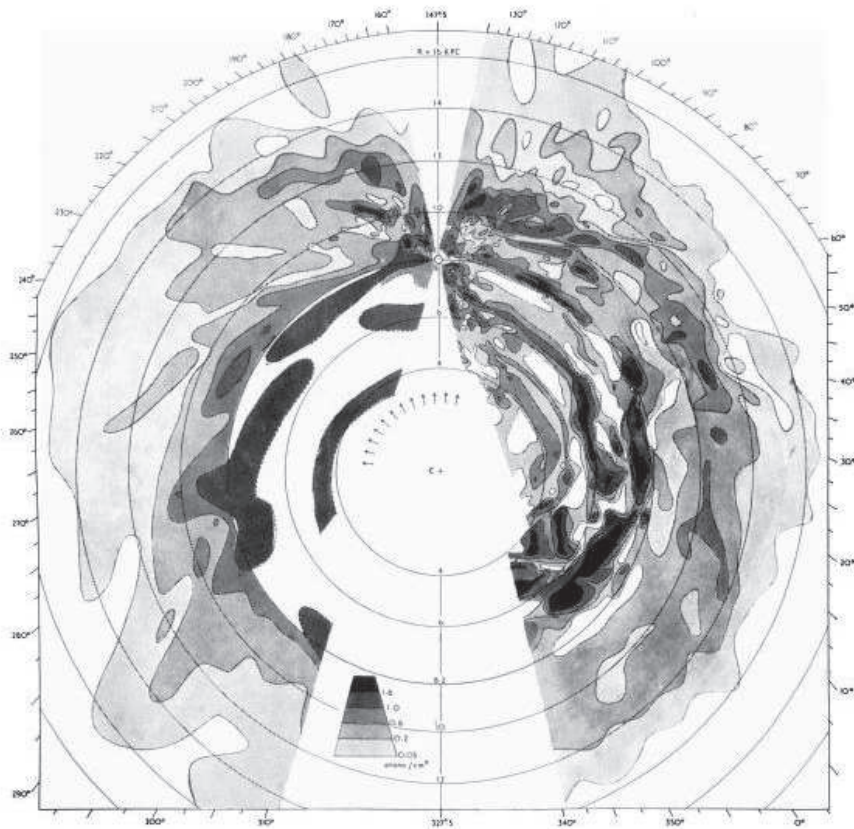


**FIGURE 4. Contours of equal density of neutral hydrogen in the Galactic System (Westerhout, 1957, Plate B)**

As one can see, these maps only cover half of the Galaxy. This is of course due to the fact that from the Netherlands, only the northern part of the Galaxy is visible. Fortunately, in the southern hemisphere some research was going on too. As mentioned in the previous chapter, shortly after the detection of the 21-cm line in the Netherlands, confirmation came from Australia. There too, follow-up research was done. In 1951, a three-month survey was undertaken by Christiansen and Hindman who had also found a hint of a spiral arm by then (see Christiansen and Hindman, 1952).

The search for the 21-cm line was the beginning of an intense cooperation between Dutch and Australian astronomers (see also Chapter IV). There was a regular exchange of data and results between the two groups. The manuscript of the article of Christiansen and Hindman of 1952 was

discussed at the board meeting of SRZM in May 1952.<sup>103</sup> Following this early work, the Australian astronomer F.J. Kerr and collaborators from the CSIRO Division of Radiophysics undertook new surveys of the Southern part of the Galaxy, using an 11-metre reflector at Potts Hill, near Sydney (Strom and Van Woerden, 2006, p. 11) In 1957, Kerr came to Leiden for several months and he and Gart Westerhout joined together their respective maps to derive the first overall look at the hydrogen in the Galaxy. This map became known as the famous 'Leiden-Sydney map of the Milky Way' (Oort, Kerr and Westerhout, 1958) (see also Chapter IV) and shows the spiral structure of the Galaxy in both the northern and southern hemisphere.



**FIGURE 5. Distribution of neutral hydrogen in the Galactic System (Oort, Kerr and Westerhout, 1958, Plate 6)**

Another important aspect of the radio telescope in Kootwijk was its role in the new Galactic Coordinate System. The Dublin General Assembly of the IAU of 1955 appointed a sub-commission to investigate the desirability of a revision of the Galactic Pole and of the zero point of Galactic

<sup>103</sup> Minutes of the board meeting of SRZM of 27 May 1952, SA.

longitude. The sub-commission reported to the Moscow General Assembly in 1958 (Strom and Van Woerden, 2006, p. 12). This Assembly endorsed a resolution which was reproduced in the final report of the Sub-Commission (Blaauw et al., 1960). The main clauses in this resolution were:

- (a) that a standard system of Galactic coordinates be adopted for which the pole is based primarily on the distribution of neutral hydrogen in the inner parts of the Galactic system
- (b) that the zero of longitude be chosen near the longitude of the Galactic nucleus
- (c) that Commission 33b be authorised to define exact values of the coordinates of the Pole and of the zero of longitude immediately after the final reduction of the relevant observations is finished (Blaauw et al., 1960, pp. 127-128)

The final report of the sub-commission contained - besides the coordinating paper of Blaauw et al., 1960 - four other papers (Gum, C.S., Kerr, F.J. and Westerhout, G., 1960; Gum, C.S. and Pawsey, J.L., 1960; Blaauw, 1960; Oort, J.H. and Rougoor, G.W., 1960). From these, it becomes clear that the definition of the Galactic Pole (and hence, of the Galactic Equator) was essentially based on the 21-cm line observations carried out at Kootwijk and Potts Hill (Strom and Van Woerden, 2006, p. 12).

The Würzburg in Kootwijk was not the only one used for radio astronomical research. Since 1952<sup>104</sup>, SRZM had been making plans to get some additional Würzburg dishes from Norway. The plan was to use these dishes for solar research, while the large radio telescope would primarily be used for Galactic research. The dishes arrived in the fall of 1954.<sup>105</sup> In 1955, they were installed in Dwingeloo, one to the east and one to the west of the large radio telescope. As planned, they were mainly used for solar research, as a two-element interferometer, but one of them also as a single dish in early polarisation studies. The fate of these dishes is documented. In 1962, the eastern dish moved to the receiving station NERA in Nederhorst den Berg to strengthen the solar effort there. In 1973, it was returned to Dwingeloo as the PTT receiving station was being wound down. This dish was dismantled in the late 1980s (Strom and Van Woerden, 2006, p. 15). The western dish ended up in the Deutsches Museum in München in 1991.

Despite the pioneering work that had been done with the radio telescope in Kootwijk, nothing is known about its fate after 1955, when observations started with the radio telescope in Dwingeloo. Several authors (e.g. Strom and Van Woerden, 2006; Beekman, 1999) have investigated the mystery of what happened with it.

It is uncertain whether the Kootwijk dish was ever transported to NERA. The PTT archives do not seem to give any clarification on this matter either (Beekman, 1999, p. 157). It is rather improbable that it still exists somewhere. Van Woerden recalls hearing that it might have broken down in 1956. If this is correct, it seems likely that it has been scrapped (Strom and Van Woerden, 2006, p. 15).

On 11 May 2011 the detection of the 21-cm hydrogen line 60 years before, was celebrated. But by then the telescope was no longer there. There did not even remain anything special visible at the 'Turfberg' - the place where the old radio dish once stood - that would remind one of the telescope.

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<sup>104</sup> Minutes of the board meeting of SRZM of 30 June 1952, SA.

<sup>105</sup> Minutes of the board meeting of SRZM of 30 November 1954, SA.

Therefore, on 11 May 2011 an information board was inaugurated at the ‘Turfberg’ to make people aware of the glorious past of this place.<sup>106</sup>



**FIGURE 6. Information board at the ‘Turfberg’ (www.pressart.nl)**

The radio telescope in Kootwijk was only used for a few years. After 1955, observations were carried out with the radio telescope in Dwingeloo. The first scientific programme of the Dwingeloo telescope was a continuum survey at 21.6 cm of which the results were published in 1958 (Westerhout, 1958). The survey contained the positions, sizes, fluxes (i.e. the apparent brightness) and identifications of 82 discrete sources (Westerhout, 1958, pp. 236-239). Later, it would be called the ‘W catalogue’ (Westerhout’s Catalogue) (Strom and Van Woerden, 2007, p. 379).

The first 21-cm line observations were carried out in the fall of 1956. They concentrated on the motion of the gas. This was a follow-up of research that had been done in Kootwijk in 1954, when deviations from circular motion had been found near the Galactic Centre.

Although spectral line work would take the lion’s share of research with the 25-m dish, continuum studies continued to be important throughout its active period (Strom and Van Woerden, 2007, p. 380). Not only were large-scale Galactic HI (i.e. neutral hydrogen) studies carried out, also several investigations of smaller structures were made. For example, the structure and motion of HI in specific regions (e.g. Orion) were mapped, and systematic studies of structure and motions of interstellar HI clouds were carried out. Moreover, studies of HI in external galaxies were performed, first of the Andromeda Galaxy (1957) and later also of other galaxies. Some solar research was carried out, but this was only in the beginning of the 1970s, when a 60-channel spectrograph was built.

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<sup>106</sup> Several videos about the inauguration board can be found on the internet, for example: <http://vimeo.com/23760815> (accessed on 10 March 2013).

After 40 years of performing frontline research, the radio telescope in Dwingeloo was decommissioned in 1999. Maintenance costs had become a problem and it was clear that new research projects could be carried out better by the radio telescope in Westerbork (Strom and Van Woerden, 2007, p. 386). As maintenance was no longer carried out, the instrument started to rust and metal pieces started to fall down. Hence, plans were made to demolish it. However, thanks to the creation of the foundation CAMRAS (C.A. Muller Radio Astronomy Station) in 2007, the future of the telescope looks very different. CAMRAS is an organisation of volunteers that set out the following goals:

- (a) making the radio telescope available for (amateur) astronomers and radio amateurs
- (b) stimulating young people's interest in science and engineering by giving school groups the opportunity to use the telescope
- (c) the conservation of the radio telescope as scientific industrial monument<sup>107</sup>

Since 2009, the radio telescope in Dwingeloo has been a protected monument, thanks to a large extent to the efforts of CAMRAS. Restoration of the dish started at the beginning of June 2012. It was a huge effort to lift the 38 ton dish off its pedestal. All parts were sandblasted and repainted, some parts were replaced. On 19 November 2012, the dish was successfully replaced. The full restoration of the telescope was completed in September 2013.<sup>108</sup>

## 2.9 THE IMPORTANCE OF BEING FIRST: BETWEEN COMPETITION AND COOPERATION

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Sometimes, early radio astronomy is presented as a field characterised by openness, (international) cooperation, interdisciplinarity etc. rather than by competition. Often, these accounts are told by (radio) astronomers themselves. Woody Sullivan, for example, sees the early days of the 21-cm hydrogen line as an example of international cooperation and not as the 'usual kind of race' (Sullivan, 2009, p. 414). But historians also sometimes defend the view that early radio astronomers worldwide constituted an open and cooperative scientific community. For example, in his recent book *A Single Sky* (2013), historian of science David Munns characterises the community of the first radio astronomers primarily as an open and cooperative scientific community. He sees this alleged cooperative spirit also as an important explanatory factor of the success of early radio astronomy. Thus, he writes that 'competition didn't drive the production of scientific knowledge in radio astronomy; sharing of data did' (Munns, 2013, p. 106).

We believe, however, that this kind of characterisation of early radio astronomy is at least partly a myth. It is true that in the radio astronomical community, overlapping research and other overlapping projects were avoided. In the late 1940s, for example, correspondence between Martin Ryle's group at Cambridge and Joe Pawsey from Australia revealed the wish of both groups to avoid overlapping research. On 3 November, Pawsey forwarded a list of his projects to Ratcliffe of Cambridge as a 'means of avoiding possible clashes of interest between our two laboratories' (quoted in Munns, 2013, p. 57). Munns considers this to be a proof of the strong desire of both

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<sup>107</sup> <http://www.camras.nl/> (accessed on 7 October 2013).

<sup>108</sup> Pictures and video's about the restauration can be found on the website of CAMRAS.

groups to forge new community ties (Munns, 2013, p. 57).

However, the strong desire to avoid overlap mostly had merely to do with matters of funding. Indeed, funding organisations were less inclined to provide funding for research that was also done elsewhere or for instruments that had duplicates abroad. When the Dutch planned to build the radio telescope in Dwingeloo, they were anxious to be the first to have such an instrument, as this would facilitate funding. In the summer of 1949, the Dutch construction company Werkspoor had made an estimate of the price tag of the large telescope and thought the construction would cost around Dfl 200 000. This would be about 16% of the entire ZWO-budget for 1950 (which was Dfl 1 410 293: Annual report ZWO, 1950). The board of SRZM realised this was a very large amount of money. Before asking a grant to ZWO, it was considered whether, similar plans existed abroad. If this was the case, it was doubted whether it would be useful to continue, because then the chances to get funding seriously diminished. The Dutch felt threatened by the Americans in the first place. Letters were written to Cornell University and the Bureau of Standards in Washington to find out whether similar plans existed there.<sup>109</sup> Some members, for example Van de Hulst, thought that if America was also preparing the construction of such a telescope, the Dutch plans had to be abolished.<sup>110</sup>

However, the fear for competing American projects proved to be groundless. Soon, an answer came from America that there were no similar projects. In the existing American plans, either the mirrors were smaller or they were fixed (the Dutch one would be fully steerable).<sup>111</sup> But the relief about the non-existence of competing American plans did not last long. A few months later, alarming news arrived from England, when the astronomer Spencer Jones wrote the Dutch that there were plans to build a 250-foot reflector in Manchester, which meant that the Dutch telescope would soon be surpassed by that instrument. Again, the board of SRZM discussed the question whether the Dutch project had not better be given up. In the end, however, it was decided to go ahead.<sup>112</sup> In the grant proposals, not a single mention was ever made about the British competing plans.

This fear of competing projects threatening funding was not groundless. Remember that when an ad hoc advisory committee of ZWO advised positively on the building of the 25-m radio telescope, an important argument was that 'in other countries, there were no plans to build such a 25-m dish and so Dutch radio astronomy would stay at the international top' (see above). In the aftermath of the war, enhancing the national prestige of the country was an important issue. And great importance was attached to being 'the first', 'the best', 'the biggest' etc. in matters of science.

Even when the decision to give the grant for the radio telescope had already been taken, the Dutch feared that similar projects abroad would be completed *before* the Dutch one, because of the huge delays in the construction caused by Werkspoor. In the meeting of September 1954, we read that the board of SRZM 'regrets the delay, especially because of the radio telescope projects elsewhere'.<sup>113</sup>

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<sup>109</sup>Minutes of the board meeting of SRZM of 20 September 1949, SA.

<sup>110</sup> Minutes of the board meeting of SRZM of 20 September 1949, SA.

<sup>111</sup> Minutes of the board meeting of SRZM of 1 November 1949, SA.

<sup>112</sup> Minutes of the board meeting of SRZM of 23 May 1950, SA.

<sup>113</sup> 'betreurt de vertraging, vooral wegens de elders op staple staande projecten voor radiotelescopen'. Minutes of board the meeting of SRZM of 14 September 1954, SA.

This very competitive attitude was not typical for the Dutch, it was a general feature of the community of the first radio astronomers. Maybe the most prominent example of this was the British astronomer Martin Ryle. Ryle is both remembered as a highly talented scientist and as a very difficult person. His temper was well-known. A story that has often been retold is that when Ryle was working at TRE during the war, he once threw an ink-bottle at a senior officer. These kind of intense outbursts seem to have been an on-going feature. As Jane Gregory – reader in science and technology studies at University College London - said:

(...) colleagues have described him as obsessive, fervent, passionate and religious (in the least complementary sense – Ryle was well known to consider himself a Humanist); and he has been credited with both genius and paranoia. According to Gold<sup>114</sup> he was ‘a very egocentric, absolutely unbelievably intense person...he had too much intensity of beliefs that were not compatible with the science.’ (Gregory, 2005, p. 56)

Ryle’s personality became also clear at the OECD *Symposium on Large Antennae for Radioastronomy* that was organised from 12 to 14 December 1961. At this symposium, two possible designs of what would become the radio telescope in Westerbork were discussed (see also Chapter IV). Although the British were by then also preparing an instrument, Ryle did not describe it at the symposium. Later that month, he explained why to Oort:

When I got back to England, I heard that the D.S.I.R.<sup>115</sup> has decided to make us a grant for our new radio telescope and this should be announced within the next few days. I am sorry that the timing of this announcement should have been such that I did not know in time for the Paris meeting. We had some discussions before I left on whether or not I should describe our instrument, but eventually for several reasons, concluded that I should not. This is partly because it was quite uncertain whether we should get support soon, at some time in the future, or whether the application would be turned down indefinitely. In the case of the second possibility it seemed a pity from our point of view because there would be a number of other groups at the conference both in Europe and the U.S.A. who might wish to take up the construction of an instrument of our design before we could, and with the financial state of our country this probably represents the only chance of our being able to build an instrument of large resolving power.<sup>116</sup>

Although Ryle may be a rather atypical example, his behaviour is still illustrative for the competitive environment of early radio astronomy. In Munns’ book, in which Ryle is frequently mentioned, this side of the story is entirely neglected.

Of course, it is absolutely true that the early community of radio astronomers was a very international community. But this was nothing exceptional. (Radio) astronomy is almost by definition an international field: to map the complete sky, observations needed to be done as well in the northern as in the southern hemisphere, which made international cooperation necessary (see the example of the Leiden-Sydney map of the Milky Way); international agreements had to be made on frequency allocations etc. (see also Chapter III). We believe, however, that this strong international cooperation does not imply that there was not much competition, as Munns suggests

<sup>114</sup> The astronomer Thomas Gold (1920-2004).

<sup>115</sup> The Department of Scientific and Industrial Research (DSIR) (founded in 1915/16) was a government organisation - comparable to the Dutch ZWO – for the support of scientific research.

<sup>116</sup> Ryle to Oort, 21 December 1961, OA, 114c.

in his book. On the contrary, international cooperation and competition went hand in hand. In his article on the history of universalism, the Dutch historian of science G. Somsen claimed that in the nineteenth century, the international organisation of science went hand in hand with scientific nationalism. While the new institutions were presented as vehicles for international cooperation, they were also meant to assess and acknowledge scientific accomplishments. After all, national achievements can only be measured by international standards. So Somsen concludes scientific internationalism was not a counterforce to nationalism, but effectively channelled and facilitated it (Somsen, 2008, p. 366). When radio astronomy emerged after the Second World War, the international political context was of course no longer the same as in 1900. However, we think that although ideas of 'nation states' and 'nationalism' were typically nineteenth century ideas that may have faded by the middle of the twentieth century, international cooperation was still a means of furthering the goals of a smaller entity, be it a nation, a research group or an individual. In our story of Dutch radio astronomy, it becomes abundantly clear that Oort furthered his own projects by means of international cooperation.

The community of early radio astronomers did not only cross national boundaries, it also traversed disciplinary boundaries. It was an interdisciplinary scientific community, consisting of radio physicists and optical astronomers, but also engineers and technicians. Like Munns says: 'The radio astronomers emerged when several groups of scientists coalesced around a set of new research tools – highly sensitive radio receivers – which became understood as new astronomical instruments.' (Munns, 2008, p. 54). However, this does not mean that there was no antagonism between the different groups.

The gap between optical astronomers and radio astronomers is dismissed by Munns as a 'foundational myth' that has been told and retold, for example by Woody Sullivan (2009). This myth, based on the recollections of 'those who were there', must be treated with care, says Munns. 'When we rely on archival sources, a very different picture emerges – a picture not of antagonism and competition, but of community with a substantial degree of cooperation and interchange.' (Munns, 2008, p. 81). However, first of all, authors such as Woody Sullivan used a great deal of contemporary sources to illustrate this point – and no 'recollections of those who were there'. As could be read in Chapter I, sources from the late 1940s and the early 1950s already mention the often very difficult relation between optical astronomers and radio astronomers.

When radio astronomy emerged, the new field did not only have to deal with a gap between optical astronomers and radio astronomers, but also with a gap between scientists and engineers. Although engineers made very essential contributions to the field, their visibility remained relatively low compared to that of the astronomers. This brings us to our following section.

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## 2.10 WHAT ABOUT THE ENGINEERS?

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De Voogt, who was an engineer, was crucial for the beginning of Dutch radio astronomy. As mentioned above, early Dutch radio astronomy embarked on an era of success when Muller was hired as the leading engineer of SRZM. And Muller was not the only engineer who was a key person for Dutch radio astronomy. At about the same time as Muller, another engineer was also hired: Ben G. Hooghoudt. Hooghoudt was an engineer from Delft who had joined the PTT. While Muller was specialised in electronics, Hooghoudt was specialised in mechanics and construction, so it was an

ideal situation for SRZM to hire both persons. In October 1950, it was decided that Hooghoudt would remain employed by the PTT, but that he would be seconded to SRZM. SRZM would then pay a part of his salary to the PTT.<sup>117</sup>

Hooghoudt's work for SRZM can hardly be overestimated. He played a crucial role in the construction of the radio telescope in Dwingeloo as well as in the construction of the radio telescope in Westerbork, as will be explained in Chapter IV.

Hooghoudt was not merely a good engineer; he was also the contact person with Werkspoor. In early 1953 he went to Manchester to study the plans for the 'Lovell Telescope' in Jodrell Bank. With what he learned in Jodrell Bank in mind, he discussed the construction of the Dutch telescope with Werkspoor.<sup>118</sup> When Werkspoor had considerably increased the price of the telescope, to Dfl 586 000, it was thanks to a thorough discussion with Hooghoudt that the price was brought down to Dfl 530 000.<sup>119</sup>

Besides being the contact with Werkspoor, Hooghoudt was also the main negotiator in the discussions with the Forestry Commission and the Society for the Preservation of Nature monuments in the search for a suitable location for the telescope.<sup>120</sup>

Although the engineers played a crucial role in Dutch radio astronomy, the radio telescopes in Kootwijk, Dwingeloo and later also in Westerbork are in the first place tied to the name of Oort. Van Delft, for example, presents the construction of the first radio telescopes as an almost exclusive 'Oort matter' (Van Delft, 2008), and historian Van Berkel also sees radio astronomy as a field that was entirely dominated by the person of Oort (Van Berkel, 2000). On the other hand, in historiography several efforts have quite recently been undertaken to emphasise the importance of the role of these engineers. It is the more remarkable that the efforts to lend the engineers more visibility in historiography, are mostly taken not by professional historians, but by radio astronomers themselves, such as Richard Strom and Ernst Raimond. Richard Strom, for example, published an article on De Voogt, whom he calls a 'radio pioneer' who set up the first radio astronomy group in the Netherlands (Strom, 2007). (Indeed, as explained in Chapter I, De Voogt set up a radio astronomy group at the PTT to study how the ionosphere influenced radio propagation and what effect solar activity had on it.) And in his description of the making of the radio telescope in Westerbork, Raimond emphasises the crucial role of the engineers in the development of the different designs of the telescope (Raimond, 1996). Not only in scientific articles, but also in the 2009 film *Spiral Galaxy, the Milky Way unraveled*, the role of engineers and technicians in the history of Dutch astronomy becomes clear. Film maker Maarten Roos – a Dutch astrophysicist by training – stresses the importance of excellent engineers - such as Muller -, in the first place for the development of good receivers. And he even goes further: the story is told by four contemporary protagonists of early postwar Dutch radio astronomy: Blaauw, Van Woerden, De Jager and... technician Arie Hin. By presenting the story this way, Roos explicitly wants to put the technicians on an equal footing with the astronomers.

But when we play the devil's advocate, we can also say that it is not entirely surprising that Oort is often seen as the embodiment of Dutch radio astronomy. In the end, we should not forget that

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<sup>117</sup> Minutes of the board meeting of SRZM of 3 October 1950, SA.

<sup>118</sup> Minutes of the board meeting of SRZM of 3 February 1953, SA.

<sup>119</sup> Minutes of the board meeting of SRZM of 27 October 1953, SA.

<sup>120</sup> Minutes of the board meeting of SRZM of 22 December 1953, SA.

in the Netherlands, the initiative for radio astronomy was taken by astronomers, while in most other countries, it was taken by engineers and physicists with a background in war industry. The latter entails that in radio astronomy it is often hard to privilege the position of scientific motivations and results vis-à-vis technological motivations and results (Sullivan, 2009, p. 450). (Early) radio astronomy was indeed very much instrumentation-driven. As will also be shown in the following chapters, a technical problem early radio astronomers had to deal with, was the *poor angular resolution* of their equipment. This meant that positions in the sky could not be adequately determined. This in turn, influenced the results that could be obtained and – more fundamental – the status of the very field. The British astronomer Scheuer, for example, wrote in his PhD thesis of 1954: ‘Radio astronomy cannot, as yet, claim to be an exact science.’ (Scheuer, 1954, p. iv; also quoted in Sullivan, 2009, p. 450).

In general, it can be said that radio astronomers faced severe technical problems, which they tried to solve as soon as possible to better answer the questions about the radio sky. But sometimes, especially in the first years, this went so far that radio astronomers were in the first place driven by applying – and improving – their instrumentation. As Sullivan says, many of the investigators had the Baconian point of view that one should look up at the sky and see what showed up. As one early radio astronomer told Sullivan in an interview: ‘We felt we were opening up the frontiers of physical knowledge ... [Our work] wasn’t to prove any particular theory or fill in any particular gap in knowledge.’ (S.J. Parsons to Sullivan, 1978; quoted in Sullivan, 2009, p. 450)

The point is now that the situation in the Netherlands was rather different. While in most countries, early radio astronomy was strongly instrumentation-driven, it was strongly science-driven in the Netherlands. There, technology was only a *means* to what was considered the more important *end* of scientific knowledge (Sullivan, 2009, p. 452). Not only was the initiative for radio astronomy in the Netherlands taken by astronomers, the field would be dominated for several decades by the astronomers, by one person in particular: Oort. The engineers were responsible for the instrumentation, for the contacts with construction companies etc. So they were vital to the success of early Dutch radio astronomy. However, the observational programme was developed by Oort and his colleagues. It was the astronomers who decided what would be investigated and the engineers were serving them. So in the end, it is not entirely surprising that the three telescopes – in Kootwijk, Dwingeloo and later Westerbork – are in the first place remembered as ‘Oort’s telescopes’.

The cooperation between the Dutch astronomers and the engineers also seems to have been very good in general. No traces of severe struggles for authority could be found. Everybody seems to have accepted that in the Netherlands, radio astronomy was ‘a matter of astronomers’ in the first place.

The situation in Britain was very different, more specifically in Jodrell Bank. As explained in the previous chapter, the early radio astronomy group in Jodrell Bank was led by B. Lovell, a physicist who had been involved in radar research during the War at TRE. In the post-war decade, Lovell’s group was the world leader in the development of techniques to measure the trajectories and velocities of meteors. Moreover, like the Dutch group, Lovell’s group started the construction of a huge fully steerable radio telescope in the early 1950s. This telescope became operational in August 1957. It had a dish of 76 m and was then the largest telescope in the world. In his book on the history of Jodrell Bank, historian of science Jon Agar pays a great deal of attention to the question of *authority* in the construction of the telescope. He emphasises that Lovell ‘was the

telescope as the telescope was him' (Agar, 1998, p. 133). Lovell's prestige was at the expense of the visibility of the engineer. Charles Husband, a Sheffield engineer, designed this telescope. After a few years, however, a conflict of authority arose between Lovell and Husband. The question was who should be in control of the telescope: the engineer or the astronomer?

The conflict became apparent after the launch of Sputnik. A few months after the radio telescope had become operational the Russians launched Sputnik on 4 October 1957. It was indeed originally intended to use the telescope e.g. on American satellites 'to obtain fundamental data which would be necessary as a first stage in the detection and tracking of enemy long range missiles' (Agar, 1998, p. 75). But the surprise of Sputnik now allowed the potentialities of the instrument to be demonstrated. The radio telescope was funded by the British government (by DSIR, an organisation comparable to ZWO) and by a private foundation: the Nuffield Foundation. As in the end the cost of the telescope was found to be much higher than originally planned, additional funding was needed. But money was not so easy to find. As a consequence, at the moment the telescope was inaugurated, it still had a debt to pay of £ 150 000.<sup>121</sup> It has often been told that the appearance of Sputnik marked a turning point in the telescope's financial history. Lovell himself said about this episode:

The time from the autumn of 1952, when work began on the foundations (...), to October 1957 when we first used the telescope, was a period of immense anxiety exacerbated by the political and financial problems which (...) nearly destroyed Jodrell Bank as a research establishment. Nevertheless, the success of the telescope in detecting by radar the carrier rocket of the first Russian Sputnik in October 1957 (...), and the few years afterwards when it became a part of the American deep space network, created the conditions which enabled us to overcome those problems. We survived, and the instrument has now for over a quarter of a century been in continuous use. (Lovell, 1984, p. 209)

Jon Agar, on the other hand, shows that the appearance of Sputnik was neither decisive in the additional government funding of Jodrell Bank, nor in persuading the industry to donate to the telescope. The industrial partners that donated to the telescope were often persuaded – often by Lovell himself – by entirely other arguments than satellite tracking (Agar, 1998, pp. 77-81).

The role of Sputnik in obtaining additional funding is in itself of minor interest for our story. What is important, on the other hand, is that the above shows that the history of the radio telescope in Jodrell Bank is very different from the history of the Dutch radio telescope. In Dwingeloo, the radio telescope was exclusively used for 'pure' astronomical research. The research programme was developed by university-based astronomers and all the funding came from the government. In Jodrell Bank, on the other hand, the situation was mixed. The initiative for the telescope was taken by a university-based scientist, Lovell, but the research programme was only partly an academic one. A part of the observation time was reserved for satellite tracking. Moreover, funding did not come only from the government, but also from industrial partners and private foundations. And it was exactly in this non-academic part of the programme that the tensions between Lovell and Husband became apparent. The day after the launch of Sputnik, Kington (of Husband & Co) had offered to 'come forthwith to Jodrell Bank in order to carry out any movements [Lovell] might require on the 250ft telescope to track the Russian satellite' (Agar, 1998, p. 119). But Lovell refused.

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<sup>121</sup> Jodrell Bank Radio Telescope Appeal, in : *Nature*, 182 (1958), p. 1484.

Husband was very disappointed. He interpreted the refusal as Lovell being in doubt whether the telescope could already be relied upon to perform. But the reality was different. In a letter of 10 October 1957 to Mansfield Cooper, Vice-Chancellor of Manchester University, Lovell wrote that it was 'an unusual and most undesirable state of affairs that a consulting engineer should attempt to dictate the research policy of a University department about whose functions he knows extremely little' (quoted in Agar, 1998, p. 120). This answer clearly illustrates that Lovell's hesitation had in the first place to do with 'ownership' of the telescope. Secondly, as Agar points out, in Lovell's explanation there was the assertion of his authority and responsibility for policy, which included the separation of the 'scientific' from other activities. And it was clear that Lovell esteemed 'academic' work much higher than satellite tracking. As he continued in his letter to the Vice-Chancellor: 'the primary function of this instrument is to explore the remote parts of the universe, ... plans for using it on satellite work have a relatively low priority' (quoted in Agar, 1998, p. 121).

The tension between Lovell and Husband can, according to Agar, be related to the scale and complexity of research that the telescope represented (Agar, 1998, p. 141). We think Agar is absolutely right in this. Moreover, Agar's thesis can also be used to explain why these kinds of tensions were non-existent in the Netherlands. There, the research was of a purely academic character. In no way was the telescope ever used for satellite tracking or other defence-related purposes. Nevertheless, this matter had occasionally been discussed since the late 1950s. In 1959, when preparations were made for the 'cross antenna', the question arose whether the Dutch astronomers should (occasionally) participate in other than purely astronomical activities with this radio telescope. In June 1959, the Dutch Minister of Foreign Affairs, Joseph Luns, wrote to Oort that, as the cross antenna would be very expensive, it was worth considering asking financial support from NASA (National Aeronautics and Space Administration). However, this support would not be unconditional:

The condition for this support will without doubt be that the telescope makes a contribution to the activities of NASA. In the strict sense, this could be done by means of the tracking of satellites, which is also done by the English telescope in Jodrell Bank. In the broader sense [it could be done] by the participation in the pure astronomical research which is undertaken by NASA too.<sup>122</sup>

However, the astronomers did not accept this offer.

The next year, an analogous matter was discussed during a board meeting of SRZM. Van de Hulst had asked whether in 1961, the radio telescope in Dwingeloo could be used for satellite tracking for NASA during about a month. However, the reactions from the board were not positive, as it was doubted whether this could be brought in line with the other activities of SRZM.<sup>123</sup> In the end no satellite tracking was done, neither with the radio telescope in Dwingeloo, nor with the one in Westerbork.

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<sup>122</sup> 'Voorwaarde voor deze steun zal ongetwijfeld zijn, dat de telescoop een bijdrage levert in de activiteit van de NASA. In engere zin zou dit kunnen geschieden door het traceren van satellieten, zoals ook wordt gedaan door de Engelse telescoop te Jodrell Bank. In ruimere zin door de deelneming aan het zuiver astronomisch onderzoek dat ook door de NASA wordt verricht.' J.C. Kruisheer voor Luns aan Oort, 16 June 1959, SA, NWO.

<sup>123</sup> Minutes of the board meeting of SRZM of 4 October 1960, SA.

The fact that in the Netherlands the research programme was purely astronomical made the role of the engineer there very clear and straightforward. Indeed, there was no way that the engineer could have a say in this, as this fell outside his domain.

In historiography, it is sometimes said that the public effacement of the engineer – and the simultaneous prominence given to the scientist – is a typically European matter. As Peter Galison said:

(...) American physicists had an entirely different relation to engineers than did their European counterparts. In particular, the Americans considered the joint physics-engineering projects of accelerator building to be a worthy collaborative endeavor. (...) European physicists (...) tended to segregate engineering tasks from physics concerns, and the physicists in the early years tended to shun the “dirty” details of engineering. (Galison, 1992, p. 5)

However, a comment should be made on this quote. It is true that in America, university physics departments undertook much more efforts to engage in research with industrial companies, engineers etc. but these co-operations often entailed a lot of tensions. Often, there were concerns over the *control* of the research, as Galison himself, Hevly and Lowen demonstrate in their contribution on physics research at Stanford (1992). Galison also mentions the American industrial company Du Pont as an example in favour of his thesis. But according to us, Du Pont is a good example to illustrate exactly the contrary. First of all, the history of Du Pont itself illustrates the often difficult relation between industrial and academic scientists. Moreover, the relations between Du Pont and external partners also illustrate the tensions between scientists and engineers.

Du Pont was founded in 1802 by a French immigrant: Eleuthère Irénée du Pont de Nemours. A century later, in 1902, the company founded its first formal research and development laboratory. Since then, the firm has been among a handful of USA corporations pursuing industrial research and development on a consistently large scale (Hounshell, 1992, p. 236). Du Pont developed a wide range of chemical products: paints, plastics, explosives, cellophane etc. These products possessed a common scientific basis. Charles Stine, the head of Du Pont’s central research organisation, thought that the company could benefit if this scientific basis was better understood. Therefore, ‘fundamental’ research had to be done by the central research unit, which would then fulfil its logical role as the central laboratory in the diversified chemical company, Stine reasoned. So in the early 1920s, Stine tried to attract some researchers of ‘higher caliber’. This, however, was not as easy as he initially thought. Several scientists declined his offer, as they were suspicious of industrial chemistry.

Finally, Stine succeeded in composing a fundamental research group consisting of about eight recently minted PhD’s and headed by Harvard chemist Wallace H. Carothers. For several years, this group massively documented the nature of polymers and polymerisation, supporting the theories proposed by the German chemist Hermann Staudinger (Hounshell, 1992, p. 239). However, this ‘academic research era’ of Du Pont was short-lived. In 1930, it came to an end. This had to do with two things: the fact that Carothers and his group quite unexpectedly discovered neoprene synthetic rubber and the first wholly synthetic fibre, and the fact that Stine was then succeeded by Bolton, a hard-nosed industrial research director who wanted *products* from Stine’s programme. Both developments led the group into the direction of applied research that had to investigate how

these products could be turned into valuable commercial goods (Hounshell, 1992, pp. 239-240).

So this episode illustrates that academic research in an industrial company is not always so obvious. The other problem – the tension between scientists and engineers – becomes clear in the episode of the Manhattan Project, in which Du Pont was an important partner. In September 1942, Leslie Groves became the leader of the new Manhattan Project and was thus charged with the construction of industrial-size plants for the manufacturing of uranium and plutonium. The next month, Groves asked some representatives of Du Pont whether the company could assume the sole responsibility for the design, the construction and the operation of the plutonium production complex. Du Pont, however, wanted some more information before accepting the offer. Consequently, Groves arranged for eight Du Pont representatives to go to the University of Chicago to evaluate its Metallurgical Laboratory's research. In this laboratory, the research to develop an atomic bomb was done.

In December 1942 Du Pont agreed to do the job for the Manhattan Project. To this end, it created a special division, called TNX, within its Explosives Department. (Hounshell, 1992, pp. 245-247). However, almost immediately a conflict erupted between the scientists at Chicago and the Du Pont Company. The Metallurgical Laboratory physicists feared that they would be controlled by an industrial organisation. When Greenewalt, head of the research section of TNX, visited Chicago, he remarked that people there held 'peculiar ideas as to the difference between 'scientific' and 'industrial' research.' (Hounshell, 1992, p. 248) Greenewalt argued that this difference was rather semantic than real and he tried to convince the Chicago physicists of Du Pont's abilities and sincere motives.

According to Hounshell, this conflict illustrates the unequal relation between physicists and engineers: 'Physicists (...) failed to appreciate the extent of the engineering problems surrounding the project and generally underestimated the importance of engineering. Here was a classic case of "science" versus "engineering"' (Hounshell, 1992, p. 250)

Hence, we can conclude that the relation between scientists and engineers in the USA seemed to be pretty much the same as in Europe. Both in the USA and in Europe, there were tensions caused by the struggle for authority and the different interests of both groups. In Dutch radio astronomy, however, the subordinate role of the engineers was clear from the start, which made this relation between scientists and engineers much easier.

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## 2.11 BEYOND AMERICAN HEGEMONY

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As a final topic of importance in this chapter, we will position early Dutch radio astronomy in a Cold War world that was dominated by the USA.

As radio astronomy arose during the Second World War and came to full bloom the first decades after the war, the field is a nice example of science in the Cold War.

However, the history of radio astronomy does not fit into the general historiography of science during the Cold War. A feature of this historiography is the continuing emphasis on America's dominance and leadership. But in early radio astronomy, the United States was definitely *not* the leader. It was even seriously lagging behind Europe and Australia. Although in recent years, there

has been a renewed attention for the history of science in the Cold War, the general picture of American dominance is hardly ever challenged. In 2006 for example, historian of science John Krige published his famous book *American Hegemony and the Postwar Reconstruction of Science in Europe*. Krige analyses how the US rebuilt European science after the Second World War. He explains that by stimulating European science, the USA was able to establish and to maintain its world leadership. So Krige shows that America needed Europe to establish its own dominant position. Yet, America's world leadership itself is not questioned. He writes:

The immense scientific and technological achievements in the United States during the war and the ongoing support for research in the country after 1945 contrasted sharply with the situation in postwar Europe. There, laboratories were ill-equipped, destroyed, pillaged (...); researchers were poor, cold, hungry, and demoralized; and national governments had far more pressing concerns than scientific (and technological) reconstruction. (Krige, 2006, pp. 1-2)

So Krige contrasts the post-war leading position of the USA with the poor situation in Europe. We believe, however, that this statement is somewhat exaggerated. It is not true that national governments had far more pressing concerns than scientific reconstruction. As has already been explained, for several European governments, including the Dutch government, scientific reconstruction was a key factor in the rebuilding of the country after the war. Even though the Dutch country was impoverished because of the war, large budgets were made available for science.

Krige's book was the inspiration for the journal for the history of science *Centaurus* to publish a Spotlight with the title 'Post—WW2 transatlantic science policies' in 2010, as mentioned in the introduction. The articles in this volume do not consider the world during the Cold War as a (merely) bipolar world, but rather as a multipolar world. Transnational science policy played a major role in the (re)positioning of regions, countries, institutions and individuals in a multipolar world that was characterised by competition for economic resources, political leadership and military strength (Abir-Am, 2010, p. 273). However, despite this very promising introduction, none of the articles really questions America's hegemony.

In the same year 2010, the journal *Isis* published a focus issue with the promising title: 'New perspectives on science and the Cold War'. In their introduction, Hunter Heyck and David Kaiser write:

(...) recent work on science during the Cold War has defined both science and the Cold War more broadly than did earlier studies, which tended to focus on the physical sciences in America. Given this focus, the central story in earlier works usually revolved around the rise of Big Science and the military-industrial-academic complex in the United States (...). Recent work, however, is much more international and multidisciplinary in perspective (...). (Heyck and Kaiser, 2010, p. 363).

And a few pages later, one can read:

Cold War shaped science in profound ways, but there was no single, monolithic Cold War Science. (...) Rather, science during the Cold War took many forms in many places, with science-state relationships varying markedly from nation to nation, agency to agency, institute to institute, and individual to individual. (Heyck and Kaiser, 2010, p. 366)

So the aim of this *Isis* focus is to give a much more varied picture of science in the Cold War.

However, this introduction leaves us with an uneasy feeling. First of all, it is not entirely true that older historiography on the Cold War usually focusses on the physical sciences in America and that this historiography was monolithic. As early as the 1960s, quite a lot has been written on developments in Russia for example. An influential author in this respect is the American historian of science Loren Graham (e.g. Graham, 1973, 1978). A lot of attention has also been paid to the fact that in the USA, there was no consensus at all on post-war (international) science policy. See for example the work of the American historian of science Ronald E. Doel (e.g. Doel, 1992). Moreover, despite its very promising title, the *Isis* issue does not come up with really *new* insights in science and the Cold War. Again, America's hegemony is not questioned.

Although it is absolutely fair to say that in strategic fields like (nuclear) physics and the geophysical sciences the USA was the world leader, there were some other – maybe less strategic – fields in which the USA was lagging behind. Radio astronomy was such a field (see also DeVorkin, 2000, p. 58). In radio astronomy, developments in Britain, Australia and the Netherlands were far ahead. A comparison between the situation in the Netherlands and the situation in the USA may enable us to lay bare the structural and incidental factors which caused the USA to be seriously behind in radio astronomy for at least the first fifteen years after the war. The comparison also shows why the Dutch group was so successful.

First, it has been explained that during the early years of radio astronomy, optical astronomers were indifferent and sometimes even hostile towards radio astronomers. This became already apparent when Reber had to face the skepticism of the astronomical community when he wanted to get an article published in the *Astrophysical Journal*. The problem between optical astronomers and radio astronomers, however, was not a problem that existed only in the USA. In the USA, however, this problem was reinforced by the fact that by the 1940s, American astronomy dominated the world in large optical telescopes, which were controlled by less than a half-dozen institutions, such as the Yerkes-McDonald Observatories, Mount-Wilson-Palomar Observatories and the Lick Observatory. Very influential scientific work had been done with these telescopes. In the early 1920s, for example, Edwin Hubble concluded from his observations at Mount Wilson Observatory that entire galaxies existed outside of our own. Therefore it is not surprising that in the USA there was a strong conviction amongst astronomers that the future of observational astronomy lay in larger and better optical telescopes (Lovell, 1977, p. 152; DeVorkin, 2000).

An illustrative example in this respect is Owens Valley Radio Observatory (OVRO) at Caltech, a major player in early radio astronomy in the USA. In 1948, Greenstein was called to Caltech to build an astronomy department in the Division of Physics, Mathematics and Astronomy, an offer he could not refuse. Long before 1948, Greenstein had been convinced by the work of Jansky and Reber and later by British and Australian radio astronomical work, that radio astronomy was of vast importance to the field of astronomy (Gunn, 2003). But radio astronomical developments in the USA at that time were far behind developments in other countries. When in a 1982 interview Greenstein was asked whether he had the feeling the USA was behind other countries, he answered: 'Oh yes. We were non-existent.' (Greenstein, 1983, p. 18)

In January 1954, a conference was organised in Washington to discuss the status of radio astronomy in the USA. Greenstein was its secretary. According to Greenstein, the reason for organising the conference was the following:

It was organised largely because of Lee DuBridge [president of Caltech]. Walter Baade, Rudolph Minkowski, and I had been yelling that radio astronomy observation was essential for optical astronomy, because the interpretation of extragalactic radio sources based on the identification by Baade and Minkowski had shown that we were finding more exciting galaxies, for example, by radio means than by others. (...) Well, I wanted radio astronomy at Caltech. It couldn't be under the Mount Wilson and Palomar Observatories, since it's too radically a different technique. DuBridge needed a little convincing; he worried whether radio astronomy would run out of problems in five years and we would be stuck with a dead-end science. So it was quite reasonable to have a conference (Greenstein, 1983, p. 18-19).

At the conference, several ideas were expressed, amongst others the founding of a national radio astronomy observatory (which would be established in 1956, see below).

It was not only difficult to get institutional acceptance for the founding of a radio observatory at Caltech, there was also a matter of getting funding. After some difficulties, federal funding was obtained from the Office of Naval research. (It is important to note that astronomy in the USA had until then almost exclusively been privately funded and the Caltech radio astronomy observatory was amongst the first departures from this norm.) (Gunn, 2003) Owens Valley Radio Astronomy Observatory was finally created in the late fifties. As the leading radio astronomers at that moment were to be found in Britain and Australia, Greenstein 'imported' several British and Australian radio astronomers (Greenstein, 1983, p. 18). An important person was the British-Australian John Bolton, who played a key role in the setup of the group. He was soon followed by his close colleague Gordon Stanley.

The first telescope at OVRO was a prototype 32-foot telescope built by Bolton and Stanley at Palomar. It was moved to OVRO in 1958. The main scientific motivation for the radio telescope was to obtain accurate position information on radio sources to better correlate them with high-resolution optical images obtained with the Palomar observatory. In the late 1950s, construction began on the first interferometer at OVRO. It became operational in 1959 – 1960. At that time, the OVRO telescopes were the most sensitive in its existence.<sup>124</sup>

Besides illustrating the gap between optical astronomers and radio astronomers, Reber's career was also illustrative for a second element early American radio astronomers had to deal with: military patronage. There were several radio astronomical initiatives in the USA after the war, but because of the military patronage, these were guided into specific directions. During the Second World War, funding Reber's work was completely out of the question. Nevertheless, he produced several radio intensity maps of our Galaxy. The post-war attempts of Grote Reber to get funding are illustrative of the science policy of the American government. The National Bureau of Standards (a USA government agency that developed economic and scientific standards) was interested in the radio research of Grote Reber. This was because NBS had many programmes studying radio propagation through the ionosphere, and solar observations could allow improved predictions of ionospheric conditions. This was important from a military point of view: solar radio bursts affected the ionosphere, which affected communications, which affected military operations. With modest equipment, Reber did a lot of solar monitoring for NBS during 1947 and 1948, but he found the work very dull and all his plans to build new equipment and to do

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<sup>124</sup> <http://www.ovro.caltech.edu/> (accessed on 3 August 2014).

measurements at new wavelengths that could be of interest for astronomy were swept aside. Reber became tired of this government work and left to spend the rest of his life as an independent astronomer, working on telescopes in Hawaii and Tasmania (Sullivan, 2009, p. 72).

In his 1987 article *Behind quantum electronics*, Paul Forman stated that the exponential growth of military funding of science after the Second World War thoroughly influenced scientific research, especially in physics. Although Forman's picturing of the physicists as victims who lost control of their discipline - without even being aware of that - may be a bit one-sided, the case of radio astronomy indicates that the influence of military patronage was indeed non-negligible.

There were several radio astronomical initiatives in the USA after the war, but because of the military patronage, these were often guided into very specific directions. In fact, it was exactly because radio astronomical research was often confined to subjects and wavelengths that were interesting from a military point of view, that from an astronomical point of view this research was lagging behind European research; military patronage was beneficial for some research subjects, but detrimental for others (DeVorkin, 2000).

In many countries, and also in the USA, several persons who took the initiative for radio astronomy held academic positions at physics departments before the war. During the war, they had been working in the war industry and after the war many of them went back to their physics departments. There, some of these physicists established radio astronomy groups, for example in Britain and also to a certain extent in France and Belgium. They had both the freedom and the support to use their newly acquired technical skills to pursue some scientific problems, which were suggested by unexpected discoveries they had made during their wartime research. In the USA, this was less common. The reason is that the American government heavily supported nuclear physics and related fields in physics departments.

So government patronage led some people away from radio research and the people who did stay in it performed this research mainly in practically-minded electrical engineering departments, such as those at Stanford and Cornell Universities, or mission laboratories, such as the US Naval Research Lab (NRL) and the National Bureau of Standards (NBS). Researchers there went after the large contracts available for research related to military communications and radar needs, and these, it turned out, were seldom ideal for obtaining by-products of use to radio astronomy. The Stanford meteor-radar group, for example, did its astronomy as a small part of an overall research program in ionospheric propagation and communications technologies. By the mid-1950s they and others had developed the transient meteor trails into a new means of communications. At a 1948 meeting of the National Academy of Sciences, they emphasised that meteor data said something about temperatures, pressures, and winds in the ionosphere, which was important to... national defence. A concurrent *New York Times* article (16 November 1948) headlined *Meteors 'clocked' as aid in defense*. When this meteor research is compared with meteor research at Jodrell Bank, it becomes clear that there it was more directed towards astronomical problems. There, questions such as 'Did any of the meteors originate from outside the solar system?' were asked (Sullivan, 2009, p. 444).

In practice, militarily useful radio research was generally done at shorter wavelengths (less than 30 cm), a technical direction that was less successful in producing first-class astronomical research. Ever since the 1930s radar development had tended toward shorter operating

wavelengths that allowed superior detection and location of targets at greater distances (Sullivan, 2009, p. 447).

Last but not least, differences in approach between individuals and resulting tensions, together with a huge bureaucracy caused serious delays in the founding of a national facility for radio astronomy in the United States. Let us explain.

In the early 1950s, the idea of a federally funded national observatory for USA radio astronomy attracted widening support (Gordon, 2005, p.1). In May 1954 the National Science Foundation (NSF) established a Panel on Radio Astronomy, consisting of prominent astronomers and physicists for advice on how best to promote the emerging science of radio astronomy. By this time, the gap between radio astronomers and optical astronomers had sufficiently narrowed to have both groups in this committee. The chair of this committee was the geophysicist Merle Tuve, Director of the Carnegie Institution of Washington's Department of Terrestrial Magnetism.

Amongst the members of this NSF panel, there was wide disagreement on how this national radio observatory should operate. Astronomer Donald Menzel (Director of Harvard College Observatory), for example, thought it was a good idea to organise American radio astronomy in a way like Brookhaven National Laboratory (BNL) – this was a high-energy physics laboratory in Long Island (New York). He got the support of the physicist Lloyd Berkner, the president of the university consortium Associated Universities Incorporated (AUI), a science management corporation founded shortly after the war. AUI managed BNL. Berkner started to promote the idea rather aggressively. The geophysicist Merle Tuve – chair of the committee - on the other hand, had a completely different opinion. He thought research flourished best not in big-science settings, but in small settings like university departments. Therefore Tuve tried to block the plans for this observatory. The disagreement between Berkner and Tuve stemmed in fact from larger conceptions of the role of science during the Cold War. The rather conservative Tuve thought that federal funding for the basic sciences undermined science as the focus shifted towards larger and larger projects. Berkner on the other hand became increasingly convinced that science should act to serve the state and be fully supported by governments (Munns, 2003, p. 99). The disagreement between Berkner and Tuve would result in a serious clash.

But also amongst the other members of the NSF Panel on Radio Astronomy, there was wide disagreement on several topics (Munns, 2003, p. 103), for example:

- *Who* can be called a radio astronomer? (Does he or she have to be trained as an astronomer, an engineer, a physicist or as something else?)
- Are there *enough* (radio) astronomers to fill the national facility?
- Should funding not be given to universities for the training of radio astronomers and the expansion of staff at universities in the first place instead of to a large radio astronomy facility?
- Would the expansion of radio astronomical facilities not be at the expense of university-based projects?
- Etc.

All these disagreements seriously delayed things. The huge bureaucracy only made this worse. Several organisations, several (sub)committees and many people were involved. In the end, Berkner's ideas prevailed. The NRAO was formally established on the 17<sup>th</sup> of November 1956. In August 1958, the construction of a radio telescope of 140 ft (43 metres) in Green Bank (West-

Virginia) began. It was completed in February 1965. Only then did the USA seriously began to make up its arrears in radio astronomy.

To conclude, we may indicate the following reasons why American radio astronomy was lagging:

- (a) There was a huge gap between (optical) astronomers and radio astronomers, reinforced by the strong tradition of optical astronomy in the USA.
- (b) Military patronage had a huge impact on the research content.
- (c) Clashing visions on the role of science during the Cold War and resulting personal tensions delayed the foundation of a national facility for radio astronomy.
- (d) A huge bureaucracy worsened the delays.

It is clear that in the Netherlands none of these situations occurred. There, radio astronomers and optical astronomers were the very same persons, so there was no antagonism between the two groups. Military funding was non-existent, Dutch radio astronomy was entirely funded by ZWO. The protagonists were also on rather good terms. The field was still so small and ZWO was still in an embryonic state, that things could be arranged very quickly.

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## 2.12 CONCLUSION

Despite all the hard work and good intentions, early Dutch radio astronomical observations were not very successful. A major problem was that good engineers were hard to find. In late 1948, engineer Hoo was hired. But he was a man whose competence was very soon doubted. When in 1949, the plan for the large radio telescope was presented to ZWO for the first time, it was not approved. The main reason was that the usefulness of this instrument was unclear. Indeed, even in Kootwijk no significant observations had been made yet, so why should another (very expensive) instrument be built? Fortunately, with the hiring of Muller and the visit of Van de Hulst to Harvard College Observatory – where the latter heard of the principle of the ‘Dicke switch’, things proceeded quickly: in May 1951, the Dutch succeeded in detecting the 21-cm hydrogen line. In August 1951, the definitive plan for the 25-m radio telescope was presented to ZWO. This time, the plan was approved, despite an estimated construction cost of Dfl 436 000. The detection of the hydrogen line was a *direct* event that certainly helped the approval, but there were deeper reasons why ZWO thought this instrument was worth funding: radio astronomy was a field in which the Dutch could play a vital role and the research would have positive effects on related disciplines. Another – merely procedural – reason why the project was easily approved was that the group of people involved was still very small. Hence, people were often judge and party at the same time.

When the decision about the funding of the radio telescope had been taken, the question arose *where* this instrument should be built. Cooperation with the Belgians was considered, the plan was to locate it on the Belgian-Dutch border. But as no suitable sites were found there, other locations were considered. In the end, the ‘Kraloër veld’ near the village of Dwingeloo (Drenthe) was chosen, as this was an interference-free zone in a nature reserve. However, the astronomers had to deal with serious resistance from the village council of Dwingeloo and the Society for the Preservation of Nature Monuments. The latter even persisted in its resistance several years after construction had been completed. Several devastating articles about the radio telescope plans appeared in the press. Fortunately for the astronomers, some parties involved were rather

positive: the trade association of Dwingeloo, the Government Service for the National Plan, and most importantly: the provincial and the national governments. So in the end, permission was given to build the telescope.

We believe, however, that this opposition against the construction of the radio telescope illustrates in the first place that radio astronomy was still a very young field that had not yet won the acceptance of the general public. Nevertheless, the Dutch astronomers made great efforts to bring their activities closer to the general public. In doing that, they followed the popularising tradition that had existed since the days of the 19<sup>th</sup> century Leiden astronomer Frederik Kaiser. Around 1950, when the astronomers tried to get a ZWO grant for the plans for the large radio telescope, strict guidelines were developed for dealing with the press. The attitude of the Dutch astronomers towards the media (especially the written press) was very paternalistic: they wanted full control of what information was made public at what time. They obviously thought that by giving good information, the general public would take a positive attitude towards the project. However, the attempt to control what appeared in the newspapers failed, as said before. Besides giving information to press agencies and newspaper journalists, the Dutch also made a documentary film about the building of the radio telescope, something that was still highly unusual in the Netherlands at the time. Indeed, in the 1950s, Dutch science was still in its 'ivory tower' to a large extent. Science popularisation in the Netherlands was still at a low ebb, compared to what was going on in, for example, the USA, Britain, France and Belgium. As a matter of fact, the efforts the Dutch astronomers undertook to inform the public about their research were in sharp contrast with the lack of popularisation efforts that were undertaken on a national scale.

Whether all these efforts of Dutch astronomers to bring radio astronomy closer to the general public really helped Dutch radio astronomy forward, is hard to say. There are no examples available where the effect of this popularisation can clearly be pinpointed.

Seen from an international perspective, early radio astronomy is sometimes presented as a field characterised by openness, (international) cooperation, interdisciplinarity etc. rather than by competition. We believe, however, that this view needs to be qualified. Early radio astronomy has been shown to be a very competitive field. On the other hand, there is not necessarily a contradiction between cooperation and competition, and this applies to radio astronomy, where international cooperation was often a means to strengthen the position of a (national) research group or an individual. Concerning the Dutch, it is abundantly clear that Oort furthered his own projects – and hence strengthened his competitive position – by means of international cooperation.

The community of early radio astronomers did not only traverse national boundaries, it also traversed disciplinary boundaries. Engineers also made vital contributions to the field. Nevertheless, most telescope projects were mainly presented as an 'astronomers' matter' and the contributions of the engineers were often overlooked. Dutch radio astronomy would never have been so successful if engineers such as Muller and Hooghoudt had not been there. Nevertheless, Kootwijk, Dwingeloo and later also Westerbork are in the first place linked to the name of Oort. It is remarkable that the efforts to give the engineers more visibility in historiography are mostly made not by professional historians, but by radio astronomers. At the same time, in the case of Dutch radio astronomy this 'public effacement' of the engineer is not too surprising. 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 (for example defence-related) purposes

in which the engineers could have a say. So in the Netherlands, engineers had a subordinate role, although a crucial one. This clear and straightforward role of the engineer had the positive effect that there was no struggle for authority between engineers and astronomers, unlike in other countries. In Jodrell Bank, for example, the relation between astronomers (Lovell in the first place) and the engineers was tense. We believe, however, that this had to do with the mixed character of the research in Jodrell Bank: the telescope was not only used for astronomical purposes, but also for satellite tracking and other defence-related purposes. In these, it was not clear whether the engineer or the astronomer had the dominant position, which in turn entailed a struggle for authority.

It is sometimes said (for example by Galison) that the public effacement of the engineer – and the simultaneous prominence given to the scientist – is typically European. However, several American examples – Du Pont's involvement in the Manhattan Project has been discussed - indicate that the situation in the USA was pretty much the same.

Last but not least, early Dutch radio astronomy is a prime example to moderate the still dominant historiographical picture that America was the world leader in matters of science during the early Cold War. In early radio astronomy, America was definitely lagging behind European and Australian developments. We believe that this was due to several factors: the strong tradition of optical astronomy in the USA; military patronage; clashing visions on the role of science; a huge bureaucracy.