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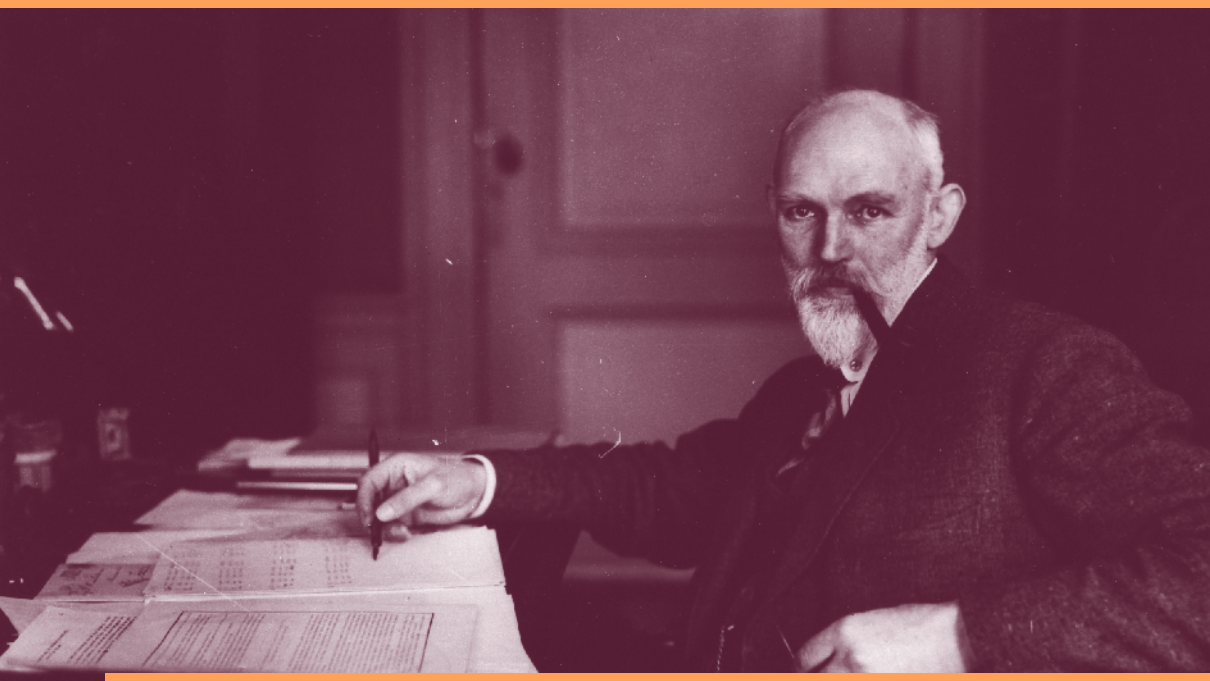

Willem de Sitter

Einstein's Friend and Opponent

JAN GUICHELAAR

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Jan Guichelaar
Amsterdam, The Netherlands

This book draws, in part, on the author's earlier work in Dutch: "De Sitter, Een alternatief voor Einsteins heelalmodel", Veen Magazines, Amsterdam, 2009. [De Sitter, An alternative for Einstein's model of the universe].

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This book is dedicated to my children Jan and Clasina

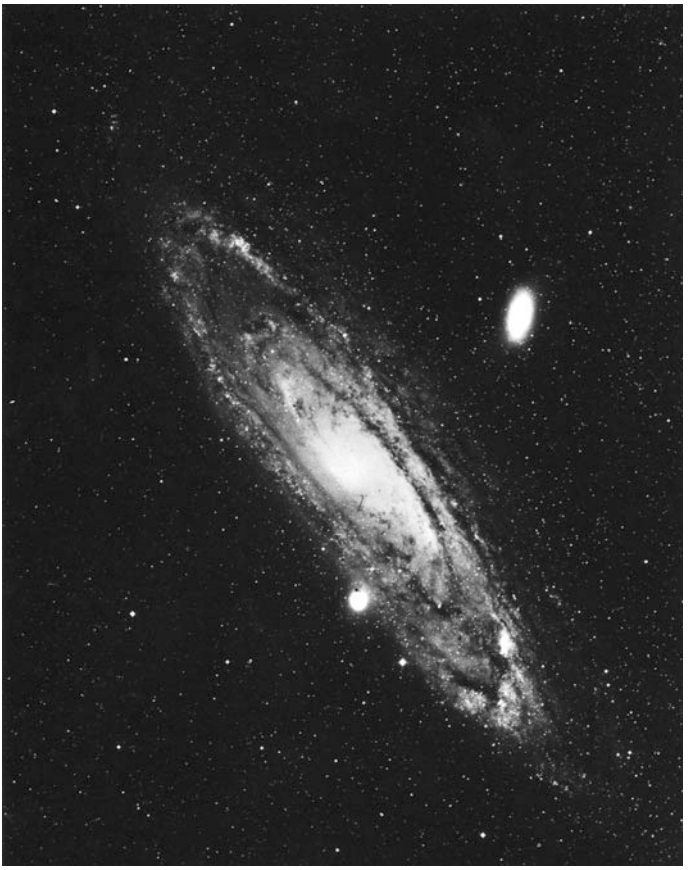
Preface

> *It is a strange chance that, of his most conspicuous contributions, one should relate to the Jovian system—first fruits of the invention of the telescope—and the other to the remotest systems that the telescope has yet revealed.*
>
> Arthur S. Eddington[1]

At the wall in the drawing room of my grandfather's house, next to the primary school where he was headmaster, a famous photograph of the Andromeda Nebula hung in the 1950s. As the son of a barber in a small Frisian village, the only way for the bright young boy to study was to attend a teacher training college, in The Netherlands sometimes called *the university for the poor*. His interests and capacities went further than the primary school teachers' level. In his youth, the universe consisted only of the visible galaxy, in the years that the Milky Way was still visible nearly everywhere in the Netherlands. He explained the Milky Way to me by roughly drawing evenly distributed dots, the *stars*, on two glass saucers. Putting one upside down onto the other, he had made a model of our galaxy. If you looked perpendicular on the saucers, you saw the stars at their normal distances. But if you looked in the plane of the two saucers, you saw the dots seemingly close to one another, forming a *Milky Way*. It was my first insight into cosmology.

In his youth, the complete universe consisted of our own galaxy, nobody supposed anything outside it. But in the 1920s, the first distances to the nebulae were measured and they turned out to be complete galaxies of their own, at extremely large distances. It must have made a great impression on the young teacher. Roughly thirty years later, his interests in astronomy had not abated. One of his daughters presented him with a telescope, which had a maximum magnification of 150. As a delighted young boy he, an older man not long before his retirement, put up his telescope night after night to see the wonders Galileo had seen 350 years

[1] Arthur S. Eddington in his obituary on Willem de Sitter in *Nature* (CXXXIV, December 15, 1934).



The Andromeda Nebula

earlier: the mountains on the Moon, the phases of Venus and the four great moons of Jupiter. Some of these sights I remember when I stayed there during holidays, at the teacher's house in a small village in the eastern part of the province of Groningen, in those days not yet connected to the main water supply, nor the gas and electricity networks. Shortly before his death, he presented the telescope to me. As a theoretical physicist, I was not active as an amateur astronomer and the box with the telescope has been stored in the garage or cellar most of the time. The last time I used the telescope was in June 2017, when friends of mine had taken the telescope to their second home in Liguria in Italy, ten miles north of Ventimiglia. When I visited them a couple of days, we put up the telescope, and on a perfectly clear night, we had a beautiful view of Jupiter and his four Galilean moons, two on either side of the small disc. I dare say that my grandfather played a role in arousing my interest in astronomy.

So it is not surprising that I chose as my topic for a biographical research the life and work of the Dutch astronomer Willem de Sitter (1872–1934), because his work knew two main topics: a new theory for the four Galilean moons of Jupiter on the basis of classical celestial mechanics, and the description of the later called De Sitter Universe on the basis of Einstein's general theory of relativity.

Explanatory Notes

- The first version of this book was written in the years before 2009. In that year, a shortened version of the current book was published in Dutch: *De Sitter, An alternative for Einstein's model of the universe* (Dutch: *De Sitter, Een alternatief voor Einsteins heelalmodel*); Veen Magazines, Amsterdam, 2009. The present biography is an extended version, including a number of new aspects. The complete scientific account with all necessary footnotes and literature references, for which there was no place in the Dutch book, is incorporated in the present book.
- In the ongoing texts, the references to letters (mostly from and to De Sitter) and a number of (dated) documents are given between square brackets. If the writer and receiver of the letter(s) are clear from the text, only the abbreviation of the archive—and sometimes a number and code—and the date of the letter are given. If the name is not clear, it is given also between the square brackets.
- A number of drawings were made using the drawing program GeoGebra.
- The photographs are for a large part, with the permission of the Leiden Observatory, taken from the archive of De Sitter in the University Library of Leiden. Another part is taken from several family archives with the permission of the owners. A number of pictures and photographs are from the author's personal archive. There are a number of photographs from other sources, and a few photographs (all more than a century old) were free of rights available in the public domain. The sources are given in the text as completely as possible.

Amsterdam, The Netherlands Jan Guichelaar
2018

Acknowledgements

In the first place, I am indebted to Anne J. Kox, emeritus Pieter Zeeman professor in the history of physics at the University of Amsterdam. In 2006, he mentioned to me the lacuna in the research into the work of Willem de Sitter and gave me advice during my research. For many stimulating discussions, I owe many thanks to Bastiaan Willink, retired sociologist and historian of science, and a close friend since 1951.

Many thanks I owe to a number of family members of Willem de Sitter, who provided me with information. First, W. Reinold de Sitter (who died in 2009), son of Willem de Sitter's son and geologist Lamoraal Ulbo, who told me in a number of conversations frankly and with humour a lot of relevant facts concerning the De Sitter family. Besides, I could use the result of his own work on his grandfather.[2] I am also indebted to Reinold's brother Lamoraal Ulbo and sister Tjada van den Eelaart-de Sitter, to Willem Jan de Sitter, son of Willem de Sitter's son and astronomer Aernout, and to Ernst de Sitter, grandson of Willem de Sitter's brother Ernst Karel Johan. I also wish to express my thanks to other members of the family, who provided me indirectly with useful information.

The original De Sitter Archive was stored in tens of boxes in the cellars of Leiden Observatory, waiting for over seventy years for an inventory to be made. A few times parts of this work were undertaken. De Sitter's correspondence with Einstein was traced and published. In 2008–2009, historian of science David Baneke made the complete inventory and now the archives are kept in the Leiden University Library.[3] I am indebted to Baneke for his support in finding relevant data in these archives. As a general reference to Dutch astronomy in the twentieth

[2]Reinold de Sitter wrote *Grandfather, a charcoal sketch* (privately published, present in the De Sitter Archive at the Library of Leiden University).

[3]The De Sitter archives are, also digitalized, present in the Leiden University Library, Special Collections, as *Leiden Observatory Archives, directorate W. de Sitter* (Collection guide written by David Baneke, 2010).

century, Baneke's book *De Ontdekkers van de Hemel* (*The Discoverers of the Heavens*) gives ample information.[4]

Adriaan Blaauw (1914–2010, till his death the nestor of Dutch astronomy) provided me in a number of conversations with information, in particular concerning life at Leiden Observatory in the thirties of the twentieth century. Blaauw started his studies in astronomy after a conversation in 1932 with De Sitter, at the end of which De Sitter nodded positively to the young Blaauw, who decided then to choose for Leiden and not Amsterdam. Blaauw is the only person I know who could recollect a conversation with De Sitter (*with his sloppy jacquet over his thin shoulders*).[5] In retrospect, I owe a lot to Blaauw.

For the analysis of De Sitter's contribution to the relativity theory, the Collected Papers of Albert Einstein,[6] in particular the work of Michel Janssen[7] therein, and the thesis of Stefan Röhle[8] have been of great importance for me. Röhle's dissertation is a gold mine of personal details, relevant archives and a nearly complete bibliography.

I owe many thanks to a large number of archival workers of Dutch archives:

- De Sitter Archives in Leiden Observatory (later Leiden University Library);
- North Holland Archives[9] (Haarlem);
- University Libraries of Groningen and Amsterdam;
- Archives of the province of Gelderland[10] (Arnhem);
- Regional Archives[11] (Leiden);
- Museum Boerhaave (Leiden);

and of a number of archives outside The Netherlands:

- University Library of Ghent (Belgium);
- Union Internationale Astronomique (International Astronomical Union) in the Institut de France in Paris (France);
- Royal Geographical Society in London (England);
- University Library of Cambridge (England);

[4]Baneke, D., *De Ontdekkers van de Hemel, De Nederlandse Sterrenkunde in de Twintigste Eeuw* (*The Discoverers of the Heavens, The Dutch Astronomy in the Twentieth Century*); Prometheus, Bert Bakker, Amsterdam, 2015.

[5]There are a few moving images of De Sitter, smoking a pipe and reading his post. They are part of an amateur film made in 1933 on the occasion of 300 years Leiden Observatory, now for restoration in the Netherlands Institute for sound and vision in Hilversum (The Netherlands).

[6]In an ongoing research process, the *Collected Papers of Albert Einstein* are being published by Princeton University Press.

[7]The results of Janssen's work on the controversies between Einstein and De Sitter concerning a number of relevant points in Einstein's cosmological ideas are included in Michel Janssen and Christoph Lehner (editors), *The Cambridge Companion to Einstein*, "No success like failure …": Einstein's Quest for General Relativity; Cambridge University Press, 2014.

[8]Stefan Röhle wrote his thesis at the Johannes Gutenberg University in Mainz in 2007: *Willem de Sitter in Leiden—Ein Kapitel in der Rezeptionsgeschichte der Relativitätstheorien*.

[9]Dutch: Noord Hollands Archief.

[10]Dutch: Gelders Archief.

[11]Dutch: Regionaal Archief.

- Huntington Library in Pasadena, Los Angeles (USA);
- Institut for Videnskabsstudier of the University of Århus (Denmark);
- Durham University in Durham (England);
- Council for Scientific and Industrial Research (CSIR) in Pretoria (South Africa).

For information, cooperation and suggestions (in conversations, by telephone, by letter, by e-mail) in support of this research I thank:

- Bertha Clemens Schröner (who died ca. 2010, Oegstgeest, the Netherlands), who for a period lived as a guest in the director's large living quarters in the old Leiden Observatory (then inhabited by Jan Oort, a successor of De Sitter);
- Dirk van Delft, Director of Museum Boerhaave in Leiden;
- Ed van den Heuvel, Professor and Former Director of the Astronomical Institute Anton Pannekoek in Amsterdam;
- Vincent Icke, Professor of theoretical astronomy at Leiden Observatory;
- Annette Joubert of the CSIR in Pretoria (South Africa);
- Jet K. Katgert, Leiden Observatory;
- Helge Kragh, Emeritus Professor of the history of science of Århus University (Denmark);
- Johan van Kuilenburg, Dutch astronomer;
- H. van Loo, Judge at the court of justice in Arnhem;
- Jan Lub, Associate Professor of astronomy at Leiden Observatory;
- Frans van Lunteren, Professor of history of science;
- Geart van der Meer, Frisian poet and translator;
- N. Nelissen, Teacher at the City Grammar School[12] in Arnhem;
- Matteo Realdi, historian of science;
- W. Suermondt, relative of De Sitter's wife, Rotterdam;
- Lambert Swaans, Old Leiden Observatory;
- Brian Warner, Professor at the Department of Astronomy, University of Cape Town (South Africa);
- Henk Venema (who died in 2011) and René Luijpen for carefully reading and improving (parts of) my original Dutch texts;
- In particular, I thank my wife Ria Koene and daughter Clasina Guichelaar, both teachers of English, for their meticulous text corrections, and my son-in-law Henk Schuitemaker for adjusting and improving a number of the photographs.

[12]Dutch: Stedelijk Gymnasium.

Contents

Abbreviations

AG	Astronomische Gesellschaft
AH	Archives of Hertzsprung, History of Science Archives, Center for Science Studies, Aarhus University, Denmark
AIP	Archives of the IAU in the Institut d'Astrophysique de Paris
AL	Archives of Lorentz in the North Holland Archives in Haarlem
AN	Astronomische Nachrichten
AOL	Annals of the Observatory in Leiden (Dutch: Annalen van de Sterrewacht te Leiden)
AP	Annalen der Physik
ASL	Leiden Observatory Archives, directorate W. de Sitter, in the University Library Leiden
AUL	Archives of Leiden University, in the University Library Leiden
BA	British Association for the Advancement of Science
BAN	Bulletin of the Astronomical Institutes of the Netherlands
BG	Board of Governors
CPAE	*Collected Papers of Albert Einstein*, Princeton University Press, since 1987
CPD	Cape Photographic Durchmusterung
DUL	Archives of Durham University Library
hbs	Higher Civilian School (Dutch: Hogere Burgerschool)
HMW	Archives of the Holland Society of Sciences, in the North Holland Archives in Haarlem. (Dutch: Hollandsche Maatschappij der Wetenschappen)
IAU	International Astronomical Union
IRC	International Research Council
IUGG	International Union of Geodesy and Geophysics
MNRAS	Monthly Notices of the Royal Astronomical Society
NAC	Dutch Astronomers Society

NAW1	Archives of the (Royal) Netherlands Academy of Sciences, in the North Holland Archives in Haarlem. (Dutch: (Koninklijke) Nederlandse Akademie van Wetenschappen)
NAW2	Reports and Proceedings of the (Royal) Netherlands Academy of Sciences, in the International Institute of Social History in Amsterdam
PZ	Physikalische Zeitschrift
RAS	Royal Astronomical Society
RGO	Archives of the Royal Greenwich Observatory in the University Library in Cambridge
RGS	Archives of the Royal Geographical Society in London

Chapter 1
Astronomy in Leiden till De Sitter's Arrival

In those days the here performed observations enjoyed, under Kaiser and Bakhuyzen, the well-earned fame of being among the most accurate of all observatories in the world.
Willem de Sitter in a speech on the occasion of the inauguration of the reorganized Observatory in Leiden by his excellency the Minister of Education, Arts and Sciences on 18 September 1924

The First Two Centuries

De Sitter called Jacob Gool in his brochure of 1933, on the occasion of 300 years of Leiden Observatory,[1] the founding father of the Observatory (De Sitter 1933). Jacob Gool, or latinized Golius (1596–1667) studied mathematics in Leiden with Willebrord Snel van Royen, latinized Snellius (1580–1626), who was professor of mathematics at Leiden University and famous for his law on the refraction of light rays. In order to study the works of the Greek mathematician Apollonius in Arabic translations, Gool studied Arabic and became a prominent Arabist as well. In the morning he lectured on mathematics, physics or astronomy and in the afternoon on Arabic language or literature. Descartes became one of his students in mathematics. In 1632 Gool persuaded the University of Leiden to buy the so-called Quadrant of Willem Blaeu (1571–1638; cartographer) from Snellius and to pay for a small wooden structure on the roof of the Academy building to be used as a modest Observatory.

Gool did measurements on comets, eclipses and planets. With the help of a quadrant the angular distance of a celestial body above the horizon or from a certain other direction could be measured. The direction of the celestial body was established by means of a narrow pipe. The angles could be read on a graduated arc.

[1]Dutch: Sterrewacht.

J. Guichelaar, *Willem de Sitter*, Springer Biographies,
https://doi.org/10.1007/978-3-319-98337-0_1

Fig. 1.1 Blaeu's quadrant in Rijksmuseum Boerhaave in Leiden. Photograph taken by the Author

After a renovation and enlargement at the end of the seventeenth century the Observatory stayed unaltered till the beginning of the nineteenth century. By several successive professors of astronomy new instruments were regularly bought. Willem Jacob 's Gravesande (1688–1742) for instance bought a reflecting telescope in 1736, made by one of the first commercial telescope makers George Hearne of London (Zuidervaart 2007). 's Gravesande studied law in Leiden and became a barrister in The Hague. Besides he was a mathematician, physicist and astronomer. He became professor in Leiden in physics and astronomy in 1717, the first professor with an explicit assignment to teach astronomy. He visited Newton in England and propagated his work in The Netherlands. But in those years there was no systematic astronomical research yet. The Observatory was mainly used for educational aims and to impress interested citizens. Plans to build a larger and better Observatory kept on being rejected.

Frederik Kaiser

Not until the nineteenth century a revolutionary change was brought about by the astronomical talent of Frederik Kaiser. Kaiser's father had come from Germany to The Netherlands, where Frederik was born in Amsterdam in 1808. After his father's demise when Frederik was eight his uncle Johan Frederik Keyser took on the care of the young Frederik. The uncle was an enthusiastic amateur astronomer and it was from his uncle that the young Frederik learned the principles of astronomy and the

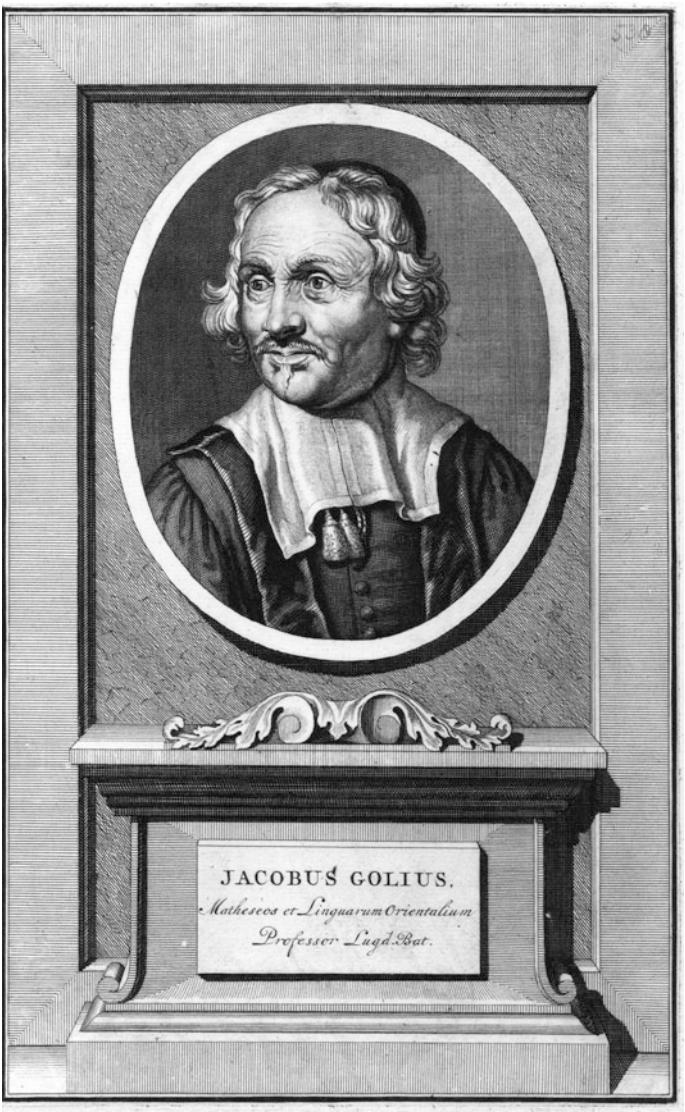


Fig. 1.2 Jacobus Golius, founding father of Leiden Observatory, professor at Leiden University in mathematics and eastern languages. Photograph from the Leiden Observatory Archive

relevant mathematics. When Frederik was only fifteen also his uncle died. The astronomer Gerrit Moll (1785–1838) from the Observatory of Utrecht, who himself had also been taught the principles of astronomy by Frederik's uncle, found the young Kaiser a job in 1826 as an observer at the Leiden Observatory with earnings of 800 Dutch guilders yearly. His appointment had been made without the

Fig. 1.3 Academy building in Leiden with observatory platform. Photograph from the Leiden Observatory Archive

knowledge of the just appointed professor of astronomy Pieter Uylenbroek (1772–1844). This was one of the reasons of their mutual poor relationship.

Kaiser was ambitious, but he lacked a thorough academic education. In his studies he did only reach the so-called first exam (cf. bachelor degree). But in 1835 at last he received recognition as a result of his excellent work on the comet of Halley. He had done his observations from the attic of his house, where he had removed some tiles. His prediction of the orbit and perihelium passing of the comet was much more accurate than those of foreign astronomers. For those results he received a doctorate *honoris causa*. That paved the way for a further career (Zuidervaart 1999). In 1837 he was appointed as lecturer and director of the Observatory. In 1840 his appointment followed as extraordinary professor and in 1845 as ordinary professor. In 1839 he complained heavily about his salary not being raised and he blamed Uylenbroek. He was notoriously complaining about nearly everything. He drastically improved the old Observatory on the roof of the Academy building, but the money for building a new 'proper' Observatory was still lacking. He started a programme of regular observations on double stars, asteroids, and comets. He popularized astronomy in large parts of the population by popular

Fig. 1.4 Frederik Kaiser, father of modern Dutch astronomy and builder of the new Observatory. Photograph from the Leiden Observatory Archive

writings and lectures. In particular his popular book *The Starry Heavens*[2] became a big success, although there is not a single picture in the book. After the successful first edition a second followed soon in 1850. But the developments in the astronomy in those years went so fast that the publisher urged Kaiser to write a completely revised third edition by 1860. He had to do this in between many pressing tasks, of which the preparations for the building of a new Observatory certainly were the most demanding. He complained heavily about this lack of time:

> I was forced to lean on my memory and I have had to experience, how much the mind is numbed by the continuous tribulations of life (Kaiser 1860).

But complaining was his second nature. The book became extremely popular and Kaiser received a lot of fan mail. From Amsterdam he received a poem, in which he was compared to Maarten Luther, who had translated the Holy Scriptures into German for the masses. From this poem (in translation):

> But with a clear voice a well of knowledge
> rises in the people's face, in which flow it's baptized.
> And with the eye directed to the visible infinity
> you open, like Luther did the Word, a different Bible.

[2]Dutch: *De Sterrenhemel*. See Kaiser (1860).

In the meantime, in spite of complete silence to all requests from the side of the government, Kaiser's popularity made it possible that a committee of private persons raised 26,000 Dutch guilders for the building of a new Observatory. By far not enough: the estimate was 112,500 guilders. But at last the train was moving. Even the students raised 800 guilders. It may be clear that Kaiser aimed at a substantial project, in view of the fact that the building of the modest observatory in Utrecht in 1854 had cost 12.583 guilders, one tenth of the estimate for Leiden (De Jager et al. 1993). But it was the appointment of Gerrit Simons to Minister of Internal Affairs (in whose portfolio Education fell) that led to real progress. Simons had been an observer with Moll in Utrecht from 1825 till 1831, where he had studied mathematics and physics (De Jager et al. 1993). Of course he was well disposed towards astronomy and he included the money for the building of the Observatory in his budget for 1857. But his budget was voted down and not much later Simons resigned. His successor ridder (*knight*) Van Rappard was an admirer of Kaiser and had been a member of the fund raising committee. The money was still included in the budget for 1858. In his function as Rector[3] of the University Kaiser used his influence to choose the southern part of the *Hortus Botanicus* (botanical garden) as location for the new Observatory. In his eyes that garden was in a poor condition. That was completely against the wish of professor of botany W. F. R. Suringar (1832–1898), director of the botanical garden. It became an indecorous struggle. In the Student's Almanac of 1857 a cartoon was shown with Kaiser trying to pull the key of the botanical garden out of the hands of the struggling professor Suringar, with a botanical box hanging round his neck (Van Herk et al. 1983). Kaiser won the battle. The Observatory in Pulkovo near St. Petersburg provided a model for the design of the Belgian architect Henri Camp. Camp was also the architect of the physics laboratory in Leiden (now the seat of Leiden Law School), later named after Nobel prize winner H. Kamerlingh Onnes (1853–1926). But Camp did not know much about astronomical requirements and to the great annoyance of Kaiser he went too much his own way. The Observatory was built for 132,000 guilders. For the stability of the new building more than 1500 wooden piles were used, of which more than 100 to provide a vibration-free support for the meridian circle (the most important telescope). In 1860 the new Observatory was opened. Of course Kaiser complained unremittingly with everyone who wanted to listen, and in pathetic language as De Sitter would write later, that the whole building process went too slowly and that he received too little money for staff and research (De Sitter 1923).

The main theme of research Kaiser chose was the fundamental astronomy, so mainly the accurate determination of the location of stars. This line of research had been decided for long before the architectural drawings were made. Fundamental determination of star locations was a field of research with which a smaller Observatory in a small country could also advance the astronomical science. But given that, perfection had to be achieved. The main instrument to reach that was the meridian circle made by Pistor and Martins in Berlin and taken into use in 1861.

[3]In Dutch the term *Rector Magnificus* is used.

Meridian Circle
A meridian circle is a telescope that can only turn in the meridian plane (the plane through the poles and the local zenith; thus north-south). It was primarily used to measure exact time, when a star passed the local meridian. Moreover, the direction of the telescope yielded (with the help of microscopes on the circles attached to the telescope) the latitude of the star (in degrees °, minutes ′ and seconds ″ of arc).

In order to measure the time the greatest accuracy was aimed for. The Hohwü 17 clock of 1860 was, as De Sitter later remarked *exceptionally good, the principle clock of the Observatory* (De Sitter 1933). The clock ran for more than forty years with only a single cleaning. Measuring the time was done electrically with a tapping-key from 1866 onwards. The key had to be tapped at the moment the star passed the crosshair in the field of vision of the meridian circle. This method was an enormous improvement in comparison to the old method, where the point of time of the passage was estimated while listening to the ticking of a clock (the eye and ear method). For Kaiser precision measurements were his first priority. In his eye they were more important than making new discoveries. Better more accurate measurements of the place and orbit of a known planet than discovering a new one. With this attitude Kaiser seems to have influenced many researchers after him: his successors Hendrik and Ernst van de Sande Bakhuyzen and perhaps also the low-temperature physicist Heike Kamerlingh Onnes (1853–1926), who had chosen *Through measuring to knowledge* as his research motto. The two revolutionary new methods of measurement in astronomy developing in those years, photography and spectroscopy, were still in their infancy. For Kaiser that was not enough for a place in his research programme. A broader programme would also have required bigger and much more expensive instruments.

Kaiser transformed the Dutch astronomy, coming from an amateur status, into a professional science, with the marks of a complete institute, the accompanying instruments, staff and a scientific research programme. He became a great scientist, greatly admired by a lot of people. In 1871 he fell ill. He wrote in desperation, slightly confused but typically Kaiser, to bookseller Sulpke:

> The greatest idiocy that ever could have entered my brain was my wish to found a seat of astronomy in Leiden.[4]

He did not recover and died in 1872. Of course a poem was written in his memory, which reads in translation:

[4]Archive of MEOB, Marine Electronic and Optical Company (Dutch: Marine Elektronisch en Optisch Bedrijf); Dutch Institute for Military History (Dutch: Nederlands Instituut voor Militaire Historie), The Hague.

While all men slumber, being awake and on his post,
Observing the horizon in the solemn nightly hour,
Enclosing the shining cupola of Gods immeasurable skies,
With all the teeming armies of the suns,
So, KAISER, did we know you.

He could have lived with it. Due to Kaiser the astronomy in Leiden counted internationally: in 1875, three years after Kaiser's death, the meeting of the important Astronomische Gesellschaft (Astronomical Society) of Germany was held in Leiden.

A Few Observers

A number of observers at Leiden Observatory has had a clear influence on the professional development of the other observatories in The Netherlands.

Utrecht: Jean Abraham Chrétien Oudemans (1827–1906)

As a young student Oudemans attended Kaiser's lectures and took his doctoral degree in 1853 under his guidance. After that he became an observer at Leiden Observatory. In 1856, still before the building of the new Observatory, at the recommendation of Kaiser he left for Utrecht as an extraordinary professor in astronomy. The post did not suit him and then he worked for years in the Dutch East Indies, inter alia on the triangulation of the island of Java. In a triangulation, with the help of triangular measurements and astronomical sightings, a country is mapped exactly. At the succession of Kaiser in 1872 he was passed by Hendrik van de Sande Bakhuyzen. The University of Utrecht asked him to return to his old chair. Thereupon he was director of Utrecht Observatory from 1875 till 1898. He taught a lot and revised Kaiser's *De Sterrenhemel*. In 1874 Oudemans led an expedition to the island of Réunion in the Indian Ocean in order to observe the transit of Venus in front of the sun. The expedition became a failure by too many clouds. During a transit the shadow of Venus is visible on the sun's disc. With these observations the distance from the earth to the sun could be measured. Members of the expedition were also Kaiser's son Pieter and Van de Sande Bakhuyzen's younger brother Ernst. In 1898 Oudemans was succeeded in Utrecht bij Albertus A. Nijland (1868–1936), who stayed director until his death and even played an interesting role in the process of De Sitter's appointment as director of Leiden Observatory in 1918 (De Jager et al. 1993; Pyenson 1989).

Venus Transit
From good observations of a Venus transit (Venus passing between the earth and the sun, creating a dark spot on the sun's disc) the distance from the earth to the sun can be calculated. This procedure was first suggested by Edmund Halley at the Venus transits of 1761 and 1769. The distance of the earth to the

sun was necessary to determine the size of the planetary system. The failure of the expedition in 1874 did not result in a Dutch expedition in 1882. A number of other countries did organize an expedition. Only in 2004 and 2012 there were the next two transits. The transits occur in couples with a time distance of 8 years. And between the couples a period of more than a century.

Groningen: Jacobus Cornelius Kapteyn (1851–1922)

Kapteyn, the later teacher of De Sitter, became an observer in Leiden after his doctorate in 1875, under Kaiser's successor Hendrik van de Sande Bakhuyzen. That was his period of apprenticeship as an experimental astronomer. As a result of the new law of 1876 on higher education in The Netherlands the University of Groningen received a chair for astronomy. Kapteyn was appointed there in 1878 and under his guidance astronomy blossomed in Groningen. At the end of the century the Kapteyn's Sterrenkundig Laboratorium (Astronomical Laboratory) had surpassed Leiden in importance. Leiden had slowly fallen into a decline by constantly holding on to sheer location measurements of celestial bodies. For a short biography of Kapteyn see Chap. 6.

Amsterdam: Antonie Pannekoek (1873–1960)

Pannekoek started his studies in mathematics and physics and chose for astronomy after his bachelor's exam. He passed his master's exam in 1895. In 1898 he became an observer at Leiden Observatory, where he wrote his doctoral dissertation with Hendrik van de Sande Bakhuyzen as supervisor: *Untersuchungen über den Lichtwechsel Algols* (*Researches on the changing luminosity of Algol*), then a very modern subject. In those days he was already an outspoken socialist. One of the short propositions in his dissertation[5] was:

> The progress of the natural sciences is hampered by the continuation of the capitalist production.

In 1906 Pannekoek left for Germany. According to Pannekoek at the Observatory there was always executed a next series of meridian measurements without making the necessary reductions. The new astronomy (photography and spectral analysis) still stayed outside the scope of the research programmes in Leiden. In Pannekoek's book *Reminiscences* (Pannekoek et al. 1982) he made two striking remarks. About the period after the appointment of Ernst van de Sande Bakhuyzen as his brother's successor:

[5]Every dissertation in The Netherlands has a number of short propositions or comments on a variety of scientific or social subjects at the end.

Then everything went even slacker.

And about Willem de Sitter's decision after his appointment not to make reductions of all old measurements:

So, all that work for which I worked so hard, swept under the carpet; and right so.

After his return to The Netherlands Pannekoek became, with the support of De Sitter, a private lecturer in Leiden. When De Sitter asked him, after his appointment as director of Leiden Observatory in 1918, to become one of the deputy directors, his appointment was blocked by the government, as a result of his explicit socialist ideas. In 1919 he was then appointed as a lecturer at the University of Amsterdam, under the jurisdiction of the city council of Amsterdam and not of the government. In 1925 he became an extraordinary professor and in 1932 a full professor. In 1925 De Sitter and Ejnar Hertzsprung, deputy director in Leiden, then proposed Pannekoek successfully as a member of the Dutch Academy of Sciences [ASL, from Hertzsprung, 1-4-1925]. Also after 1919, already at work in Amsterdam, Pannekoek kept being in close contact with De Sitter. He borrowed a lot of things from Leiden in his first years in Amsterdam: a Repsold measuring device, books, magazines. Moreover he often asked De Sitter's advice concerning his current investigations. At first he worked on stellar astronomy and the structure of the universe, in line with Kapteyn's research, later he focussed on the evolution of stars. In 1921 he founded The Astronomical Institute of the University of Amsterdam (now called the Anton Pannekoek Institute for Astronomy). On 4 October 1918 he gave his public lecture, titled *The Evolution of the Universe* (Pannekoek 1918). In this lecture he stated, on the basis of the conservation laws of mass and energy: the world did not originate and will not perish, there is only evolution. He was occupied with the universe, although he neither mentioned the general theory of relativity, published a few years earlier, nor the first articles about cosmology of Albert Einstein and De Sitter. Probably those were too recent (Pannekoek et al. 1982).

Kaiser as Auditor of the Empire's Nautical Instruments

In addition to his astronomical activities Frederik Kaiser was appointed in 1858 as *Auditor of the Empire's Nautical Instruments*, a title he coined himself. It is not remarkable that the care for accurate nautical instruments was entrusted to an astronomer. In order to determine a ship's location at sea the precise place of a number of celestial bodies and the instruments to measure these played an important role. With this job Kaiser earned an additional 1000 Dutch guilders a year, and he equipped a small room in the Academy building for the purpose. It was not long before he started to complain about the workload, he felt a warehouse manager. In 1860 he managed to appoint an assistant auditor, a clerk and a servant. Not completely free of nepotism he managed to get his son appointed to assistant auditor. Kaiser advised the Secretary of the Navy regarding purchase and inspection