JACOBUS CORNELIUS KAPTEYN

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In May 1922 the first meeting of the *International Astronomical Union* (I.A.U.), one of the first of such disciplinary scientific organisations, was held in Rome. The meeting was chaired by the French astronomer Baillaud, who mentioned in his opening speech what he felt were the three most important developments that in his fifty years of active scientific research had revolutionised astronomy. Even now –almost a century later– two of these immediately come to mind, namely the discovery of the photographic plate and the construction of giant telescopes, culminating at that time with the enormous 100-inch telescope on Mount Wilson near Los Angeles that had just been opened. The third matter that Bailaud mentioned was the Kapteyn's "Astronomical Laboratory" at Groningen.

Kapteyn, who lived from 1851 to 1922, would certainly have attended this conference, had his health permitted him. He died one month later, but even in his last year he was still busy with the preparations of this meeting in Rome. In his days he was one of the most prominent astronomers in the world, nowadays he is almost forgotten. The American astronomer-historian Owen Gingerich recently investigated to what extent Kapteyn is mentioned in textbooks for courses in introductory astronomy at American universities. Although he is mentioned in seven of the ten introductory textbooks that Gingerich investigated, he is in all cases only mentioned as the rival of the American astronomer Harlow Shapley, who laid the foundations for our modern understanding of the structure of our Milky Way Galaxy. Kapteyn's model for the distribution of stars in space, determined after many years of hard work on the basis of counts of stars over the whole sky, was shown to be incorrect and Shapley was right in general terms. Kapteyn's model proved to have a much too small size as a result of the absorption of starlight by dust in interstellar space. Ironically, Kapteyn had worried about this possible absorption and had searched for indications of it for many years, because he was well aware that it could be a fatal flaw in his life's work. He actually wrote scientific papers looking for signs of interstellar absorption, predicting (and correctly so) that it would be more pronounced at blue than at longer wavelengths and therefore should be visible as a increasing reddening of the colors of the stars with distance from us. Unfortunately, the measurements in his days were not sufficiently accurate to detect this reddening. Although young astronomers all over the world are now taught that Kapteyn's model was simply wrong, only few are actually aware of this side of the story, let alone know of his other accomplishments.

Leading position.

There are more indications of Kapteyn's importance for astronomy than the remarks by Baillaud. He succeeded in mobilising almost the full astronomical world to embark on a project, the *Plan of Selected Areas*, which aimed at making a census of the stars to very faint level in a set of carefully selected fields on the sky. And from his disadvantaged position he succeeded to become one of the trusted colleagues of George Ellery Hale, the builder of the giant telescopes in the United States, and a very welcome annual guest (as parttime paid research associate) at the Mount Wilson Observatory in California. And at home Kapteyn laid the foundations for the leading position that the Netherlands has since assumed in astronomy worldwide through his personality, perseverance and vision. All of this when there was no astronomical tradition whatsoever in Groningen when he took up his appointment.

There are certainly factors to be identified that explain the way Kapteyn appears in textbooks. His last paper, *First attempt at a theory of the arrangment and motion in the Sidereal System*, was published only months before his death and had already before it appeared in print been contradicted by Shapley's work on globular clusters that indicated a much larger scale for the Galaxy than Kapteyn's approach would allow. He never had the chance to put his work in that context. To his disadvantage also was the fact that the focus of astronomical researh shifted from the carefull counting and cataloguing of stars in Europe in so-called *"Durchmusterungen"* to the fascinating new discoveries with the new giant telescopes in the U.S., combined with the 'God's-own-country' syndrome in American society. These factors should not hinder our assessment of the role Kapteyn played in the national and international development of astronomy.

'Two star streams'.

As already briefly touched upon, Kapteyn's career was not straightforward. In 1876 a new law had been introduced in the Netherlands concerning the structure of higher education, in which it was stipulated that the three government-sponsored universities in Groningen, Leiden and Utrecht each should have a chair in astronomy. As a result of this Kapteyn was appointed professor in astronomy and theoretical mechanics at the University of Groningen in 1878 at the age of twentyseven. But Groningen had no observatory and the university weas not even able to provide any funds to Kapteyn for scientific research of any substance. But Kapteyn did not give up his ambition to start a research program and decided to negotiate a deal with what became to be his life-long close friend Sir David Gill in Capetown. Gill had become impressed with the possibilities of using photographic plates to count, measure and catalogue stars. He would send his plates to Groningen where Kapteyn would measure them. This resulted in the *Cape Photographic Durchmusterung* that was published in three volumes, the last one, maybe symbolically, in 1900, the last year of the nineteenth century. Thirteen years of hard work, the very detailed measuring of the position and brightness of over 450,000 stars from the plates, finally gave Kapteyn international recognision.

His next step was the discovery of systematic motions of stars in the solar neighborhood. This discovery, by Kapteyn himself designated as 'two star streams' and made public at a large astronomical conference during the *St. Louis International Exposition* in 1904, amazed the astronomical world. Although the final explanation of this phenomenon was provided later by Karl Schwarzschild and not by Kapteyn himself, it still is quoted as one of the major discoveries in the early years of the twentieth century. Kapteyn developed methods to intepret counts of stars of various brightness ('magnitudes') over the sky in terms of their spatial distribution. To this end he investigated systematics in the properties of stars that could be helpful in estimating distances of stars and developed a statistical method to find average distances to groups of stars from their general motions on the sky (so-called 'secular parallaxes'). And he also was the first to look into the connection between motions and distributions of stars in a consistent dynamical model, providing a basis for the study of the dynamics of our Galaxy. With these tools he was able to perform the first determination of the average density of matter in the solar neighborhood, an approach that was improved by his pupil Jan Hendrik Oort. This scientific work in itself makes Kapteyn one of the most prominent astronomers of his times.

Anglo-Saxon inclination.

The most important lasting accomplishemnts of Kapteyn are to be found in other areas, although these were facilitated by his scientific standing. In the first place this holds for the

Plan of Selected Areas, already mentioned above. Kapteyn realised that further progress was only possible through a coordinated effort of the major observatories worldwide to observe carefully chosen parts of the sky, distributed over all directions, to do counts and measure properties of stars to the accuracies that were possible with the then state-of-the-art techniques. George Ellery Hale's support has undoubtedly contributed in an essential manner to the adoption of this approach. Kapteyn published his *Plan* in 1906 and was, after carefull and detailed preparation, supported by the directors of in effect all leading observatories in the world. It envisaged the determination of the bightness of order 200,000 stars in these *Selected Areas* and in addition for the brightest half also the motion on the sky, the velocity with respect to us and the type (judged from the appearance of the spectrum). Much of the necessary photographic plates were measured at Kapteyn's own *Astronomical Laboratory*, which he described as an observatory without telescopes. The *Plan of Selected Areas* constitutes one of the earliest examples of international scientific endeavors.

Kapteyn also pioneered in other areas. In his days German science was seen as the model for the academic world. International conferences were generally held in German, while this also was the language in which international publications were often written. Contrary to this, Kapteyn showed from early on in his career a more Anglo-Saxon inclination. This surprising and remarkable fact needs to be subject of more thorough study and research.

It is not exaggaration to state that Kapteyn is the 'father' of all Dutch astronomy that came to such prominence in the twentieth century. When Kapteyn arrived in Groningen, astronomy in the Netherlands was insignificant. There were two observatories, one in Leiden and one in Utrecht, that were involved in a struggle for power, but that joined forces to successfully block all efforts of Kapteyn to found an observatory in Groningen. As a result of Kapteyn's international contacts and his orientation towards the United States he started a tradition for (young) Dutch astronomers to visit American observatories or even pursue a career in astronomy there. In most scientific disciplines this trend started much later.

Kapteyn's significance for (Dutch) astronomy is also evident in the prominence of his students. To these below Willem de Sitter (later director of Leiden Observatory), his successor Pieter van Rhijn, Jan Hendrik Oort, Peter van de Kamp, Bart Bok and Adriaan van Maanen, that all played important roles in American or Dutch astronomy. In 2000 a symposium was held in Leiden at the occassion of the centenary of Oort's birth. During this meeting a presentation was given by the nestor of Dutch astronomy, Adriaan Blaauw, third director of the Astronomical Laboratory 'Kapteyn'. Blaauw mentioned that Oort's first priority was Leiden astronomy, in second place came international astronomy and only in third place Dutch astronomy. Oort always considered himself a student of Kapteyn, but in this respect he was different from his teacher. From what we know of Kapteyn it appears that his first priority was international astronomy with Dutch astronomy in second place and Groningen astronomy only third.

Biography.

A critical biography of Kapteyn remains to be written. His daughter Henrietta Hertzsprung-Kapteyn wrote a moving, but not very objective biography (*Leven en Werken van J.C. Kapteyn*) in 1928. This work has been made available to the international community through an English translation by the American historian E.R. Paul and published by Kluwer Academic Publishers. But unfortunately this translation is not very reliable. Kapteyn's student Willem de Sitter (when he was director of Leiden Observatory) and the Leiden historian Johan Huizinge (the Huizinga's were very good friends of Kapteyn) were certainly planning to write a biography. Probably in preparation for this, a large fraction of Kapteyn's archives, except for his correspondenc with

David Gill, was collected by them and send to the west of the country. The biography has never been written and the collected correspondece of Kapteyn has been lost, probably during the bombardment of Rotterdam in 1940. Fortunately we have bee able to make a detailed inventory of archives all over the world and have collected photocopies of the correspondence from and to Kapteyn as far as it is still in existence.

Maybe it is time for a critical biography. That was also the impression from the symposium 'The Legacy of J.C. Kapteyn' held at the occassion of the 385-th anniversity of the University of Groningen in 1999. Eminent historians of science along with astronomers with an interest in the history of their profession have discussed the significance and influence of Kapteyn. The proceedings of that symposium have been published by Kluwer Academic Publishers as *The Legacy of J.C. Kapteyn: Studies of Kapteyn and the Development of Modern Astronomy*, edited by P.C. van der Kruit and K. van Berkel. I have in this account freely made use of the insight provided by experts at this meeting.