Jan Oort, astronomer : catalogue of an exhibition in Leiden University library, April 20 - May 27, 2000

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Jan Oort, astronomer

Exhibition in the University Library
April 20 through May 27, 2000

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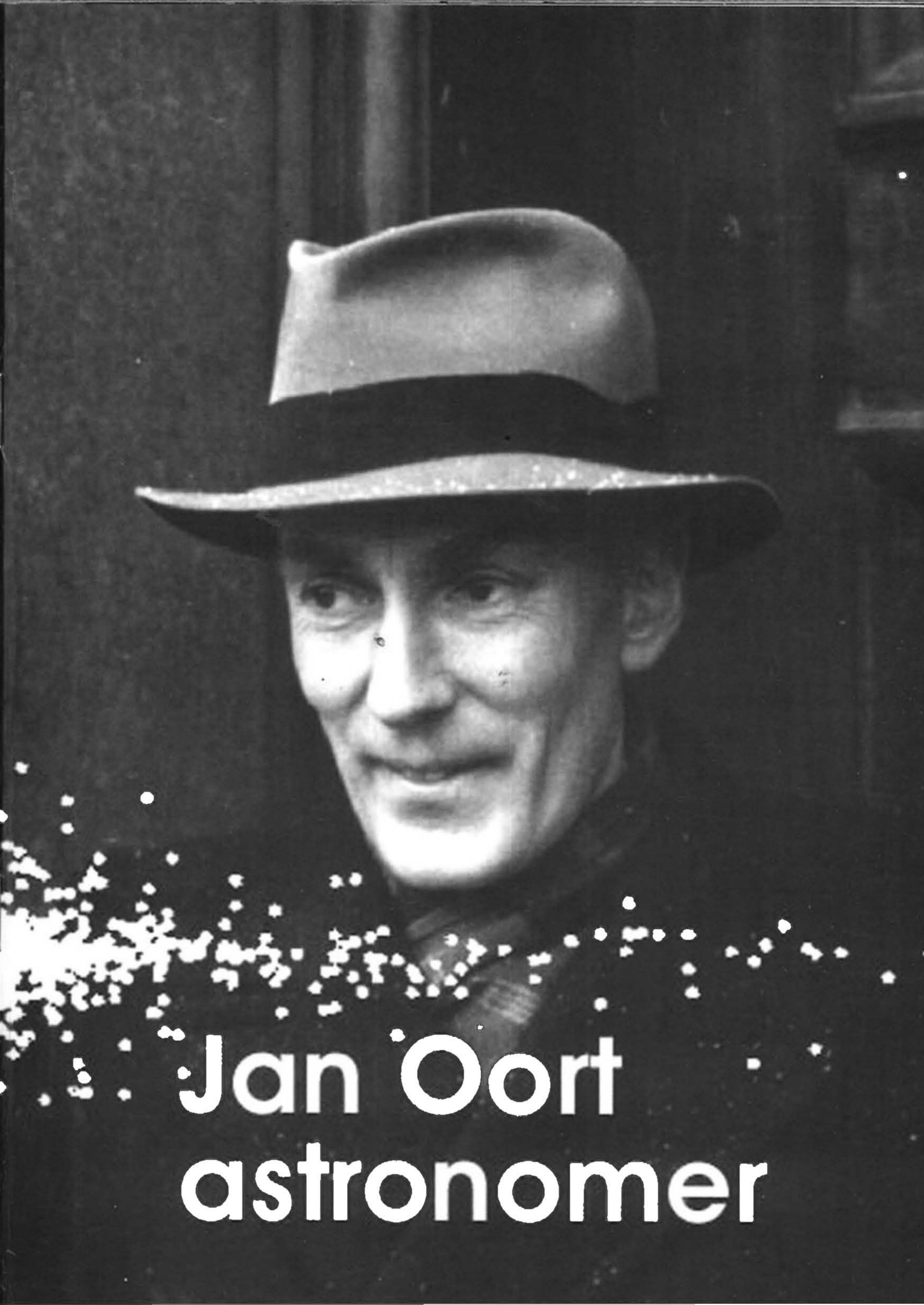
On display are manuscripts, memorabilia, and various items relating to the scientific life of Jan Hendrik Oort.



Jan Oort astronomer

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J.H. Oort, in front of the former Leiden Observatory (1976)

JAN OORT,
ASTRONOMER

CATALOGUE OF AN EXHIBITION IN
LEIDEN UNIVERSITY LIBRARY
APRIL 20 – MAY 27, 2000

WITH CONTRIBUTIONS
BY
J. KATGERT-MERKELIJN & JOS DAMEN

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The two brothers, Jan and Hein Oort, c. 1910

A SHORT BIOGRAPHY OF JAN HENDRIK OORT

Franeker is a small town in the north of the Netherlands, in the province of Friesland. It has its claim to fame: in the middle ages, and well into modern times. It boasted its own University, and it derives some astronomical importance from being the home of the Eise Eisinga Planetarium, a particularly beautiful 18th-century clock-work model of the solar system. Franeker established a second claim to astronomical fame by being the birthplace of Jan Hendrik Oort, the second son of Abraham Hendrikus Oort and Hannah Faber, on April 28, 1900. The association with Franeker was brief. A.H. Oort was in medical practice, and left Franeker in 1903 to become Director of the Psychiatric Clinic 'Endegeest' in Oegstgeest, within a very short distance of Leiden.

In Oegstgeest Jan Hendrik went to primary school, and afterwards on to the H.B.S. (secondary school) in Leiden, where he proved an indifferent language scholar, but good, in fact progressively better, at physics and mathematics. In 1917 he matriculated, and went on to Groningen University to study physics. He took the usual courses in subjects like Hydrodynamics, Light and Sound, Analysis, Electricity, and the Method of Least Squares. Quantum theory had already been added to the curriculum. He also followed the course on Popular Astronomy, which was given by Kapteyn, and was so impressed that he decided to graduate in Astronomy rather than Physics, as had been his original intention.

In 1921 Oort took his final, 'doctoral' exam. He was appointed Assistant in Groningen but it was clear that it would be wise for him to get some overseas experience, and arrangements were made for him to go to Yale Observatory in the United States, as an assistant to F. Schlesinger.

Oort arrived in New Haven in September, 1922. At the Yale Observatory, he was responsible for the observations with the zenith telescope. Schlesinger was trying to develop a new method to obtain increased accuracy in positional astrometry, and Oort was expected to take the necessary plates and to measure them. It was not the type of work that appealed to him most, and he realized he had no particular aptitude for it, but still the results were satisfactory. Schlesinger probably also realized that this type of work was a waste of Oort's talents, and must have begun to think very highly of him otherwise,

J.H. Oort as a young researcher, at a meeting of the American Astronomical Society, Poughkeepsie, N.Y., Vassar College, December 1923. Oort is standing in the centre, on the one but last row .

because when Oort had been in New Haven for about a year, he was offered the opportunity to go to the Southern Station of Yale Observatory that was to be built in Johannesburg. Oort hesitated. He may have seen it as some sort of exile, and he wrote to his senior colleagues (De Sitter and Van Rhijn; Kapteyn had died in 1921) in the Netherlands to discuss the offer with them.

Their reaction was prompt: they felt that this was not Oort's kind of work at all, and that although observing was a very useful experience, he should ultimately turn to interpretation and theory. In fact, De Sitter had just finished a reorganization of Leiden Observatory. As a result he had some vacancies and he would be most happy if Oort would join the staff at the end of his spell in New Haven, with good prospects for his future career. Oort had no hesitation at all about accepting. At the end of his second year (1924) he left New Haven to take up the position of Research Assistant at Leiden Observatory, where he was subsequently appointed as Conservator in 1926, as Lecturer in 1930, and as Professor Extraordinary in 1935.

In Leiden Oort continued work on a research topic in which he had become interested in New Haven: the properties of high-velocity stars. He had collected as many data as he could, in the hope of getting some clue to the reason for the odd distribution over the sky of their velocity vectors: for stars with velocities relative to the Sun of less than 63 km/sec these are randomly oriented, but for those with a velocity above this value there is a pronounced asymmetry. They all seem to move into the same direction. This was to become the subject for this doctoral thesis, but he wrote it up as a thesis and obtained his doctorate (at Groningen University, on May 1st, 1926) without having come much nearer to an explanation.

Some of his work notes from the time show him worrying away at the problem, but still in terms of the Kapteyn system[1]. He is on record as saying he should have realized the implications of the odd velocity distribution of the high-velocity stars at that time. The Shapley-Curtis debate on the composition and size of the Galaxy and the role

[1] Kapteyn had derived a model for the Galaxy in which the Sun was near the centre of gravity, and the stellar density fell off away from the sun in such a way as to form a flattened system, with a radius of c. 4000 pc and a thickness of c. 1000 pc.

of globular clusters had already taken place[2], and the idea of a distant centre of the galaxy had been launched. But then, in 1927, the classic paper by B. Lindblad was published in which the suggestion of differential rotation around a distant centre was made, and Oort realized that this was in fact the correct model, and that he could show that it was supported by the observations. In doing this, Oort derived two elegant formulae describing the local effects of galactic rotation, and showed how the available data fitted the formulae. Into the formulae he introduced two constants, which he called A and B, but which have ever since been referred to as 'Oort's constants'. Oort also derived the distance of, and direction to, the Galactic centre, as well as the rotational velocity of the Solar neighbourhood. The model proved to give a neat solution of the problem of the high-velocity stars, and of the distribution of the globular clusters.

In fact the data Oort used in his first article to support Lindblad's theory were very sparse, and only gave the confirmation he sought after being averaged. He published the result anyway, but straightaway set about collecting more and better data, and was able to confirm his first results within half a year.

The response from the astronomical world was immediate, and in 1927, which was also the year in which Oort married Mieke Graadt van Roggen, he suddenly became one of the better known young astronomers. A direct result of this was that in 1930, and again in 1932, he had offers of important posts in the United States. In 1930 he was offered the Willson Chair of Astronomy at Harvard, a position that involved a considerable amount of teaching, and in 1932 he was offered the directorship of the astronomy department of Columbia University. He discussed the offers extensively with his mentors, mostly Van Rhijn at Groningen, Schlesinger at Yale, and De Sitter at

[2] This was a public debate, in which Shapley and Curtis disputed as follows: Shapley held that the globular clusters belonged to the galactic system, and that the fact that they are predominantly found in one hemisphere, and are concentrated towards a very distant point in the direction of the constellation Sagittarius indicates that our Galaxy is much larger than had previously been thought, and that its centre is the centre of gravity of the globular clusters. He also held that the spiral nebulae were part of the Galaxy. Curtis defended the Kapteyn system (see above) and the view that the spiral nebulae are extragalactic, and possibly galaxies in their own right.

Wedding photograph of Jan Oort and Mieke Graadt van Roggen (May 24, 1927). Clockwise around the bridal couple from left to right: Jetske Oort, Lien and Coen Graadt van Roggen, Mr. and Mrs. A.H. Oort, Mrs. and Mr. W. Graadt van Roggen, Jo and Pivy Oort, Emy Oort.

Leiden, but in the end he declined both posts. He would mention in later years that, much as he enjoyed lengthy visits to other countries he was always glad to come back to the Netherlands. He felt a special affection for the Dutch landscape and climate, for the way of life, and specifically for Leiden Observatory, and would have considered a permanent post in another country as a kind of exile.

In the years following the publication of the Oort-Lindblad theory of galactic rotation two main themes can be recognized in Oort's research, both following logically from the new theory. One theme was concerned with expanding the new knowledge of the dynamics of the galaxy, collecting the data needed for a better determination of the Oort constants, of the mass distribution, of the distance to the galactic centre, and (a major piece of research, especially considering the scarcity of the data), of the force perpendicular to the galactic plane, K_z. With the realization that most of the nebulae at high galactic latitudes were extragalactic also came the desire to know which of those nebulae most closely resembled our Galaxy. The other theme involved the realization that the discrepancy between the Kapteyn system and the new model for the Galaxy could be explained only if there were considerably more interstellar absorption than had been realized previously. Oort set into motion the effort to find out what caused this absorption, and thus gave rise to an important branch of Dutch astronomy.

In all these activities, Oort was hampered by the fact that in Leiden he did not have personal access to the sort of telescopes that could provide him with the data he needed. There were various ways of getting round this problem, and Oort availed himself of all of them. Through his entire career he wrote to colleagues that could provide him with the data he needed, he planned observations to be carried out at the Southern Station of Leiden Observatory (at the time in Johannesburg, South Africa), and he took himself to where there were telescopes he could use. In 1932, together with his wife, he spent half a year at the Perkins Observatory, in Delaware, Ohio, to take plates of external galaxies in order to do photometry of their luminosity distributions. The article discussing these observations was only published in 1940, indicating how time-consuming the reduction of this type of observations was.

Oort was increasingly called upon to take on official functions. After Oort's return from Perkins, De Sitter left for a half-year's sabbatical,

Staff of the Leiden Observatory in 1933. See Catalogue No. 11 for an identification of the persons.

and left Oort in charge. He had previously become adjunct-director of Leiden Observatory, together with Hertzsprung. When De Sitter died, in November 1934, and was succeeded by Hertzsprung as director of Leiden Observatory, Oort became Hertzsprung's second-in-command, with considerable administrative responsibilities. In 1935 Oort was appointed General Secretary of the International Astronomical Union (IAU). Due to the second world war he had to wait until 1948 to be able to hand over this post to his successor. 1935 also saw the Oort family[3] move to Sterrewacht 5, De Sitter's former house. Apart from a few years during the war, Oort lived there until his retirement in 1970.

These were fairly quiet years, one could almost say 'the lull before the storm'. Oort did not travel much, his major trips were to the congresses of the IAU (in Cambridge, USA, in 1932; in Paris in 1935, and in Stockholm in 1938). A few times he was left in charge while Hertzsprung was away. Summer holidays were spent with his family in 'Sandy Hook', the house Oort's father owned in Katwijk, a seaside village some eight kilometers from Leiden[4]. In 1939, Oort was able to spend another half year in the United States, visiting colleagues, attending the inauguration of the McDonald Observatory, and doing some observing himself, his wife was not able to come this time[5]. In retrospect the timing of the trip looks foolhardy. Having left in March, Oort did not get back to the Netherlands until the end of August, 1939, just weeks before the outbreak of the second World War. The trip to the USA must have been very useful. One of its results was that Oort became interested in the Crab Nebula. Mayall had just made a better determination of the expansion velocity of the Crab Nebula and derived a more accurate value for its age. One of Oort's good friends in Leiden, J.J.L. Duyvendak, was a Sinologist, and Oort

[3] They now had three young children, Coen (b. 1928), Marijke (b. 1931) and Bram (b. 1934).

[4] The house in Katwijk was sold after the war. In 1960 the Oorts bought a holiday cottage in Haamstede, on Schouwen. Its official name was also 'Sandy Hook', but it was known as the Haamstede Cottage. They spent a lot of time there.

[5] While their children were growing up Oort's wife was mostly unable to accompany him on extensive journeys, but later she would accompany him to foreign meetings and visits to the USA whenever possible.

lost no time getting him interested in going over Chinese and Japanese chronicles in search of further mentions of a Guest Star (one mention was already known). The result was a couple of papers in the PASP in 1942. In the first paper Duyvendak gave the additional mentions he had found, and in the second paper Mayall and Oort concluded that the Crab Nebula was the result, not of a nova, but of a supernova explosion.

When these papers were published, the war in Europe had already lasted three years. After the invasion of the Netherlands in May, 1940, contact with the USA had remained possible until December, 1941. After that, Swiss and Swedish sources were occasionally able to get some news across, but this route was only used for important communications.

In the Netherlands, Oort belonged to the group of people that quickly decided against cooperation with the German authorities. In 1942 he resigned from the Royal Academy (to which he had been elected in 1937), from his post as a Professor Extraordinary at Leiden University, and from his adjunct-directorship of the Observatory. This last function caused the most trouble. He was summoned to an interview and told that this resignation could not be accepted as he had not been given permission to resign by his superior, E. Hertzsprung. In view of possible repercussions[6], he decided to disappear from view, and in the summer of 1942 he moved, with his family, to a cottage called 'De Potbrummel' in the village of Hulshorst, a very quiet part of the country, some 100 km to the east of Leiden. There he sat out the war, although he kept contact with the Observatory throughout, cycling to Leiden with stops in Utrecht, lecturing and putting people to work. His professorial salary had been stopped, and it is not clear from the archives where his income came from. It is known that he earned some money by doing calculations for a life-insurance firm. He probably had to borrow from his father-in-law and may have been given some money from the 'National Fund', a fund set up to support the professors that had resigned in protest against the nazification of Leiden University. There are some indications that his salary as adjunct-director of Leiden

[6] He ran the risk of being interned as a hostage, as quite a few of his colleagues had been (e.g. Minnaert from Utrecht, who spent a large part of the war as a hostage at St. Michielsgestel).

Observatory was continued, at least for part of the time[7]. In Hulshorst he began work on a book on Stellar Dynamics, with interruptions by colleagues and relatives, but also by food-finding expeditions. There are letters that mention the load of potatoes he managed to find and send to Leiden during the last hungry winter of the war. He also turned up at scientific meetings of the Nederlandse Astronomenclub (NAC) and some of these meetings turned out to be very important for Dutch astronomy, as follows.

One of the people Oort had put to work was H.C. van de Hulst, then a student in Utrecht. His attention had already been directed towards Van de Hulst by the results of a prize contest on the subject of 'Formation of solid particles and condensation in interstellar space'[8]. No prize was awarded, but Van de Hulst got an honourable mention. Now (c. 1944) Oort was looking for someone who would be able to work out the answer to a new question. He was asking that question because some fascinating news had reached him (a telegram service with important astronomical news was still functioning via Zürich) about the detection of radio radiation from the Milky Way made by an American engineer, Grote Reber. The question he asked can be summarized as follows: 'Is there a spectral line at radio frequencies we should in principle be able to detect? If so, because at radio frequencies absorption would be negligible, we should be able to derive the structure of the Galaxy. We might even be able to detect spiral arms, if they exist.' Van de Hulst went to work on this, and answered: 'There is a spectral line at 1420 Mhz (21.1 cm) due to the hyperfine structure of the ground state of hydrogen. There is such a lot of hydrogen in the Galaxy that we should be able to detect it.' This was reported at a meeting of the NAC held in Leiden on April 15, 1944, and published in the journal of the Dutch Physical Society in December, 1945[9].

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[7] P.J. Idenburg, *De Leidse Universiteit 1928-1946*, Leiden (Universitaire Pers) 1978.

[8] The subject of the prize contest had been inspired by the second theme of Oort's research in the years preceding the second world war.

[9] A facsimile reproduction, as well as a translation into English, of the minutes of this meeting has been published in: *Atlas of Galactic Hydrogen*, by D. Hartmann and W.B. Burton, Cambridge 1997.

Oort also set to work organizing the apparatus needed for a detection of this line. At this same meeting he had already had some preliminary discussions with physicists working in the Physical Laboratory of the Philips Company, and he now began to enquire whether they would be able to provide him with a receiver at the proper wavelength. This first enquiry was at 50 cm (c. 600 Mhz). He thought the chief of the observatory workshop should be able to build him a 20-m radio antenna. Ultimately, he wanted a resolution of about 0.°5. His correspondent at Philips objected that in that case he should have to increase the size of his telescope, or go to higher frequencies. On the other hand, there might be a receiver available 'after the war'. This correspondence dates from June, 1944. Although Eindhoven, the home town of the Philips Company, was liberated in September, 1944, the Oorts still had to live through the hardest winter of the war years, with severe food shortages and extreme cold. During the battle of Arnhem Oort's brother and his family, who lived in Wageningen, had had to be evacuated and came to Hulshorst as refugees. Oort and his family ended up moving to Nunspeet, as 'De Potbrummel' was getting overcrowded.

The war in the Netherlands ended on May 5, 1945, but Oort did not get back to Leiden until some time during June. Travelling at first was scarcely easier than it had been during the war. One needed permits to move around, as there were scarcely any trains or buses left. In Leiden, Hertzsprung had been able to keep the Observatory going, as his Danish nationality to a certain extent protected him from interference by the Germans, and his policy of 'astronomy first' was misinterpreted by the Germans as co-operation. At the end of the war, Hertzsprung, at 71, was past statutory retirement age, and his efforts to get the Observatory back to normal working conditions were not appreciated by the staff, who were malnourished, and certainly unable to go back to working full days within a few weeks of the end of the war. In June an SOS reached Oort, asking him to come back and take over. He answered it and went back to Leiden, ahead of his family, to occupy himself with getting the Observatory back to normal.

The first few years after the war were confused. So many things to do, all at the same time. Most importantly for Oort, who had now succeeded Hertzsprung as Director of the Observatory and Full Professor of Astronomy, the teaching and research activities of Leiden Observatory had to be resumed. At first this caused great difficulties,

Staff of the Leiden Observatory in 1960. See catalogue No. 12 for an identification of most persons on this photograph.

because of the condition of the observatory staff. As mentioned before, the people were badly undernourished, and at first working hours were confined to the mornings. These were gradually extended, as more food became available and people got stronger[10]. Oort took some steps to reinforce the sense of cohesion of the Observatory staff. One important step was that he instituted communal coffee sessions at 11.00 a.m. To get these going he used real coffee that had been sent to him from the USA, as the Netherlands were still stuck with ersatz. The Observatory coffee break quickly grew into a tradition, combining a sense of community with efficiency. Those who ever spent some time at Leiden Observatory during Oort's directorate will remember staff members queuing up during coffee to have a quick word with Oort on minor points, or to make an appointment for more important discussions.

Then Oort was still nominally General Secretary of the IAU. During the war, Walter Adams in Pasadena had taken care of what business there was, but Oort had to take over again, until the next General Assembly. Contacts with the rest of the world had to be restored. Of special concern were the contacts with the Leiden Southern Station in Johannesburg, and with the Bosscha Observatory at Lembang on Java. The Johannesburg station had survived the war years without great problems. With no funds forthcoming from Leiden, the salaries of the Dutch staff had had to be advanced locally, but this was a relatively minor problem. The Bosscha Observatory was a worse case. Oort's good friend A. de Sitter (a son of the former Director of Leiden Observatory), who had been appointed there in 1939, had been interned by the Japanese and had died in prison camp. The instruments at the Bosscha Observatory had been damaged, and so had its archives and plate collection. Oort allowed one of his senior staff members (C.H. Hins) to restore order, and at the end of Hins's term of office Oort was closely involved in sending another Dutch astronomer, G.B. van Albada, who successfully got the Bosscha observatory back into operation, and was its Director until 1960.

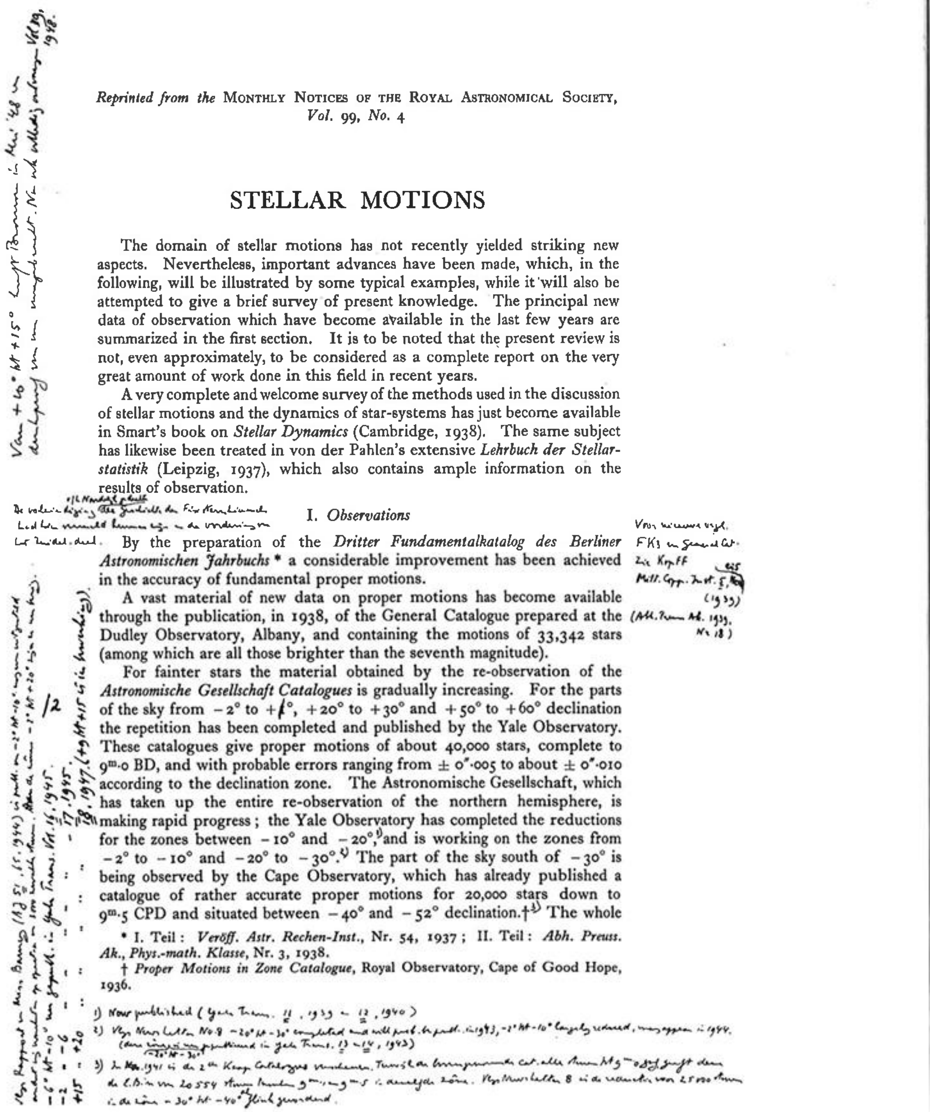
But all this was of an administrative character. Oort was of course most concerned about the direction astronomical research should

[10] Help did not come in time for everybody though: J. Woltjer, who had been lecturer in Astrophysics, died soon after the end of the war, probably as an indirect result of malnourishment.

take, and he set out a number of lines of research that he thought should be pursued.

First there was radio astronomy. In most countries, this new field was taken up by radio engineers, especially those who had worked on radar during the war. Oort was probably the first astronomer to realize the importance of this new technique. It has already been mentioned how, during the war, he took the first steps towards making use of it. After the war he set about realizing his plans. He attempted to make an estimate of the cost of constructing a radio telescope, asking Grote Reber how much his telescope had cost him and trying to scale it to the size Oort wanted, and then applied to the Department of Science and Education for the money. The Department did not have that kind of money available just then, as their total budget for scientific instrumentation was just about as large as the sum of money Oort asked for, but sometime during these years someone came up with the idea that the radar antennas the Germans had left behind might as well be used for the time being. One 7.5-m Würzburg antenna was put at Kootwijk, on the site of a research station of the Dutch Postal and Telephone Company, and Oort managed to wrangle some money to enable someone to start building a receiver for a 21-cm wavelength. The matter was put on a proper footing by the foundation (in 1949) of the SRZM (the National Foundation for Radio Astronomy), closely followed by the foundation by the government of the Netherlands Organization for the Advancement of Pure Research (ZWO), which was henceforth to provide the funds for pure research. It was extremely fortunate for Dutch astronomy that the director of the new foundation, J.H. Bannier, took a strong interest in astronomy. His support for the large instrumentation projects of the fifties and sixties was invaluable.

Then there was the organization of the Kenya expedition to determine accurate declinations. This was a sequel to a previous expedition, and had already been set in motion during the war years. The Leiden astronomer G. van Herk, with assistants, was sent to a place as near as possible to the equator with an improved instrument to determine accurate declinations of stars by measuring their azimuths at rising and setting. The expedition lasted four years, and probably resulted in improved declinations, although the improvement was not as large as had been hoped, mostly due to climatic conditions.



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STELLAR MOTIONS

The domain of stellar motions has not recently yielded striking new aspects. Nevertheless, important advances have been made, which, in the following, will be illustrated by some typical examples, while it will also be attempted to give a brief survey of present knowledge. The principal new data of observation which have become available in the last few years are summarized in the first section. It is to be noted that the present review is not, even approximately, to be considered as a complete report on the very great amount of work done in this field in recent years.

A very complete and welcome survey of the methods used in the discussion of stellar motions and the dynamics of star-systems has just become available in Smart's book on *Stellar Dynamics* (Cambridge, 1938). The same subject has likewise been treated in von der Pahlen's extensive *Lehrbuch der Stellarstatistik* (Leipzig, 1937), which also contains ample information on the results of observation.

I. *Observations*

By the preparation of the *Dritter Fundamentalkatalog des Berliner Astronomischen Jahrbuchs* * a considerable improvement has been achieved in the accuracy of fundamental proper motions.

A vast material of new data on proper motions has become available through the publication, in 1938, of the General Catalogue prepared at the Dudley Observatory, Albany, and containing the motions of 33,342 stars (among which are all those brighter than the seventh magnitude).

For fainter stars the material obtained by the re-observation of the *Astronomische Gesellschaft Catalogues* is gradually increasing. For the parts of the sky from −2° to +1°, +20° to +30° and +50° to +60° declination the repetition has been completed and published by the Yale Observatory. These catalogues give proper motions of about 40,000 stars, complete to $9^{m}.0$ BD, and with probable errors ranging from ± 0″·005 to about ± 0″·010 according to the declination zone. The Astronomische Gesellschaft, which has taken up the entire re-observation of the northern hemisphere, is making rapid progress; the Yale Observatory has completed the reductions for the zones between −10° and −20°, and is working on the zones from −2° to −10° and −20° to −30°. The part of the sky south of −30° is being observed by the Cape Observatory, which has already published a catalogue of rather accurate proper motions for 20,000 stars down to $9^{m}.5$ CPD and situated between −40° and −52° declination.† The whole

* I. Teil: *Veröff. Astr. Rechen-Inst.*, Nr. 54, 1937; II. Teil: *Abh. Preuss. Ak., Phys.-math. Klasse*, Nr. 3, 1938.

† *Proper Motions in Zone Catalogue*, Royal Observatory, Cape of Good Hope, 1936.

J.H. Oort supplementing his own work. A page from his working copy of 'Stellar Motions'.

All this left little time for Oort's own research, but what time there was he used efficiently. He was still involved in Van de Hulst's work on dust particles in interstellar space, and was working on a model for Nova Persei 1901, using the suggestion that the effect of an illuminating beam sweeping a region containing clouds may give the appearance of faster-than-light velocities, and trying to work out the effects of braking by the interstellar medium on the ejected clouds. He had not forgotten his old interest in the Crab Nebula, and had come up with an intriguing idea to test theories about the energy supply. He thought of constructing a very accurate photometer to measure the decrease in the surface brightness of the Crab Nebula due to its expansion. The current theory was that the light of the Crab was due to free-free emission, and although this gave very unlikely values for the mass contained in the gas (namely between 20 and 30 solar masses), it predicted a steady decrease in surface brightness. Oort had just the right person on his staff to build such an apparatus: Th. Walraven, who, apart from being an eminent astrophysicist was also an instrumentation wizard, and he started him off on this project.

And then Oort came across comets, due to a Ph.D. student he was supervising. When the student had obtained his Ph.D. the thought kept nagging at Oort's mind that there might be more to be got out of the data. And so there was. From the distribution of the *inverse* of the major axes of comets Oort concluded that most comets come originally from a reservoir of debris almost halfway to the nearest stars (nowadays generally referred to as the Oort Cloud), are disturbed into orbits around the sun by passing stars, and occasionally captured by the major planets, particularly Jupiter. These latter comets are the periodic ones, like Halley's comet, having periods of from 5 to some 70 years. Oort also speculated that the debris had originated in the asteroid belt and been diffused outward again by disturbance by the major planets. The theory gave a direct answer to the old question of what comets are: members of the solar system rather than visitors from interstellar space. Oort's ideas rapidly found wide acceptance.

Oort's acceptance of the position of General Secretary of the IAU in 1935 had already given an indication of his interest in international cooperation. This interest, together with the obligations of his position caused him to spend a lot of his time travelling, much more than

he had done before. Also, honours came his way. In 1946 an Honorary Doctorate at Copenhagen on the occasion of the quatuorcentenary celebrations of the birth of Tycho Brahe, and the George Darwin Lecture of the Royal Astronomical Society in the same year. In 1948, he travelled to the United States, visiting the major Observatories. He went to South Africa to see for himself how things were at the Southern Station. H. van Gent, the Leiden Southern Observer, who had died unexpectedly in 1947 while on leave in the Netherlands, had already indicated that observing conditions in Johannesburg were deteriorating due to the growth of the city. This proved to be the case to such an extent that a move seemed advisable. In the following years a site was sought, and one was found at Hartebeespoortdam within fairly easy distance of Johannesburg; the Rockefeller instrument was moved there in 1951. On this journey he also visited the Kenya expedition. He also spent a month in Egypt during 1950, at Helwan Observatory, as visiting professor and advisor. During the second half of 1951 he was finally able to take half a year off. The Oorts (his wife was able to come, too) spent most of this time at Princeton, with visits to Pasadena. He must have enjoyed this visit tremendously. It gave him the much needed opportunity to spend most of his time on research, and in inspiring discussions with colleagues. It resulted in some collaborative papers in the succeeding years, of which one of the most important is probably the one by Oort and Spitzer on the acceleration of interstellar clouds by O-type stars. It obviously gave him fresh energy to continue with the work at home.

He had come to the United States just after the first detection of the 21-cm line. This project had run into difficulties due to manpower problems. The construction of the receiver did not seem to be getting anywhere, and ended with a fire that destroyed what had been achieved so far. The fire probably was a blessing in disguise. The project was taken up again by a young radio engineer, C.A. Muller, and he finally succeeded in constructing a receiver that would be able to observe the 21-cm hydrogen line, and did so, with the antenna in Kootwijk, on May 11th, 1951 - six weeks after the line had been first detected at Harvard by Purcell and Ewen. Two months later the detection was also confirmed in Australia, by Christiansen's group, and all three reports were published simultaneously in *Nature.*

The Harvard group hoped to use the line as a probe of the physical conditions in interstellar regions, but in Leiden the detection opened the way to the systematic study of the Galaxy, or at least of that part of it that could be observed from the Netherlands - the Australian group did the same for the southern hemisphere - not just the local part but all of it, including the region on the other side of the galactic centre, which had so far been completely inaccessible. The detection also gave Oort the opportunity to renew his attempts to get funding for a bigger instrument, built specifically for hydrogen-line observations. This time he was successful, and in 1956 a 25-m radio telescope was built at Dwingeloo. For about a year, until the completion of the 250-ft telescope at Jodrell Bank, this was the biggest radio telescope in the world.

While the Dwingeloo telescope was being built, Oort became involved in another organizational problem: in 1953, the German-American astronomer Walter Baade had come to Leiden as a visiting professor. He came just for a couple of months, but the results of his visit were far-reaching, for in the course of the discussions he and Oort had, the point came up that what Dutch astronomers lacked was guaranteed access to a large telescope in the southern hemisphere. All there was at that time was a number of smaller instruments in South Africa and Australia. With the projects already being implemented it was unlikely that the Netherlands would be able to set up such an instrument by itself, but there might be opportunities for co-operation with other European countries. In June of that year a conference was held in Groningen on 'The Co-ordination of Galactic Research', to which most of the leading European astronomers came. During a boat excursion on the IJsselmeer the matter was discussed thoroughly by the participants, and steps were set in motion to see if such an observatory could not be organized jointly by six European countries.

The foundation of the European Southern Observatory has been described fully by A. Blaauw.[11] Suffice it to say here that it took ten years from that conference until the go-ahead for its building was finally given. Ten years of continual lobbying, meetings, drafting of

[11] *ESO's early history. The European Southern Observatory from concept to reality*, by A. Blaauw. EOS, Garching bei München, 1991.

Official opening in 1956 of the 25-m Dwingeloo telescope
by H.M. Queen Juliana, J.H. Oort explaining.

plans, etc., with Oort as the chairman of the committee striving for the realization of ESO.
Oort did not leave it at that, for as soon as the Dwingeloo telescope was in operation, he turned his thoughts to its successor: a much larger and thereby much more sensitive instrument, with higher resolving power, to be able to study external galaxies in similar detail as our own Galaxy had been studied with the 7.5-m Wurzburg antenna at Kootwijk. Also, the Netherlands was perfectly suitable for radio astronomy, and there was no comparable instrument being planned elsewhere, so Oort set up a group of people to investigate the possibilities of a large radio telescope and to make some preliminary design sketches. The Belgians were also interested in these possibilities, so it was decided to make it a joint effort, and the Benelux Cross Antenna Project came into being. This is not the place to go into the problems the project ran into - a full description of the origin and history of the final result has been given in the book that was published on the occasion of the 25th anniversary of the WSRT[12] - but in 1970 the Westerbork Synthesis Radio Telescope, consisting of twelve 25-m dishes laid out in an east-west line - with a total length of 1.5 km went into operation. It was officially inaugurated on June 24, 1970.
Clearly these organizational tasks, added to the 21-cm research, occupied a great deal of Oort's time. However, there still proved to be enough time for further research initiatives. Two subjects should be mentioned briefly.
The first of these is the Crab Nebula. It has been mentioned above that Oort had set Walraven to the task of constructing a photometer for an attempt to measure the decrease in intensity expected from the fact that the Crab Nebula was expanding. This photometer was just about ready when reports reached Oort that some Russian astronomers had followed up a suggestion that the optical light of the Crab might be due to synchrotron radiation, and had measured a high degree of polarization. Adding a polaroid to the photometer was easy, and Oort and Walraven were able to confirm the presence of strong polarization. They promptly proceeded to map this polarization, and

[12] *The Westerbork Observatory, Continuing Adventure in Radio Astronomy*, by E. Raimond, R. Genee, Eds. *Astrophys. Space Sci. Lib.*, Dordrecht (Kluwer Academic Publishers) 1996.

got Baade involved in doing additional observations with the 200-inch telescope on Mt. Palomar. The results showed conclusively that the interpretation of the light as synchrotron emission was correct. And somewhat later there were the high-velocity clouds. It should be remarked that as research interests of astronomers in Leiden and in Groningen matured the Dwingeloo telescope, once finished, was mostly used for different types of observations than it was originally intended for, namely for detailed studies of part of the Milky Way rather than for extensive surveying. This resulted in, first, the discovery of an expanding arm between the Sun and the Galactic Centre, the so-called 3-kpc arm. Later, it led to the discovery of tenuous clouds at high galactic latitudes and with anomalously large velocities, the high-velocity clouds. This was a discovery that would occupy Oort almost until the end of his life. Once they had been mapped properly, the main problem with these clouds was that it proved practically impossible to derive their distances. The kinematic considerations used in mapping the Milky Way did not apply, and in fact the only possibility of deriving at least limits to their distances was the detection of absorption lines due to the clouds in the spectrum of background objects. Such observations continue to be extremely difficult and there is still no consensus on the distances to high-velocity clouds, although the few results that there are indicate distances of the order of 4-6 kpc, meaning that they are not very local.
To all the demands that were made upon Oort's time, the Presidency of the International Astronomical Union was added (1958-1961). Most of the documents relating to this presidency are in the IAU archives. Oort's own archives contain some documents concerning the difficulties with the membership of Taiwan. A further description of this can be found in the book by A. Blaauw[13] on the History of the IAU.
One demand Oort did manage to avoid. In 1960 or 1961 it would have become his turn to serve as Rector Magnificus of Leiden University. Oort felt that he was not suited for this position, and that he would loose what little time he had left to do research. He introduced a question to the Senate as a matter of principle. Should active research scientists be required to leave their research for a year to do

[13] 'The China Crisis' in : A. Blaauw, *History of the IAU*, Dordrecht (Kluwer Academic Publishers) 1994.

something that was becoming more time-consuming as the University increased in complexity, and that they were not particularly suited for? Wouldn't it be better to leave the principle of having the most senior professor as Rector and appoint someone more specialized in administration, preferably for a longer term than one year? Other professors felt as he did, so Oort carried his point, and the Statutes of the Senate were duly revised.

At the end of the sixties we thus have the following picture. The Observatory had just celebrated its centenary in its present location. It was thriving, attracting many foreign astronomers who would come to stay for anything from a few days to a year. In Chile the European Southern Observatory consortium had a 3.6-m optical telescope under construction (some smaller telescopes were already functioning). In the woods near Hooghalen (Drenţe) the Synthesis Radio Telescope was nearing completion. Although administrative duties still occupied him as much as ever, Oort still had his former research interests. He avidly followed whatever became known about the centre of our Galaxy, and he was still trying to elucidate the high-velocity clouds, mostly in terms of the formation of galaxies, giving some indication of a shift in his interest: he was becoming more interested in cosmological problems. And quite close now were two important events: The completion of the Synthesis telescope, and his retirement. He was making plans for both, and of course they were closely connected, as his retirement would leave him more time for research, and he was planning what should be done with the new instrument.

Oort gave his farewell lecture, customary for retiring professors in the Netherlands, in September, 1970. His directorate of Leiden Observatory came to an end, and with it his residency in the Observatory building. The Oorts moved to a newly-built house in Oegstgeest, on a canal where they could leave the boat that had been given Oort on the occasion of his 70th birthday. He kept an office at the Observatory, and the fact that many administrative responsibilities had come to an end together with his directorship meant that he now had much more time to spare for scientific research than he had ever had since the second world war. His wife had some hopes that he would finally find the time to write the book about dynamics he had started on during the war years, but with the WSRT in operation Oort could not resist throwing himself whole-heartedly into the flood of new data that came pouring out. Especially the observations of nearby galaxies

had his interest, witness his collaboration in the discussion of NGC 4258, with its anomalous radio arms. He did not get directly involved in the reduction and discussion of observations of the rotation curves of external galaxies, but he closely followed them. He continued his work on high-velocity clouds and became more and more interested in all the new results there were on the galactic centre. Ultimately he wrote a review article on the subject (*Annual Review* 1977), in which he brought together everything known about the galactic centre so far. In fact it was not just a review article, but included considerable original research. To collect the material he corresponded with colleagues all over the world, and the result is a classic.

Having finished this review, Oort shifted his interest. Sufficient data had now become available for him to feel that the time was ripe for progress in the problems of Galaxy formation and the origin of structure in the Universe, in particular the origin of superclusters. He had been very much impressed by the theoretical articles on the subject by Russian colleagues, particularly those by Zel'dovich. Also, since his retirement he had been spending one to two months each year at Princeton, where there was a strong interest in the subject. Oort tackled the problem by way of the quasar absorption lines, about which he published a number of papers. He reached the conclusion that Zel'dovich's pancake model gave a good representation of the Universe. His interest in superclusters culminated in another *Annual Review* paper, again based on as broad a survey of the data available as possible, and again including a great deal of original research.

After the publication of this paper he continued to work in this field for a few more years. These are the years in which some of the most important prizes came his way: in 1984 the prize of the (Italian-Swiss) Balzan Foundation, followed by the Japanese Kyoto Prize in 1987.

In addition to Oort's natural ability and enthousiasm, without which no important role in astronomy would of course have been possible at all, two aspects of Oort's scientific work are particularly striking to anyone who has come into contact with it. The first aspect is its timeliness. Oort had a very good sense for the kind of investigation that might 'strike gold'. The best example of this is probably his early recognition that radio astronomy was important. He was the first and, for some time, the only classical astronomer to do so. But this char-

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THE STRUCTURE OF THE CLOUD OF COMETS SURROUNDING THE SOLAR SYSTEM, AND A HYPOTHESIS CONCERNING ITS ORIGIN,

BY J. H. OORT

The combined effects of the stars and of Jupiter appear to determine the main statistical features of the orbits of comets.
From a score of well-observed original orbits it is shown that the "new" long-period comets generally come from regions between about 50000 and 150000 A.U. distance. The sun must be surrounded by a general cloud of comets with a radius of this order, containing about 10^{11} comets of observable size; the total mass of the cloud is estimated to be of the order of 1/10 to 1/100 of that of the earth. Through the action of the stars fresh comets are continually being carried from this cloud into the vicinity of the sun.
The article indicates how three facts concerning the long-period comets, which hitherto were not well understood, namely the random distribution of orbital planes and of perihelia, and the preponderance of nearly-parabolic orbits, may be considered as necessary consequences of the perturbations acting on the comets.
The theoretical distribution curve of $1/a$ following from the conception of the large cloud of comets (Table 8) is shown to agree with the observed distribution (Table 6), except for an excess of observed "new" comets. The latter is taken to indicate that comets coming for the first time near the sun develop more extensive luminous envelopes than older comets. The average probability of disintegration during a perihelion passage must be about 0·014. The preponderance of direct over retrograde orbits in the range from a 25 to 250 A.U. can be well accounted for.
The existence of the huge cloud of comets finds a natural explanation if comets (and meteorites) are considered as minor planets escaped, at an early stage of the planetary system, from the ring of asteroids, and brought into large, stable orbits through the perturbing actions of Jupiter and the stars.
The investigation was instigated by a recent study by VAN WOERKOM on the statistical effect of Jupiter's perturbations on comet orbits. Action of stars on a cloud of meteors has been considered by ÖPIK in 1932.

1. *Sketch of the Problem.*

Among the so-called long-period comets there are 22 for which, largely by the work of ELIS STRÖMGREN, accurate calculations have been made of the orbits followed when they were still far outside the orbits of the major planets [1]). Approximate calculations of the original orbits by FAYET [2]) are available for 8 other comets with well-determined osculating orbits. For the present limiting ourselves to the comets for which the perturbations were rigorously determined, and excluding 3 for which the mean error of the reciprocal major axis, $1/a$, is larger than 0·000100, the values of $1/a$ for the remaining 19 comets are distributed as shown in Table 1.

TABLE 1
Distribution of original semi-major axes
(a in Astronomical Units)

1/a	n
< ·000 05	10
·000 05 – 10	4
10 – 15	1
15 – 20	1
20 – 25	1
25 – 50	1
·000 50 – 75	1
> ·000 75	0

The mean errors of $1/a$ are all smaller than 0·000061; their average is ±·000027. The steepness of the maximum for small values of $1/a$ indicates that the real mean errors of the original $1/a$ cannot greatly exceed these published mean errors. The 22 comets do not form a representative sample of the long-period comets; there has been a selection for small values of $1/a$, so that the real proportion of comets with $1/a$ > ·000 50 is much larger than indicated in the table. It can be shown, however, that the selection has not appreciably influenced the relative numbers in the rest of the table. Among the comets in the first division there are two with negative values of $1/a$, viz. −·000007 and −·000016, probably due to observational errors.

It is evident from Table 1 that the frequency curve of $1/a$ shows a steep maximum for very small values. The average for the 10 orbits in the first interval is ·000 018, thus corresponding to a major axis of 110000 A.U. We may conclude that a sensible fraction of the long-period comets must have come from a region of

1) A list of these is given by SINDING, *Danske Vidensk. Selsk., Mat.-Fys. Medd.* 24, Nr 16, 1948, or *Publ. o. Mindre Medd. Köbenhavns Obs.* Nr 146. VAN BIESBROECK's orbit for comet 1908 III has been added to this list.
2) *Thèse*, Paris, 1906; also in *Ann. Paris, Mém.* 26A, 1910.

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Annotated copy of J.H. Oort's article 'The structure of the cloud of comets surrounding the solar system, and a hypothesis concerning its origin'.

acteristic also shows in his work on interstellar dust, on comets, on the Crab Nebula, on superclusters. The second aspect is his capacity for deep physical insight, which must have been innate, but which was enhanced and stimulated by Kapteyn's teaching. Kapteyn considered mathematics as no more than a tool for astronomy, a tool which one should not allow to obscure the essentials, and Oort always found himself in total agreement with this attitude. It was the insight into the physics of the phenomena that counted. In practice this meant that Oort would 'translate' abstruse mathematical papers into physical terms in order to be able to work with their ideas. The best example of this is, of course, the results that first brought him fame. In 1927, Lindblad published his theory of differential galactic rotation in difficult mathematical terms. It took Oort to translate this into a physical model for which he realized he had the data to prove it correct. Another example can be found in his work on comets, where he had derived the existence of the comet cloud on the outskirts of the Solar System from the observations, using the mathematics needed in dynamics, but then deduced the origin of this cloud using general physical arguments and a minimum of mathematics. His working methods were to 'ponder' a problem and then write down the results of his thoughts in a systematic fashion. Especially for the later research, the records are there in the archives, page upon page of work notes, dated for ordering in which problems were thought out, intermediate results noted, comments made on missing information, etc. etc.

During his Directorate of Leiden Observatory Oort was the natural leader of Dutch astronomy, which thrived under this leadership. His authority and persistence were such that he generally managed to obtain the support he needed from Leiden University, and from government and industry. In this he was aided by his conviction that astronomy was of considerably higher intrinsic worth than most things people were spending money on, and that you should not be held back by considerations of equal opportunities but ask for what you genuinely felt was necessary. Moreover, he was strongly supported by the Director of ZWO, J.H. Bannier (mentioned above), and by the President of the Board of Curators of Leiden University, J.E. de Vos van Steenwijk. The results are still with us in the form of first-class institutes and access to telescopes in various wavelength ranges. However, the immaterial results of Oort's style of leadership have also persisted. He attached great importance to good relations between astronomers and between institutes, and during his directorship a solidarity and family-feeling developed at the Leiden Observatory, and also between the various astronomical groups in the Netherlands.

One cannot say that Oort put the Netherlands on the map astronomically. After all, Kapteyn, De Sitter, and Hertzsprung had gone before, and the importance of Pannekoek, Zanstra, and particularly Oort's contemporary Minnaert, should not be underestimated. But it was during Oort's tenure as Director of Leiden Observatory that the international importance of the Netherlands increased out of all proportion to its size. Not only Oort, but other Dutchmen took up important functions in international councils (especially Oosterhoff, Van de Hulst, and Blaauw), or held important posts at foreign observatories particularly in the USA. This trend had already begun in the thirties, when Kuiper, Bok, Schilt, and Van de Kamp went to the USA, but it continued after the war (Schmidt, Westerhout, Woltjer, Blaauw). On important astronomical decisions, Oort was the obvious person to consult, and it is noteworthy that when in 1955 *LIFE magazine* published a list of the 100 most famous people, Oort was on it (together with people like Eisenhower, Churchill, Krushchev, Stravinsky, and Picasso). His importance is also reflected in the number of foreign Science Academies of which he was a member (sixteen, including all the major ones), and the number of Honorary Doctorates that he was awarded (ten). Oort was certainly one of the great astronomers of the 20th century.

Most of his life was taken up with astronomy, but not all of it. His family was very dear to him, and although he often was obliged to work evenings and weekends and to take his work along with him when he went on holiday, part of each day was kept apart to spend with his family. On those trips on which he was unable to take his wife he wrote long letters every few days. He loved skating. He found skimming over dark ice under a wintry sun towards the horizon a very special experience, and when the ice was good enough (which happened, for him, rather sooner than for everybody else, because of his low weight and high speed) he would go on long skating trips. If the ice was very good the Observatory staff would be given a half-day off, and whoever could skate would join Oort in an excursion on the lakes to Kaagdorp, where one of the staff members lived, who would

provide hot drinks before the return trip was made. He also liked rowing. During his student days he coached a championship four, and after his retirement he took up rowing again to keep in shape. Oort had been brought up to appreciate books, music, paintings. He learned to play the piano but did not become sufficiently proficient to keep it up. But it was painting that he loved best. He followed art-appreciation courses, and when visiting another country he would always try to take some time off to visit the local museums and exhibitions. He became very knowledgeable on art, and in the fifties served for some years as chairman of the pictorial arts committee of the Leiden Academical Arts Centre, which had among other things the task of organizing expositions. He threw himself into the work heart and soul, getting to know some of the better-known contemporary painters in the process.

Oort's physical condition remained good until the mid-eighties, although he was somewhat hampered by increasing deafness. In 1981 he took a nasty fall while out skating on the lakes, knocking himself out, and from then on he stopped going out on extended skating tours, but he kept rowing and riding his bicycle to work at the Observatory[14]. From about 1985 onwards, however, he became increasingly frail, and his journey to Japan in 1987 to accept the Kyoto Prize proved extremely taxing, even though his hosts did everything in their power to make the journey as comfortable as possible. In the late eighties, Oort was no longer able to come to the Observatory every day, and his field of work narrowed down. At about this time he returned to the comets he had explained so successfully in 1950, adding new data and working on a strengthening of the theory. Early in 1992 deteriorating health both of himself and his wife made it necessary to move to an old peoples' home. In November of that year Jan Oort took a bad fall, and died of the effects a few days later[15]. It was the end of an era.

[14] In 1974, the staff of the Observatory had been moved to new offices on the outskirts of Leiden, taking the name 'Observatory' with them. The old buildings were referred to from then on as 'The Old Observatory'.
[15] His wife survived him by seven months. Mieke Oort died in June, 1993, also as the result of a fall.

As Chandrasekhar put it: 'The great oak of Astronomy has been felled, and we are lost without its shadow.'[16]

[16] Further reading:
J.K. Katgert-Merkelijn, *The letters and papers of Jan Hendrik Oort, as archived in the University Library, Leiden.* Dordrecht (Kluwer) 1997.
[J.H. Oort], 'J.H. Oort', in *McGraw-Hill modern men of science. 426 leading contemporary scientists.* New York 1966-1968.
Oort and the universe. A sketch of Oort's research and person. Liber amicorum presented to Jan Hendrik Oort on the occasion of his 80th birthday. Dordrecht 1980.
H.C. van de Hulst, 'Jan Hendrik Oort (1900-1992)', in *The Quarterly Journal of the Royal Astronomical Society* 35 (1994), pp. 237-242.
A. Blaauw, 'Jan Hendrik Oort, 28 april 1900 – 5 november 1992', in *Zenit,* mei 1993, pp. 196-210.
A. Blaauw & M. Schmidt, 'Jan Hendrik Oort (1900-1992)', in *Publications of the Astronomical Society of the Pacific* 105 (1993), pp. 681-685.

Visit to Berlin (1919). J.H. Oort the second from right, with friends, standing before the Reichstag. Postcard.

CATALOGUE OF THE EXHIBITION [17]

1. Biography

1. House of birth of Jan Hendrik Oort, Zilverstraat 16, Franeker. Oort was born on April 28, 1900, and lived here for three years.

2. Parents of Jan Oort: Abraham Hermanus Oort and Hannah Faber (c. 1930)

3. The two brothers Jan and Hein Oort (c. 1910)

4. Relatives and friends as Indians. Jan Oort seated centre. (c.1910)

5. Visit to Berlin (1919). Oort the 2nd from right, with friends before the Reichstag. Postcard from Jan Hendrik Oort, Berlin, January 2, 1919, to his mother in Davos, Switzerland. He writes: 'Dear Mother, you can not half imagine how I am enjoying my stay here. Everything is cheap here, or rather almost everything. I have been to the large Opera House twice. I have never seen something so magnificent and beautiful, and that for *f* 1,20, extraordinarily beautiful seats. You can buy here everything, also foodstuffs, and mostly cheaper than in Holland. Yet, it is a terrible situation in the streets. Everything unpainted, there are horse-drawn trams, humping and bumping again through the Friedrichstrasse. We are staying here in the centre of town (Gendarmen Platz) in a quiet and very pleasantly decorated hotel for DM 15, breakfast not included. The journey was splendid. We sat comfortably the whole day in the D-train from Cologne to Berlin, on which we boarded in Hannover (2nd class for *f* 4,00, almost 500 km). It was not crowded. For the Germans who are not so very rich, as we are here now, the food situation is really difficult. Tonight we will see the *Oresteia* of Aeschylus in the Grosse Schauspielhaus, which has recently been built. If I could I would like to stay here for a full month. The large streets and everything else!

[17] Unless otherwise stated, all objects exhibited originate from the Oort Archives, kept in the Department of Western manuscripts in Leiden University Library and in the collections of the Leiden Observatory.

Many greetings to all in Davos. This is us, in front of the Reichstag building, for 3 cents! Yours, Jan.'

6. Wedding photograph of Jan Oort and Mieke Graadt van Roggen (May 24, 1927). Clockwise around the bridal couple from left to right: Jetske Oort, Lien and Coen Graadt van Roggen, Mr. and Mrs. A.H. Oort, Mrs. and Mr. W. Graadt van Roggen, Jo and Pivy Oort, Emy Oort

7. Passport photograph of Jan Oort (c. 1935). Photograph by H. Jonker, Leiden

2. Leiden Observatory

8. Brochure Leiden Observatory, with an introduction by J.H. Oort. *Honderd jaar Leidse Sterrewacht.* Leiden 1965

9. The 'Former Leiden Observatory' (photograph by Jan Zwart, 1996)

10. J.H. Oort, leaving the main building of Leiden Observatory (1976)

11. Staff of the Leiden Observatory in 1933. Photograph H. Jonker & Zoon)
(1) G. van Herk, (2) P.Th. Oosterhoff, (3) C.H.L. Sanders, (4) W.E. Kruytbosch, (5) J. Uitterdijk, (6) C.H.Hins, (7) A.J. Wesselink, (8) H.A. Kluyver, (9) G.P. Kuiper, (10) J.H. Oort, (11) A. de Sitter, (12) C.H. de Nie, (13) H. Kleibrink, (14) P.P. Bruna, (15) E. Hertzsprung, (16) J.M. Kriest, (17) M.D. Schepper, (18) B.C. Mekking, (19) L. Gaykema, (20) J.C. Gaykema, (21) P. de Haan, (22) J.E. Prins, (23) H. Zunderman, (24) W. de Sitter, (25) J.E. Stol, (26) L.J.F. van Leeuwen, (27) W. van Heuzen, (28) A. Luteyn, (29) D. Gaykema, (30) J.H. Kasten, (31) H.M. Swaak, (32) J. Woltjer, (33) J. Nicaise, (34) G. Pels, (35) F. de Haas, (36) E.W. de Rooy

12. Staff of the Leiden Observatory in 1960. Photograph N. van der Horst).
(1) W.N. Christiansen, (2) E. Raimond, (3) J. Kluiters, (4) P. Kiel, (5) C.J. van Houten, (6) W. Star, (7) D. Ondei, (8) R. Rijf, (9) L.

Maitimo, (10) P. de Hoorn, (11) I. Robbers, (12) L. Braes, (13) K.K. Kwee, (14) A. Ollongren, (15) T. Hoekema, (16) unknown, (17) unknown, (18) H. Pels-Kluyvers, (19) J.H. Oort, (20) unknown, (21) J.A. Högbom, (22) J. Bevelander, (23) H. Kleibrink, (24) P.Th. Oosterhoff, (25) unknown, (26) W.W. Shane, (27) B. Hooghoudt, (28) unknown, (29) G.P. Smith (?), (30) A. Meester, (31) A.G. Jansen, (32) unknown, (33) L. Gaykema, (34) G. Westerhout, (35) F. Hermans, (36) unknown, (37) unknown, (38) unknown, (39) A. Filippo, (40) J. Tinbergen, (41) unknown, (42) M. Flohr, (43) unknown, (44) C. Kooreman, (45) unknown, (46) M. Pauw, (47) I. Starre, (48) W. Rougoor, (49) unknown, (50) W.N. Brouw, (51) G. van Agt, (52) A.M. van Genderen

3. Leiden University

13. Solemn procession of the Professors on their way from the University building on the Rapenburg in Leiden to the nearby Church of St. Peter (c. 1950). J.H. Oort following at the back. Photograph by N. van der Horst.

14. J.H. Oort discussing Observatory affairs with P.Th. Oosterhoff (1947). Photograph by Ad Windig.

15. J.H. Oort in conversation with H.C. van de Hulst, at the reception on the occasion of Oort's quadragenarian jubilee as a staff member of Leiden Observatory in 1964

16. At his retirement in 1970, J.H. Oort was awarded the insignia of 'Commandeur of the Order of Oranje-Nassau' by the then Minister for Education, Dr. G.H. Veringa

17. A Ph.D. ceremony in the Senate Room of Leiden University, 1977. Behind the table, left to right: R.D. Ekers, H.C. van de Hulst, J. van den Berg, the Rector, H. van der Laan, J.H. Oort, C. van Schooneveld, A. Blaauw

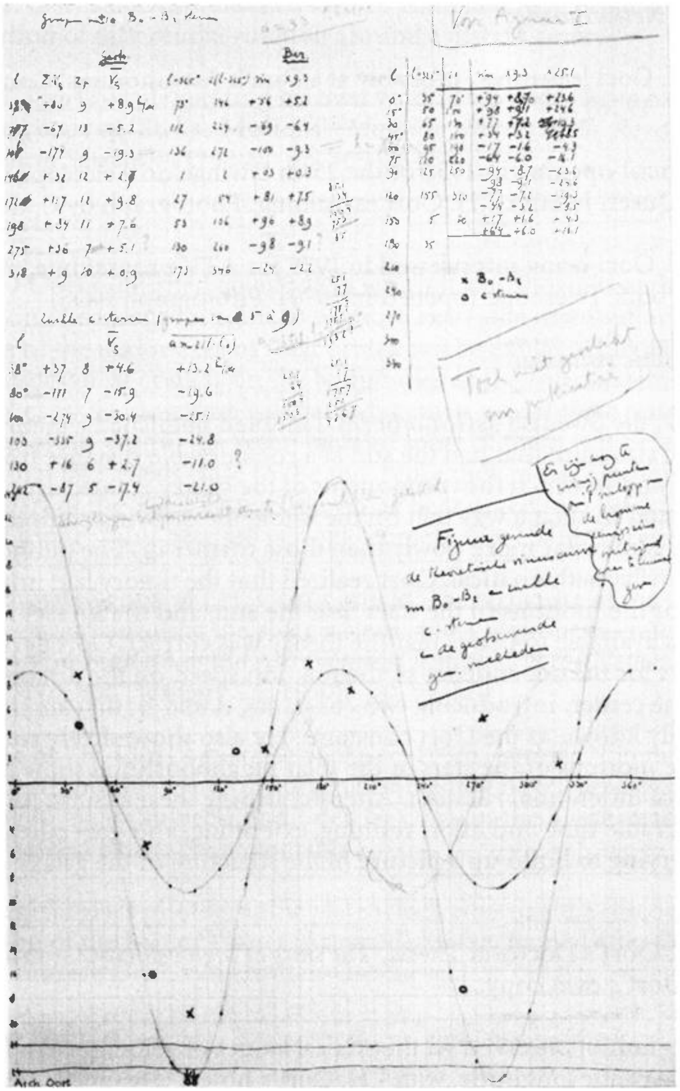


Diagram of observed vs. theoretical values of velocities as a function of galactic longitude, with J.H. Oort's note: 'Unsuitable for publication after all'. Unpublished in this form.

4. The Netherlands

18. J.H. Oort lecturing , probably at a Dutch Astronomers' Conference (c. 1956)

19. Official opening in 1956 of the 25-m Dwingeloo Telescope by H.M. Queen Juliana, J.H. Oort explaining. Photograph by C. de Boer

20. J.H. Oort being interviewed in 1978 for a TV programme, at the Westerbork Telescope (opened in 1970). Photograph NOS.

5. Galactic rotation

In 1927, the Swedish astronomer B. Lindblad published a theory of galactic structure that had the sun at a considerable distance from the center, and in which the components of the galaxy rotated around that center in such a way that on the whole the outlying components moved somewhat more slowly than those further in. The publication was heavily mathematical. Oort realized that the theory had implications for the motions of the stars near the sun, and that in fact material was available to prove that the theory was correct. Oort derived the laws for the dependence of the rotation speed on the distance from the center, introducing two constants, A and B, that are now generally known as the Oort constants. He also showed very roughly that the motions of the stars in the solar neighbourhood show the effects of differential rotation. After publishing these results, he spent considerable time and effort refining, extending, and generalizing them, trying to build up a picture of the structure of the galaxy as a whole.

21. J.H. Oort's Doctoral Thesis, *The stars of high velocity*. Groningen 1926. Oort's own copy.

22. Diagram of observed vs. theoretical values of velocities as a function of galactic longitude, with J.H. Oort's note: 'Unsuitable for publication after all'. Unpublished in this form: too few data points, therefore unconvincing. Version with more data published in *Bulletin of the Astronomical Institutes of the Netherlands* 1927 (4) pp. 79-89 and 94.

23. J.H. Oort's correspondence with B. Lindblad, who originated the suggestion of differential rotation around a distant centre

24. J.H. Oort supplementing his own work. Two pages from his working copy of 'Stellar Motions' (*Monthly Notices of the Royal Astronomical Society* 99 (1939), pp. 369-384)

6. Comets

In 1950 Oort published an article in which it was shown that the distribution of comet orbits, or, to be more exact, the distribution of the inverse of the major axes of their orbits, can be explained by assuming a reservoir of comets on the boundaries of the solar system. Disturbances by passing stars will perturb comets out of their roughly circular orbits within the reservoir, and some of them will be led into orbits that take them close to the sun. Once they move through the inner part of the Solar system, they may be trapped into thighter orbits by Jupiter, and become periodic comets, like Halley's comet.

25. Annotated copy of J.H. Oort's article 'The structure of the cloud of comets surrounding the solar system, and a hypothesis concerning its origin' in *Bulletin of the Astronomical Institutes of the Netherlands* vol. 11, No. 408 (January 13, 1950), pp. 91-110

26. One of J.H. Oort's exercise books (c. 1956), entitled 'Literature, Radio Astronomy'. Carefully organized reading notes, arranged according to major subjects, indicated by Oort on the home-made tabs, and preceded by a table of contents.

27. Original glass photographic plate which contains the discovery detection of the Minor Planet (Asteroïd) Mieke, named after Oort's wife. Courtesy Dr. I. van Houten-Groeneveld

7. Crab Nebula

In the early 1950's Russian astronomers suggested that the radiation from the Crab Nebula might be synchrotron radiation. Oort had long

[illegible]

Oegstgeest,3o Juli 194o

Amice,

Het is my gelukt nog een plaats te vinden waar je Nova wordt vermeld.Er bestaat n.l.een uitvoerig werk,waarvan pas enkele jaren geleden een Ms.photolithographisch is gepubliceerd(en dat dus aan vroegere onderzoekers niet bekend kon zyn),handelende over de instellingen van de Sung dynastie,-de dynastie waartoe het jaar 1o54 behoort.De naam is Sung Hui Yao.In deel 54 daarvan,op p.2b(maar de bladzyden zyn niet genummerd)is een korte paragraaf over "gastster en", de term die ook in de je reeds bekende werken gebruikt wordt. Deze tekst interesseert zich niet voor astronomische verschynselen als zoodanig,maar alleen in verband met de astrologische interpretatie van goed of slecht voorteeken.

Daar wordt vermeld dat op den 22sten dag van de 7de maand van het 1ste jaar van de periode Chih-ho(27 Augustus 1o54,Juliaansche kal.)door Yang Wei-tê werd gerapporteerd dat er een"gastster" zichtbaar was,"die eenigszins had een irriseerende gele kleur".

In de 3de maand van het 1ste jaar van de periode Chia-yü(19 Maart- 18 April 1o56 Juliaansch)werd gerapporteerd dat de "gastster"onzichtbaar was geworden,-een voorteeken van het vertrek van gasten.

Hieraan wordt toegevoegd:"Aanvankelyk was dit gesternte in de 5de maand van het 1ste jaar van de periode Chih-ho(9 Juni-8 Juli 1o54 Juliaansch)zichtbaar geworden aan den oostelyken hemel in T'ien-kuan(zeta Tauri);h t was overdag zichtbaar,als Venus;puntige stralen schoten er op vier plaatsen uit(d/i.waarschynlyk "overal";dit is dezelfde uitdrukking die dient ter definitie van de term"zich als komeet gedragen"in de andere teksten);de kleur was rood-wit. In het geheel was het zichtbaar 23 dagen".(eigenlicht is de bedoeling dat het 23 dagen overdag zichtbaar was?).

J.J.L. Duyvendak, Professor of Chinese in Leiden University, about the identification of the Crab Nebula with the supernova of 1054. Letter by Duyvendak , Oegstgeest, July 30, 1940, to J.H. Oort.

MOUNT WILSON AND PALOMAR OBSERVATORIES
CARNEGIE INSTITUTION OF WASHINGTON
CALIFORNIA INSTITUTE OF TECHNOLOGY

813 SANTA BARBARA STREET
PASADENA 4, CALIFORNIA

1955 April 30.

Dear Oort:

Many thanks for your very exciting letter. When you mentioned in one of your letters around Christmas that Walraven had succeeded in detecting polarization in the Crab nebula I kept the news to myself because I wanted to keep intruders off this work. The first confirmation that he must have had full success came when I saw the Manchester program with the announcement that you were going to discuss the polarization of the Crab nebula. But I must say I gasped when I saw the diagram which summarizes Walraven's measures. It is a wonderful piece of work, especially when one takes into account the modest size of the refractor with which the work was done and the large handicaps imposed by the weather. Walraven is certainly tops!

I am very glad that the discovery of the polarization reopens the whole question of the interpretation of the Crab continuum. During the past two years the following difficulty has plagued me very much: on Minkowski's interpretation a large mass (10 to 15 $\odot$) is unavoidable for the Crab nebulosity. But it is very difficult to see how supernovae I can have such large masses. They are clearly members of the pop. II and hence must have masses $\leq 1.5 \odot$. I have often discussed this difficulty with Minkowski and I believe he begins to realize the seriousness of this difficulty. Since Shklovsky claimed

Correspondence between W. Baade and J.H. Oort about the Crab Nebula (Pasadena, April 30, 1955).

been interested in the Crab Nebula. Some ten years earlier he had collaborated with the sinologist J.J.L. Duyvendak in an attempt to identify the event that had given rise to the Crab Nebula. They concluded that it must have been the 'guest star' of 1054, and that it must have been a supernova rather than a nova. At the time Oort heard of a synchrotron suggestion, he was working with T. Walraven on an instrument to determine possible expansion of the nebula. The instrument was easily adapted for measuring polarization, the footprint of synchrotron radiation, and they succeeded in showing that the Crab Nebula did indeed show strong polarization, confirming its synchrotron character and allowing conclusions to be drawn about the energy source.

28. Crab Nebula. Photograph of May 30, 1996, by J. Hester & P. Scowen, and NASA.

29. J.J.L. Duyvendak, Professor of Chinese in Leiden University, about the identification of the Crab Nebula with the supernova of 1054. Letter by Duyvendak , Oegstgeest, July 30, 1940, to J.H. Oort. Oort added in pencil: 'Must write an airmail letter about this to Mayall and Baade, as soon as I am back in Leiden'.
Duyvendak's letter begins as follows: 'Amice, I have succeeded in finding another place where your Nova is mentioned. There exists an extensive work, of which a facsimile edition was published only a few years ago (and which could not have been known to earlier researchers), treating the institutions of the Sung dynasty, which includes the year 1054. The name is *Sung Hui Yao*. In vol. 54 of this work, ...'

30. Correspondence between J.H. Oort and W. Baade about the Crab Nebula (1955). Carbon copy of one of Oort's letters to Baade (April 26, 1955), and Baade's handwritten answer to Oort (Pasadena, April 30, 1955)

31. 'Further data bearing on the identification of the Crab Nebula with the supernova of 1054 A.D.'
Part I. J.J.L. Duyvendak, 'The ancient oriental chronicles'
Part II. N.U. Mayall and J.H. Oort, 'The astronomical aspects'
(in *Publications of the Astronomical Society of the Pacific* 54 (1942), pp. 91-94 and 95-104)

8. International contacts

32. J.H. Oort as a young researcher, at a meeting of the American Astronomical Society, Poughkeepsie, N.Y., Vassar College, December 1923. Oort is standing in the centre, on the one but last row. Near him are P. van de Kamp and W.J. Luyten.

33. J.H. Oort in discussion with W. Baade on a boat trip at the General Assembly of the IAU (International Astronomical Union), Stockholm, 1938.

34. The beginnings of ESO (European Southern Observatory), Groningen 1953. Discussions during an excursion by boat on the IJsselmeer. Left to right: Vladimir Kourganoff, J.H. Oort, Harold Spencer-Jones

35. J.H. Oort lecturing at the inauguration of the ESO building in Garching bei München, 1981. Left to right (as if seen by Oort): unknown, Ch. Fehrenbach, D. Sciama, B. Strömgren, O. Heckmann

36. At the General Assembly of the IAU, Moscow, 1958. In the foreground, left to right: A. Massevitch, A. Danjon, J.H. Oort.

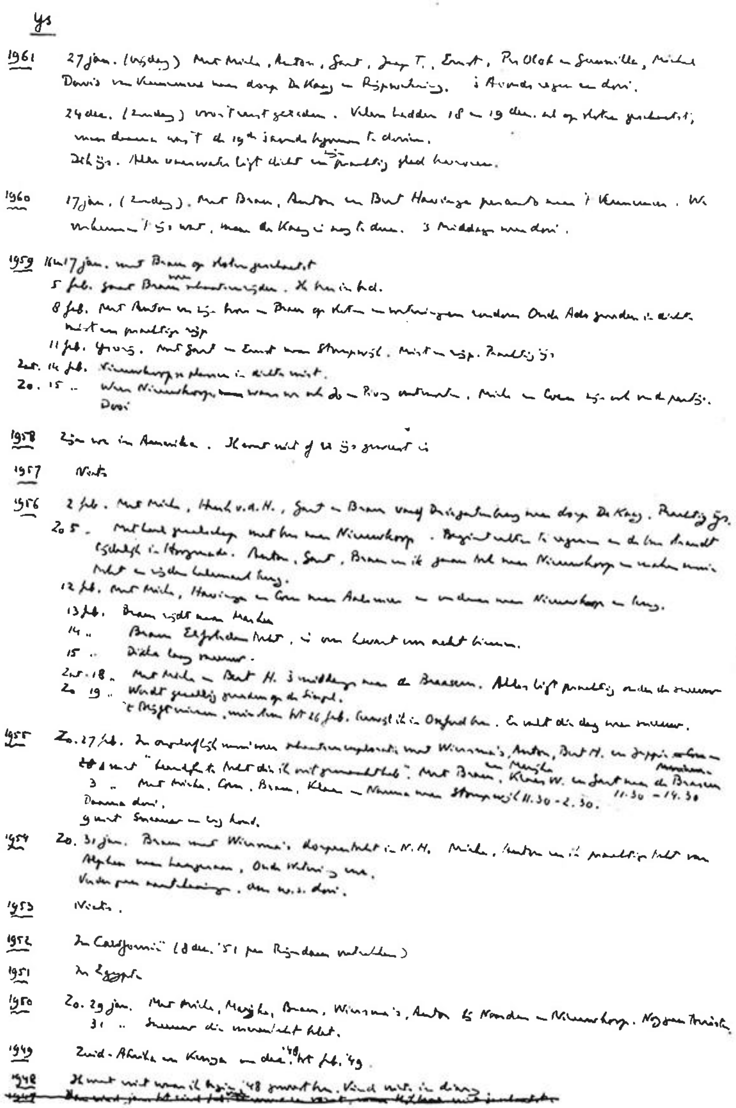
37. Diploma of the Royal Society of London, 1959 (Loan Academisch Historisch Museum Leiden)

38. Honorary promotion in Cambridge, July 25, 1960. Solemn procession, Oort at the right of the centre. Photograph by Cambridge Daily News

39. Honorary promotion in Cambridge, July 25, 1960, the *Laudatio* (1960)

40. Vetlesen medal and certificate of Columbia University New York, 1966 (Loans Rijksmuseum Het Koninklijk Penningkabinet Leiden, and Academisch Historisch Museum Leiden)

41. The Kyoto Prize Certificate 1987 (Loan Academisch Historisch Museum Leiden)



List of J.H. Oort's skating excursions, recollections carefully recorded in 1961 by himself, for the past years, back to 1946.

9. Mens sana ...

Oort's interests were diverse: Art (as shown by his work for the Leiden Academical Arts Centre (LAK), nature, family and sports.

42. J.H. Oort steering a Groningen students' rowing team (c.1920)

43. J.H. Oort's skates (Loan Mrs. Marijke de Smidt–Oort).
Oort was a fanatic skater (just like De Sitter). He always skated on this typical Frisian 'doorlopers'. In 1981 (!) he took a nasty fall while out skating on the lakes near Leiden. Afterwards he mostly stuck to rowing and biking.

44. List of J.H. Oort's skating excursions, recollections recorded in 1961 for the past years, back to 1946. The records begin as follows:
'Ice.
1961. January 27 (Friday). With Mieke, Anton, [...] to village De Kaag and Rijpwetering. In the evening rain and thaw.
December 24 (Sunday). Skated for the first time. Many had skated already on December 18 and 19 on the ditches in the fields, but after December 19, thaw had set in. Thick ice. All through going canals are splendidly frozen.'

45. Notes by J.H. Oort concerning meetings about the organization of artistic activities in Leiden. Possibilities of exhibitions dedicated to van Gogh, van Goyen and Jan Steen were discussed, 1947.

46. Painting of J.H. Oort by Gerard de Wit (1987) (Loan Academisch Historisch Museum Leiden)

47. Painting of J.H. Oort by D. Nijland (1938) (Loan Academisch Historisch Museum Leiden)

48. Bust of J.H. Oort by A. Oort (Loan Sterrewacht Leiden)

49. Medallion of Mieke Graadt van Roggen by A. Oort (Loan Sterrewacht Leiden)