Jan Hendrik Oort (1900–1992)

An obituary by L. Woltjer

In 1922 at the inaugural General Assembly of the International Astronomical Union in Rome, an unknown astronomy student, 22 years of age, managed (perhaps slightly 'illegally') to attend the scientific sessions. Seventy years later, on 5 November 1992, Jan Hendrik Oort, once described to me by S. Chandrasekhar as this century's most productive astronomer, passed away. During his research career spanning 70 years, Jan Oort has had an incredible direct influence in many areas of research: the structure and dynamics of galaxies; interstellar matter and supernova remnants, dark matter and cosmology, comets and many others. In parallel with his research activities he was a capable administrator and a firm believer in international collaboration—director of Leiden Observatory (1945–1970), president of the IAU (1958–1961), initiator of the European Southern Observatory (ESO) and its first president (1964–1965).

Jan Oort's research career has been characterized by a deep-seated curiosity into the nature of the Universe and by an infallible intuition as to the lines of research which were most promising. When necessary, Jan Oort developed the required mathematics for the solution of his problems, but he never developed theory for its own sake, preferring to stay as close as possible to the reality of observation. It is probably this characteristic of his approach that has made Jan Oort's articles of the distant past still largely valid today. When he started out, the rotation of our galaxy was just beginning to be suggested and the expansion of the Universe was still to be discovered. Radio and X-ray astronomy were still a distant future. Seventy years later, Jan Oort was still in the forefront of contemporary research avidly studying the large scale distribution of galaxies in the Universe and still inspiring others to follow where he led.

One of Jan Oort's first researches dealt with the rotation of our galaxy. B. Lindblad had proposed that the galaxy was composed of a number of flattened subsystems, each rotating with a certain angular velocity. Jan Oort realized that the rotation was more likely to be differential—like in the solar system—and proceeded to demonstrate that this was the case from the available observations of the radial velocities of stars. A first order expansion of the velocity field (in the absence of random motions) would yield for the radial velocity v_r and proper motion μ of a star at a distance r and a longitude l (with the galactic centre at $l=0$).

$$v_r = rA \sin 2l$$

$$\mu = B + A \cos 2l$$

where the 'Oort constants' are given by

$$A = \frac{1}{2} R_0 \frac{d\Omega}{dR} \quad \text{and} \quad B = A + \Omega_0$$

all quantities being evaluated at the position of the sun. Here R_0 is the distance to the center of rotation and Ω_0 the angular velocity at the position of the sun. Even with much uncertainty as to the distances, Jan Oort was able to show the double sine wave character of the radial velocities which demonstrated the basic correctness of the picture of differential rotation. For the next half century the determination of A, B and R_0 remained one of the central topics in galactic structure, since the scale of the galaxy and the rotational velocity $\Omega_0 R_0$ are determined by these.

One of the problems encountered in the determination of these constants and in all of galactic structure is the effect of interstellar absorption. When G. Reber published the first map of radio noise which showed that it had a galactic origin, Jan Oort immediately realized the importance of radio waves for the study of galactic structure, since these would penetrate the interstellar dust unhindered. But Jan Oort wanted more, namely velocities, and he suggested to H. C. van

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de Hulst to search for possible spectral lines which would allow their determination. This led to the celebrated prediction by the latter of the 21-cm spin flip line at 1.42 GHz of atomic hydrogen. As soon as possible after the war Jan Oort organized a campaign to develop the instrumentation for its detection. Following a delay due to a fire which destroyed much of the receiver equipment, the line was discovered, just after the same discovery had been made at Harvard. However, Jan Oort's interest was not just to prove the existence of the hydrogen line, but to utilize it for the study of galactic structure. Through successive developments (25-m dish at Dwingeloo, Westerbork Radio Synthesis Telescope) the group stimulated by Jan Oort, for the first time mapped much of the galaxy and later other galaxies both in the 21-cm line and in the continuum, thereby gathering the first global information on the overall structure of the galaxy and on the dramatic phenomena taking place in the area around its center.

In 1932 Jan Oort published a paper on the determination of the gravitational force $K(z)$ perpendicular to the galactic plane in the neighborhood of the sun. It was determined by combining information on the density of certain classes of stars as a function of height above the plane with data on the distribution of perpendicular velocities in the plane. The situation is the same as in an atmosphere where gravity and temperature determine the scale height. One of its purposes was 'the derivation of an accurate value for the total amount of mass, including dark matter, corresponding to a unit of luminosity in the surroundings of the sun'. With some extrapolation Jan Oort found that it was likely that stars could account for most of this mass and concluded that 'the total mass of meteors and nebular material is probably small in comparison with that of the stars'. Thirty years later, Jan Oort again evaluated the situation, at a time when more was known about the population of faint stars, and concluded that some 'dark matter' might well be present. Today after a number of similar investigations the pendulum has swung back and forth and a definitive answer has not yet been given.

Jan Oort, however, moved on to consider larger scales and discussed the question of the density of visible matter in the Universe concluding that visible matter in galaxies could account for only a few per cent of the critical density—the density which separates forever expanding from finally collapsing Friedman models—but that, nevertheless, a Universe with the critical density remained a possibility. Two decades later the conclusion has not changed. In recent years, Jan Oort turned to the question of the distribution of galaxies in space—a subject that at the moment constitutes one of the central areas in cosmology.

We have only discussed a few of the lines of Jan Oort's research. We should have mentioned his discovery of the 'Oort cloud', the cloud of comets far out in the solar system from which passing stars occasionally send a new comet close to the sun, the work on the Cygnus Loop and the Crab Nebula, and many others.

Jan Oort has been a leader of the astronomical community—leading into many new areas and continuing to lead in several of these for many decades. He had a profound insight in searching out the areas in which significant progress could be made. At the same time, he was a modest, unassuming, friendly person with broad interests and a felicitous family life. Few of us can look forward to such a life of undiminished creativity till the age of 90. He was truly a fortunate man.

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