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## Jan Hendrik Oort – A Complete Astronomer (1900–1992)

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Jan Oort represented the spirit of modern astrophysics more than anyone in the last century. What sets the field of astrophysics apart from other branches of physics, is the sync between theory and observations, as well as the wide range of topics that astronomers work on. Oort's work ranged from the birth of comets to the dynamics of galaxies. And his theoretical work on galaxy rotation was complemented by his search for new tools of astronomy, which led to his pioneering works on radio observations of our Galaxy.

Born in 1900 in a farming village (Franeker) in the Netherlands, young Oort attended school in Leiden. At that time, Jacobus Kapteyn was a prominent figure in Dutch astronomy and Oort chose to study in Groningen under Kapteyn. Then, after spending a couple of years at the Yale National Observatory, he joined the Leiden University Observatory in 1924 as a conservator, where he remained until his formal retirement in 1970. During the Second World War, he became one of the vocal protesters against the policy of dismissing Jewish professors by the occupying Nazi rulers, and he resigned from the University in 1941. He went into hiding in the countryside, although his scientific interest could not be tamed by his dismissal. He often cycled to Leiden to give secret lectures to his loyal students.

One of the topics he worked on after joining the Leiden Observatory was to confirm earlier speculations about the rotation of our Galaxy. He analyzed the motions of distant stars and found that our Galaxy rotates differentially, the inner parts moved ahead of the outer parts. He quantified the differential nature in terms of two constants, which are known as Oort constants (see article by R Nityananda in this issue). Studying the movement of stars in our vicinity in the vertical direction (relative to the plane of the Galaxy), he noticed something that did not quite make sense. Consider the motion of a projectile on earth's surface. Given an initial speed, the maximum height reached by a projectile depends on the strength of the gravitational force on it. Similarly, given the typical speed of stars, the height reached by them, or, equivalently, the thickness of the plane of the Galaxy, is determined by gravity. What Oort found was that the vertical motion of stars implied a magnitude of gravity that could not be supplied by the stars that are visible. This was one of the earliest hints that there is 'missing mass' in our Galaxy, and in the whole Universe. Today, we know that dark matter is a major component of the total gravitating mass of our Galaxy and the Universe.



Oort also worked on a theory of the origin of comets, and considered a distant storehouse of comets, which is known as the Oort Cloud. Numerous icy objects milled around in this cloud, hypothesized to be located roughly 1.5 light years from the Sun (roughly halfway to the nearest star). When one of them is occasionally dislodged by passing stars that makes them scurry towards the inner solar system and show up as comets in our sky.

During the war, he worked with Hendrik C van de Hulst on the possibility of detecting a signature radiation from neutral hydrogen atoms. Although the probability of a single atom emitting this radiation – in the radio wavelength of 21 cm – is small, they argued that the enormous number of atoms in any line of sight through the Galaxy would outweigh the small probability. Their efforts with a small radio telescope at Dwingeloo led to a completely different vision of our Galaxy than offered by visible stars, whose light is blocked by gas and dust and therefore makes our vision shortsighted. The radio map revealed spiral arms of our Galaxy, and showed that the Milky Way was similar in appearance to other spiral galaxies.

Oort is remembered not only as the father of Dutch astronomy, but also as a major figure in spearheading astronomical research in Europe, and in particular, setting up the European Southern Observatory. Above all, he is remembered as one of the most influential astronomers of the last century.

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