

## Project Title

The formation and evolution of the Oort cloud

## Summary

Jan Hendrik Oort hypothesized, based on a spike in the reciprocal orbital separation at  $1/a \gtrsim 10^{-4} \text{ au}^{-1}$ , the existence of a distant cloud of cometary objects that orbit the Sun [Oort(1950)].

In a recent paper, Portegies Zwart, Torres, Brown, and Cai (all from Leiden Observatory, Submitted to Nature Astronomy) proposes a consistent chronology for the formation of the Oort cloud. The model's consequences are further generalized in several papers for stars near the Sun and link the existence of Exo-Oort clouds to the recent interstellar visitors 'Oumuamua (rock-like) and Borisov (comet-like). This relates the new formation-theory of the Oort cloud to this new class of interstellar asteroids. This new class of asteroids are further theorized to affect star and planet formation.

Understanding the formation and dynamics of the Oort cloud is therefore paramount understanding a wide range of phenomenon. LSST (first light expected in October 2021) is expected to directly observe Oort-cloud objects and detect many more interstellar asteroids. These observations allow us to further precisize the theory and establish the link between these two classes of objects.

Our model makes precise predictions about the dynamics of the inner and outer Oort clouds, and on the origin of the scattered Kuiper-belt, trans-Neptunian asteroids and on the family of Senda-like asteroids. The orbits of these closer objects will be further characterized in the upcoming Gaia DR3.

The sequence of events that led to the Oort cloud has (and its further repercussions) never been tested self consistently. The main objective of this PhD project is to perform the necessary simulations to test the scenario. These simulations start by the formation of the Solar system in a star cluster and continue until today. We will test the entire sequence of events on the formation and evolution of the Oort cloud in a single multi-scale and multi-physics simulation.

We will address the following:

Characterize the Oort cloud orbital distributions.

Determine the rate of interstellar asteroids.

What is the effect of erosion on the Oort cloud?

Do other stars also have an Oort cloud, and what is their relation to their local planets or debris disks?

Is the eluded periodicity in comets showers a natural consequence of the formation and evolution of the Oort cloud, and is this different in other planetary systems?

## References

[Oort(1950)] Oort, J. H. 1950, Bul. Astron. Inst. Neth. , 11, 91