Asteroid masses with ESA/*Gaia*

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Asteroids are remnants of the planetesimals that evolved into planets, thus containing key information about the formation and subsequent physical and orbital evolution of our Solar System. To this end, studying the different properties, such as orbital and compositional distributions, of asteroids reveals the history of the Solar System. To accurately model orbital dynamics in the Solar System one needs to take into account the masses of several of the largest asteroids. On top of this, the composition and structure of an asteroid can be constrained by its bulk density, which is derived as the ratio of the mass and volume of the asteroid, hence making asteroid mass estimation with realistic uncertainties an interesting task.

Asteroid masses are often estimated by assessing the effects of their gravitation on the orbits of other bodies, e.g., perturbations on planets, binary asteroid systems, asteroid-spacecraft close encounters, and asteroid-asteroid close encounters. In this project asteroid-asteroid close encounters are analysed to determine the mass of the more massive asteroid (perturber) based on the change in the orbit of the less massive one (test asteroid). Mass estimation is carried out with Markov chain Monte Carlo algorithms, which sample a probability-density distribution describing the orbits of the asteroids and perturber mass, leading to a rigorous mapping of the parameters as well as astrometric uncertainty of the observations. The best data available to estimate asteroid masses is the milliarcsecond accuracy astrometry that ESA's *Gaia* space telescope provides. The accuracy of *Gaia* decreases for larger asteroids due to shape and size effects. One such effect is the photocenter-barycenter offset, the correction of which became an integral part of this project.

It is expected that *Gaia* data helps constrain asteroid masses with realistic uncertainties. The photocenter-barycenter offset correction should improve orbital fitting, i.e. residuals and number of outliers should be smaller. As of now the results are very preliminary and are not behaving exactly as expected: the mass estimations carried out so far are an order of magnitude too large, leading to unphysical density estimates, and the photocenter-barycenter offset correction yields unambiguous results.