New Detections of the Yarkovsky Effect with Gaia DR2

F. Spoto, P. Tanga and B. Carry

Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, France

The Yarkovsky effect (the result of the recoil force acting on rotating bodies as a consequence of their thermal emission) is the most important non-gravitational perturbation for asteroids. It produces a semi-major axis drift, which changes the orbit of small asteroids over millions of years. It is fundamental to understand the aging process of asteroid families and compute an impact risk for near-Earth asteroids experiencing close encounters with the Earth. It is also the responsible of the transport mechanism from the asteroid belt to the inner Solar System and ultimately of the meteorite delivery to the Earth. Direct detection of Yarkovsky is challenging because it can be measured only for small asteroids with very accurate orbits.

The Gaia second data release (DR2, April 2018) contains about 2,000,000 observations for 14,099 Solar System Objects (SSOs). While available ground-based observations have a typical accuracy of the order of 300-400 mas, Gaia SSO observations reach an accuracy between 2 and 5 mas for the faintest asteroids (G~20.5) and at the sub-milliarcsecond level for brighter objects. However, Gaia DR2 observations cannot be used alone to detect this effect because of the limited duration covered by the observations. To exploit Gaia observations together with other existing data, we have developed a new method to correct the already existing bias of ground-based astrometry reduced with old stellar catalogs (debiasing) and a new weighting scheme taking into account the performances of each observer for each catalog used.

From the entire list of Gaia DR2 SSO asteroids, we have chosen more than 70 objects for which the combination of Gaia DR2 and ground-based astrometry produces a very accurate orbit and that are small enough to possibly detect the Yarkovsky effect. We show that the use of Gaia DR2 data is essential to detect the Yarkovsky effect: we measure the Yarkovsky effect for a sub-sample of our initial list, which includes the asteroid (3200) Phaethon, the target of the DESTINY+ mission and the binary asteroid (66391) 1999 KW4 among the others. From our detections we are also able to estimate some physical parameters, like the density of the asteroids.