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The impact of the Gaia mission on asteroid astrometry

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ABSTRACT

The ESA Gaia mission has released the most detailed map of the Milky Way in April 2018. This second data release (DR2) contains 1.7 billion of stars with positions and proper motions, and for the first time it also includes almost 2 millions of observations for 14 099 Solar System Objects (SSOs) covering 22 months of observation (Gaia Collaboration, Spoto F. et al. 2018).

As a result, Gaia asteroid observations reach an extraordinary accuracy: typical values are between 2 and 5 mas for the faintest asteroids (around G~20.5) and it reaches the sub-milliarcsecond level for brighter objects (G<17.5). The accuracy is almost one-dimensional, and it follows the along-scan direction, while the precision across scan is very limited (~600 mas). This uncommon quality opens new perspectives in the study of the SSO population (Gaia Collaboration, Spoto F. et al. 2018).

The high accuracy of Gaia asteroid observations can be used to detect small perturbations. The most important non-gravitational force is the Yarkovsky effect. It is the result of the recoil force acting on rotating bodies as a consequence of their anisotropic thermal emission. It produces a secular semi-major axis drift, which means that it changes the orbit of small asteroids over long time span (Vokroulický et al. 2000).

Gaia observations cannot be used alone to detect the Yarkovsky effect because of the short time span covered. To exploit Gaia DR2 observations along with other existing data, we have to take into account the zonal errors of past catalogs that affect ground-based observations. We thus have developed a new debiasing method that makes use of Gaia DR2 as reference catalog. We have also created a new weighting scheme taking into account the performances of each observer for each catalog used (Spoto F., Tanga P., Carry B. 2018, submitted)

We have chosen more than 70 asteroids from DR2 which have a good orbit determination when including Gaia observations and which are small enough to possibly detect the Yarkovsky effect. Our sample contains different categories of objects, from Near Earth Asteroids to Main Belt Asteroids.

We present our results:

1. The detection of the Yarkovsky effect for a sub-sample of our initial list, which includes some interesting cases, like e.g. (3200) Phaeton, the target of the DESTINY+ mission and the binary asteroid (66391) 1999 KW4;
2. The estimation of physical parameters for the same sub-sample of asteroids.

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