Asteroid spins and shapes by combining Gaia and ground-based observations

J. Durech[1]

[1]Astronomical Institute, Faculty of Mathematics and Physics, Charles University in Prague, V Holesovickach 2, 18000 Prague, Czech Republic

The astrometric and photometric satellite Gaia of the European Space Agency, launched in 2013, will observe all point sources brighter than ~ 20 mag during its five-year mission. Apart from its main goal — accurate astrometry and photometry of billions of stars — it will also observe minor planets in our Solar System. The estimated total number of asteroids observed by Gaia is $\sim 400,000$, with typically 40–100 detections per object [1]. Gaia's sparse-in-time photometry will be used to derive asteroid spin-axis orientations and shapes by using triaxial ellipsoid models and a genetic algorithm for finding the best-fit model [2]. The expected number of successfully determined models is $\sim 10,000$. Although Gaia photometry is accurate enough to enable us to obtain a unique solution from the Gaia data alone, the number of models can be dramatically increased if Gaia data are combined with photometry from other ground-based surveys and with dense lightcurves. Then the data will cover a longer time interval with changing geometry, and we can model asteroids as convex bodies using the lightcurve inversion method [3]. The problem of finding a unique solution of the inverse problem for photometry sparse in time is time consuming because the sidereal rotation period has to be found by scanning a wide interval of physically possible periods. This can be efficiently solved by splitting the period parameter space into small parts that are sent to computers of volunteers and processed in parallel. We will show how this approach of distributed computing works with currently available sparse photometry processed in the framework of project Asteroids@home. We will also demonstrate the importance of Gaia-complementary data on asteroid photometry from Hipparcos satellite combined with photometry from ground-based surveys.

References: [1] Tanga, P.; Mignard, F. (2012): The Solar System as seen by Gaia: The asteroids and their accuracy budget, Planetary and Space Science 73, 5–9. [2] Cellino, A.; Dell'Oro, A. (2012): The derivation of asteroid physical properties from Gaia observations, Planetary and Space Science 73, 52–55. [3] Kaasalainen, M.; Torppa, J.; Muinonen, K. (2001): Optimization Methods for Asteroid Lightcurve Inversion. II. The Complete Inverse Problem, Icarus 153, 37–51.