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Analysis of photocentre offset from Gaia astrometry on selected asteroids and planetary satellites

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The Gaia space mission provides highly precise astrometric data about 160,000 solar system objects. Because the object is extended and Gaia observes at a non-zero solar phase angle, the measurement is subject to a photocentre-barycentre shift effect. In other words, astrometry records the centre of the illuminated part (photocentre) of the celestial body instead of the actual centre of mass. This displacement is determined by the surface properties, size, spin and shape of the target [1]. The effect can be shown by statistically significant residuals after the fitting of heliocentric or planetocentric orbits using Gaia astrometric data. The typical magnitude of the offsets for the largest bodies (with diameters > 100km) is of a few mill-arcseconds, larger than the Gaia precision.

In this work, we used two approaches to correct the effect. The first is to assume that the body is a sphere and use an analytical formula to estimate the offset [2], which is a valid approximation for dwarf planets or planetary satellites. Secondly, we directly used the simulated displacement from a complex shape model by reconstructing the Gaia-object-Sun geometry at the observation epoch. This is done by using an updated spin and shape topographic model derived from photometric data (including Gaia DR3 photometry) using the Sage method [3,4].

In the presentation, we will show the effect of the photocentre correction using both methods on a selection of large asteroids and Jovian satellites.

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