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NEO Characterization

Photocenter offset: Case study of two NEAs

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ABSTRACT

Photocenter-barycenter offset is the difference between the measured photocenter and the actual centre of mass of objects. Astrometry of near-Earth objects typically determines the position of the asteroid's photocenter, which can lead to biases and/or increased uncertainties in orbit determination. The effect is up to 10-20% of the asteroid's apparent diameter (roughly from a few to tens of milliarcseconds for the largest objects). This subtle effect can now be detected in the sub-milliarcsecond asteroid astrometry arriving from the European Space Agency (ESA) Gaia mission. Gaia had its third data release (Gaia DR3) published on 13 June 2022 and it contains a vast number of precise asteroid astrometry that cover approximately 1000 days, starting from the year 2014.5.

We determined the photocenter-barycenter offset for two near-Earth asteroids with well-determined models: (433) Eros, and (1620) Geographos. We used non-convex shape models. We applied the offsets for all available astrometric observations and determined the orbits. We studied the photocenter offset impact on: residuals Gaia DR3 astrometry, global residuals, the Yarkovsky effect and its SNR, orbital elements, their uncertainties and the overall RMS.

Generally, the Photocenter-barycenter effect is detectable in the DR3 Gaia data and can improve the overall accuracy of the remaining astrometry. Including the photocenter offset for NEOs can improve the determination of the Yarkovsky effect and predictions of Earth impact probabilities.

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