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YARKOVSKY ACCELERATION OF (99942) APOPHIS

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ABSTRACT

A reliable detection of Yarkovsky acceleration requires that the data be free of significant systematic errors that might mimic a signal that in reality is not there. Until recently, reference star catalogs have suffered from significant biases and/or absence of proper motion information that precluded a trustworthy astrometric analysis of the Yarkovsky acceleration of (99942) Apophis, which remains an impact hazard for the Earth, with impact solutions as soon as 2068 April 12. With the release of Gaia DR2, we now have an astrometric reference catalog that enables positional measurements not limited by the catalog itself. We have begun to reprocess nearly a thousand observations of Apophis spanning 14 years, most with astrometric uncertainties of less than 0.1 arcsec, with the goal of placing limits on the amount of Yarkovsky acceleration this asteroid is experiencing, and refining impact predictions for the next century. Analysis of the data has revealed that differential atmospheric refraction can represent a significant source of systematic error for unfiltered observations made at the largest zenith distances, so it is necessary to include color information in the astrometric reductions; modification of the reduction code to handle this effect is in progress. An orbit solution that includes the

Yarkovsky effect, based on about half of the observations that have been reprocessed to date, but limited to those made at smaller zenith distances, has yielded a positive value of weak statistical significance for the Yarkovsky acceleration, which would imply prograde rotation, in contrast to the negative value expected from rotational lightcurve analysis, which has indicated a retrograde rotation. Apophis becomes observable again in early 2019, with another radar opportunity during a close approach in March 2021. This next apparition will be crucial for firmly establishing the impact threat represented by this near-Earth asteroid.

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