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THE EFFECTS OF NON-GRAVITATIONAL PERTURBATIONS ON POTENTIALLY HAZARDOUS OBJECTS' TRAJECTORIES AND EARTH APPROACH PARAMETERS

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ABSTRACT

Some of the primary questions underpinning any discussion concerning a Potentially Hazardous Object (PHO) are whether and when that PHO will impact the Earth. We present new capabilities that we have added to our MONTE-based orbit determination software (Greenberg et. al 2017, Astronomical Journal, in press) to calculate trajectories and associated uncertainties for these PHOs. This software takes into account gravitational perturbations caused by the eight planets, as well as the 24 most massive minor planets and the Moon. Our software can quantify close Earth approach distances and epochs, and can model the reduction in uncertainties

expected from the addition of new optical and radar astrometric measurements at specific epochs. Understanding the effects of new observations at certain epochs on orbital uncertainties can motivate the procurement of these measurements.

Furthermore, our software can compute the effects that non-gravitational perturbing forces have on approach parameters and uncertainties. We will examine one such perturbing force, the Yarkovsky effect, in detail, as it is known to be the dominant source of trajectory uncertainty for near-Earth asteroids with diameters less than ~1 km. We will present tests of our methods on a suite of virtual PHOs, with a variety of orbital elements. Finally, we will demonstrate these modelling capabilities by analyzing two test-cases — the asteroids 1566 Icarus and 2001 YE4. The former has a known shape, spin axis orientation, and Yarkovsky drift rate due to our radar observations. The latter has ranging information on three separate epochs (2002, 2012, 2016), which allows detailed quantification of non-gravitational forces.

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