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Topic Selected: NEO Characterization

THE LONG-TERM IMPACT HAZARD OF KM-SIZED NEAR-EARTH OBJECTS

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ABSTRACT

Operational impact monitoring systems such as JPL's Sentry rigorously assess the impact risk for known near-Earth objects (NEOs) for the next 100 years. These time scales allow reliable modeling of the trajectory of an asteroid and the evolution of the associated uncertainty [1]. Impact hazard analysis beyond the next century is limited after the position of the asteroid can become highly uncertain. We extend the impact hazard analysis to longer intervals using the fact that a very low Earth minimum orbit intersection distance (MOID) is a necessary condition for a collision[2], [3]. The main advantage is that the MOID uncertainty does not increase as fast as the orbital uncertainty, which is mostly in mean anomaly. For NEOs with well constrained orbits, the MOID can accurately be known for several centuries. Using this method, the computational burden of the Monte Carlo simulations is greatly reduced as we need a smaller number of particles.

We propagate the orbits of all known km-sized NEOs for the next 1000 years and compute their Earth MOID. In turn, we compute the range of dates in which an Earth collision is possible and rule out potential collisions when the MOID remains greater than 0.01au for the next 1000 years. This is true for more than half of the km-sized NEO population, including some objects currently classified as Potentially Hazardous (current Earth MOID < 0.05 au and absolute magnitude <22).

However, there are a few objects whose Earth MOID is likely to be smaller than 0.01 au during a significant part of the next centuries. We list these objects including the dates when their orbit stops being deterministic, which indicates candidates for further observation and characterization. We show in detail a few examples such as 143651 or 314082 Dryope.

When the MOID is sufficiently small and the position is unknown along the orbit, we use analytical estimates of the probability of collision[5]. This estimate allows us to rank NEOs in orbits corresponding to a higher intrinsic probability of collision in the future. In the next 1000 years, we find 54 km-sized NEOs with a future unknown mean

anomaly period while the MOID < 0.01 au out of the 852 objects considered. According to our ranking, the highest ranked objects in terms of impact hazard are 164121 (2003 YT1) and 7482 (1994 PC1), for which we found a continuous presence of MOID < 0.01 au for all Monte Carlo runs. Among the list, objects can rank higher with a less frequent low Earth MOID because of a favorable orbit relative to Earth's orbit, which is implicit in the analytical estimate of the impact probability. We show examples of this effect, such as 1620 Geographos (1951 RA).

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Comments:

*The results of this study highlight NEOs that need further observation and study and discover NEOs whose orbits are intrinsically more hazardous. Thus, "***Near-Earth Object (NEO) Discovery***" or "***Space Mission & Campaign Design***" could also be considered as alternative sessions for this abstract.*

The preferred format to present this work is an Oral presentation.