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Near-Earth Object (NEO) Discovery

2032 AND 2036 RISK ENHANCEMENT FROM NEOs IN THE TAURID STREAM

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Impact risk is normally quantified by summing the product of the probability of an event and some measure of its consequences over the set of all possible events. The probability factor is considered to be more objective and is based on the size frequency distribution of NEOs and an implicit assumption of randomness, which can be described as "stochastic catastrophism". Impact frequency does change with time, however, and there have been episodes in the deep geological past when the flux has been much higher.

The hypothesis of "coherent catastrophism" suggests large variations on shorter timescales. It postulates the existence of a "Taurid resonant swarm" (TRS) of debris associated with Comet Encke that is stabilized by Jupiter and in a 7:2 resonance with it. The hypothetical cluster orbits in the broad Beta Taurid stream, which crosses Earth's orbit twice a year at its nodes. Theoretical calculations by Asher and Clube [1] suggest that the last close approaches, within 1° absolute mean anomaly difference $|\Delta M|$ were in November 1971 and June 1975 for its perihelion approach and departure, respectively. Circumstantial evidence (large daytime fireballs and seismic activity on the moon at the time of the 1975 crossing) are consistent with an increase in the flux of larger fragments. Rates and data for fireballs that correlated with the predicted 2015 return were recorded by Egal et al. [2]. Large uncertainties remain in the number of objects larger than meter-sized in the TRS, so its significance to risk remains poorly constrained and contentious. There is some evidence for a few objects large enough to be hazardous, associated with the 2015 swarm, but the population has not yet been shown to be statistically significant.

In 2019 and 2022, the predicted node crossings were close enough to attempt targeted surveys [3,4], with $|\Delta M|$ of 5° and 17°, respectively, based on extrapolation of predicted swarm encounters [1]. Upcoming potential targeted survey opportunities will be 2025, 2026, and 2029 ($|\Delta M|$ of 25°,18° and 23°, respectively). Targeted surveys provide the opportunity to put further constraints on the population of the hypothetical swarm as well as to determine potential future close passes or impacts if the swarm exists. The 7:2 resonance with Jupiter happens to come close to a 18:61 resonance with Earth, so the next set of 1° node crossings will be in 2032 and 2036, which would be years of increased impact probability. We also suggest that this possibility could form the

basis for a semi-hypothetical tabletop exercise, based on the trajectory of the Tunguska object, which was in an orbit consistent with the Beta Taurid stream [5]

Most members of the planetary defense community are skeptical of coherent catastrophism due to misinformation, misunderstandings, and misinterpretations associated with the Younger Dryas impact hypothesis (YDIH) and its pseudoscientific corollary claims [6]. Nevertheless, the possibility of enhanced risk from an undiscovered population of small NEOs in the hypothetical TRS should not be dismissed unless comprehensive targeted surveys demonstrate that there is no significant population.

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