☒ **Advancements and Progress in NEO Discovery**

On The Likelihood Of A Neptune-Crossing Object Being Directly Diverted Onto A Path With Perihelion In The Inner Solar System

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ABSTRACT

Over the past 25 years vast numbers of large bodies classified as minor planets have been discovered in the region just beyond Neptune, some of them having paths that cross that giant planet. As to whether these objects should be regarded as being asteroidal or cometary in nature is a moot point which is left aside here, and they are treated simply as test particles assumed to remain intact with their orbital evolution being controlled only by gravitational effects.

Under planetary perturbations the paths of such objects can gradually be altered until such time as they become crossers of one or more of the outer planets, whereupon they are generally classified as being Centaurs and the rate at which their orbits change becomes greatly enhanced. Many numerical-integration studies of the dynamical evolution of Centaurs have been conducted.

The much-slower evolution of trans-Neptunian objects or shallow-crossers of Neptune implies that numerical integrations of modelled particles need to cover huge spans in terms of particle-years in order to provide statistical usefulness. It will be shown here, for example, that a typical low-eccentricity Neptune-crosser has a probability of being flipped directly onto an Earth-crossing orbit of order 10^{-13} per annum; therefore numerical integration studies need to involve above 10^{15} particle-years so as to deliver useful results from the perspective of developing an understanding of the likelihood of such an event (with conceivable calamitous implications for life on Earth) taking place.

Here a probabilistic technique is applied to a set of characteristic orbits for Neptune crossers in which the chance of a close-approach to that planet (within about 0.5 au) is convoluted with determinations of the consequential orbital changes of the test particles using a two, two-body method across all minimum approach distances and angular aspects relative to the planet. The outcome is a set of assessments of the probabilities of singular close-approaches to Neptune resulting in immediate diversions of such objects into paths that cross each of the other planets, including Earth.

This study therefore portrays an aspect of the overall celestial impact hazard we face that is quite distinct from the random asteroid impact scenario upon which much planetary defense research focusses. The concept under consideration, in summary,

is the possibility of a large (say 50-100 km) object currently orbiting at 30-40 au from the Sun being diverted onto a path bringing it to perihelion in the inner planetary region, with multifarious implications for the environment in our part of the solar system.

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