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Study and analysis of the role of the Moon in asteroid deflection

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The underestimated impact hazard by an asteroid is becoming increasingly apparent. There is no need to appeal to the famous mass extinction occurred 65 million years ago [1], recent events like the Tunguska [2] or Chelyabinsk [3] remind us how vulnerable we are to such an event.

Luckily, catastrophic events of these magnitudes have an estimated frequency of around 100 million years. However, the frequency of impacts increases as the size of the object decreases, reaching that a meteoroid of only 50 meters in diameter could produce 5000 victims, being its typical range of impacts of less than 300 years [4].

In the last few years, asteroid deflection proposals have been proliferating: Kinetic Impactor, Ion Beam Deflection, Gravity Tractor, Enhanced Gravity Tractor, and Laser Ablation and so on [5]. Likewise, with the advance of technology, astrodynamic models are becoming capable of providing more accurate results, being able to make probabilistic predictions in the years to come of only a few thousand kilometers of precision [6].

In the context of a Potentially Hazardous Asteroid (PHA) deflection, we discuss the possible role that the Moon may play in this scenario, and address the idea of using the Moon as a defense mechanism. Running high accuracy numerical simulations [7], we study different situations of Earth-asteroid encounter depending on the position and extension of the Moon's sphere of influence, in order to analyze the gravitational effect of the latter at the moment of maximum encounter. From this, we extract relevant information regarding possible deflection strategies that put into consideration a close encounter, or even a subsequent collision with the Moon [8]. In this regard, we not only analyze the use of the Moon to avoid short-term impacts, but also study its role when envisaging future re-encounters after deflection. See Figure 1.

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Based on these calculations, we particularly tackle the PDC hypothetical asteroid impact scenario, and propose a deflection strategy including realistic calculations and precise error estimation. Finally, we evaluate the limits of this planetary defense method by taking into account the consequences that a potential impact on the Moon could have on its orbit.

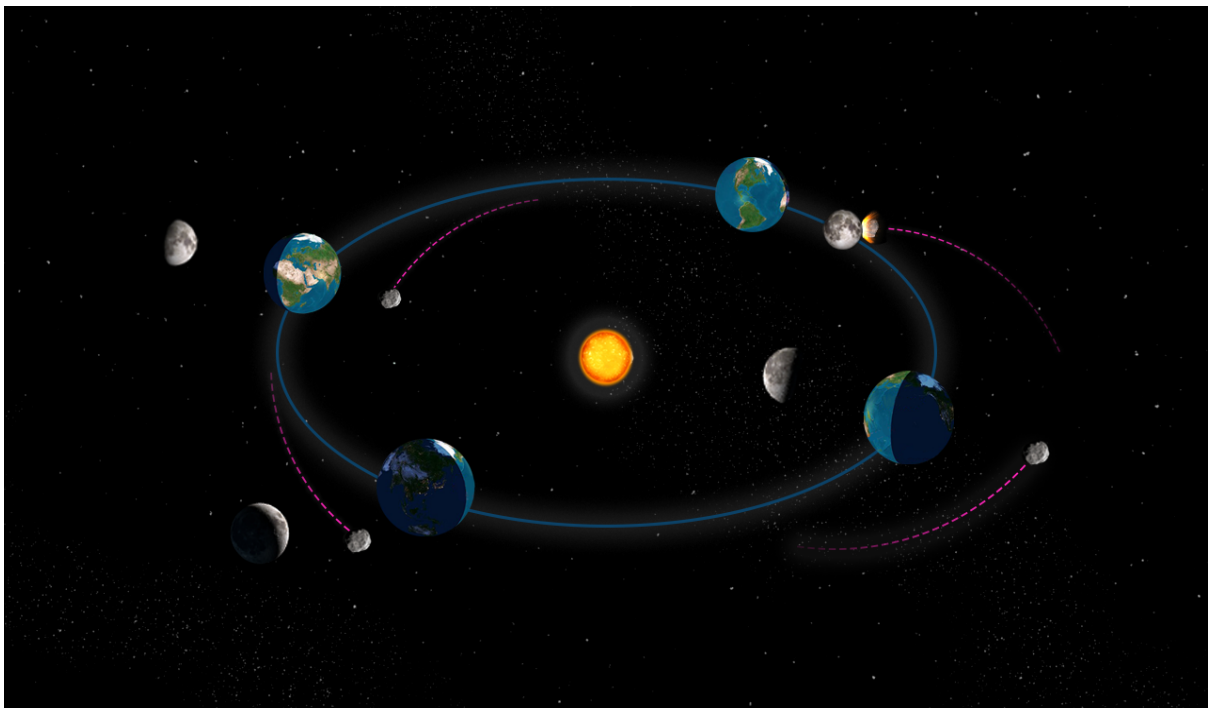

Figure 1: Conceptual illustration of different Earth-Moon-asteroid encounters to be analysed. Not to scale.

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