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On the Selection of Targets for Human Missions to NEOs

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Abstract

The possibility of sending a manned mission toward a Near Earth Object (NEO) has recently become a high priority for the US exploration program. Such a mission would allow to develop, test and validate the technologies needed for a crew to survive the radiation environment of the interplanetary space. Being an intermediate step before any attempt to reach a more distant target (e.g. Mars) the spacecraft is required to remain in the surrounding the Earth's orbit. Target selection should then take into consideration only objects that come close to the Earth at reasonably low relative velocities within the time span 2025-2029 – when the mission is expected to occur. Several studies have so far performed extensive numerical simulations in order to isolate potential targets, making use of trajectory optimization algorithms. Results depend strongly on the constraints imposed to the model: mission duration, launch date, launch scenario, size of the target. Within this framework we propose a method for quickly isolating a subset of potential targets based on the evaluation of dynamical quantities such as the Tisserand invariant (which gives the relative velocity at encounter) and the synodic period of the aseroid with respect to the Earth (which rules the launch window computation). This "pre-optimization" technique could turn out to be particularly useful because the number of NEOs is expected to grow significantly in the near future with the operation of the new generation sky surveys and the launch of orbiting observatories which can greatly contribute to NEO discoveries.