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Low-Energy Trajectory Design with the Keplerian Map for Asteroid Capture

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Abstract
Defining a spacecraft's trajectory is one of the first activities in the design of a space mission and has a considerable impact on the overall project. The path traversed from launch to arrival at the destination has to be carefully computed in order to satisfy all mission requirements and constraints, while limited by fuel consumption. Furthermore, the complex dynamical system, including gravitational interactions from the Sun and planets, has to be accurately modelled. While in the early years of space exploration the patched-conic model provided a suitable dynamical representation, the challenges posed by new and prospective missions require a much more accurate modelling of the sensitivities in multi-body dynamics. The Keplerian Map is such a model: based on a semi-analytical approximation of the Circular-Restricted Three-Body Problem (CR3BP), it is a low computational cost method that allows for a quick preliminary trajectory design.

The Keplerian Map can be used to find low-cost interplanetary trajectories for several novel concepts: one of them is asteroid capture missions. Nowadays, the prospect of exploiting Near Earth Asteroids is very present in the space industry, for purposes ranging from planetary protection to technology demonstrations and in-situ resource utilisation. The asteroid's mass is a vital parameter for the trajectory design: in order to capture the asteroid, the spacecraft must have enough fuel to move their combined mass. However, the propulsive capability of current systems may not be enough to retrieve some larger asteroids: thus, the exploitation of the chaotic nature of our Solar System and its numerous gravitational perturbations is a great way to capture heavier bodies, which are very interesting targets in terms of science and economical profit.

Brief Bio
Rita Neves is a PhD candidate in space trajectory design at Cranfield University. She works in dynamical modelling for interplanetary spaceflight, with a focus on low-energy trajectories.
Rita completed her masters in Aerospace Engineering at the Technical University of Lisbon in 2015, with an exchange year at Technical University of Munich. She finished her master thesis during a placement at the Advanced Concepts Team in ESTEC, where she worked in Artificial Intelligence for optimization of interplanetary missions.
Besides her PhD topics, her interests range from machine learning to computer science, where she pursues some projects. Rita is also an advocate for scientific outreach and the leader of the Female Research Network at Cranfield University.

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