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# Analysis of Jupiter's Third-Body Perturbation Effects on Optimal Asteroid Deflection Maneuvers

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***Keywords:*** *Asteroid Deflection, Planetary Defense, Bi-Circular Restricted Four-Body Problem; Perturbation Theory*

## ABSTRACT

Several options have been considered for an asteroid deflection, e.g. detonation of a nuclear device, gravity-tractor and kinect impactor. They are separated into impulsive and non-impulsive methods. Among the impulsive approaches, the kinect impactor, changing the asteroid orbit by means of an impact of one or more spacecraft, is one of the most feasible at the current technological status. This paper aims to analyse the effects of Jupiter's perturbation for the impulsive approach by mapping the deflections obtained with various impulse values. Moreover, the intercept time before the predicted Earth close approach is also considered. In order to do so, a Bi-Circular Restricted Four-Body Problem system composed by the asteroid, Earth, Sun and Jupiter is considered, as well as a suitable semi-analytical perturbative approach to model Jupiter's third-body perturbation. They are compared with a two-body analytical model based on patched-conics approximation to account for the Earth gravity. This is made to highlight the importance of considering Jupiter in a preliminary design if possible. The asteroid selected as a study case in this work has the orbital characteristics of the asteroid 2019 PDC. An analysis by changing some of the orbital elements is also made and their influence evaluated. Previous results have shown that Jupiter's perturbation can severely changes the outcome of a deflection strategy. The Jupiter addition to the dynamics causes magnitude and phase shift in the predicted miss distance compared to the analytical estimate. The research also shows that in some cases the gravitational interaction between the

Earth and the asteroid changes, which can culminate in large miss distances or impact scenarios that would not be predicted by an analytical estimate. This paper suggests the need for new studies of the Jupiter influence in asteroid deflection strategies. This could culminate in a better preliminary mission design through constraining the design space.

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