IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 1) (4A)

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SCIENCE OPPORTUNITIES IN THE DIDYMOS BINARY: THE ROLE OF POST-IMPACT EJECTA LONG-TERM DYNAMICS IN THE PROXIMITY OPERATIONS DEFINITION

Abstract

Modelling the evolution of small fragments in highly perturbed orbital scenarios is a key aspect for pushing forward the capabilities to predict the outcomes of peculiar high energy events in the solar system. In particular, considering also recent trends in the space community, the attention has been moved toward hypervelocity impacts, which represent a relevant topic for both planetary science and space engineering. A peculiar example of the latter category is represented by the joint effort of international space agencies in the planetary defence programs, such as the AIDA collaboration between NASA and ESA with the aim of studying the kinetic impactor strategy using the Didymos binary asteroid system as a testbed. Within this framework, the American probe DART in 2022 will impact the secondary body, with the aim of perturbing its orbit in a significant and measurable manner. The european mission Hera will instead reach the binary 4 years later and perform accurate measurements of the impacted body, to help the planetary defence community in reconstructing the dynamics of the collision. The paper addresses the analysis of the post-impact scenario in the Didymos environment on the long term, with the goal of recording the fate of the generated ejecta which may either re-deposit on the asteroids' surface, remain in a peculiar orbital motion or just escape the system. The time frame under study is comparable to the arrival to the Hera spacecraft to Didymos, in order to depict a dynamical framework representative of what the European probe will experience, where the presence of particles agglomerations may represent either a scientific chance to better study such phenomenon and a constraint for the proximity operations of the Hera mission. The environment under which the fragment plume is exposed entails different forcing terms, from the non-keplerian irregular gravitational field of the binary system, to the solar perturbations and to higher order terms. The effectiveness of each term in the particles evolution is assessed and classified in terms of relevance for the fate estimation, also with respect to the different parameters describing the impact scenario. Additional analysis on the resulting trajectories are carried out, with the aim of categorising the different behaviour of the particles. Indeed, by the means of mathematical tools from dynamical system theory, the trajectories can be inspected to evaluate their stability in relation to the orbital resonances and to further investigate the chaotic nature of the highly perturbed system.