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A TWO-STAGE ASTEROID DEFLECTION CAMPAIGN CONSISTING OF PRECURSOR MISSION AND IMPACTOR MISSION

Abstract

The collision mitigation missions for potentially hazardous asteroids (PHAs) proposed so far have mostly been single-phase "sorties." However, high uncertainties in the physical properties of asteroids due to our limited knowledge easily lead to either an excessively conservative overdesign that is wasteful or a flawed design that fails to achieve deflection requirements. To reduce uncertainties and optimize the configuration of such deflection missions, this paper proposes a multi-phase "campaign" methodology, where a precursor mission is executed first prior to an actual deflection mission. In this framework, a precursor first makes in-situ measurements in proximity of a target asteroid to obtain highly accurate information about the target asteroid's physical characteristics. Next, the deflection mission is fine-tuned and adapted as a result of this information while the precursor spacecraft continues to function as a transponder. Preliminary results from a virtual scenario of deflecting 99942 Apophis before 2029 shows that precursor-impactor campaigns using kinetic energy impactors can considerably reduce the total launch mass with improved accuracy of the asteroid's position estimates and mass information. Different options for precursor types and impactor speeds are also considered to optimize the details of a campaign configuration. Finally, this paper discusses future work to expand this methodology to other deflection methods and a larger population of PHAs.