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AIDA DOUBLE ASTEROID REDIRECTION TEST (DART) MISSION: MODELING EXPECTED OUTCOMES

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ABSTRACT

The Asteroid Impact & Deflection Assessment (AIDA) mission will be the first space experiment to demonstrate an asteroid impact hazard mitigation technique by using a kinetic impactor to deflect an asteroid. AIDA is a joint effort between NASA and ESA, composed of two mutually supportive elements, ESA's Asteroid Impact Monitoring (AIM) mission and NASA's Double Asteroid Redirect Test (DART) mission, entering Phase A studies in 2015. The AIDA target is the near-Earth binary asteroid 65803 Didymos, which will make an unusually close approach to Earth in 2022. The ~300-kg DART spacecraft is designed to impact the moon at 6.25 km/s and demonstrate the ability to modify the trajectory of an asteroid through momentum transfer. The Didymos system is an ideal target for the kinetic impactor experiment in October, 2022 because it is easily observable from Earth, and because it is accessible for a low cost rendezvous mission. Thus, the deflection of the moon following the DART impact will be measured by Earth-based observations of the change in the orbital period of the moon. In addition, AIM will rendezvous with the Didymos system in advance of the DART impact, and it will characterize the moon and make detailed studies of the impact effects including orbital deflection. While each of these missions has value independently, the return is greatly increased when they fly jointly.

The material properties and internal structure of the moon of Didymos are, unfortunately, poorly constrained. Analytic and numerical simulations are thus required to better understand the range of possible outcomes of the DART impact. Here, we will describe a modeling effort combining analytical models, CTH simulations and simulations using the n-body code *pkdgrav* that cover a wide

parameter space to provide predictions for crater size, ejecta mass, momentum transfer, and trajectory deflection following the impact. For impacts into “realistic” asteroid types, model DART impacts produce craters with diameters on the order of 10m, an imparted Δv of 0.5–2 mm/s and a momentum enhancement of 1.07 to 5 for a highly porous aggregate to a fully dense rock. Following impact, simulations of the system evolution using *pkdgrav* track changes in the orbital period of the moon and examine the effects of Didymos and its moon’s shape on the deflection of the moon. These simulations indicate that the shape of the bodies can significantly influence the trajectory deflection of the moon.

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