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DART: First Test Of Asteroid Deflection

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ABSTRACT

The NASA Double Asteroid Redirection Test (DART) mission will be the first space experiment to demonstrate asteroid deflection by a kinetic impactor. DART will impact the secondary member of the [65803] Didymos binary asteroid system in October, 2022 in order to demonstrate the ability to modify the trajectory of the moon through momentum transfer. DART is part of the Asteroid Impact & Deflection Assessment (AIDA) international cooperation along with the ESA Hera mission study. DART is the first hypervelocity impact experiment on an asteroid at a realistic scale relevant to planetary defense, where the impact conditions and the projectile properties are fully known. DART will provide validation of the kinetic impactor technique and improve models of kinetic impactor effects to enable applicability to different targets.

The impact of the 560 kg DART spacecraft at 6 km/s on the 160-m Didymos moon will change the binary orbital period by ~8 minutes (about a 1% change) assuming a unit momentum transfer efficiency. This change will be measured by supporting Earth-based optical and radar observations, since Didymos in October, 2022 will be

only 0.07 AU from Earth. Ground-based optical observations of the Didymos light curve will measure the period change via the timing of mutual events, while radar will observe the orbital motions. These measurements determine the orbital velocity change from the DART impact.

The momentum transfer efficiency depends on impact conditions such as local slope, on target physical properties such as strength and porosity, and on internal structures such as boulders. To understand the effectiveness of the kinetic impact deflection, DART will determine or constrain these impact conditions and target characteristics in order to compare experimental results with hypervelocity impact models which predict the effects on impact outcomes and momentum transfer efficiency.

DART will determine the DART impact location and the local surface slope and topography by returning high resolution images (ground sampling distance of 50 cm per pixel or better) from the terminal approach. The DART impact will release a large volume of particulate ejecta that may be directly observable from Earth or possibly resolvable as a coma by ground-based telescopes. DART impact ejecta will be observed by the LICIA Cube 6U CubeSat which is proposed by the Italian Space Agency to be carried by DART to Didymos. LICIA Cube would be released ~2 days prior to the impact, so as to perform a separate flyby of Didymos with closest approach several minutes after the DART impact. It will obtain images of the impact ejecta and their evolution, the DART impact site and impact crater if the ejecta plume is sufficiently transparent, and the non-impact hemisphere of the target asteroid.

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