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Double Asteroid Redirection Test (DART) element of AIDA mission

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Abstract

The Asteroid Impact & Deflection Assessment (AIDA) mission will be the first space experiment to demonstrate asteroid impact hazard mitigation by using a kinetic impactor. AIDA is a joint ESA-NASA cooperative project, consisting of the NASA Double Asteroid Redirection Test (DART) kinetic impactor mission [1] and the ESA Asteroid Impact Mission (AIM) which is the asteroid rendezvous spacecraft [2]. The AIDA target is the near-Earth binary asteroid 65803 Didymos. During the Didymos close approach to Earth in October, 2022, the DART spacecraft will impact the Didymos secondary at 6 km/s and deflect its trajectory, changing the orbital period of the moon in the binary system. This change can be measured by Earth-based optical and radar observations.

The primary goals of AIDA are to (1) perform a full-scale demonstration of asteroid deflection by kinetic impact; (2) measure the resulting deflection; and (3) validate and improve models for momentum transfer in high-speed impacts on an asteroid. The combined DART and AIM missions will provide the first measurements of momentum transfer efficiency from a kinetic impact at full scale on an asteroid, where the impact conditions of the projectile are known, and physical properties of the target asteroid are also characterized.

The DART kinetic impactor baseline mission has changed from that given in [1]. DART will launch as a secondary payload to geosynchronous orbit and use the NASA Evolutionary Xenon Thruster (NEXT) ion propulsion system to spiral out from Earth orbit and transfer to Didymos. The Didymos impact will occur on Oct. 7, 2022, a few weeks later than in the baseline design of [1], but the incident momentum is significantly increased from that in [1], leading to a larger target deflection and a larger crater. If the incident momentum is transferred to the target, the binary orbit period is predicted to decrease by over 7 minutes, about 1% of the orbital period of 11.92 hours. Moreover the DART impact may induce librations of the Didymos secondary of several degrees amplitude, depending on its axial ratio. It will furthermore make a ~7 m to ~20 m crater (depending on target properties and other impact conditions) that can be studied by the AIM spacecraft, and it will release a volume of particulate ejecta that may be directly observable from Earth or even resolvable as a coma or an ejecta tail by ground-based telescopes.

AIDA with both DART and AIM will be the first fully documented impact experiment, including characterization of the target's properties and the outcomes of the impact, to test and refine our understanding and models at an actual asteroid scale. AIDA will check whether current extrapolations of material properties such as strength from laboratory scale to asteroid scale are valid. AIDA will validate the kinetic impactor technique to deflect a small body and reduce risks for future asteroid hazard mitigation.

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References

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