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Ongoing and Upcoming Mission Highlights

DYNAMICAL INTERPRETATION OF OBSERVED EJECTA FEATURES FOLLOWING NASA'S DART IMPACT ON DIMORPHOS

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ABSTRACT

On September 26th, 2022, NASA's Double Asteroid Redirection Test (DART) impacted at high speed the asteroid Dimorphos, the secondary component of the binary asteroid system (65803) Didymos, to perform the first full-scale demonstration

of kinetic impact for planetary defense purposes [1]. The DART kinetic impact provides a unique opportunity to investigate the consequences of hypervelocity impacts on asteroids, allowing direct observations of the formation and evolution of the ejected material. The study of the dynamical processes following hypervelocity impacts on asteroids is paramount to the understanding of the origin and evolution of these celestial bodies. The effects of the DART kinetic impact were observed extensively and at different spatial/time scales, both by ground-based and space-based observatories [2], including the Hubble Space Telescope (HST) [3] and ASI's CubeSat LICIACube [4]. More detailed investigations on the long-term effects of the impact on the binary system will be performed by ESA's Hera spacecraft, which will visit the Didymos system in 2027 [5].
We perform here a first dynamical assessment of ejecta features observed in a time span ranging between a few hours and a few weeks after the DART impact. We provide a dynamical interpretation of these features by comparing direct observations with the results of numerical simulations. In particular, this work makes reference to the observation campaign performed by the HST [2] but is not only limited to this dataset.
We performed an extensive numerical simulation campaign, with a wide range of parameters that are representative of the physical, dynamical and optical properties of ejecta particles, including e.g., their size distribution, material density and velocity distribution. Ejecta particles are propagated forward in time considering all major gravity sources involved (Didymos, Dimorphos and the Sun), as well as the effects of Solar Radiation Pressure (SRP). We set up an automated pipeline to extract features from telescopic images and compare them with features appearing in numerical simulations.
Preliminary results allow us to make a distinction between gravity-dominated and SRP-dominated features, and to estimate the properties of ejecta particles that contribute to each feature's formation and evolution. Worth mentioning are features identified in HST images [2], including the spiral feature, the asymmetry between northern and southern features, the early tail, and the double tail. In particular, we found that the binary nature of the system creates complex dynamical structures, which are not expected for non-binary active asteroids and are needed to explain some of the features observed in the present scenario [6,7].

References: [1] Daly et al., 2022 (submitted). [2] Li et al., 2022 (submitted). [3] Thomas et al., 2022 (submitted). [4] Dotto et al., 2022 (in preparation). [5] Michel et al., 2022, PSJ. [6] Ferrari et al., 2022, PSJ. [7] Rossi et al., 2022, PSJ.

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Comments: *Oral presentation preferred, will be attending in person*