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Impact Effects & Consequences

DART-driven ejecta cone geometry measurement from Hubble Space Telescope and LICIACube

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ABSTRACT

NASA's Double Asteroid Redirection Test (DART) spacecraft successfully impacted Dimorphos, the secondary body of the Didymos binary asteroid system, on September 26, 2022 [1] and the pre- and post-impact behaviors of the system were observed [2]. The DART impact generated an ejecta plume captured by the Hubble Space Telescope (HST) [3] and LICIACube [4]. Their images provided detailed information about the ejecta plume evolution. The early stage ejecta cone geometry provides essential information about how the ejecta plume carries its momentum, vital to understanding the momentum enhancement factor [5]. This paper reports a preliminary assessment of the ejecta cone geometry. Throughout the analysis, we assumed that the ejecta plume is perfectly conical along its axis, later known as the

cone axis. The cone opening angle also defines how widely the plume opens, defined as the angle between the cone edges as seen from normal.

Our approach attempted to determine the cone axis and opening angle by performing two steps: (1) extracting the projected directions of the cone edges onto the viewing planes of HST and LICIACube, and (2) comparing these projected directions to the modeled projected edge directions. In the first step, the cone edges were extracted by tracking the edges of brighter features over each image. This process assumed that brighter regions contain higher particle densities (and thus scattering) along the line of sight. The cone edge directions were then converted to their position angles, measured from the north toward the east in the Earth Mean Equator J2000 (EME2000) inertial coordinate frame. To focus on the early stage of the ejecta plume geometry, we applied LICIACube images after its closest flyby and HST images taken ~2 hours after the impact to see similar ejecta speed distributions. The second step generated a 3D cone geometry at a given time after the DART impact and created the modeled position angles of the cone edges in viewing planes. Finally, we searched for the best solution with these parameters that produces a 3D cone geometry statistically satisfying the position angles of the measured cone edges.

[1] Daly et al., 2022 submitted
[2] Thomas et al., 2022, submitted
[3] Li et al., 2022, submitted
[4] Dotto et al., 2022 in preparation
[5] Cheng et al., 2022 submitted

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Comments:

This presentation mainly focused on techniques for determining the cone geometry with no science discussions and is supposed to be a poster presentation.