PDC2023
Vienna, Austria

Space Mission & Campaign Design
Impact Effects & Consequences

MONTE CARLO MODELING OF THE DUST EJECTA GENERATED BY THE DART IMPACT ON DIMORPHOS SURFACE

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Keywords: *DART, Dimorphos, dust dynamics*

ABSTRACT

On September 26th 2022, the NASA/DART spacecraft impacted on Dimorphos, the secondary component of the (65038) Didymos system. The impact generated an extensive cloud of dust debris that evolved into a comet-like dust coma and tail, in a way similar to some active asteroids, as we had predicted in advance[1]. The tail is still detectable after two months since the impact event. In order to assess the physical properties and mass of the ejecta, we have developed a Monte Carlo model for the dynamics of the dust particles, including the computation of the dust coma and tail brightness images as a function of time. The resulting synthetic images are then compared to the high spatial resolution Hubble Space Telescope images acquired since impact time till October 15th, 2022[2]. A trial-and-error procedure is devised in order to find the physical parameters that best fit the observations.
The dynamical model takes into account the combined effect of the gravity of Dimorphos, Didymos, and the Sun, as well as the solar radiation pressure, on the ejected particles. To fit the HST images, we found that two ejecta components have probably been generated after the impact. On one hand, most of the dust particles are ejected at relatively high speeds on the surface of a cone with a thickness of about 10 degree, cone opening angle of some 120 degree, and having the cone axis oriented nearly opposite to the calculated impact velocity vector. In addition, a low-velocity ejecta component, with isotropic distribution, and with velocities comparable to Dimorphos escape velocity (0.09 m/s) would have also been generated. The first ejecta component led to the northern and south-eastern arms seen in the HST and ground-based images (Fig.1a and Fig.1b). The largest particle population of the two ejecta components escape from the Hill sphere of the binary system at different

timeframes, leading to the double tail structure seen in the HST images since early October (Fig.1c and Fig.1d). In the simulations shown, a differential power-law size distribution function of index -2.5 has been used, with minimum and maximum particle sizes at 1 µm and 1 cm.

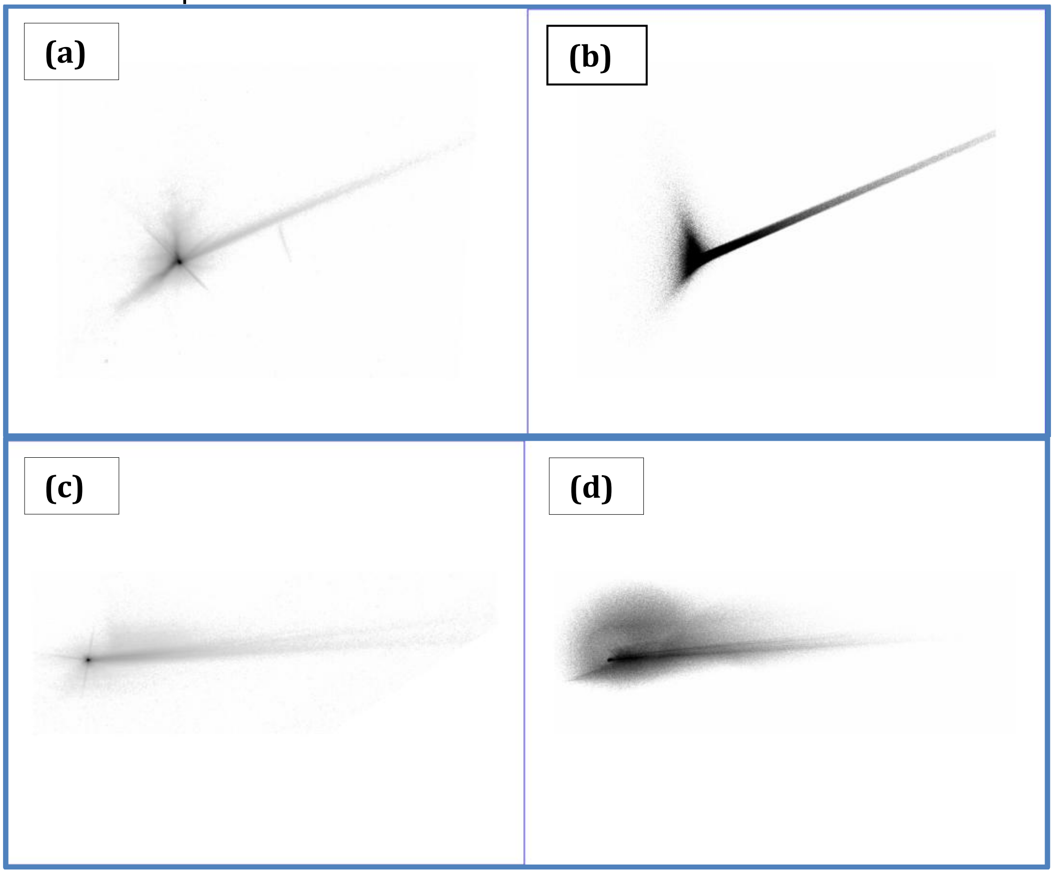

Figure 1. *Ejecta patterns on 28.1 September (panels (a) and (b)) and 11.87 October 2022 (panels (c) and (d)). Panels (a) and (c) show the HST images, and (b) and (d) the corresponding Monte Carlo simulations. All images are displayed in the same logarithmic brightness stretch.*

Although many of the features are already reproduced in the simulations, there are still some patterns that are not. Examples are the brightness excess near the optocenter, and the corrections needed to fit more closely the orientation of the emitting cone (see Fig.1b and Fig.1d). An in-depth study of the sensitivity of the input parameters to the output images is under way.

References

[1] Moreno, F. et al. 2022. Ground-based observability of Dimorphos DART impact ejecta: photometric predictions. MNRAS, 515, 2178.

[2] Li et al. 2023 Ejecta from the DART-produced active asteroid Dimorphos, *submitted.*

Comments: *Oral/Poster*