PHYSICAL PROPERTIES AND COMPOSITION OF PLUME EJECTED FROM DIMORPHOS AFTER DART IMPACT, INVESTIGATED USING LICIACUBE-LUKE RGB COLOR DATA.

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Introduction: NASA's DART mission [1] successfully demonstrated the first test of planetary defense through the kinetic impactor technique on 26th September 2022. The primary target of the mission was Dimorphos, which is the ~151 meters wide satellite in the binary system (65803) Didymos. The ASI CubeSat LICIACube [2], separated from the DART spacecraft 15 days before the impact, acquired more than 400 images during a fly-by, before and after the moment of DART impact, to witness the success of the mission and acquire images for the analysis of the surface of the two asteroids and the plume produced by the impact. LICIACube close approach [CA] to Dimorphos was about 58 km. One of the LICIACube payloads, the LUKE (LICIACube Unit Key Explorer) camera, was equipped with an RGB Bayer filter for acquiring color data [3]. As a result of the impact, the secondary asteroid Dimorphos decreased its orbital period around the primary Didymos by about 33 minutes with a large amount of ejected material observed by both LICIACube and ground- and space-based telescopes.

Methods: Analyses of the colors of the plume are critical to constrain the physical properties of the material ejected from Dimorphos, such as grain size [4], composition, and a possible contribution from the degree of alteration by space weathering [5], although lower than the other contributions. We evaluated the relationship between different RGB filters of LUKE to investigate possible color differences. The ratio of red to blue filter shows that the center of the plume has a prominence of bluer material with respect to the outer part of the plume, likely related to the presence of material with different grain size and probably less alteration by space weathering excavated from the Dimorphos subsurface. Intensity profiles on the various channels along the streamers of the plume reveal its inhomogeneity and allow us to assess color differences within the dust filament of the ejecta by tying these results to patterns of plume evolution.

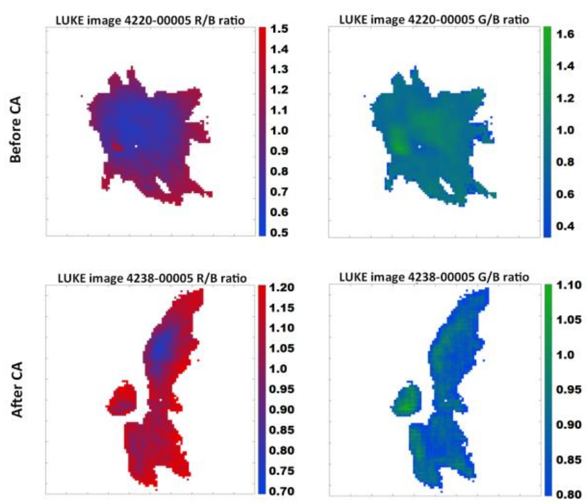

Figure 1. Color ratios from LUKE data for two images before (top) and after (bottom) the close approach [CA]. Red/blue ratio shows a color gradient between the inner and outer part of the plume with a bluer color in the inner part shifting towards red in the outer part (left panels). The green/blue ratio (right panels) is able to highlight internal structures within the plume possibly linked with physical properties and grain size dimension of the dust.

Results: Several color variations were observed within Dimorphos plume [6]. The inner part of the plume is characterized by a stronger blue color while as the distance from the asteroid is increasing, the plume color is progressively shifted towards the red within increasing distance from Dimorphos (Figure 1, top left panel). This could be related to abundant micrometer, or even smaller dust grains <1 µm and a possible contribution from excavated material from the fresh subsurface of Dimorphos, therefore less altered material with a bluer slope as shown by laboratory experiments. Same behavior but with a reduced color gradient is observed in the images post-CA, as visible in Figure 1 lower left panel. Evaluating the green over blue ratio of LUKE images we observed visible structures in the plume, both pre- and post-CA (Figure 1, right panels). Profile of RGB color intensity within the single filaments visible in the plume reveal inhomogeneity likely related to the complex structure of the plume.

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