ROTATIONAL RESOLVED SPECTROSCOPY OF THE DIDYMOS SYSTEM, TARGET OF THE DART/LICIACUBE MISSION.

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Introduction: Near-Earth objects (NEOs), due to their proximity to our planet, represent one of the most accessible bodies in the whole Solar System. Their investigation can provide answers to several pressing questions in modern planetology (regarding, e.g., planetary formation, delivery of water and organics to the early Earth, and emergence of life). Moreover, water and valued minerals stored inside NEOs have already intrigued governments and private companies, allured by the idea of exploiting resources through asteroid mining [1]. However, NEOs can represent a risk for future human civilization, since some of them can be potential impactors [2]. To this purpose, the NASA Double Asteroid Redirection Test (DART) has been approved to be the first demonstration of an hazard mitigation of an asteroid by using a kinetic impactor [3].

The DART/LICIACube mission: The DART spacecraft, to be launched in mid-2021, will impact Dimorphos, the secondary member of the Didymos binary asteroid system, in late 2022. A 6U cubesat space mission, LICIACube (Light Italian Cubesat for Imaging of Asteroids) [4] will be hosted as a piggyback during the 15 months of DART interplanetary cruise. LICIACube, supported by the Italian Space Agency (ASI) will be released ten days before the DART impact and autonomously guided along its fly-by trajectory with Dimorphos, passing its closest Approach (CA) at around 55 km [5] some minutes after the DART impact.

Ground-based characterization of the Didymos system prior to the impact: The available data in literature for the binary NEO 65803 Didymos is scarce. Only few spectra were taken during the latest observational windows, suggesting a possible silicate composition [6], similar to the most common meteorites retrieved on Earth, the ordinary chondrites (See Fig. 1). Spectral characterization is even more crucial due to its binary nature, in order to disentangle the contribution of the primary from the secondary body and asses the heterogeneity of the surface composition.

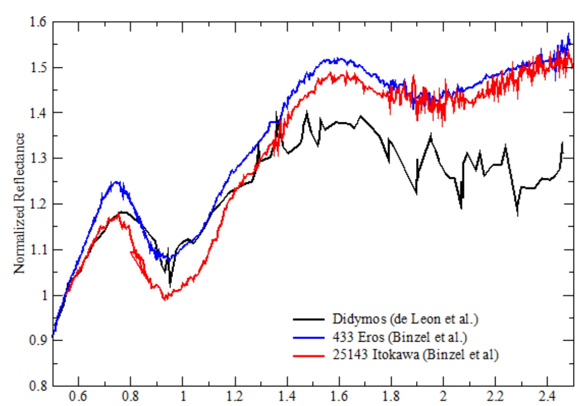

Fig. 1: Vis-NIR spectrum of (65803) Didymos compared to NEAs Eros and Itokawa, adapted from [7].

This scientific conundrum can be resolved with the remote characterization of the system using ground-based observations at different rotational phases during the next observable window in early 2021. These observations are crucial, since this will be the last opportunity to characterize the system prior to the impact. The Italian LICIACube consortium (supported by ASI is actively involved in an international observing campaign, with the aim to characterize at best the Didymos system *before* and *after* the impact. This will be achieved with the analysis of simultaneous spectroscopic and photometric data obtained during the 2021 apparition.

We will present the results of the Didymos characterization campaign at Telescopio Nazionale Galileo (TNG), obtained mainly through visible spectroscopy at different rotational phases. The visible spectra obtained in February, when Didymos is at its brightest (V_{mag}=18.9) will be used to further constrain the surface properties of the system, as the heterogeneity of Didymos composition has not yet been explored. Due to the favorable geometric observing conditions for 2021 (when the Earth and Sun will be close to the orbital plane of the system), ”mutual events”, namely occultations and eclipses, can be observed from Earth. Such investigation could help assess the role of the secondary body in the occurrence of mutual events, and identify if the spectral variations are due to contribution of the secondary on the characterization of the primary body.

In order to correlate the spectra acquired with the location on the surface of Didymos, and examine the possible contribution of Dimorphos during mutual events, the spectra will be phase-correlated with lightcurves obtained in February. In addition, we will also compare data obtained in 2021 with spectra of the binary system obtained during the last observational windows (2003 and 2019) to search for long-term variability.

Acknowledgments: This research was supported by the Italian Space Agency (ASI) within the LICIACube project (ASI-INAF agreement AC n. 2019-31-HH.0).

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