THE ESA HERA MISSION TO THE NEAR-EARTH ASTEROID BINARY (65803) DIDYMOS: DOCUMENTATION OF THE NASA DART IMPACT AND FULL CHARACTERIZATION OF THE ASTEROID SYSTEM.

P. Michel[1], M. Küppers[2], A. Fitzsimmons[3], S.F. Green[4], M. Lazzarin[5], S. Ulamec[6], P. Abell[7], S. Sugita[8], P. Martino[9], I. Carnelli[9], [1]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Lanoratoire Lagrange, Nice, France, michelp@oca.eu, [2]ESA/ESAC, Camino bajo del Castillo S/N, Urbanización Villafranca del Castillo, 28692 Villanueva de la Cañada, Madrid, Spain, [3]Queen's University Belfast, Belfast BT7 1NN, Northern Ireland, School of Physical Sciences, [4]The Open University, Robert Hooke Building, Walton Hall, Milton Keynes MK7 6AA, UK, [5]Department of Physics and Astronomy, Padova University, Vicolo dell'Osservatorio, 3 35122 Padova, Italy, [6]DLR RB-MUSC, Linder Höhe 1, 51147 Cologne, Germany, [7]NASA Johnson Space Center, 2101 NASA Parkway, Mail Code XI, Houston, TX 77058-3696, USA, [8]University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan, [9]ESA-ESTEC, Keplerlaan 1, Noordwijk 2200 AG, Netherlands.

Introduction: The Hera mission is in development within the ESA Space Safety Program for launch in October 2024 with a Falcon 9 rocket. It will perform a rendezvous with the binary asteroid (65803) Didymos in early 2027 and investigate it over a period of 6 months [1]. Together with the NASA DART mission [2], Hera will contribute to the first deflection test of an asteroid, in the framework of the international NASA- and ESA-supported Asteroid Impact and Deflection Assessment (AIDA) collaboration.

Objectives: ESA's Hera mission, with NASA's DART mission, will offer the first fully documented asteroid deflection test. DART successfully impacted Dimorphos, the ~150 meter-sized moon of Didymos on 26 September 2022 [3]. The DART impact resulted in a decrease of 33 minutes from the initial 11 hours 55 minutes orbital period of Dimorphos around Didymos [4].

Although the DART mission was extremely successful, many questions remain open about the interpretation of its outcome and the full validation of the numerical impact models: (1) What is Dimorphos' mass? Mass is needed for an actual determination of DART momentum transfer efficiency [5]. (2) Is Dimorphos a monolith covered with gravel and boulders or, as currently assumed, an aggregate? This has great influence on the interpretation of the DART impact outcome. (3) What is Dimorphos' final state, i.e., what is the size of the crater left by the DART impact or was Dimorphos globally or in large parts reshaped? (4) What is the final binary system's dynamical state? All this knowledge is crucial to fully validate numerical impact models aimed at reproducing the impact and to have an unbiased interpretation of the DART impact outcome. Other questions relate to the thermal properties and mineralogical composition of Dimorphos, including the new areas that may have been revealed by the DART impact, and the potential presence of dust in the close environment of the binary system.

Answering these questions is the goal of Hera that will perform the first asteroid binary rendezvous. Hera will also answer key questions regarding the formation of small asteroid binaries and small body geophysics in general.

Mission: With its mother-spacecraft, which carries five instruments including two asteroid framing cameras, a hyperspectral imager, a laser altimeter, a thermal-IR imager from JAXA, and its two Cubesats, Juventas and Milani, it will measure the DART impact outcome in great detail, including the crater properties and/or Dimorphos' shape change as well as Dimorphos' mass, from which the transferred momentum can be precisely determined. It will measure Dimorphos' compositional and physical characteristics that play a significant role in its impact response. With the low-frequency radar JuRa onboard Juventas, the first measurements of subsurface and internal properties of an asteroid will be performed. Hera will also perform the first Cubesat landing on such a small body, providing information on the surface mechanical response in its very low gravity environment.

Conclusions: The mission development is ongoing nominally and the various working groups of the Hera Science Team are working intensively, adjusting their investigations to account for the new and important results provided by DART and LICIAcube data.

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