EMBARGADO HASTA EL 1 DE MARZO A LAS 17H

PRESS RELEASE

Astronomy: Assessing the impact of the DART mission

International teams, with the participation of the Centro de Astrobiología (CAB), INTA-CSIC, publish today in Nature the results of the first observations of NASA's DART mission.

Understanding how the impact of the DART spacecraft modified the orbit of the asteroid Dimorphos will help in the development of strategies and defense systems against possible collisions of astronomical objects with the Earth.

01-03-2023

The DART mission ran a spacecraft into Dimorphos, the moon of near-Earth asteroid (65803) Didymos, on 27 September 2022 (CET). The aim of the collision was to change the orbit of the moon, testing a potential method of asteroid deflection. Scientists from CAB, INTA-CSIC, have participated in reconstructing the impact of the DART spacecraft on Dimorphos and in analyzing the Hubble Space Telescope observations of the ejected material by the DART impact. These interesting results are reported in two scientific articles published in Nature today.

Several experiments, carried out in the EPIC chamber (Experimental Projectile Impact Chamber) of CAB, have served to validate the numerical codes used in simulations to predict and interpret the effects of NASA's DART kinetic impactor onto the asteroid Dimorphos.

Successful Kinetic Impact into an Asteroid for Planetary Defence

In a pioneering study led by Ronald Terik Daly (Johns Hopkins University Applied Physics Laboratory, USA), the scientists from CAB, Jens Ormö and Isabel Herreros, along with other DART Investigation Team members, reconstruct the impact of the DART spacecraft on Dimorphos, which may help with the planning of future missions and could help to predict outcomes with more certainty. They also describe the location and nature of the impact site, noting that it was between two boulders, one of which was grazed by the spacecraft as it made contact with the moon.

While no known asteroid poses a threat to Earth for at least the next century, the catalogue of near-Earth asteroids is incomplete for objects whose impacts would produce regional devastation. Several approaches have been proposed to potentially prevent an asteroid impact with Earth by deflecting or disrupting an asteroid. NASA's Double Asteroid Redirection Test (DART) mission is the first full-scale test of kinetic impact technology. The mission's target asteroid was Dimorphos, the secondary member of the S-type binary near-Earth asteroid (65803) Didymos. This binary asteroid system

was chosen to enable ground-based telescopes to quantify the asteroid deflection caused by DART's impact. While past missions have utilized impactors to investigate the properties of small bodies, those earlier missions were not intended to deflect their targets and did not achieve measurable deflections. They report the DART spacecraft's autonomous kinetic impact into Dimorphos and reconstruct the impact event, including the timeline leading to impact, the location and nature of the DART impact site, and the size and shape of Dimorphos. The successful impact of the DART spacecraft with Dimorphos and the resulting change in Dimorphos' orbit demonstrates that kinetic impactor technology is a viable technique to potentially defend Earth if necessary.

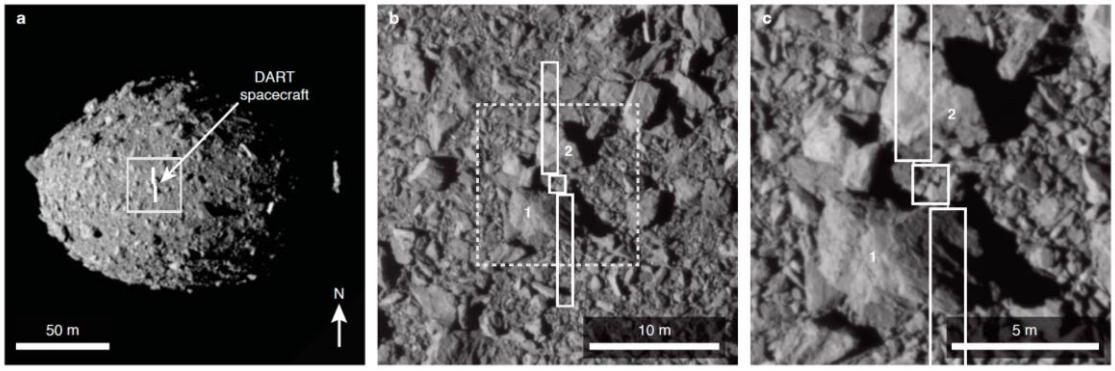


Image: DART impact on the surface of Dimorphos [Image modified from Terik Daly et al., Nature 2023]

Ejecta from the DART-produced active asteroid Dimorphos

The researchers from CAB, Jens Ormö and Isabel Herreros, take part in the study led by Jian-Yang Li (Planetary Science Institute, Tucson, USA), analyzing the Hubble Space Telescope observations of the ejecta plume (debris) created by the DART impact. The speed and evolution of this ejected material may explain the momentum change caused by the impact.

Some active asteroids have been proposed to be the result of impact events. Because active asteroids are generally discovered serendipitously only after their tail formation, the process of the impact ejecta evolving into a tail has never been directly observed. NASA's Double Asteroid Redirection Test (DART) mission, apart from having successfully changed the orbital period of Dimorphos, demonstrated the activation process of an asteroid from an impact under precisely known impact conditions. Here the observations of the DART impact ejecta with the Hubble Space Telescope (HST) from impact time T+15 minutes to T+18.5 days at spatial resolutions of ~2.1 km per pixel are reported. The observations reveal a complex evolution of ejecta, which is first dominated by the gravitational interaction between the Didymos binary system and the ejected dust and later by solar radiation pressure. The lowest-speed ejecta dispersed via a sustained tail that displayed a consistent morphology with previously observed asteroid tails thought to be produced by impact. The ejecta evolution following DART's controlled impact experiment thus provides a framework for understanding the fundamental mechanisms acting on asteroids disrupted by natural impact.

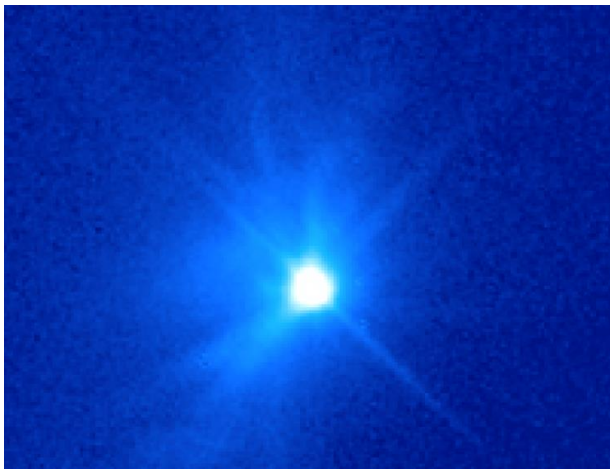
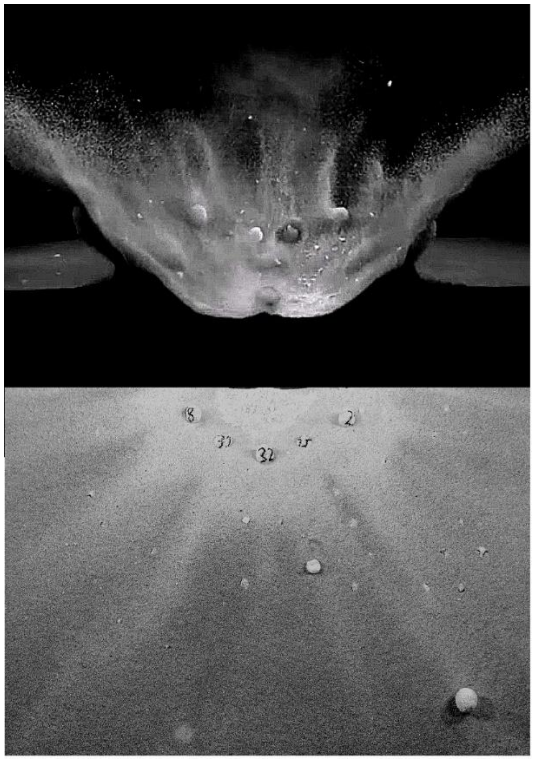


Image: DART impact observed by the Hubble Space Telescope 1.9 hour after impact [Image modified from Jian-Yang Li et al., Nature 2023]

The research team at CAB conducted several experiments with impact velocities of about 400 meters per second with different target configurations to understand how boulders in the target material (i.e., “rubble-pile”) affect the material ejection, the shape of the crater and lowers momentum transfer (i.e. the effective "push" of the asteroid).

These results assisted in the validation of the numerical models used by the DART Investigation Team to predict and interpretate the outcomes of the mission.



Images: Top: Photo from one of the EPIC (CAB CSIC-INTA) “rubble-pile” impact experiments obtained with a high-velocity video camera. It shows how embedded “boulders” in the target move in relation to the sand matrix. The crater is approximately 20cm wide; Down: Ray system formed by the deposition of the ejected material on the target. Credits: Laboratory for Experimental Impacts (CAB, CSIC-INTA) [Image modified from Ormö et al., 2022].

About CAB

Centro de Astrobiología (CAB), CSIC-INTA is a joint research center of the Spanish National Research Council (CSIC) and the National Institute of Aerospace Technology (INTA). Created in 1999, it was the world's first center dedicated specifically to astrobiological research and the first non-US associate member of NASA's Astrobiology Institute (now the NASA Astrobiology Program). It is an interdisciplinary research center whose main objective is to study the origin, presence and influence of life in the universe. In 2017, CAB was distinguished by the Ministry of Science and Innovation as "María de Maeztu Unit of Excellence" for the period 1 July 2018 to 30 June 2022.

CAB has led the development of the REMS, TWINS and MEDA instruments, all operational on Mars since August 2012, November 2018 and February 2021, respectively; as well as the science of the RLS Raman instrument of the ESA's Exomars Mission. In addition, since its inception, the center has been developing the SOLID instrument, aimed at the search for life in planetary exploration. Likewise, CAB participates in different missions and instruments of great astrobiological relevance, such as CARMENES, CHEOPS, PLATO, BepiColombo, DART, Hera, the **MIRI** and **NIRSpec** instruments at JWST and the HARMONI instrument at ESO's Extremely Large Telescope (ELT).

More information

Neither Dimorphos nor Didymos poses any hazard to Earth before or after DART's controlled collision with Dimorphos.

Johns Hopkins Applied Physics Lab built and operated the DART spacecraft and manages the DART mission for NASA's Planetary Defense Coordination Office as a project of the agency's Planetary Missions Program Office. LICIACube is a project of the Italian Space Agency (ASI), carried out by Argotec.

For more information about the DART mission, visit https://www.nasa.gov/dart or https://dart.jhuapl.edu.

Access to the publications in Nature (01/03/23)

Daly et al.: https://www.nature.com/articles/s41586-023-05810-5 (DOI: 10.1038/s41586-023-05810-5)

Li et al.: https://www.nature.com/articles/s41586-023-05811-4 (DOI: 10.1038/s41586-023-05811-4)

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