THE ESA HERA AND NASA DART MISSIONS TO THE BINARY ASTEROID (65803) DIDYMOS: PLANETARY DEFENSE, SCIENCE AND INTERNATIONAL COORDINATION

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Résumé: Les missions DART (NASA) et Hera (ESA) vont fournir le premier test entièrement documenté de déviation d'astéroïde basé sur la technique de l'impacteur cinétique, ce qui permettra de vérifier et potentiellement valider cette technique et les simulations numériques d'impact à l'échelle d'un astéroïde. Que vont faire ces deux missions? Quelles sont les résultats attendus et les incertitudes? Quelle est leur importance scientifique? Et comment organise-t-on notre réponse au risque d'impact à l'échelle internationale, et pourquoi?

Introduction: The Hera mission is in development for launch in October 2024 within the ESA Space Safety Program [1]. 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.

The impact of the NASA DART spacecraft [2] on the 160 m-diameter natural satellite called Dimorphos of the binary asteroid 65803 Didymos on September 26th, 2022, will change its orbital period around Didymos. As Didymos is an eclipsing binary and close to the Earth on this date, the change can be detected by Earth-based observers. Before impact, DART will deploy the Italian LICIACube that will provide images of the first minutes after impact. Hera will rendezvous Didymos four years after the impact and perform the measurements necessary to understand the effect of the DART impact on Dimorphos, in particular its mass, its internal structure, the direct determination of the momentum transfer and the detailed characterization of the crater left by DART.

Planetary Defense Return: The objectives of Hera (Fig. 1) related to the deflection demonstration are the following:

•Measuring the mass of Dimorphos to determine the momentum transfer efficiency from DART impact.

•Investigating in detail the crater produced by DART to improve our understanding of the cratering process and the mechanisms by which the crater formation drives the momentum transfer efficiency.

•Observing subtle dynamical effects that are difficult to detect for remote observers.

•Characterizing the surface and interior of Dimorphos to allow scaling of the momentum transfer efficiency to different asteroids.

Science return: Hera will also provide unique information on many current issues in asteroid science. The reason is that our knowledge of these fascinating objects is still poor, especially for the smallest ones. Hera will rendezvous for the first time with a binary asteroid. Its secondary has a diameter of only 160 m in diameter. So far, no mission has visited such a small asteroid. Moreover, for the first time, internal and subsurface properties will be directly measured with many science implications.

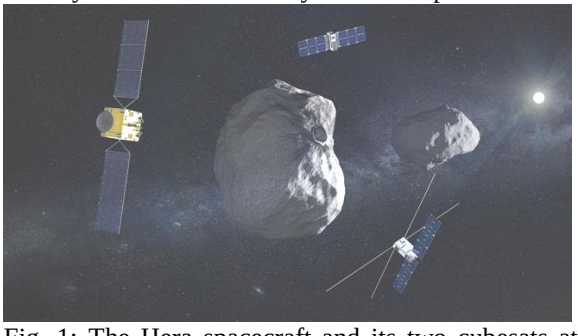

Fig. 1: The Hera spacecraft and its two cubesats at proximity of Didymos.

International Response: The European Commission supports planetary defense projects, such as the H2020 projects NEO-MAPP (Near Earth Object Modelling and Payload for Protection) and NEOROCKS. In addition, two groups endorsed by the UN are working on a coordinated response at international level, including the prediction, the decision-making process, the legal aspects, the communication and the mitigation.

Conclusion: The risk of an asteroid impact is one of the least likely risks on a human timescale, but it is among the only ones that can be predicted and prevented with reasonable and feasible means that we are currently implementing. We must be ready before we need it and our planetary defense efforts are aimed at offering a robust plan to the future generations, so that they will not have to improvise, given the potentially high consequences.

References: [1] Michel P. et al. (2022) *Planet. Sci. J.*, accepted. [2] Rivkin A. et al. (2021) *Planet. Sci. J.*, *2*, 173.

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