PDC2021
Vienna, Austria

Please submit your abstract at https://atpi.eventsair.com/7th-iaa-planetary-defense-conference-2021/abstractsubmission

You may visit https://iaaspace.org/pdc

(please choose one box to be checked)
(you may also add a general comment - see end of the page)

☐ **Key International and Political Developments**
☐ **Advancements and Progress in NEO Discovery**
☐ **NEO Characterization Results**
☐ **Deflection and Disruption Models & Testing**
☒ **Mission & Campaign Designs**
☐ **Impact Consequences**
☐ **Disaster Response**
☐ **Decision to Act**
☐ **Public Education & Communication**

HERA RADIO SCIENCE EXPERIMENTS THROUGH GROUND-BASED AND SATELLITE-TO-SATELLITE DOPPLER TRACKING

Paolo Tortora[(1)], **Marco Zannoni**[(1)], **Edoardo Gramigna**[(1)], **Riccardo Lasagni Manghi**[(1)], **Sebastien Le Maistre**[(2)], **Ryan S. Park**[(3)], **Giacomo Tommei**[(4)], **Ozgur Karatekin**[(2)], **Etienne Le Bras**[(5)], **Paolo Martino**[(6)], **Paolo Concari**[(6)], **Michael Kueppers**[(7)], **Patrick Michel**[(8)], **Ian Carnelli**[(9)]

[(1)] *Dipartimento di Ingegneria Industriale, Alma Mater Studiorum - Università di Bologna, I-47121 Forlì, Italy, paolo.tortora@unibo.it*
[(2)] *Royal Observatory of Belgium, Brussels, Belgium*
[(3)] *CalTech/ Jet Propulsion Laboratory, Pasadena, CA, USA*
[(4)] *Università di Pisa, Pisa, Italy*
[(5)] *GomSpace Luxembourg S.à.r.l., L-4370 Belval, Luxembourg*
[(6)] *ESA/ESTEC, 2200 AG Noordwijk, The Netherlands*
[(7)] *ESA/ESAC, Villanueva de la Cañada (Madrid), Spain*
[(8)] *Université Côte d'Azur, Observatoire de la Côte d'Azur, Nice, France*
[(9)] *ESA/HQ, 75738 Paris Cedex 15, France*

Keywords: *Hera, Radio science, Inter-satellite link, orbit determination, gravity science*

ABSTRACT

ESA-Hera mission together with its NASA-DART (Double Asteroid Redirection Test) counterpart, represent the first humankind's investigations of a planetary defense technique. The missions are part of the Asteroid Impact & Deflection Assessment

(AIDA), an international collaboration supported by ESA and NASA to assess the feasibility of the kinetic impactor technique to deflect an asteroid. At the end of 2022, DART will impact the secondary of the binary near-Earth asteroid (65803) Didymos, recently named Dimorphos. After 4 years, Hera will follow-up with a detailed post-impact survey of Didymos, to fully characterize and validate this planetary defense technique. Additionally, Hera will deploy two CubeSats around Didymos once the Early Characterization Phase has completed, to complement the observations of the mother spacecraft. The first Cubesat, called Juventas, will complete a low-frequency radar survey of the secondary, to unveil its interior, while the second Cubesat, Milani, will perform a global mapping of Didymos and Dimorphos, focusing on their compositional difference and their surface properties. In this context, one of the main objectives of Hera is to determine the binary system's mass, gravity field and rotational state and orbits using radio tracking and imaging data. The gravity science experiment will be based on Doppler, ranging and optical images measurements. In particular, the experiment includes classical ground-based radiometric measurements between Hera and ground stations on Earth by means of a standard two-way X-band link, onboard images of Didymos, and spaceraft-to-spacecraft satellite-to-satellite radiometric tracking between Hera and the Cubesats. The Inter-satellite link (ISL) represents a crucial add-on to the gravity estimation of low-gravity bodies by exploiting the proximity of the Cubesats to the binary, as the range-rate measurements carried out by the inter-satellite link contain information on the dynamics of the system, i.e. masses and gravity field of Didymos primary and secondary.

We will describe the updated mission scenario for the Hera gravity science experiment to be jointly carried out by the three mission elements, i.e. Hera, Juventas and Milani. To conclude, our updated analysis and latest results as well as the achievable accuracy for the estimation of the mass and gravity field of Didymos and Dimorphos are presented.