JuRa: the Juventas Radar on Hera to fathom Didymoon

Alain Herique, Dirk Plettemeier, Hannah Goldberg, Wlodek Kofman

EPSC Abstracts
Vol. 14, EPSC2020-595, 2020, updated on 12 Jul 2022
https://doi.org/10.5194/epsc2020-595
Europlanet Science Congress 2020

JuRa: the Juventas Radar on Hera to fathom Didymoon

Alain Herique[1], Dirk Plettemeier[2], Hannah Goldberg[3], Wlodek Kofman[1], and the JuRa Team[*]
[1]Univ. Grenoble Alpes, CNRS, CNES, IPAG, Grenoble, France (alain.herique@univ-grenoble-alpes.fr)
[2]Technische Universität Dresden, Dresden, Germany (dirk.plettemeier@tu-dresden.de)
[3]GOMSPACE, Aalborg, Denmark (hrg@gomspace.com)
[*]A full list of authors appears at the end of the abstract

The ESA Hera mission approved by the last ESA council Sapec19+ will be launched in 2024 to deeply investigate the Didymos binary system and especially its moonlet. Onboard the Juventas small platform, the JuRa radar will fathom Didymoon and provide the first direct observation of an asteroid deep interior. The question of asteroids' internal structure is crucial for science, planetary defense and exploration. After several rendezvous missions, our knowledge relies entirely on inferences from remote sensing observations of the surface and theoretical modeling [1].

Didymos binary asteroid system is an S-type asteroid system orbiting the sun with a semi-major axis of 1.64 AU. The primary body has a diameter of 800 m and Didymoon, the secondary body with a diameter of 160 meters is orbiting around the main at a distance of 1.2 km [2]. In 2022, DART, the NASA contribution to the AIDA program, will impact the moonlet to quantify the mechanical response of the body, mainly from ground-based observation [3]. Five years later, Hera is a unique opportunity to observe in detail the bodies, the crater and the ejecta in order to better constraints mechanical models [2], [4]. Hera will provide a global characterization of the binary system: shape, density, dynamic properties, thermal properties, composition, …

JuRa, aboard the small platform Cubsat Juventas, will probe the moonlet. The JuRa instrument is a monostaic radar, BPSK coded at 60MHz carrier frequency and 20MHz bandwidth, inherited from CONSERT/Rosetta [5], [6] and redesigned in the frame of the AIDA/AIM phase A/B [2], [7]. JuRa maps the backscatter coefficient (sigma zero - s0) of the surface or subsurface, which quantifies the returned power per surface or volume unit. It is related to the degree of heterogeneity at the scale of the wavelength and to the dielectric contrast of heterogeneities, giving access to both, the sub-meter texture of the constituent material and larger scale structure.

- The first objective of JuRA is to characterize the moonlet's interior, to identify internal geological structure such as layers, voids, sub-aggregate, to bring out the aggregate structure and to characterize its constituent blocks in terms of size distribution and heterogeneity at different scales (from submetric to global).
- The second objective is to estimate the average permittivity and to monitor its spatial variation in order to retrieve information on its composition and porosity, especially in the area of the impact crater. Radar bypasses the near surface alteration by space-weathering and thermal-cycling as observed with optical remote sensing.
- The same characterization applied to the main asteroid of the binary system is among the

secondary objectives, to detect differences in texture and composition and to support the modeling of the binary system's formation. Supporting shape modeling and the determination of the dynamic state through radar ranging are other secondary objectives.

Thus, the observation of the structure and composition of moonlet will provide constraints on the mechanical model of the impact process. By When compared to the observation of the main body, it will constraint the model of binary system formation to discriminate between progressive versus catastrophic process and more generally on the stability condition of the system.

Acknowledgments

Hera is the ESA contribution to the AIDA collaboration. Juventas and JuRa are developed under ESA contract supported by national agencies. JuRa is built by EmTroniX (Lux), UGA/IPAG (Fr), TUD (Gr), Astronika (Pl) and BUT (Cz). Juventas is built by Gomspace (Lux).

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 870377 (project NEO-MAPP).

References

[1] A. Herique et al., « Direct observations of asteroid interior and regolith structure: Science measurement requirements », Advances in Space Research, vol. 62, n° 8, p. 2141□2162, oct. 2018, doi: 10.1016/j.asr.2017.10.020.

[2] P. Michel et al., « Science case for the Asteroid Impact Mission (AIM): A component of the Asteroid Impact & Deflection Assessment (AIDA) mission », Advances in Space Research, vol. 57, n° 12, p. 2529□2547, juin 2016, doi: 10.1016/j.asr.2016.03.031.

[3] A. F. Cheng et al., « Asteroid Impact & Deflection Assessment mission: Kinetic impactor », Planetary and Space Science, vol. 121, p. 27□35, févr. 2016, doi: 10.1016/j.pss.2015.12.004.

[4] S. D. Raducan, T. M. Davison, et G. S. Collins, « The effects of asteroid layering on ejecta mass-velocity distribution and implications for impact momentum transfer », Planetary and Space Science, vol. 180, p. 104756, janv. 2020, doi: 10.1016/j.pss.2019.104756.

[5] W. Kofman et al., « The Comet Nucleus Sounding Experiment by Radiowave Transmission (CONSERT): A Short Description of the Instrument and of the Commissioning Stages », Space Science Reviews, vol. 128, n° 1□4, p. 413□432, mai 2007, doi: 10.1007/s11214-006-9034-9.

[6] W. Kofman et al., « Properties of the 67P/Churyumov-Gerasimenko interior revealed by CONSERT radar », Science, vol. 349, n° 6247, p. aab0639, juill. 2015, doi: 10.1126/science.aab0639.

[7] A. Herique et al., « A radar package for asteroid subsurface investigations: Implications of implementing and integration into the MASCOT nanoscale landing platform from science requirements to baseline design », Acta Astronautica, mars 2018, doi: 10.1016/j.actaastro.2018.03.058.

JuRa Team: Lucas Cicero (EmTroniX) Laurent Crochet (EmTroniX) Henri Du Faux (EmTroniX) Oriane Gassot (IPAG) Ronny Hahnel (TUD) Martin Laabs (TUD) Yann Le Corre (EmTroniX) Cedric Lorant (EmTroniX) Marco Mütze (TUD) Sylvain Rochat (IPAG) Yves Rogez (IPAG) Baptiste Soukiassian (IPAG) Filip Záplata (BUT)