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The Hera Entry Probe Mission to Saturn, an ESA M-class mission proposal

O. Mousis (1), D.H. Atkinson (2), T. Spilker (3), E. Venkatapathy (4), J. Poncy (5), A. Coustenis (6), K. Reh (7) and the Hera Team
(1) Aix Marseille Université, CNRS, LAM (Laboratoire d'Astrophysique de Marseille) UMR 7326, 13388, Marseille, France (olivier.mousis@lam.fr), (2) Department of Electrical and Computer Engineering, University of Idaho, Moscow, Idaho, USA, (3) Solar System Science & Exploration, Monrovia, USA, (4) NASA Ames Research Center, Moffett Field, California, USA, (5) Thales Alenia Space, Cannes, France, (6) LESIA, Observatoire de Paris, CNRS, UPMC, Univ. Paris-Diderot, France, (7) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA

Abstract

A fundamental goal of solar system exploration is to understand the origin of the solar system, the initial stages, conditions, and processes by which the solar system formed, how the formation process was initiated, and the nature of the interstellar seed material from which the solar system was born. Key to understanding solar system formation and subsequent dynamical and chemical evolution is the origin and evolution of the giant planets and their atmospheres. Additionally, the atmospheres of the giant planets serve as laboratories to better understand the atmospheric chemistries, dynamics, processes, and climates on all planets in the solar system including Earth, offer a context and provide a ground truth for exoplanets and exoplanetary systems, and have long been thought to play a critical role in the development of potentially habitable planetary systems.

Remote sensing observations are limited when used to study the bulk atmospheric composition of the giant planets of our solar system. A remarkable example of the value of *in situ* probe measurements is illustrated by the exploration of Jupiter, where key measurements such as noble gases abundances and the precise measurement of the helium mixing ratio have only been made available through in situ measurements by the Galileo probe. Representing the only method providing ground-truth to connect the remote sensing inferences with physical reality, *in situ* measurements have only been accomplished twice in the history of outer solar system exploration, via the Galileo probe for Jupiter and the Huygens probe for Titan. *In situ* measurements provide access to atmospheric regions that are beyond the reach of remote sensing, enabling the dynamical, chemical and aerosol-forming processes at work from the thermosphere to the troposphere below the cloud decks to be studied.

A proposal for a Saturn entry probe mission named Hera was recently submitted to the European Space Agency Medium Class mission announcement of opportunity. Hera comprises a single entry probe carried by a flyby spacecraft that will also act as a relay station to receive the probe science telemetry for recording and later transmission to Earth. A solar powered mission, Hera will take approximately 8 years to reach Saturn and will descend under a sequence of parachutes to depths of at least 10 bars in approximately 75 minutes. The Hera probe will carry a Mass Spectrometer to measure the composition of Saturn's atmosphere, an Atmospheric Structure Instrument to measure atmospheric pressures and temperatures, and a Doppler Wind Experiment to measure the dynamics of Saturn's atmosphere. Other possible instruments in the Hera scientific payload include a Net Flux Radiometer to measure the energy balance of the Saturn atmosphere and a Nephelometer to measure cloud locations and densities.

In the context of giant planet science provided by the Galileo, Juno, and Cassini missions to Jupiter and Saturn, the Hera Saturn probe will provide critical measurements of composition, structure, and processes that are not accessible by remote sensing. The results of Hera will help test competing theories of solar system and giant planet origin, chemical, and dynamical evolution.