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JUICE: A European mission to explore the emergence of habitable worlds around gas giants

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Abstract

JUICE - JUpiter ICy moons Explorer - is the first large mission in the ESA Cosmic Vision 2015-2025 programme. The mission was selected in May 2012 and adopted in November 2014. The implementation phase started in July 2015, following the selection of the prime industrial contractor, Airbus Defense and Space (Toulouse, France). Due to launch in May/June 2022 and to arrive at Jupiter in October 2029, it will spend at least three ½ years making detailed observations of Jupiter and three of its largest moons, Ganymede, Callisto and Europa. The status of the important project milestones in 2018 are presented.

1. Science Objectives

The focus of JUICE is to characterise the conditions that might have led to the emergence of habitable environments among the Jovian icy satellites, with special emphasis on the three worlds, Ganymede, Europa, and Callisto, likely hosting internal oceans [1,2]. Ganymede, the largest moon in the Solar System, is identified as a high-priority target because it provides a unique and natural laboratory for analysis of the nature, evolution and potential habitability of icy worlds and waterworlds in general, but also because of the role it plays within the system of Galilean satellites, and its special magnetic and plasma interactions with the surrounding Jovian environment. The mission also focuses on characterising the diversity of coupling processes and exchanges in the Jupiter system that are responsible for the changes in surface and space environments at Ganymede, Europa and Callisto, from short-term to geological time scales. Focused studies of Jupiter's atmosphere and magnetosphere, and their interaction with the Galilean satellites will further enhance our understanding of the evolution and dynamics of the Jovian system. The overarching theme for JUICE is: The emergence of habitable worlds around gas giants. At Ganymede, the mission will characterise in detail the ocean layers; provide topographical, geological and compositional mapping of the surface; study the physical properties of the icy crusts; characterise the internal mass distribution, investigate the exosphere; study Ganymede's intrinsic magnetic field and its interactions with the Jovian magnetosphere. For Europa, the focus will be on the surface composition, understanding the formation of surface features and subsurface sounding of the icy crust over recently active regions. Callisto will be explored as a witness of the early solar system trying to also elucidate the mystery of its internal structure. JUICE will perform a multidisciplinary investigation of the Jupiter system as an archetype for gas giants. The Jovian atmosphere will be studied from the cloud tops to the thermosphere. The focus in Jupiter's magnetosphere will include an investigation of the three dimensional properties of the magnetodisc and in-depth study of the coupling processes within the magnetosphere, ionosphere and thermosphere. JUICE will study the moons' interactions with the magnetosphere, gravitational coupling and long-term tidal evolution of the Galilean satellites.

2. The Payload

The JUICE payload consists of 10 state-of-the-art instruments plus one experiment that uses the spacecraft telecommunication system with ground-based instruments. This payload is capable of addressing all of the mission's science goals [1,2], from in situ measurements of the plasma environment, to remote observations of the surface and interior of the three icy moons, Ganymede, Europa and Callisto, and of Jupiter's atmosphere. A remote sensing package includes imaging (JANUS)

and spectral-imaging capabilities from the ultraviolet to the sub-millimetre wavelengths (MAJIS, UVS, SWI). A geophysical package consists of a laser altimeter (GALA) and a radar sounder (RIME) for exploring the surface and subsurface of the moons, and a radio science experiment (3GM) to probe the atmospheres of Jupiter and its satellites and to perform measurements of the gravity fields. An in situ package comprises a powerful suite to study plasma and neutral gas environments (PEP) with remote sensing capabilities via energetic neutrals, a magnetometer (J-MAG) and a radio and plasma wave instrument (RPWI), including electric fields sensors and a Langmuir probe. An experiment (PRIDE) using ground-based Very Long Baseline Interferometry (VLBI) will support precise determination of the spacecraft state vector with the focus at improving the ephemeris of the Jovian system.

3. The mission profile

The mission is due to launch from Kourou with an Ariane 5 ECA. The baseline launch is 1st of June 2022, which is in the middle of a 20 days launch window. There are backup launch slots two or three times per year. The interplanetary transfer sequence relies on gravity assist with Venus, the Earth and Mars. The Jupiter orbit insertion will be performed in October 2029. An initial Ganymede swing-by is performed just before the capture manoeuvre. The tour of the Jupiter system, as currently designed, starts with a series of three Ganymede swing-bys. The spacecraft is transferred to Callisto to initiate the Europa science phase, one year after the Jupiter insertion. This phase is composed of two fly-bys, separated by 15 days, with closest approach at 400 km altitude. The next phase is a 200-day period characterised by an excursion at moderate inclinations, in order to investigate regions of the Jupiter environment away from the equatorial plane. A series of resonant transfers with Callisto raise the inclination with respect to Jupiter's equator to a maximum value of about 28 deg. The spacecraft is then transferred from Callisto to Ganymede with a series of Callisto and Ganymede flybys, followed by a gravitational capture with the moon. The science phase around Ganymede is decomposed into a first elliptic subphase, a circular orbit at 5000 km altitude followed by a second elliptic subphase, and then a circular phase at 500 km altitude. The total duration of the Ganymede orbital phase is about nine months, the end of mission being planned in September 2033. The spacecraft will eventually impact the surface.

References

[1] JUICE Definition Study Report, Reference ESA/SRE(2014)1,2014. http://sci.esa.int/juice/54994-juice-definition-study-report/

[2] Grasset, O., et al., JUpiter ICy moons Explorer (JUICE): An ESA mission to orbit Ganymede and to characterise the Jupiter system, Planetary and Space Science, Volume 78, p. 1-21, 2013