JUICE: A European Mission to Jupiter and its Icy Moons

O. Witasse[1*], *and the JUICE Science Working Team*

[1]*European Space Agency, Noordwijk, The Netherlands*

1. Introduction

JUICE - JUpiter ICy moons Explorer - is the first large mission in the European Space Agency Cosmic Vision programme. The implementation phase started in July 2015. JUICE will be launched in June 2022 from Kourou, and will arrive at Jupiter in October 2029. It will spend three years characterizing the Jovian system, the planet itself, its giant magnetosphere, and the giant icy moons Ganymede, Callisto and Europa [1,2]. JUICE will then orbit Ganymede for almost a year.

2. The science objectives

The main goal is to explore the habitable zone around Jupiter. Ganymede is a high-priority target because it provides a unique laboratory for analyzing the nature, evolution and habitability of icy worlds, including the characteristics of subsurface oceans, and because it possesses unique magnetic fields and plasma interactions with the environment. On Europa, the focus will be on recently active zones, where the composition, surface and subsurface features (including putative water reservoirs) will be characterized. Callisto will be explored as a witness of the early Solar System. JUICE will also explore the Jupiter system as an archetype of gas giants. The circulation, meteorology, chemistry and structure of the Jovian atmosphere will be studied from the cloud tops to the thermosphere and ionosphere. JUICE will also investigate the 3D properties of the magnetodisc, and will study the coupling processes within the magnetosphere, ionosphere and thermosphere. The mission also focuses on characterizing the processes that influence surface and space environments of the moons.

3. The payload

The payload consists of 10 instruments plus a ground-based experiment (PRIDE) to better constrain the S/C position. A remote sensing package includes imaging (JANUS) and spectral-imaging capabilities from the UV to the sub-mm wavelengths (UVS, MAJIS, SWI). A geophysical package consists of a laser altimeter (GALA) and a radar sounder (RIME) for exploring the moons, and a radio science experiment (3GM) to probe the atmospheres and to determine the gravity fields. The in situ package comprises a 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).

4. The trajectory

The mission profile can be divided into two main parts: an interplanetary transfer to Jupiter, and the transfer to a Ganymede bound trajectory during the science phase at Jupiter. The mission is based on a launch from the Centre Spatial de Guyane in Kourou (CSG) with 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. The tour of the Jupiter system starts with a series of four Ganymede swing-bys that reduce the orbit energy, the inclination and the infinite velocity, and which initiate the Europa science phase, one year after the Jupiter insertion. The Europa science 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 to moderate inclinations, in order to investigate regions of the Jupiter environment away from the equatorial plane. A series of resonant transfers with Callisto gravity assists raises the inclination with respect to Jupiter's equator to a maximum value of 29 deg. After decreasing the inclination again, the spacecraft is then using Callisto and Ganymede flybys to prepare the insertion into Ganymede orbit, in September 2032. The science phase around Ganymede is decomposed first into an 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 the nominal mission being planned in June 2033. The spacecraft will eventually impact the surface, in line with planetary protection.

5. References

[1] JUICE Definition Study Report, ESA/SRE(2014)1,2014.
[2] Grasset et al., Plan. Space Sci., 78, 2013

Short Summary

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