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The Jupiter Ganymede Orbiter as part of the ESA/NASA Europa Jupiter System Mission (EJSM)

O. Grasset (1), J.-P Lebreton (2), M. Blanc (3), M. Dougherty (4), C. Erd (2), R. Greeley (5), B. Pappalardo (6), and the Joint Science Definition Team.

(1) University of Nantes, France, (olivier.grasset@univ-nantes.fr). (2) ESA/ESTEC, The Netherlands. (3) Ecole Polytechnique, France (4) Imperial College, UK. (5) Arizona State University, USA. (6) NASA/JPL, USA

A Joint Mission to the Jupiter System

The merging of ESA's Cosmic Vision *Laplace* proposal and NASA's two Outer Planets Flagship mission studies, "*Europa Orbiter*" and "*Jupiter System Observer*" led to the joint "*Europa Jupiter System Mission*" (EJSM) study. This is an international mission proposed to be developed in collaboration between ESA and NASA. The reference mission architecture consists of the following elements:

• A Jupiter Ganymede Orbiter (JGO), to be developed and launched by ESA.
• A Jupiter Europa Orbiter (JEO), to be developed and launched by NASA.
In addition, a Jupiter Magnetospheric Orbiter (JAXA-lead) and a Europa Lander (Roskosmos-lead) will possibly be developed but are not yet part of the current baseline of the mission.

The goal of the mission is to study Jupiter and its magnetosphere, the diversity of the Galilean satellites, the physical characteristics, composition and geology of their surfaces. This paper presents the main characteristics of the Jupiter Ganymede Orbiter platform.

Science objectives for JGO

Jupiter as a planet
The main goals of JGO for the Jovian atmosphere concern the radiative and hydrodynamic coupling in the Jovian atmosphere, with the two questions: How does Jupiter radiate its internal energy to space? What are the dynamics and coupling in its atmosphere? The upper atmosphere, the stratosphere, and the troposphere will be sounded to address these questions. In addition, the connection to the interior would be studied through the detection and characterization of internal waves of Jupiter, assumed to link the deep interior with the external layers.

Magnetosphere of Jupiter
The Jovian magnetosphere is driven by the fast rotation of its central spinning object, Jupiter. Its major plasma source is the volcanic moon Io, deep inside the magnetosphere, which releases about 1 ton/s of oxygen and sulphur and feeds with this iogenic plasma an equatorial magnetodisc extending out over 100s of planetary radii. The Jovian magnetosphere is the most accessible environment for direct *in situ* investigations of processes regarding: (i) the stability and dynamics of magneto-discs, and more generally, angular momentum exchange and dissipation of rotational energy, (ii) the electro-dynamical coupling between a central body and its satellites including plasma/surface interactions, transport processes and turbulence in partly ionized media. Jupiter is also a powerful particle accelerator, its inner magnetosphere being the most severe radiation environment in the Solar System. The various processes that lead to such efficient particle acceleration could also radically affect the 'habitability' on the surfaces of the Jovian moons.

Ganymede and Callisto
The JGO mission profile is defined in order to focus on the two icy outer moons, while JEO will focus on the two inner moons. First of all, JGO will search for the presence and spatial distribution of liquid water within the moons. It will also investigate the characteristics of the upper icy layers (thickness, composition, detection of water reservoirs in the crust, …), and will study the deep interiors (Figure 1).

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Surface composition, geologic features, and surface exchange processes will be thoroughly investigated by JGO. One of the main objectives is to determine the nature of the non-ice components at the surfaces and how they are linked to the interior and to the exosphere. Especially for Callisto, JGO will aim to quantify the rates of sublimation-degradation, a major process of surface modification. As for Ganymede, the relative roles of geological processes (tectonism, volcanism, mass wasting) that have shaped its surface will be investigated.

A unique characteristic of Ganymede is its intrinsic magnetic field generated in the satellite's metallic core. The investigation of Ganymede's magnetosphere and its deep interior structure are very important to understand the Jovian system as a whole. The interplay between intrinsic field, induced magnetic fields generated in the subsurface ocean, and the Jovian magnetosphere will be characterized by JGO during a dedicated elliptical orbit phase.

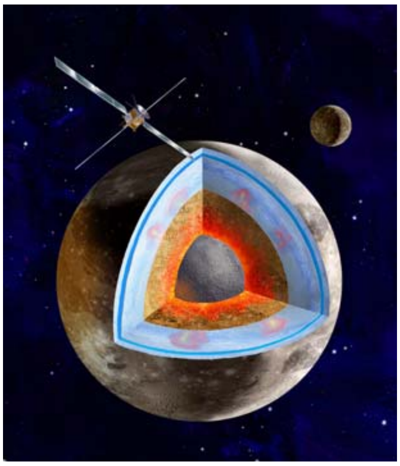

Figure 1: Artist's illustration of the JGO platform around Ganymede.

JGO as part of the EJSM mission

Many other EJSM science objectives will be at least partly addressed by JGO, as one of the two platforms of the whole EJSM mission (inner system – moons and rings, the irregular satellites, …).

JGO will also address the study of processes which occur within the Jupiter system, especially related to satellite/magnetosphere interactions, and also to tidal coupling among Jupiter and the Galilean Satellites.

Mission architecture

An ESA internal assessment study of EJSM/JGO was conducted in 2008 (ref 1). JGO is a 3-axis stabilized spacecraft with a dry mass of 1275 kg and a wet launch mass of 3493 kg. Electrical power is generated by ~51m^2 GaAs solar cell arrays. JGO would be launched by Ariane 5 in 2020 and arrive at Jupiter 6 years later where orbit insertion would take place in early 2026. At the end of the internal assessment study, a model payload of 10 instrument packages was retained.

During the tour through the Jupiter system, the instruments onboard would observe Jupiter and perform measurements in its magnetosphere. In this part of the trajectory, JGO would perform some flybys of Callisto and up to 9 flybys of Ganymede. About two years after Jupiter orbit insertion, JGO moves into a 2:3 resonant orbit with Callisto to perform remote sensing observations during 19 low-altitude fly-bys. After more than 1 year in resonant orbit with Callisto, JGO is transferred to Ganymede and inserted into an elliptical polar orbit (200 km x 6000 km) above the surface of the moon, remaining there for around 80 days, performing amongst other observations measurements in the Ganymede magnetosphere.

Afterwards, JGO transfers to a 200 km near-polar circular orbit for close-by observations of Ganymede with duration of around 180 days (the duration is limited by the gained total radiation dose (design goal <100krad) and the orbit stability). The mission would end with a propulsive manoeuvre to force an impact onto Ganymede.

EJSM/JGO Mission status

JGO enters into a 1-year industrial assessment phase in July 2009. Within ESA, JGO will compete with two astronomy missions, LISA and IXO for the first slot L-class slot of ESA's Cosmic Vision. An updated status of the mission will be presented.

1. ESA-SRE(2008)1; ESA-SRE(2008)2