

The Ganymede Laser Altimeter (GALA) for the Jupiter Icy Moons Explorer (JUICE): Science objectives

*Jun Kimura¹, Hauke Hussmann², Shunichi Kamata⁴, Koji Matsumoto⁵, Jurgen Oberst², Gregor Steinbrugge⁶, Alexander Stark², Klaus Gwinner², Shoko Oshigami³, Noriyuki Namiki⁵, Kay Lingenauber², Keigo Enya³, Kiyoshi Kuramoto⁴, Sho Sasaki¹

1. Osaka University, 2. DLR, 3. JAXA, 4. Hokkaido University, 5. NAOJ, 6. NASA Jet Propulsion Laboratory

Laser altimetry is a fundamental and powerful tool for addressing the major objectives of planetary physics and geodesy. Through measurements of distances between a spacecraft and the surface of the planetary bodies, it can be used to determine the local topography and global shape, including tidal deformation and rotational states. Laser altimeters have been applied in planetary explorations of the Moon, Mars, Mercury, and the asteroids.

The Ganymede Laser Altimeter (GALA) onboard JUICE spacecraft will be a first-ever laser altimetry for the icy object, and will acquire the topography data (globally for Ganymede, and fly-by region for Europa and Callisto). It will make surface geologies clear and tremendously improves our understanding of the icy tectonics. By comparing their tectonic styles on the rocky planets/moons, GALA data leads to reconsider the Earth's plate tectonics. In addition, the GALA will infer the presence or absence of a subsurface ocean by measuring the tidal and rotational responses. Furthermore, collaborating with the radio science experiment also improves the accuracy of gravity field measurements reflecting the interior structure. Signal strength and the waveform of the laser pulses reflected from the moon's surface contain information about surface reflectance at the laser wavelength and small scale roughness. Therefore we can infer the degrees of chemical and physical alterations, e.g., erosion, space weathering, compaction and deposition of exogenous materials, through GALA measurements without being affected by illumination conditions.

JUICE spacecraft carries 11 science payloads including GALA.

They work closely together in a synergistic way with GALA being one of the key instruments for understanding the evolution of the icy satellites Ganymede, Europa, and Callisto.

Characterization of the icy moons will be achieved not only from the GALA measurements but also synergy of other scientific instruments onboard JUICE spacecraft, for examples, surface images taken by optical camera (JANUS) will confirm the position of GALA laser footprint to complement the GALA "point" data for precise topographic mapping. A radar sounder (RIME) and a radio science experiment (3GM) probe the interior structure, especially interior of the icy crust to figure out an occurrence of tectonic features. A visible and infrared imaging spectrometer (MAJIS), an ultraviolet imaging spectrograph (UVS) and a sub-millimeter wave instrument (SWI) will acquire a surface and atmosphere compositional data. A magnetometer (J-MAG) monitors moons' inductive response to the Jovian magnetic field and probes the subsurface ocean with the help of a particle environment package (PEP) and a radio and plasma wave investigation (RPWI). The GALA works closely together with these instruments and plays a leading and a supporting role to clarify the whole picture of Ganymede and other icy moons.