JUICE/GALA-J (2): JUICE搭載ガニメデレーザー高度計 (GALA)が拓くサイエンス
JUICE/GALA-J (2): Science objectives of the GAnymede Laser Altimeter (GALA) for the JUICE mission

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The JUpiter Icy Moons Explorer (JUICE), led by European Space Agency, has started development toward launch in 2022 (arrival at Jupiter in 2029, and Ganymede orbit insertion in 2032), and we are now developing the GALA instrument onboard JUICE spacecraft collaborating with German Aerospace Center (DLR) and other institutions in Europe. Primary objective of GALA is to acquire the key information for understanding the evolution of icy bodies and to play an essential role in the JUICE's purpose: exploration of deep habitat.
Jovian icy moon Ganymede, which is the largest moon in the Solar System and the primary target of the JUICE, can be said to be one of the typical solid bodies along with terrestrial planets in terms of its size and the intrinsic magnetic field originated from the metallic core. However, current knowledge provided by previous explorations is extremely limited since it comes from only several fly-bys. The JUICE will uncover the whole picture of Ganymede by the first "orbiting" in the history around extra-terrestrial moon. Expected new big picture of the origin and evolution of Ganymede will not only be a key to unveil the origin of diversity among the Solar System bodies, but also contribute to understand exoplanets with a wide diversity.
The GALA will measure a distance between the spacecraft and the surface of icy moons and acquire the topography data (globally for Ganymede, and fly-by region for Europa and Callisto). It will be a first-ever laser altimetry for the icy object. Such information makes 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 confirm a presence/absence of the subsurface ocean by measuring tidal and rotational response, and also the gravitational information reflecting the interior structure will be greatly improved. In addition, strength and waveform of laser pulse reflected from the moon's surface have information about surface reflectance at the laser wavelength and small scale roughness, and therefore we can see degrees of erosion and space weathering without being affected by illumination condition through GALA measurements.
In order to interpret and understand such measurements, accumulated studies for the Earth over the years will be effectively utilized: e.g., the data for surface topography, roughness and albedo will lead to describe the icy tectonics through the knowledge from terrestrial glaciology and experiments on impact and deformation process. The tidal measurements by GALA will also be a window to see its interior based on our knowledge and experiences cultivated through the past geodetic observations, e.g., the SELENE mission for the terrestrial Moon.
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.

