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PPS01-P01 会場:3 階ポスター会場 時間:4 月 30 日 18:15-19:30

木星圏探査機 JUICE 搭載サブミリ波放射計 SWI の開発
Submillimeter-Wave Instrument (SWI) for JUICE: Current Status of the Instrumental Development

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The Submillimetre-Wave Instrument (SWI) is a passive submillimeter-wave heterodyne instrument proposed as one of the scientific payload instruments for the Jupiter Icy Moons Explorer (JUICE) mission. It measures the thermal emission from atmosphere of Jupiter and its moons at the frequency region of 500 - 600 GHz (with keeping 1200 GHz range as an optional concept). Thermal emission from the surface of moons will also be measured. JUICE/SWI provides unique observational data for characterization of the Jovian stratosphere such as thermal structure, dynamics, and distribution of minor species; and for exploration of tenuous-atmosphere and surface environment of the Jovian moons. By detecting hydrogen and oxygen isotopes in the water vapor of Jovian moons' atmosphere, SWI can also contribute to understanding the origin and distribution of water in our solar system.

This paper presents the current status of the development of SWI instrument, including the updates on the science targets and their feasibility studies. The SWI instrument is being developed through international cooperation. The Japanese team contributes to the development of the submillimeter reflector (mirror). The submillimeter reflector is one of the key components of SWI, and it determines the spatial resolution of observations. Currently a 30-cm aperture diameter reflector is considered, providing a spatial resolution of 2 mrad (FWHM) at 600 GHz. In order to fulfill the stringent requirement of weight reduction, we evaluated the material of the reflector and optimized its rib structure. The side lobe suppression is also an important factor to improve the quality of observations.

キーワード: 木星, 氷衛星, JUICE, サブミリ波, リモートセンシング, 測器開発
Keywords: Jupiter, Icy moon, JUICE, Submillimeter wave, Heterodyne

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Development of JUICE/Ganymede Laser Altimeter (GALA)
Development of JUICE/Ganymede Laser Altimeter (GALA)

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The overarching theme for JUICE is: The emergence of habitable worlds around gas giants, and the focus is to characterise the conditions that may have led to the emergence of habitable environments among the Jovian icy satellites, with special emphasis on the three oceanbearing worlds, Ganymede, Europa, and Callisto. JUICE will be launched in 2022, and will arrive at Jupiter in 2030. After several fly-bys to Europa and Callisto, JUICE will be inserted into an orbit around Ganymede in 2032 and will continue scientific observations for eight months until the end of nominal mission in 2033. Ganymede Laser Altimeter, GALA, measures distance between the spacecraft and the surface of the satellite from time of flight of a laser pulse. Together with positions of the spacecraft and mass center of the satellite, surface topography of the satellite is calculated from measured distances. The GALA data are particularly important for finding of internal ocean.

1) if the ocean exists beneath icy crust, tidal deformation of the satellite is so large that temporal variation of the topography as great as a few tens meter shall be detected.

2) small eccentricity of orbit of Ganymede causes libration that will be observed as lateral shifts of footprint of laser beam at the surface.

3) improved determination of spacecraft orbits by cross over analysis results in precise estimate of low degree harmonics of gravity field. Thus accurate Love number will be calculated to infer internal density structure of the satellite.

Global topographic data derived by GALA are also important for the study of tectonic history at the surface, elastic and viscous structure of ice crust, and thermal evolution of interior of the icy satellite. For example, linear structures such as ridges and grabens reveal extension stresses due to past variation of thermal states. As well, flat surface and thin crust may indicate partial melting of the crust and consequent internal lake. These observations on various geologic activities lead to understanding of transport of heat and materials from interior to the surface. Further, a comparison of styles of tectonics of ice crust and that of silicate lithosphere will likely shed a new light on the theory of plate tectonics of the Earth.

GALA is developed by international collaboration of scientists and engineers in Germany, Switzerland, and Japan. Its conceptual design is based on the laser altimeter on board of Mercury orbiter, BepiColombo, and consists of transceiver unit (TRU) with laser optics and appropriate electronics, electronic unit (ELU) with digital range finder module, digital processing module and power converter module, and laser electronic unit (LEU) with laser control electronics. Japanese team provides receiver telescope, backend optics, detector, and analogue electronics of TRU. The transmission optics of TRU and entire LEU are developed at DLR in Germany, and ELU is developed at Bern University in Switzerland. Assembly and integration are conducted at DLR under a supervision of the principal investigator of GALA. We therefore need to pay special caution on interfaces between analogue electronics and range finder, low-temperature environment, and radiation environment that Japanese space scientists have never experienced before.

Keywords: Jupiter, Ganymede, Laser Altimeter, Exploration, Spacecraft, Habitability

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周惑星円盤への衛星材料物質の供給
Accretion of Solid Materials onto Circumplanetary Disks from Protoplanetary Disks

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We investigate accretion of solid materials onto circumplanetary disks from heliocentric orbits rotating in protoplanetary disks, which is a key process for the formation of regular satellite systems. In the late stage of gas-capturing phase of giant planet formation, the accreting gas from protoplanetary disks forms circumplanetary disks. Since the accretion flow toward the circumplanetary disks affects the particle motion through gas drag force, we use hydrodynamic simulation data for the gas drag term to calculate the motion of solid materials. We consider wide range of size for the solid particles (10^{-2}-10^{6}m), and find that the accretion efficiency of the solid particles peaks around 10m-sized particles because energy dissipation of drag with circumplanetary disk gas in this size regime is most effective. The efficiency for particles larger than 10m size becomes lower because gas drag becomes less effective. For particles smaller than 10m, the efficiency is lower because the particles are strongly coupled with the back-ground gas flow, which prevent particles from accretion. We also find that the distance from the planet where the particles are captured by the circumplanetary disks is in a narrow range and well described as a function of the particle size.

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Keywords: satellite formation, circumplanetary disks