

Investigations of ice properties on Galilean satellites through telescope observations and laboratory experiments in wavelengths of 1.0-1.5 μm

*丹 秀也¹、葛原 昌幸^{2,3}、関根 康人¹、トビー ガブリエル⁴、ルメン アーワン⁴、ジャボッド ブノワ⁴
*Shuya Tan¹, Masayuki Kuzuhara^{2,3}, Yasuhito Sekine¹, Gabriel Tobie⁴, Erwan Le Menn⁴, Benoit Jabaud⁴

1. 東京工業大学地球生命研究所、2. アストロバイオロジーセンター、3. 国立天文台、4. ナント大学
1. Earth-Life Science Institute, Tokyo Institute of Technology, 2. Astrobiology Center, 3. National Astronomical Observatory of Japan, 4. Nantes University

Icy Galilean satellites, Europa, Ganymede, and Callisto are attracting attentions as targets of future exploration missions, such as JUICE and Europa Clipper. Properties of their surface materials (e.g., chemical composition, grain size, and crystallinity) could provide constraints on subsurface environments and interactions from outside space. However, such information are mainly based on optical spectral data of Galileo spacecraft with low-wavelength resolutions (e.g., McCord et al., 1998). Recent telescope observations with high-wavelength resolutions have provided spectra in limited ranges of visible and near-infrared wavelengths, typically 1.5-2.5 μm (e.g., Fischer et al., 2015).

We observed surfaces of icy Galilean satellites in wavelength range 1.0-1.5 μm with high-wavelength resolutions using the Subaru telescope/IRCS and adaptive optics AO188. Obtained reflectance spectra of each satellite show characteristic reflectance and slope, consistent with previous observational data with low-wavelength resolutions (e.g., McCord et al., 1998). In especially, the spectra of the three satellites show different absorption depths of H₂O ice at 1.28 and 1.50 μm .

In addition, we also performed laboratory measurements of reflectance spectra of powder samples of H₂O ice, and mixtures of H₂O ice and NaCl as analogs of surface materials of icy satellites. Mixture samples show a selective weakening of absorptions of H₂O ice at 1.28 μm , compared with those at 1.50 μm . This behavior would be due to differences in mixing conditions and/or crystallinity of particles, since NaCl itself has no characteristic spectral features in the wavelength range. Such selective weakens of absorptions at 1.28 μm are shown on observed spectra of a part of Europa's surface. This would support that recent observations suggest the presence of NaCl on the surface of Europa (e.g., Trumbo et al., 2020). On the other hand, spectra of Ganymede and Callisto show no clear selective trends for absorptions of H₂O ice. Thus, there would be a minor presence of materials with similar effects on the two satellites. The present study suggests the necessity of spectral measurements for mixture materials of H₂O ice and contaminants as analogs of surface materials of icy bodies in the Solar system.

キーワード：ガリレオ衛星、赤外線スペクトル、望遠鏡観測、H₂O氷、室内実験

Keywords: Galilean satellites, Infrared spectra, Telescope observation, H₂O ice, Laboratory experiments