Geophysical and astrobiological perspectives for future spacecraft missions to Jovian icy moons

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Jovian icy moons, Europa, Ganymede, and Callisto, are key objects to understand both of the evolution of early Solar System and habitability beyond Earth. Geologically-inactive Callisto may preserve chemical information (e.g., isotopic compositions of volatiles) of building materials of the Jovian system, which is essential to constrain the formation temperature of proto-Jupiter in the protoplanetary disk. The interior structure is determined by its formation time in the circum-Jovian disk and, thereby, is essential to constrain the accretion rate of solid materials onto proto-Jupiter. Ganymede and Europa are believed to possess subsurface oceans beneath the icy shells. Given the sustainability of liquid water, habitability of these subsurface oceans largely relies on the availability of both reductants and oxidants. Reductants can be found in plume materials erupting from Europa’ s surface, whereas oxidants can be observed on the surface. However, the existence of oxidants and reductants is unconstrained based on observational data.

In this talk, we discuss key observations in future spacecraft missions to constrain the formation of the Jovian system and habitability of Europa and Ganymede. The key observations include the moment of inertia of Callisto (and Ganymede) based on high resolution gravity measurements, lateral heterogeneity of crustal thickness, isotopic compositions of water, the abundance of reductants, H_2 and H_2S, in Europa’ s plume, and the chemical compositions of surface salts on Europa and Ganymede. We discuss how these observations can be used to resolve the key issues on the formation of the Jovian system and habitability in the subsurface oceans.

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