Metallic core and interior evolution of icy bodies

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In our Solar System, there are 175 known natural moons orbiting 8 planets as of January 2018, and all of their surfaces excepting moons of terrestrial planets are covered with ice, mainly solid H_2O. However, their interior structures have not been sufficiently determined compared with the Earth because seismological approaches are not yet available for the moons. Currently we can use only gravitational field measurements and bulk density of their bodies for constraining their interiors and these data indicate that only Ganymede, one of Jovian moon and the largest moon in the Solar System having radius of 2,634 km, has a metallic core at the center on the basis of a small value of Moment of Inertia ratio of 0.315, which the smallest value among all solid bodies in the Solar System. In addition, the presence of the metallic core can be supported by the fact that Ganymede is the only moon in the Solar System known to have a substantial magnetosphere which can be considered to be generated by a dynamo activity in the core.

However, formation of the metallic core in Ganymede (and icy bodies if they have) not seems to be obvious in terms of its initial thermal state just after the end of accretion which mainly controlled by a body size. It is thought that Ganymede’s radius, about 350 km smaller than Mars, is not sufficient to differentiate a metallic component from a silicate and to form the core. Furthermore, numerical models for the thermal history suggests that Ganymede’s metallic core formation and generating magnetic field could be started at a later stage in its history. Here we summarize current understandings of the interiors including metallic core in the icy bodies and possible scenario for their evolution, and present future perspectives to investigate further the origin and evolution using theoretical models and spacecraft explorations.

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