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Application of Neutrino Interaction to Icy Satellite Research

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Europa, the second closest Galilean satellite is one of the most interesting moons in the solar system because of the characteristic features such as very young surface and internal ocean. For thermal structure of Europa and astrobiology as well as inspecting the existence of the ocean, accurate specification for the thickness of icy layer is a key. Although gravitational observation by Galileo probe estimated the H2O layer thickness is 80-170 km [1], phase of H2O is not specified since the difference of density between ice and water is too small to distinguish the phase. From other researches such as the analysis of surface feature or induced magnetic field, the thickness is also estimated. The ice thickness of Europa has been so far categorized into two groups: Thin-Crust [2], the thickness is a few kilometers, and Thick-Crust [3], the thickness is a few tens of kilometers. Whether Europa is Thin-Crust or Thick-Crust is not yet settled.

Recently, as a new idea to determine the ice thickness, a method for detecting the electromagnetic waves induced by high energy (around 10ˆ18 eV) cosmic neutrinos is proposed [4, 5]. When high energy neutrinos flying in the outer space traverse Europa, coherent Cherenkov lights are emitted at frequency between a few hundreds of MHz and a few GHz region [6]. Cherenkov lights from the icy layer have such strong intensity that can be detected by probe orbiting around Europa, while lights from water layer attenuate immediately because of high conductivity. Thus the number detectable emissions depends on the thickness of the icy layer. Shoji et al. (2010) [5] performed simulation and showed that the the number of detectable emissions changed with the ice thickness. This time we inspected this method more carefully considering topography of Europa and specific mission. We also report a feasibility of this method in the case of Enceladus, an another possible target having internal ocean.

References

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