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Proposal for the survey of Enceladus by high energy neutrinos
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庄司 大悟[1*], 栗田 敬[1], 田中 宏幸[1]
Daigo Shoji[1*], Kei Kurita[1], Hiroyuki Tanaka[1]

[1] 東京大学　地震研究所
[1]Earthquake Research Institute

Enceladus is a small icy satellite of Saturn orbiting between Mimas and Tethys. In 2005 Cassini has identified characteristic surface features at the south pole of Enceladus such as high albedo and paralleled lineaments called “ tiger stripes ”, which emanate vapor plume [1]. These features suggest that Enceladus has young and active surface around the south pole region. On the other hand, at the north pole, Enceladus has surface whose albedo is lower than the south pole. Such asymmetry of the surface has aroused strong interests on the internal structure as well as its evolution as the origin.

To investigate the surface layer of Enceladus, electrical conductivity is an important information to constraint for the internal structure. Electrical conductivity depends on primarily on temperature [2]. If we can determine the value of conductivity, we can specify the property of ice such as temperature distribution of icy layer. In this presentation we propose a new method to determine the electrical conductivity of ice layer by detecting the radio waves induced by interaction between cosmic neutrino and ice.

When cosmic neutrinos flying in the outer space traverse through Enceladus, Cherenkov radiation induced by the weak interaction of neutrino with Enceladus is emitted. Radiations whose frequency is between a few hundreds of MHz and a few GHz (radio wave) become coherent and have such strong intensity that orbiting probe can detect. The number of detectable emissions depends on attenuation level of radio wave. The attenuation level of water ice can be approximated as $A=0.0009s$ (dB/m) where A and s are attenuation level and electrical conductivity (in μ S/m) respectively [3]. Thus, if we can count the number of emissions and determine their intensity level, electrical conductivity and temperature can be estimated. Since radio waves induced by neutrino interaction come from subsurface area of icy layer (~10 km in depth) local temperature distribution can be obtained by latitude-dependent summation for the emission in polar orbits.

To evaluate this method, we have performed a simulation about interaction of neutrinos with the icy layer and obtained that the number of detectable number of emissions and the shape of intensity distribution changed with the electrical conductivity of the layer. The strong point of this method is the passive detection of radio wave. Further more, accurate determination of electrical conductivity can make the rader system inspect the inner structure more precisely. We consider this radio detection method can be an useful tool to constrain the subsurface temperature of Enceladus.

References

[1] Porco et al. (2006), Cassini Observes the Active South Pole of Enceladus, *Science*, 311, 1393-1401
[2] Corr et al. (1993), Radar absorption due to impurities in Antarctic ice, *Geophys. Res. Lett.*, 20, 1071-1074
[3] Moore (2000), Model of Rader Absorption in Europan Ice, *Icarus*, 147, 292-300

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