**Aw-007** Room: C402 Time: June 11 10:30-10:45

# Magnetic Field of Europa: A probe for Detecting an Underground Ocean

# Yoshihiko Saiganji [1], Kiyoshi Kuramoto [2], Tetsuo Yamamoto [3]

[1] Earth and Planetary Sci., Hokkaido Univ, [2] Earth and Planetary Sci., Hokkaido Univ., [3] Earth and Planetary Sci., Nagoya Univ

We present a strong constraint to clarify the presence or absence of a liquid water layer of Europa. We calculate, as a function of the depth of the ocean, the intensity and direction of the magnetic field in Europa induced by the periodic variation of the Jovian magnetospheric field seen from Europa. The results indicate that the intensity depends sensitively on the presence or absence of the ocean because of the large difference in the electrical conductivities of sea water and ice, and that the presence of the ocean leads to the direction almost antiparalell to that of the time-varying component of the magnetic field of Jovian magnetosphere. The recent observation of the magnetic field of Europa by Galileo spacecraft suggests that there is the ocean deeper than 140 km.

We propose a method to clarify the presence or absence of an ocean in Europa by noting magnetic field induced in Europa. This study is of exobiological interest since liquid water is believed to be essential for origin of life.

The magnetic field is induced in Europa by the mechanism mentioned below. The magnetic field of Jovian magnetosphere seen from Europa varies with time because the magnetic dipole moment of Jupiter is tilted away from its spin axis. In consequence, eddy electric current is driven in Europa to produce magnetic field that varies periodically.

The intensity and direction of the induced magnetic field depends upon the electrical conductivity profile of Europa's interior. It is suggested that Europa consists of a metallic core, a silicate mantle, an ice or liquid water layer, and an ice crust. To estimate radii of the core and mantle, we consider partition of elements in Europa's interior. As a result, we obtain the core and mantle radius of less than 60 % and 90 % of Europa's radius. We estimate the electrical conductivity of sea water of Europa assuming that NaCl is the most important solute controlling the conductivity, and that the number ratio of Cl and Si in Europa is the same as that in CI chondrite. The electrical conductivity of the ocean estimated above is much larger than that of ice.

The intensity and direction of the induced magnetic field are calculated as a function of the depth of the ocean. It is shown that 1)the difference of the intensity at the surface of Europa due to the presence or absence of the ocean becomes up to 111 nT, which is significantly larger than the observational accuracy of 5 nT, and 2)the direction of the induced field is almost antiparalell to that of the time-varying component of the magnetic field of Jovian magnetosphere. These results show that the observation of the intensity and direction of the induced magnetic field provides strong constraints to the issue whether or not there is the ocean in Europa.

Shielding effect by Europa's ionosphere is estimated. The ionospheric current is restricted when it acrosses magnetic field lines. In Europa's ionosphere, splitting of the guiding centers of electrons and ions produced by electron impact ionization is the most

effective mechanism of electrical conduction across magnetic field lines. The electrical conductivity due to this mechanism is too small to induce significant eddy electric current there.

Discussion is given on the comparison with the theoretical predictions and the observational data. Galileo magnetometer observed substantial departures from the magnetic field of Jovian magnetosphere at Europa's orbit. We compare this magnetic perturbation with the magnetic field theoretically predicted to be induced in Europa. As a result, when there is an ocean with 140 km depth, it is shown that both exhibit good agreement. This suggests strongly the presence of a deep subsurface ocean.