Search for Subsurface Oceans of Astrobiological Potential in the Outer Solar System Satellites Using Magnetic Data

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Galileo and Cassini spacecraft have made close approaches to 10 of the large (radius > 250 kms) icy satellites of the solar system. Many different lines of geological and geophysical evidences point to the possibility of liquid subsurface oceans on Europa, Ganymede and Callisto in the Jupiter system and Enceladus and Titan in the Saturnian system. The magnetic data from these flybys have provided us a wealth of information on the induced and permanent fields of these satellites. The magnetic field measurements have been inverted to reveal the interior structures of these moons and to learn how these moons interact with the magnetospheres of Jupiter and Saturn.

In this talk, I will first summarize the magnetic field observations from the icy Galilean satellites of Jupiter. After presenting the evidence of internal magnetic field in Ganymede, the solar system's largest moon, I will discuss the discoveries and implications of the induced magnetic fields in Europa, Ganymede and Callisto. It is now well accepted that the induction fields in these satellites arise from eddy currents flowing in the subsurface oceans in response to the rotating field of Jupiter.

The exploration of the icy satellites of Saturn has just begun. Cassini has already made 9 close flybys of Enceladus, one each of Tethys, Dione, Rhea and Hyperion and Iapetus and 66 flybys of Titan. Magnetic field observations from Enceladus have led to the discovery of water plumes originating from the south polar region of this moon. It is now believed that a subsurface liquid water aquifer maintains these geysers on Enceladus. Finally I will discuss the status of induction fields in the Saturnian moons, and the future plans of the Cassini team for additional magnetic field measurements of the Saturnian moons.