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Exploration of Ganymede: Lessons Learned and Open Questions after the Galileo Mission

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Abstract

The Galileo mission spent over seven years in orbit around Jupiter, exploring Jupiter's magnetospheric environment, atmosphere, and satellites. Ganymede, the largest satellite in the solar system, was one of the high priority targets of the mission from its inception. Multiple encounters with Ganymede were planned to explore its varied surface with visual, IR and UV remote sensing, investigate its interaction with Jupiter's magnetosphere, and understand its internal structure though analysis of gravity and magnetic field measurents.

Major Galileo scientific results for Ganymede include:

- Discovery of a dipolar, internally generated magnetic field, implying the existence of a fluid, electrically conducting core, probably composed of FeS.
- Constraints on the moment of inertia from gravity measurements imply a differentiated interior.
- Induced magnetic field variations suggest the presence of an electrically conducting salty global ocean beneath the satellite's icy crust.
- Imaging of the bright terrains show that fracturing and tectonic resurfacing dominate, although there is localized evidence for cryovolanism.
- Evidence for non-ice materials, including salts and organics on the surface.

As we consider the next stage of exploration of Ganymede, there are a number of open questions:

- How is Ganymede's magnetic field generated? What thermal/dynamical history is consistent with a contemporary dynamo?
- How much communication has there been between subsurface liquid layers and the surface has there been; over what time scales?
- When and where has cryovolcanism occurred?
- What is the composition of the non-ice material on the surface?

One of the key lessons learned from the Galileo mission is that measurements from many different types of instruments are needed to understand a world as complex as Ganymede and its interactions with its environment.

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