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Magnetic induction Signals at Ganymede: implications for a subsurface ocean

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Abstract

Ganymede's strong internal field sets it apart from all the other known icy satellites of the solar system. The surprisingly strong magnetic field from its interior argues for a source of energy inside the moon to maintain convection in its metallic core and raises the possibility that the outer H_2O ice shell may be molten beyond a certain depth. Confirmation of a subsurface ocean was provided by the discovery of an electromagnetic induction signature in response to the rotating magnetic field of Jupiter and its magnetosphere (1).

Because, the primary inducing field at Ganymede is weak (~ 100 nT) compared to the strong dipolar internal field of Ganymede (~1500 nT at the surface near the pole), the expected time varying induction field is dwarfed by Ganymede's internal field. In addition, strong perturbation fields arise from Ganymede's interaction with Jupiter's magnetosphere. Therefore, fitting techniques required to establish Ganymede's internal field must correct the measured field to remove the perturbations arising from currents flowing outside of the moon. In this presentation we will analyze the magnetic field measured near Ganymede and critically evaluate the modelling efforts made so far. We show how results from a recent MHD simulation can be used to establish perturbations arising from currents flowing outside of Ganymede and remove them from the measured field. The difference field is close to that arising only from currents internal to Ganymede. This difference field is fit using two different models, both of which give satisfactory representations of the data. One model fits internal multipoles through quadrupole order (dipole plus 5 free parameters), finding a small ratio of quadrupole to dipole moments; the other fits data to a dipole plus an inductive response to the temporal variations imposed by Jupiter's magnetosphere (dipole plus one or two free parameters). Assuming the latter model, we discuss the implications of the improved value of the induction signal for the properties of the subsurface ocean.

References

[1] Kivelson M.G., Khurana, K.K. and Volwerk M., (2002) *Icarus*, 157, 507-522.