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The Magnetic Structure of Liquid Iron in the Interior of Mercury

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Abstract

In order to fully understand the internal structure of Mercury it is necessary to determine the properties and behaviour of its major constituents. Mercury has an average density of 5.4 gcm^{-3}, which is only marginally less dense than that of the Earth. However, comparatively Mercury is much smaller and hence the interior of the planet is not subject to as much compression. This strongly supports the view that the interior of Mercury is iron-rich. It is widely thought that an active dynamo generates the Mercurian magnetic field, which would require the core to be at least partially molten; more recently observations of the longitudinal librations also indicate a liquid layer within the planet [1]. At the conditions of the core of Mercury (up to 40 GPa and 4000K), the magnetic structure of liquid iron may undergo subtle changes such as a transition from ferromagnetic to an anti-ferromagnetic state. Ab-initio calculations have been well proven in their ability to predict the structure and behaviour of minerals and so can provide a uniquely unbiased look at the structures and properties of materials. This work investigates the magnetic structure of liquid iron at conditions relevant to the core of Mercury using density functional theory and ab-initio methods. The aim is to obtain a greater understanding of the weak observable magnetic field of Mercury and the structure of the interior of the planet.

References

[1] Margot, J.L., Peale, S.J., Jurgens, R.F., Slade, M.A., Holin, I.V.: Large Longitude Libration of Mercury Reveals a Molten Core, Science, Vol. 316, pp. 710-714, 2007.