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Current Knowledge of the Interior of Mercury

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Current knowledge of the interior of Mercury is based on a combination of Earth-based and Mariner 10 observations as constrained by theoretical models of interior dynamics. Mercury has the largest uncompressed density of the planets and thus the largest metal/silicate ratio, exhibiting a fractional core iron content of 0.65. It is believed that the planet has differentiated into an iron-nickel core ~ 0.75 the planets radius. Unfortunately because the planet spins slowly, the measured flattening (J2) of Mercury as measured by Mariner 10 does not yield a useful constraint on the radial density distribution.

Mariner 10 made the surprising measurement of a present-day dipole magnetic field of likely internal origin. Possible interpretations of this internal field include remanent magnetization of Mercurys crust and a present-day dynamo generated due to convective motions in a liquid iron outer core. Crustal remanence had earlier been dismissed as implausible, but a recent study has demonstrated that it can explain the Mariner 10 observations. A core dynamo would require Mercury to possess a liquid outer core, and this possibility has motivated considerable effort to discern the planets core state. Peale developed a formalism that allows core state to be determined given measurements of planetary gravity field parameters J2 and C2,2, and the planets obliquity and forced physical libration. Poorly constrained values of the first two parameters are available from Mariner 10 radio tracking. Earth-based and orbital methods are underway/planned to measure the latter two.

Mercurys inferred magnetic dipole moment of approximately 300 nT − R3M is not well constrained due to the spatial distribution and limited quantity of Mariner 10 observations, but even with this uncertainty, the inferred field strength appears problematic for all typical sources of planetary magnetic fields. A recent numerical study shows that Mercury-like dynamos only occur when the outer core is relatively thin and the Rayleigh number is relatively low. These numerical studies demonstrate that a dynamo solution for Mercury’s weak observed dipole field is possible, however they do not rule out other mechanisms.