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Insights into Mercury's interior structure from geodesy measurements

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Abstract

The measurements of the gravitational field of Mercury by MESSENGER [1] and improved measurements of the spin state of Mercury [2] provide important constraints on the interior structure of Mercury. In particular, these data give strong constraints on the radius and density of Mercury's core and on the core's concentration of sulfur if sulfur is the only light element in the core [3]. Although sulfur is ubiquitously invoked as being the principal candidate light element in terrestrial planet's cores its abundance in the core depends on the redox conditions during planetary formation. MESSENGER data from remote sensing of Mercury's surface [4] indicate a high abundance of sulfur and confirm the low abundance in FeO supporting the hypotheses that Mercury formed under reducing conditions [5]. Therefore, substantial amounts of other light elements like for instance silicon could be present together with sulfur inside Mercury's core. Unlike sulfur, which does almost not partition into solid iron under Mercury's core pressure and temperature conditions, silicon partitions virtually equally between solid and liquid iron. Thus, if silicon is the only light element inside the core, the density jump at the inner-core outer-core boundary is significantly smaller if compared to an $Fe - FeS$ core. If both silicon and sulfur are present inside Mercury's core then as a consequence of a large immiscibility region in liquid $Fe - Si - S$ at Mercury's core conditions and for specific concentrations of light elements [6] a thin layer much enriched in sulfur and depleted in silicon could form at the top of the core. In this study we analyze interior structure models with silicon as the only light element in the core and with both silicon and sulfur in the core. Compared to models with $Fe - FeS$ both settings have different mass distributions within their cores and will likely deform differently due to different elastic properties. Consequently their libration and tides will be different. Here we will use the measured 88 day libration amplitude and polar moment of inertia of Mercury in order to constrain the interior structure of both settings and calculate their tides.

Acknowledgements

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