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Viscoelastic Tides of Mercury and Implications for its Inner Core Size

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We study the tidal deformation of Mercury based on the geodetic constraints from the MESSENGER mission and show that a future determination of the tidal Love number h2 can yield important constraints on the inner core when combined with the available (or future) measurements of k2. We further study the potential range of tidal phase-lags and resulting tidal heat dissipation in Mercury's mantle. All parameters discussed in this contribution could be measured by the upcoming BepiColombo mission scheduled for launch in 2018 and operated by the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA). We find that in the considered range of interior structure and rheologic models the tidal Love number h2 ranges between 0.77 and 0.93. The corresponding tidal amplitudes range from 1.93 to 2.33 m at the equator and 0.24 to 0.29 m at the poles. The maximum values for Im(k2) consistent with the geodetic constraints are between 0.02 and 0.03. The maximum tidal dissipation would then correspond to a surface heat flux of < 0.13 mW/m2. An important advantage of analyzing both tidal Love numbers is that certain dependencies can be suppressed by combining them. A linear combination as well as the ratio h2/k2 cancels out the ambiguity on the inner core size to a certain extent. The linear combination is known as the diminishing factor 1+k2-h2, which has been proposed previously to better constrain the ice thickness of Jupiter's moon Europa but is also applicable to other icy satellites, e.g. Ganymede. For small solid cores, the h2/k2 ratio or linear combination would allow the determination of an upper bound for the size of the inner core but a determination of the actual inner core size would only be feasible with a significant uncertainty due to the remaining ambiguity. For cores > 700 km in radius, the size can potentially be inferred but a measurement accuracy in the order of 1% in h2 would be required.