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Influence of the internal structure of Europa on the Doppler signal of an orbiter

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Abstract

Europa, the second Galilean satellite starting from Jupiter, probably has a liquid ocean beneath the icy shell but the thickness of these layers is poorly known. From the values of the gravitational coefficients C_{20} and C_{22} of Europa determined by the Galileo mission, the total thickness of the ice and water layer is evaluated to $80 - 170$ km [1]. However, the thickness of the individual ice and water layers could not be determined, since their densities are similar.

An important goal of the Europa Jupiter System Mission under study by NASA and ESA is to better constrain the ice shell and subsurface ocean of Europa. Important information on the interior structure is thought to result from observation of the tides, librations and obliquity of Europa. Here we assess the possibility to measure those quantities with a Radio Science instrument, which is part of the scientific core payload of the Europa orbiter of EJSM.

Together with the static gravity field of Europa, tides and rotation determine the orbital motion of a spacecraft around Europa. The quantities we take into account are C_{20}, C_{22}, the libration amplitude, the obliquity, the Love number k_2 and its quality factor Q. For their dependence on the internal structure, see e.g. [2], [3], [4], [5], [6], [7] and [8].

All these quantities induce perturbations (secular, long term and short period) of the orbital elements of the orbiter, thereby changing the spacecraft position and the relative radial velocity between the orbiter and a terrestrial observer (or Doppler signal). We calculate these perturbations by integration of Lagrange's equations in order to obtain an analytical expression for the Doppler signal (see [9] for a similar study for Mars).

The effect of each parameter on the Doppler signal is determined for different initial orbital elements of the orbiter. To test the measurability, the effects are compared with the expected accuracy of the Doppler signal.

References

[1] Anderson, J. D. et al. (1999) *Science*, 281, 2019–2022.

[2] Van Hoolst, T. et al. (2008) *Icarus*, 195, 386–399.

[3] Van Hoolst, T. et al. (2009) *Icarus*, 200, 256–264.

[4] Peale, S. J. et al. (1988) *Mercury, University of Arizona Press*, 461–493.

[5] Bills, B. G. and Nimmo F. (2008) *Icarus*, 196, 293–297.

[6] Wu, X. et al. (2001) *Geophysical Research Letters*, 28, 2245–2248.

[7] Wahr, J. M. et al. (2006) *JGR*, 111, 12005–.

[8] Lainey, V. (2005) *PhD Thesis, Observatoire de Paris*

[9] Yseboodt, M. (2003) *PhD Thesis, UCL*