Geophysical Research Abstracts
Vol. 16, EGU2014-11758, 2014
EGU General Assembly 2014


# The gravity fields of Ganymede, Callisto and Europa: how well can JUICE do?

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With 20 flybys of Callisto, 2 of Europa and an extended orbital phase around Ganymede, ESA's JUICE mission offers an excellent opportunity to investigate the interiors of the three Galilean satellites. All of these moons can host an internal ocean, but the evidence is compelling only for Europa, where Galileo's measurements of the induced magnetic field are not marred by an intrinsic field as for Ganymede. However, both Europa's and Ganymede's appear to be differentiated (Showman and Malhotra, 1999), and probably hosting a subsurface liquid water ocean underneath the icy surface (Khurana et al., 1998; Kivelson et al., 2002). But even for Callisto, which appears as an undifferentiated body of ice and rock (Showman and Malhotra, 1999), a global or partial subsurface ocean cannot be ruled out (Khurana et al., 1998).
The determination of the interior structure of the Galilean satellites, one of the main goal of the JUICE mission, can be accomplished by a combination of gravity, altimetric and magnetic measurements. Gravity measurements are addressed by the 3GM (Geodesy and Geophysics of Jupiter and the Galilean Moons) by means of highly accurate Doppler tracking of the spacecraft from ground antennas. Precise range rate measurements are enabled by a dedicated Ka-band (32-34 GHz) transponder, heritage from the Juno and BepiColombo missions. The expected range rate accuracies are around 0.01 mm/s at 60 s integration time, at nearly all solar elongation angles. A complete cancellation of the interplanetary plasma noise is indeed possible by operating simultaneously the links at X and Ka band.
The current mission profile envisages two, low altitude, orbital phases around Ganymede: a circular polar, orbit at an altitude of 500 km for the first 102 days, and circular polar orbit at an altitude of 200 km for the last 30 days. The low altitude will permit the determination of Ganymede's gravity field with a relative accuracy of about $10^{-5}$ for both J2 and C22. The 18 tidal cycles of Ganymede observed by JUICE will allow the determination of the k2 Love number with an absolute accuracy of about $10^{-3}$, both for the real and the imaginary part. The presence or absence of an internal ocean will be therefore assessed unambiguously. Numerical simulations of the gravity experiment show also an excellent sensitivity to the satellite's rotational state (obliquity and libration amplitude).
Prior to the orbit insertion around Ganymede, the JUICE spacecraft will perform also 20 flybys of Callisto. The determination of the octupole gravity field appears certainly attainable. Since Callisto will be observed at different mean anomalies, its Love number k2 can be estimated with an accuracy of about 0.06, enough to provide evidence for an internal ocean. In the same mission phase, two Europa flybys will offer the opportunity to measure the static quadrupole field and test if the satellite is in hydrostatic equilibrium.

References

K.K. Khurana et al., Nature 395, 777 (1998).
M.G. Kivelson et al., Icarus 157, 507 (2002).
A.P. Showman and R. Malhotra, Science 286, 77 (1999).