Geophysical Research Abstracts
Vol. 14, EGU2012-11912-2, 2012
EGU General Assembly 2012

Gravity Science with The JUICE Mission

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JUICE (Jupiter Icy Moon Explorer) is a European mission to the Jovian system, proposed in the frame of the ESA Cosmic Vision program. The spacecraft will reach the Jovian system and fly several times by the moons Callisto and Europa before being inserted in a nearly circular, polar orbit around Ganymede. After its arrival in 2030, the mission timeline entails two Europa flybys (2030), twelve Callisto flybys (2031) and the orbital phase at Ganymede (2033) [1].

Gravity measurements will provide crucial information on the interior structure of the three satellites. If the bodies are in hydrostatic equilibrium, the radial density distribution may be constrained from their moment of inertia factor and low-degree gravity field coefficients [2]. Furthermore, the determination of the high-degree harmonics will provide the distribution of gravity anomalies. Evidence for subsurface oceans within Ganymede and Callisto, one of the main scientific goals of the mission, will be obtained by the determination of the tidal Love number k2 as part of a global solution for the static and variable gravity field.

Gravity fields and tidal deformations will be determined by means of precise Doppler tracking of the spacecraft in Ka-band (32.5-34 GHz). The Radio Science Instrument (RSI) is enabled by a Ka-band transponder which, complemented by suitable ground instrumentation, will enable a radio link with a very high phase stability. The main observable quantity for gravity field determination is the range rate (to 3 micron/s at 1000 s integration time, two-way). The spacecraft range (accurate to 20 cm, two-way) will be used to improve the ephemerides of the Jupiter system.

Gravity science at Ganymede will be carried out during the orbital phase. According to the mission profile (subject to change), the first 102 days will be spent at an altitude of 500 km. The orbit will be lowered to 200 km in the last 32 days of the mission. If the spacecraft will be endowed with a steerable medium gain antenna, gravity measurements can be carried out also during the Europa and Callisto flybys. For Europa, the two planned flybys will enable the unconstrained determination of the quadrupole field and polar moment of inertia (if the body is found in hydrostatic equilibrium). For Callisto, thanks to the considerable number of flybys, the k2 Love number can be determined, in addition to the low-degree gravity field and geoid.

Numerical simulations of the gravity experiment by means of a multi-arc least square filter have been performed for the orbital phase around Ganymede and for the Europa and Callisto flybys. Range rate data have been simulated by introducing an additive white Gaussian noise corresponding to the expected end-to-end performances of the radio link. We report on the results of the simulations and provide our current best estimate of the attainable accuracies in the gravity harmonics and the spacecraft position.

References

[1] Erd, C. : JUICE/Laplace Mission Summary and Status, JUICE Instrument WS, Darmstadt | 9/11/2011 | SRE-PA.

[2] Asmar, S., Folkner, W., Iess, L., and Tortora, P.: Galilean Satellites Gravity Investigations and Interior Structure with Future Missions, American Geophysical Union, Fall Meeting 2009, abstract #P51E-1172.