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Scientific Performance of the BepiColombo Laser Altimeter (BELA) at Mercury

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Abstract

The BepiColombo Laser Altimeter (BELA) is one of 11 instrument onboard the Mercury Planetary Orbiter (MPO) which is part of the BepiColombo mission scheduled for launch in October 2018. Here the prospects for the BELA experiment, in particular with respect to Mercury's topography, interior structure and evolution will be discussed.

1. BELA: Scientific Performance

Mercury is an intriguing planetary object with respect to its dynamical state and evolution. The planet is differentiated and contains a large iron core overlain by a relatively thin silicate mantle and crust. Mercury is locked in a unique 3:2 spin-orbit coupling and its intrinsic magnetic dipole field tells us that at least part of Mercury's iron core is liquid. From libration measurements it has been concluded that Mercury's outer core is liquid, decoupling the silicate mantle from the deep interior. Phases of global contraction and phases of volcanic activity occurred in the thermal history of the planet.
The BepiColombo joint mission by the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) consists of two spacecraft, the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO). The spacecraft stack will be launched in October 2018 and conduct a one year nominal mission in Mercury orbit, with the possibility of an extension by one additional year [1]. Here the prospects for investigations with the BepiColombo Laser Altimeter (BELA) [2] will be discussed. We present an updated semi-analytical instrument performance model estimating the signal to noise ratio, single shot probability of false detection, range error and pulse-width reconstruction accuracy. The model is generally applicable to laser altimeters using matched filter algorithms for pulse detection and has been validated against the recently tested BELA flight model after integration on the MPO spacecraft. Further, we present numerical simulations of the instrument performance expected in orbit about Mercury. In particular, we study the measurement accuracy of topography, slopes and surface roughness, which will allow us to estimate local and global topographic coverage based on the current trajectory design. We also assess the potential for measuring the tidal Love number h_2 using cross-over points, which we estimate to be constrained with an absolute accuracy of 0.14 corresponding to a relative accuracy of about 18% after two years in Mercury orbit.

References

[1] Benkhoff et al (2010) Planetary and Space Science 58, 1-20.

[2] Thomas et al. (2007) Planet. Space Sci., 55, 1398-1413.