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Mars' rotational state and tidal deformations from radio interferometry of a network of landers.

L. Iess (1), S. Giuliani (1), and V. Dehant (2)

(1) Universita' La Sapienza, DIMA, Roma, Italy (luciano.iess@uniroma1.it, +39 0644585670), (2) Royal Observatory of Belgium, Brussels, Belgium veronique.dehant@oma.be

The precise determination of the rotational state of solar system bodies is one of the main tools to investigate their interior structure. Unfortunately the accuracies required for geophysical interpretations are very stringent, and generally unattainable from orbit using optical or radar tracking of surface landmarks. Radio tracking of a lander from ground or from a spacecraft orbiting the planet offers substantial improvements, especially if the lander lifetime is adequately long. The optimal configuration is however attained when two or more landers can be simultaneously tracked from a ground antenna in an interferometric mode. ESA has been considering a network of landers on Mars since many years, and recently this concept has been revived by the study of the Mars Network Science Mission (MNSM). The scientific rationale of MNSM is the investigation of the Mars' interior and atmosphere by means of a network of two or three landers, making it especially suitable for interferometric observations.

In order to synthesize an interferometer, the MNSN landers must be tracked simultaneously from a single ground antenna in a coherent two-way mode. The uplink radio signal (at X- or Ka-band) is received by the landers' transponders and retransmitted to ground in the same frequency band. The signals received at ground station are then recorded (typically at few tens of kHz) and beaten against each other to form the output of the interferometer, a complex phasor. The differential phase retain information on Mars' rotational parameters and tidal deformations. A crucial aspect of the interferometric configuration is the rejection of common noise and error sources. Errors in the station location, Earth orientation parameters and ephemerides, path delays due to the Earth troposphere and ionosphere, and, to a good extent, interplanetary plasma are cancelled out. The main residual errors are due to differential path delays from Mars' atmosphere and differential drifts of the transponder delays. The latter contributions can be minimized by adopting a spread spectrum communication channel in the radio link. A preliminary error budget indicates that the relative distances of the two landers from ground can be determined at the level of 1 mm for a Ka-band radio link and 3-4 mm at X band. We report on the proposed experimental configuration and the associated error budget, and provide preliminary estimates of the attainable accuracies for the rotational parameters and the h2 Love number.