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Planetary Rotation and Interior from Lander Radio-science

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The knowledge of the interior structure of planets and moons is fundamental to our understanding of their formation and evolution. The variations in rotation and orientation of these celestial bodies, as well as their tidal deformation, can be used to deduce characteristics of their interior. Both rotation variations and tides can be estimated from radio tracking of a spacecraft landed on the surface of the body.

The precession of the spin axis determines the polar moment of inertia (MOI), which quantifies the mass concentration towards the center and is a major constraint for models of the interior structure of planets. We will present the latest Mars precession and MOI solutions obtained from a combination of tracking data of several lander missions (from Viking to InSight).

The short-period variations of the planet spin-axis direction, so-called nutations, are modulated in amplitudes by the presence of internal liquid layers. We will discuss the determination of Mars nutations from the ongoing InSight-RISE tracking data [2] and present the expected improvement from the forthcoming ExoMars 2020-LaRa tracking data [3, 1]. We will then examine how the nutation estimates will soon be used to infer some physical properties of the Mars liquid core.

Finally, we will depict the power of a lander radio-science experiment in constraining the internal structure of small rocky moons, like Phobos, through the determination of their libration amplitudes or of large and layered moons, like Ganymede, through the possible determination of their tidal deformation and librations.

References

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