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Planetary deep interiors, geodesy, and habitability

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The evolution of planets is driven by the composition, structure, and thermal state of their internal core, mantle, lithosphere, crust, and by interactions with possible ocean and atmosphere. This presentation puts in perspective the fundamental understanding of the relationships and interactions between those different planetary reservoirs and their evolution through time. It emphasizes on the deep interior part of terrestrial planets and moons. The core of a planet, when composed of liquid iron alloy, may provide magnetic field and further interaction with the magnetosphere, ingredients believed to be important for the evolution of an atmosphere and of a planet in general. The deep interior is believed to be of high importance for its habitability.

Lander and orbiter, even rover at the surface of planets or moons of the solar system help in determining their interior properties. First of all orbiters feel the gravity of the planet and its variations. In particular, the tidal mass redistribution induces changes in the acceleration of the spacecraft orbiting around a planet. The Love number k_2 has been determined for Venus, Mars, and the Earth, as well as for Titan and will be deduced for Mercury and for some of the Galilean satellites from new missions such as JUICE (Jupiter Icy satellite Explorer). The properties of the interior can also be determined from the observation of the rotation of the celestial body. Radar observation from the Earth ground stations of Mercury has allowed Margo et al. (2012, JGR) to determine the moments of inertia of Mercury with an unprecedented accuracy. Rovers such as the MERs (Mars Exploration Rovers) allow as well to obtain the precession and nutation of Mars from which the moments of inertia of the planet and its core can be deduced. Future missions such as the InSIGHT (Interior exploration using Seismic Investigations, Geodesy, and Heat Transport) NASA mission will further help in the determination of Mars interior and evolution, and thus in the understanding of the habitability of Mars.