Study of the rotation of the Earth and application to Mars

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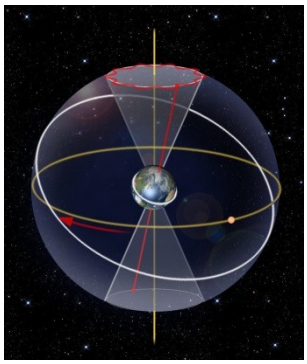
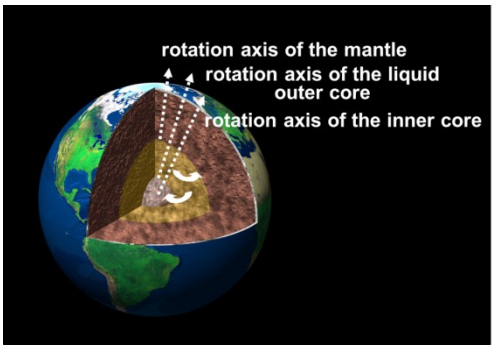
Our fundamental understanding of the interior of the Earth comes from geophysics, geodesy, geochemistry, and geomagnetism. Measurements in these fields have revealed the basic internal layering of the Earth, its thermal structure, its gross compositional stratification. In particular, the **rotation and orientation of the Earth (precession and nutation)** are used to obtain essential information on the deep Earth interior. They are subject to irregularities induced by global mass redistributions with time and external forcing such as the gravitational pull of the Sun and the Moon. The term ‘precession’ describes the long-term trend of the orientation of the axis of spin, while ‘nutation’ is the name given to shorter-term periodic variations. The rotation axis of the Earth is moving in space at the level of 1.5km/year due to precession (as seen from space in a plane tangent to the pole) and has periodic variations at the level of 600 meters. With the advance of observation precision, the causes of Earth orientation changes are progressively being identified by geodesists and geophysicists. **The present observations allow scientists to measure these at the sub-centimeter level enabling them to identify further physics of the Earth’s interior** to be taken into account in the Earth orientation models such as the coupling mechanisms at the boundary between the liquid core and the viscoelastic mantle, as well as many other factors (sometimes not yet definitely identified). The existence of a liquid core inside the Earth and all the coupling mechanisms at the core-mantle boundary play indeed an important role in nutation amplitudes. An everyday example of the influence of the physical state of the interior on the rotation is that raw (liquid) and cooked (solid) eggs rotate differently.





This brings us to the idea of using observation of **rotation and orientation of Mars** for obtaining information on its core, and in particular on its dimension, composition, and physical state. In 2016 and 2018, there will be two missions, the NASA InSIGHT mission and the ESA ExoMars mission involving landers at the surface of Mars that contain a direct-to-Earth radio system and this will allow us to performed radioscience. These future observations will allow us to perform measurements of Mars deformation, rotation and orientation with an unprecedented accuracy.