Introduction of tidal models in lunar ephemerides

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Abstract

Since the start of the Artemis program, interest in lunar studies has been renewed. The Lunar Laser Ranging (LLR) experiment measures the Earth-Moon distance at a few centimeters accuracy and the Moon's librations at a one milliarcsecond accuracy (1), providing a refined description of the tidal deformation of the Moon. The ephemeris INPOP of the Paris Observatory is a joint numerical integration of the orbits of the Moon and the planets as well as the lunar rotation, which is fitted to the LLR data. Studying the lunar tides allows us to probe the internal composition of the Moon. For example, recent results from tidal constraints highlight the presence of a solid inner core (2). The tidal response depends on the density and the rheology of the layers, and on the dissipation due to the viscosity of the lunar interior (e.g. (3), (4)). The tidal Love number *k2* and the dissipation inside the Moon depend on the forcing frequencies, which are mainly exerted by the Earth and the Sun.
In INPOP the tidal deformation accounts for a *k2* independent of the excitation frequency and a unique time delay (1). The formulation in Fourier series of the distortion coefficients (also called variation of the Stokes coefficients) by Williams and Boggs (2015) (3) allows us to describe the tidal gravitational variation by taking into account the frequency dependency. We introduce the distortion coefficients as Fourier series in order to test the impact of the variation of the Love number and of the dissipation on libration measurements.

References

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