EPSC Abstracts
Vol. 7 EPSC2012-615 2012
European Planetary Science Congress 2012

Dynamical rotation of Phobos

N. Rambaux (1,2), J. Castillo-Rogez (3), S. Le Maistre (4), P. Rosenblatt (4)
(1) Université Pierre et Marie Curie, UPMC, (2) IMCCE, Observatoire de Paris, CNRS UMR 8028, (3) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109, (4) Royal Observatory of Belgium, Brussels, Belgium, (Nicolas.Rambaux@imcce.fr).

Abstract

Phobos is in synchronous spin-orbit resonance, like our Moon. The variations of its rotational motion are described by oscillations, called physical librations. The largest libration was first detected by [1] and the determination of this libration has been recently improved by [2] using *Mars EXpress* observations.

Here we present the large spectrum of Phobos' librations and highlight the relationship between dynamical and geophysical properties of the body [3]. The knowledge of the librational spectrum is also useful for cartographic and geodetic purposes. The origin of the libration results from the interaction of the non-spherical shape of the satellite with the gravitational field of Mars and they are driven by the orbital motion of Phobos. The model of Phobos' rotation includes the point-mass Mars acting on the second degree and third degree gravity field in order to take into account the shape of Phobos and the effect of Mars' oblateness because Phobos is very close to Mars. The forced librations spectrum is computed through a numerical integration and we extract them through a frequency analysis

We find that the libration in longitude presents a quadratic term that coincides with the secular acceleration of Phobos falling on Mars. The primary libration in longitude has a period equal to the anomalistic mean motion, whereas the primary libration in latitude has a period equal to the Draconic mean motion (node to node). Both librations have amplitudes around one degree leading to a surface displacement around 200 meters. The amplitude of the primary librations in longitude and latitude dominate by a factor one thousand for the libration in longitude and a factor one hundred for the libration in latitude. However, even though the amplitude of the following librations are small, their amplitudes bear the signature of Phobos' third degree gravity harmonics and Mars' oblateness at a level of 10^{-4} degrees. These both signatures are present in the primary librations and in librations whose frequencies are close to the proper or free frequencies because the amplitudes strongly depends on the proper frequencies. The determination of these librations would bring strong constraint on Phobos' internal structure [4] and on the principal torques acting on the moon. We also investigate the obliquity variations of Phobos and find that their amplitudes are larger than the mean value of the obliquity.

Phobos exhibits a rich and varied set of librational oscillations. The librations close to the proper frequencies are the most sensitive to the interior structure, but the main libration remains the best candidate to constrain the interior [4]. On the other hand, the superimposed effect of large amplitude librations is likely to make the determination of the mean obliquity challenging.

Acknowledgements

Part of this work has been conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA. Government sponsorship acknowledged. Part of this work was financially supported by the Belgian PRODEX program managed by the European Space Agency in collaboration with the Belgian Federal Science Policy Office.

References

[1] Duxbury, T. C., & Callahan, J. D. 1981, Astronomical Journal, 86, 1722

[2] Willner, K., Oberst, J., Hussmann, H., Giese, B., Hoffmann, H., Matz, K.-D., Roatsch, T., & Duxbury, T. (2010), Earth and Planetary Science Letters, 294, 541

[3] Rambaux, N., Castillo-Rogez, J.C., Le Maistre S., and Rosenblatt P., 2012, A&A, submitted.

[4] Le Maistre S., Rosenblatt P., Rambaux N., Castillo-Rogez J., Dehant, V., Marty, J.C., 2012, submitted.