EPSC Abstracts
Vol. 13, EPSC-DPS2019-1250-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

What we know about Titan's gravity field after Cassini

D. Durante (1), D.J. Hemingway (2,3), P. Racioppa (1), L. Iess (1) and D.J. Stevenson (4)

(1) Sapienza University of Rome, Italy (daniele.durante@uniroma1.it)

(2) University of California, Berkeley, CA, USA

(3) Carnegie Institution for Science, Washington, DC, USA

(4) California Institute of Technology, Pasadena, CA, USA

Abstract

Since its arrival at Saturn in 2004, Cassini performed nine flybys of Titan that were dedicated to the determination of its gravity field. An accurate determination of the static and time-variable components of the field are crucial to constrain the interior structure of Saturn's largest moon [1, 2]. The static gravity field is dominated by the moon's hydrostatic response to its rotation and the large tidal perturbation coming from Saturn. Any deviation of the J_2/C_{22} ratio from the hydrostatic value of 10/3 tells us the non-hydrostatic component of the field, which may be related to internal processes.

The time-variable component of the field is associated with large eccentricity tides. The magnitude of the response, controlled by the tidal Love number k_2, depends on the interior composition. The large value presented in [2] indicates that Titan is deformable on the timescale of its orbital period. The conclusion is that an internal global ocean layer must exist below the moon's surface.

We present here an updated analysis [3] of the gravity data acquired by Cassini during the past six years as well as an update on Titan's interior structure. The new solution is based on all the available data (i.e., nine gravity-dedicated passes and one high-altitude pass, T110, when Cassini was tracked on the Low-Gain Antenna). All the previous results are fully confirmed, but the new gravity solution provides higher resolution for both the gravity field coefficients and the tidal response. The new solution includes higher degree and order harmonic coefficients (up to 5, see Figure 1) and offers an improved map of gravity anomalies. The geoid is poorly correlated with the topography, implying strong compensation. Our latest solution can be used as a guideline for planning future missions to Titan, as well as to understand the interiors of other icy moons.

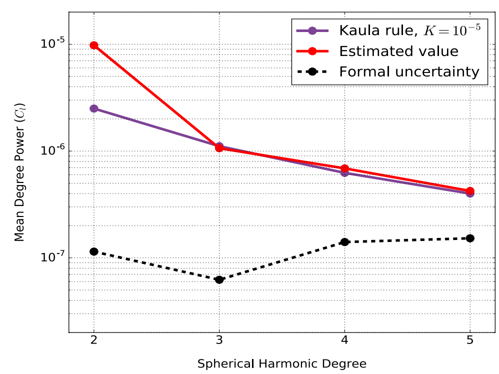

Figure 1: RMS of the fully normalized gravity coefficients, C_l. The values and 1-σ uncertainties are compared to a Kaula's rule, $C_l=K/l^2$, with $K=10^{-5}$.

References

[1] Iess, L., Rappaport, N.J., Jacobson, R.A., Racioppa, P., Stevenson, D.J., Tortora, P., Armstrong, J.W., Asmar, S.W.: Gravity field, shape, and moment of inertia of Titan, Science 327, pp. 1367–1369, 2010. doi: 10.1126/science.1182583

[2] Iess, L., Jacobson, R.A., Ducci, M., Stevenson, D.J., Lunine, J.I., Armstrong, J.W., Asmar, S.W., Racioppa, P., Rappaport, N.J., Tortora, P.: The tides of Titan, Science 337, pp. 457–459, 2012. doi: https://doi.org/10.1126/science.1219631

[3] Durante, D., Hemingway, D.J., Racioppa, P., Iess, L., and Stevenson, D.J.: Titan's gravity field and interior structure after Cassini, Icarus 326, pp. 123–132, 2019. doi: 10.1016/j.icarus.2019.03.003.