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Titan's interior constrained from its obliquity and tidal Love number

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In the last few years, the Cassini-Huygens mission to the Saturn system has measured the shape, the obliquity, the static gravity field, and the tidally induced gravity field of Titan. The large values of the obliquity and of the k2 Love number both point to the existence of a global internal ocean below the icy crust. In order to constrain interior models of Titan, we combine the above-mentioned data as follows: (1) we build four-layer density profiles consistent with Titan's bulk properties; (2) we determine the corresponding internal flattening compatible with the observed gravity and topography; (3) we compute the obliquity and tidal Love number for each interior model; (4) we compare these predictions with the observations.

Previously, we found that Titan is more differentiated than expected (assuming hydrostatic equilibrium), and that its ocean is dense and less than 100 km thick. Here, we revisit these conclusions using a more complete Cassini state model, including: (1) gravitational and pressure torques due to internal tidal deformations; (2) atmosphere/lakes-surface exchange of angular momentum; (3) inertial torque due to Poincaré flow. We also adopt faster methods to evaluate Love numbers (i.e. the membrane approach) in order to explore a larger parameter space.