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On the libration and tides of synchronously rotating icy satellites

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Icy satellites rotating synchronously with their orbital motion are expected to show small periodic variations of their rotation rate (or forced longitudinal librations) due to a gravitational torque exerted by the central planet when the orbit is not circular. This torque depends on the non-spherically symmetric shape of the satellite, which is determined largely by the tides raised by the central planet. We calculate the effect of the tidal deformations on the forced longitudinal librations. For entirely solid satellites, we show that the forced librations are well approximated by the rotation variations for a rigid body. When the satellite has a global internal subsurface ocean, different solid layers, separated by the liquid layer, can rotate differently. Moreover, the layers also respond differently to tidal forcing. As a result, the forced longitudinal librations of the surface will be affected by the liquid layer and the global internal structure of the satellite. We will present results for the Galilean satellites and Titan, satellites for which accurate rotation data is already available thanks to the Cassini mission or will be measured in the future by missions like EJSM-LAPLACE, under study by ESA and NASA. Observations of rotation data have the potential of yielding information on the interior structure of icy satellites and may reveal the existence of putative subsurface oceans.