Extension of Cassini's Laws

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We investigate the Cassini's laws which describe the rotational motion in a 1:1 spin-orbit resonance. When this rotational motion follows the conventional Cassini's laws, the figure axis coincides with the angular momentum axis. In this case we underline the differences between the rotational Hamiltonian for a "slow rotating" body as the Moon and for a "fast rotating" body as Phobos. Then, we study a more realistic rotational Hamiltonian where the angle J between the figure axis and the angular momentum axis could be different from zero. This Hamiltonian has not been studied before. We find a new particular solution for this Hamiltonian which could be seen as an extension of the Cassini's Laws. In this new solution the angle J is constant, which is not zero, and the precession of the angular momentum plane is equal to the mean motion of the argument of pericenter of the rotating body. This type of rotational motion is only possible when the orbital eccentricty of the rotationg body is not zero. This new law enables to describe in particular the Moon mean rotational motion for which the mean value of the angle J is found to be equal to 103.9 ± 0.7 seconds of arc.