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Cassini states in p:q spin-orbit resonances

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We generalize Cassini states in the p:q spin-orbit problem including the gravity field of degree and order 4. The results cover recent results published in [1]. We derive Peale's alike formulae that link the gravity field, the secular orbital elements, and the rotational parameters of a celestial body in presence of arbitrary spin-orbit resonance. The new theory is based on averaging theory, and supported by means of numerical simulations. Typical applications are found in studies of the history of the rotation of tidally locked celestial bodies in our solar system. As an example we apply our theory to the case of planet Mercury, and provide estimates of the magnitude of the obliquity and libration periods in the past, when the planet was trapped in other spin-orbit resonances than the 3:2.

[1] Lhotka, C. Celest Mech Dyn Astr (2017) 129: 397. https://doi.org/10.1007/s10569-017-9787-3