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Connecting gravity field, moment of inertia, and core properties in Jupiter through empirical structure models

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Constraining Jupiter's internal structure is crucial for understanding its formation and evolution history. Recent interior models of Jupiter that fit Juno's measured gravitational field suggest an inhomogeneous interior and potentially the existence of a diluted core. These models, however, strongly depend on the model assumptions and the equations of state used. A complementary modelling approach is to use empirical structure models.
These can later be used to reveal new insights on the planetary interior and be compared to standard models.
Here we present empirical structure models of Jupiter where the density profile is constructed by piecewise-polytropic equations. With these models we investigate the relation between the normalized moment of inertia (MoI) and the gravitational moments J_2 and J_4.
Given that only the first few gravitational moments of Jupiter are measured with high precision, we show that an accurate and independent measurement of the MoI value could be used to further constrain Jupiter's interior. An independent measurement of the MoI with an accuracy better than ~0.1% could constrain Jupiter's core region and density discontinuities in its envelope.
We find that models with a density discontinuity at ~1 Mbar, as would produce a presumed hydrogen-helium separation, correspond to a fuzzy core in Jupiter.
We next test the appropriateness of using polytropes, by comparing them with empirical models based on polynomials.
We conclude that both representations result in similar density profiles and ranges of values for quantities like core mass and MoI.