Unveiling Jupiter's interior with Juno

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In orbit since July 2016, Juno is changing the way we see Jupiter, paving the way for a much better understanding of the giant planet and its role in the formation of the solar system. The gravity field measured during just the first two orbits is an order of magnitude more accurate than previous measurements (Bolton et al. 2017, Folkner et al. 2017), allowing discrimination between contradictory measurements prior to Juno and to further constrain interior differential rotation and structure. Interior models consistent with the data favour solutions in which Jupiter’s core is diluted in the envelope (Wahl et al. 2017), in line with recent models of the formation of the planet.

Another longterm mystery is whether Jupiter’s observed zonal flows penetrate deep into the interior or not. In a series of 3 articles published recently (Iess et al., Kaspi et al., Guillot et al. Nature 2018) we show that this mystery can be solved thanks to the greatly increased accuracy of Juno’s gravity measurements. The determination of a north-south asymmetry in the gravity field, the interpretation of this asymmetry in terms of penetration of the observed atmospheric wind speed and the coupling with interior models point to the same result: the flows seen in the atmosphere of Jupiter penetrate to a depth of about 3000km into the interior, and differential rotation is suppressed deeper down where hydrogen becomes conductive and is dragged by Jupiter's powerful magnetic field into a nearly-uniform rotation. These results have consequences for the analysis of dynamical circulation in gaseous planets in general. They pave the way for the characterisation of Jupiter’s interior and composition with Juno, with a much better precision.

Juno's interior models however must rely on equations of state whose accuracy in the Mbar regime and moderate temperatures (~6000K) are still uncertain. Equations of state available for astrophysical purposes differ in this regime, mostly because of different entropy tables. The location and extent of the helium-hydrogen phase separation is also an important, poorly known parameter entering the models. Progress in our understanding of this difficult high-pressure regime will directly benefit the interpretation of the now extremely accurate measurements of Jupiter's gravity field.