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Analysis of Ganymede's gravitational field in support of JUICE mission

In the absence of seismic data, the gravity field allows to investigate the internal distribution of mass of a planetary object. The upcoming missions JUICE (ESA), BepiColombo (ESA-JAXA) and Veritas (NASA) will measure the gravitational fields of Ganymede, Mercury, and Venus, respectively, to constrain their interiors.

The moment of inertia, derived by the gravity field coefficient J_2 and C_{22}, will enable to model the deepest structure and the level of hydrostatic equilibrium of planetary bodies. In addition, the gravitational anomalies (i.e. Free-Air and Bouguer) and the admittance Z analysis, evaluated by comparing the gravity field with the topography, will reveal variations in crustal density, crustal-mantle boundary, and, potentially, core-mantle interface.

I developed a novel code to compute gravitational anomalies and admittance's profile $Z(n)$, following the spherical harmonic expansion approach (Wieczorek, 2015), which exploits the associated Legendre polynomials P_{nm}. The code is able to handle gravity data in the form of Stokes' coefficients $[C_{nm}, S_{nm}]$, resulting numerically stable up to the highest available degree (~2190). In preparation for the JUICE mission, I modelled the gravitational anomalies of Mercury, Earth, Venus and Moon. The so-obtained resulting maps are consistent with those reported in the literature, validating both the code and the performed analysis.

Future works will further detail the study of the degree spectrum through the application of a new mathematical tool, called Spherical Iterative Filtering (Cicone, 2024), and the development of inversion methods.

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