

# Hydrodynamical modelling of tidal dissipation in gas giant planets at the time of space missions

H. Dhouib, C. Baruteau, S. Mathis, F. Debras, A. Astoul and M. Rieutord

Gas giant planets are differentially rotating magnetic objects that have strong and complex interactions with their environment. In our Solar system, they interact with their numerous moons while exoplanets with very short orbital periods (hot Jupiters), interact with their host star. The dissipation of waves excited by tidal forces shapes the orbital architecture and the rotational dynamics of these systems.

During the last decade, several revolutions have occurred in our understanding of tides in these systems. First, much stronger tidal dissipation in Jupiter and Saturn than previously predicted has been inferred thanks to high precision astrometric constraints on the orbital migration of their moons. Second, the broad diversity of orbital architectures and radii of hot Jupiters remains unexplained. Third, new constraints obtained thanks to Kepler/K2 and TESS indicate that tidal dissipation in gas giant exoplanets should be weaker than in Jupiter and Saturn. Finally, the space missions Juno and the grand finale of the Cassini mission have completely changed our vision of the interiors of Jupiter and Saturn. They revealed that these planets are structured by a central stably stratified core, a convective metallic shell, a potential intermediate stable layer in the case of Jupiter, and an outer differentially rotating molecular convective envelope.

In this work, we present results of hydrodynamical calculations modelling tidal interactions in Jupiter, taking for the first time the latest, state-of-the-art interior model of the planet. We develop 2D numerical simulations of linear tidal waves that propagate and dissipate within Jupiter interior by taking into account viscous, heating and chemical diffusions. This new model allows us to explore the properties of the dissipation and the associated tidal torque as a function of all the key hydrodynamical and structural key parameters. Finally, we discuss future perspectives of this work to take differential rotation and magnetic fields into account and to build a coherent picture of gas giant planet systems evolution.