Experimental acoustic eigenmodes measurements: from sphere to spheroid

Sylvie Su[1], Philippe Cardin[1], David Cébron[1] & Henri-Claude Nataf[1]

ISTerre, Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, IRD, IFSTTAR, 38000 Grenoble, France
sylvie.su@univ-grenoble-alpes.fr

Acoustic eigenmodes have been widely used in asteroseismology to retrieve physical properties of stars, e.g. internal flows [1]. Application of this method in experimental fluid dynamics has been recently investigated to measure the velocity of rotating flows enclosed in spherical shells [2]. In spheres, acoustic modes are degenerate in the azimuthal direction but this degeneracy can be lifted, e.g. in the presence of rotation. This is responsible for modal splittings, that can be inverted to access information on the flow velocity. However, full azimuthal degeneracy leads to crowded spectral regions after splitting, which can make mode identification difficult. A way to circumvent this difficulty is to partially lift the degeneracy at rest, through the geometry of the resonator. To keep the spherical formalism, for which perturbation methods and variational principles have been widely employed to describe the geometrical splitting [4], we consider a spheroidal geometry that departs slightly from a sphere.

We build two different apparatus, a sphere and an oblate spheroid with a polar flattening of 0.05 aligned with the rotation axis of the apparatus. Both apparatus have the same equatorial radius and same instrumentation. We confront acoustic spectra from both apparatus to analytical calculations [3] and numerical simulations from the finite-element commercial code COMSOL.

References

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