

Inertial waves focusing into localized turbulence in rotating fluid

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In geophysics or astrophysics, flows are often submitted to stable-stratification-induced buoyancy force or to rotation-induced Coriolis force, causing the formation of internal gravity waves (IGW) or inertial waves (IW). In the ocean, energy injected by tidal forces generates internal gravity waves that interact with the ocean topography causing energy dissipation into localized turbulence. This phenomenon can be geometrically idealized in a flow containing an oscillating solid torus, hence reproducing the focalization of waves at the apex of the propagation cone with an angle θ (fig. 1).

Several studies for IGW in stratified fluid, but also for IW in a rotating fluid, have analyzed this torus configuration by using numerical simulations of IW¹, experiments of IGW², or analytical theory of IGW³. Note that IGW and IW are both transverse waves with similar dispersion relation, so that their dynamics can be expected to be comparable, at least qualitatively.

In this study, a vertically oscillating torus in a rotating fluid is used to produce the inertial waves focussing. The objective is to study the energy conversion in the focus zone, direct numerical simulations (DNS) have been performed with spatial resolution of 512^3 points. The spectrogram of the vertical velocity signal on the focus zone in nonlinear DNS shows that the principal forcing frequency coming from the oscillating torus transfer energy to higher frequency (superharmonics). Higher order statistic HOS are used to characterize the flow dynamics. Among them, bispectra and bicoherences will also be presented in order to propose a transition scenario in terms of triadic wave resonance.

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¹ Duran-Matute et al., *Phys. Rev.*, E, 87:041001(R) (2013).

² Shmakova and Flór, *J. Fluid Mech*, 862:R4 (2019).

³ Voisin et al., *J. Fluid Mech*, , 666:308–357 (2011).

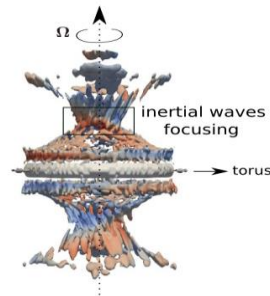


Figure 1: Isosurfaces of the vertical velocity u_3 from numerical simulation