Strongly non linear wave turbulence in stratified water

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The dynamics of the ocean interior at submesoscales ($\ll$ 100 km horizontal wavelengths) is dominated by nonlinear internal gravity waves supported by the natural density stratification of the ocean due to vertical variations of temperature and salinity. These waves have a major role in the global ocean budget through turbulent mixing and dissipation that requires to be modeled accurately for climate predictions [12]. To a large extent, waves are excited by large scale currents or tides flowing over bottom topography or by coupling with atmosphere during strong events such as storms. Here we investigate experimentally such turbulence by forcing stratified water by large scale waves. Stratified turbulence is characterized by both a large Reynolds number and a small Froude number so that experimental studies require large facilities. We use the Coriolis facility (Grenoble, France) that is a large tank (13 m-diameter, 1 m-deep) in which stable stratification in density can be set using vertically varying concentration of salt. The tank can rotate as well to introduce the impact of planetary rotation.

We investigate the statistical properties of the resulting flow by using Particle Image Velocimetry and vertical density profiles[34]. At the largest buoyancy Renolds numbers, several turbulent regimes can be identified: weakly non linear wave turbulence at large scales, strongly nonlinear waves at intermediate scales and intermittently overturning waves that generate strongly nonlinear turbulence at the smallest scales (Fig. 1). The observed spectra suggests that the Garrett & Munk spectrum that models oceanic data[5] is due to strongly nonlinear internal wave turbulence rather than by weakly nonlinear wave turbulence.

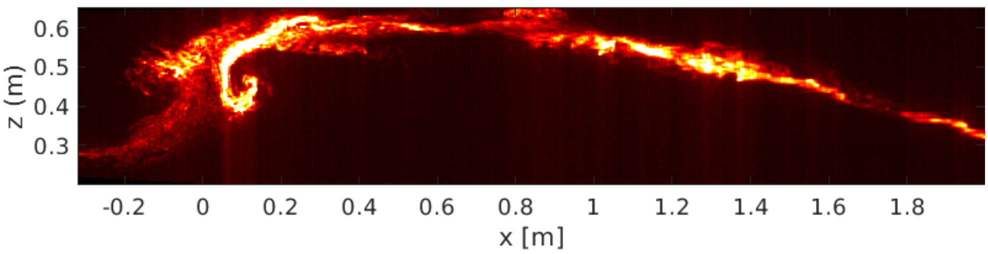

Figure 1: Vertical slice of the flow showing a layer of rhodamine advected by stratified turbulence. The large scale ondulation results from large scale waves. An overturning internal wave is visible at the left of the image that will evolve into a region of strongly nonlinear turbulence.

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