
Geometric focusing of internal waves: experiments versus theory

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Abstract

The interaction of tidal motion with ocean bottom topography results in the radiation of internal gravity waves into the ocean interior, known as the baroclinic tide. Dissipation due to nonlinear breaking is believed to play an important role in the mixing of the abyssal ocean, and therefore in the large-scale ocean circulation.

Over the past five decades the dynamics of particularly diverging internal waves have been considered, such as generated by an oscillating object, see for example Mowbray and Rarity (1967) for a cylinder, or King et al. (2009) and Ermanyuk et al (2011) for a sphere. Wave focusing is known to occur for wave reflection on inclined boundaries (Maas et al. 1997), but the geometric focusing as occurs for oscillating bodies of ring shaped topography is not well known, and only the case studied by Bühler and Muller (2007) who considered a ring with Gaussian generatrix placed at the bottom is known.

Here we present results on internal waves in a linearly stratified fluid generated by a torus with a circular generatrix of radius a oscillating horizontally with amplitude A . The LIF and PIV techniques are used to measure respectively the isopycnal displacement and the velocity field.

It is shown that for weak oscillation amplitudes (i.e. with $Ke = A/a < 0.5$) the entire wave field (i.e. structure and amplitude) is in good agreement with the linear theory. With increasing oscillation amplitude wave slopes in the focal zone grow linearly. Overturning occurs for $Ke > 0.7$. In this case the focal zone radiates waves in the horizontal plane.

Complimentary experiments have been conducted in the Coriolis platform with a large torus of 15 cm generatrix radius and 180 cm diameter (small Froude number, large Reynolds number) to study bimodal and nonlinear effects, and the turbulence in the focal zone.

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