

Resonance between waves propagating on the flow in a cylindrical tank with a rotating bottom

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In the terrestrial and planetary atmospheres, non-axisymmetric structures are often formed from the axisymmetric environments. We can realize such non-axisymmetric flows in a very simple laboratory experiment using a cylindrical tank filled with water whose bottom rotates rapidly.

For the theoretical analysis of such phenomena, the axisymmetric flow as the basic state is necessary. We have been analyzed the axisymmetric flows using boundary layer theories, and obtained the basic axisymmetric flow, which predicts the water elevation of the axisymmetric regime of the laboratory experiments precisely.

Based on the obtained flow field, instability of the axisymmetric flow is investigated, under the shallow water system, but some differences are found between the results of the stability analysis and the laboratory experiment. The instability is considered using the concept of resonance between counter-propagating waves. The instability is considered to be caused by resonance between a topographic Rossby wave and a gravity wave along the side wall. In particular, the propagation of the gravity waves should be estimated considering the finite depth of the water layer.

Keywords: rotating flow, instability, resonance between waves, laboratory experiments