Sidewall boundary region and instability of an axisymmetric flow in a cylindrical tank with a rotating bottom

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Non-axisymmetric flows are often formed in the terrestrial and planetary atmospheres even under their axisymmetric environments. Such non-axisymmetric flows can be realized in a very simple laboratory experiment using a cylindrical tank filled with water by rapidly rotating a disk at the bottom.
In order to treat theoretically such phenomena, the axisymmetric flow as the basic state has been analyzed. The comparison of the theory with results of laboratory experiments show a slight difference of the water surface height near the side-wall boundary. Considering the angular momentum budget around this region, a corrected theory is shown which predicts the water surface elevation precisely.
Based on the obtained flow field, instability of the axisymmetric flow is investigated. Considering a problem as a shallow water system, the unstable modes are calculated, which shows some differences with the experimental results. The treatment as the shallow water system not only shifts the existence range of the unstable modes, but also may have a significant influence on the existence itself of the unstable modes, through the disappearance of the overlapping of the dispersion curves which should resonate originally.

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