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# Oscillation on surface of water over rotating disc

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In the terrestrial and planetary atmospheres, the axisymmetry of a vortex occasionally breaks and vortices with various structures are observed. For example, polygonal eyes of tropical cyclones are sometimes observed, and polar stream of Saturn has a hexagonal pattern. Moreover, such non-axisymmetric phenomena are not always steady: polar jet of the earth occasionally meanders but also takes relatively straight path.

Similar phenomena are observed on water surface in laboratory experiments in which water layer in a right cylindrical tank is driven by a rapidly-rotating bottom plate: the shape of the water surface near the rotation center is modified to be a polygon under a certain condition of rotation rate, and it oscillates greatly and becomes calm alternately in another case.

In this study, we focused on the cases of rotation rate of the bottom plate less than that of the polygonal patterns: in certain ranges of this slow rotation rate, the water surface oscillates with a large amplitude. We investigated the features of the flow in vacillation. We can summarize the characteristics of the vacillation as follows: as the initial water depth becomes deeper and as the rotation rate of the plate becomes faster, the vacillation interval becomes shorter and the amplitude of the water surface oscillation becomes smaller. Furthermore, we found small and steady oscillation in other rotation rate range.

We also examined the condition of initial water depth and rotation rate of the plate that the vacillation occurs from the view point of resonance between waves. The fundamental flow of water is rigid body rotation with approximately the same rotation rate of the plate near the center of the tank, though it is slower in the outer region. Moreover, the depth of water becomes shallower near the center of the tank: owing to the gradient of the water layer thickness, there exist topographic Rossby waves. Thus, the coincidence of the phase velocity of a gravity wave travelling along the outer wall in the same direction of rotation of the plate and that of topographic Rossby wave near the center on the flow, which itself travels in the opposite direction of rotation of the plate, leads an instability which might cause these vacillation or oscillation phenomena.

Keywords: rotating fluid, laboratory experiment, oscillation