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A Bathtub Vortex under the Influence of a Taylor Column in a Rotating Tank[1] SHIH-LIN HUANG, YIN-CHUNG CHEN, ZI-YA LI, CHIN-CHOU CHU, CHIEN C. CHANG, National Taiwan University — Numerical simulations and laboratory experiments were conducted to investigate a bathtub vortex under the influence of a Taylor column in a rotating tank. A central drain hole is placed at the bottom of the tank and a top-down cylinder is suspended from the rigid lid. We examine the effects of the Rossby number, *Ro* and the Ekman number, *Ek*. Steady-state solutions are shown to have good agreements with flow visualizations and PTV measurements. It is found that at $Ro{\sim}10^{-2}$, a bottom Ekman pumping forms a classic one-celled structure for the case of no suspended cylinder $h/H{=}0$, while for various $h/H \neq 0$, the strong interaction of the bathtub vortex and Taylor column results in a two-celled structure with an inner Ekman pumping and an outer Taylor column induced upwelling. In $h/H \neq 0$, the Taylor wall separates the vortex into an inner and an outer region, but allows the outer fluid to flow into the inner region through a top and a bottom gap which can be classified into two and three flow paths, respectively. Moreover, the individual flow rate of each path and the weaker influence of the Taylor column at $Ro{\sim}1$ and ${\sim}10^2$ are also discussed. Finally, we observe that the vorticity strength of the vortex exhibits the relationship with a dimensionless group $\sqrt{fQ/gH^2(1-h/H)}$.

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