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Segregation of Suspended Particles in a Rotating Fluid-Filled Horizontal Cylinder – Experiment and Theory

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A dilute suspension of particles in an almost inviscid fluid that fills a rotating horizontal cylinder has recently been observed to segregate into well-defined periodic vertical bands. We present the results of an extensive experimental investigation into the main features of this phenomenon, including the dependence of the periodic spacing between bands on the tube length and a previously unreported phenomenon of oscillations between two interleaving band patterns. A theoretical approach to the banding mechanism, assuming very small Ekman and Rossby numbers, is presented whereby the gravity-induced motion of the suspended particles excites inertial waves, whose flow pattern leads to the observed axial segregation. The experimental results agree well with the theory with no adjustable parameters. We shall also discuss some effects of viscosity and non-linearity which were neglected in the theory.

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