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Faraday Instability in a Conjugated-Double-Liquid-Layer System

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The Faraday instability of two conjugated liquid layers of disparate thickness is investigated theoretically. Owing to the coupling effect, a unique instability mode is shared between the two layers. At the same time, caused by the disparity of the layer thicknesses, the top thick layer destabilizes with wavelengths at the same order of its own thickness, i.e. the short-wavelength mode (SW), while the bottom thin film exposes a long-wavelength (LW) mode. Different from cases where the two layers are both sufficiently thick, the deformation of the liquid-liquid interface in the present system is mainly induced by the viscous shearing effect. Because the inertial force is negligible in the bottom film, the potential Rayleigh-Taylor instability is rather weak even when the top layer has a higher density. The influence of the bottom film on the top layer can be characterized as a generalization of the classical Navier-slip boundary condition which lowers the instability threshold. Therefore, as the thickness of the bottom film becomes very small, the present system serves as a testing ground for the influence of the wall boundary condition on the onset of instabilities in liquid films.

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