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Frozen waves in the inertial regime

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Interfaces subjected to strong time-periodic horizontal accelerations exhibit striking patterns known as frozen waves. In this study, we experimentally and numerically investigate the formation of such structures in immiscible fluids under high-frequency forcing. In the inertial regime–characterized by large Reynolds and Weber numbers, where viscous and surface tension effects become negligible–we demonstrate that the amplitude of frozen waves scales proportionally with the square of the forcing velocity. These results are consistent with vibro-equilibria theory and extend the theoretical framework proposed by Gréa & Briard (2019) to immiscible fluids with large density contrasts. Furthermore, we examine the influence of both Reynolds and Weber numbers, not only in the onset of secondary Faraday instabilities–which drive the transition of frozen wave patterns toward a homogenized turbulent state–but also in selecting the dominant wavelength in the final saturated regime.

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