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Experimental observation of Duffing dynamics in liquid sloshing[1]

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We show that low-amplitude sloshing in a horizontally oscillated rectangular tank obeys Duffing dynamics with linear damping. The motion of the liquid's centre of mass is used to characterize the amplitude and phase-lag of the sloshing unambiguously and globally. As the driving amplitude increases deviations from Duffing dynamics are first seen in the phase-lag, well before complex wave patterns emerge. We observe that at resonance the sloshing motion is in quadrature with the driving independently of the observed flow state. This confirms the theoretical 90°-phase-lag criterion and highlights the phase-lag (so far rarely measured in experiments) as a key indicator of transitions in sloshing liquids.

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