Faraday resonance in a two-liquid layer system

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We consider resonating wave interactions in a vertically oscillating rectangular box, which carries two liquids of different densities. The natural frequencies \( \omega_1 \) and \( \omega_2 \) of the system are assumed to satisfy the resonant condition \( 2\omega_1 = \omega_2 = \Omega \), where \( \Omega \) is the frequency of the vertical vibration of the box. To study this interaction we have obtained amplitude equations which approximate the behaviour of the system in the region in parameter space where the \( 2\omega_1/\Omega = 1 \) and \( \omega_2/\Omega = 1 \) Mathieu instability regions cross. Our system can be transformed to that of Gu and Sethna (1987), who analysed the problem of Faraday resonance in the case of a single liquid in a rectangular container. We complement their results to quadratic order and extend them by including cubic order interactions. In particular, the results of our study show the importance of cubic order terms for second harmonic resonance, especially when dissipation is small. We choose a certain range in parameter space in order to make comparisons with previous results (Gu and Sethna 1987) and present the sequences of bifurcations and regions of chaotic behaviour for this interaction.

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