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Drift instabilities in quasi-one dimensional localized driven Faraday waves

Juan F. Marín[1]*, Rafael Riveros Ávila[2]†, Saliya Coulibaly[3], Majid Taki[2], Leonardo Gordillo[1], and Mónica A. García-Ñustes[2]
[1]Departamento de Física, Universidad de Santiago de Chile, Av. Víctor Jara 3493, Santiago, Chile
[2]Instituto de Física, Pontificia Universidad Católica de Valparaíso, Casilla 4059, Chile
[3]Université de Lille, CNRS, UMR 8523, PhLAM, F-59000 Lille, France
∗juan.marin.m@usach.cl, †rafael.riveros.a@mail.pucv.cl

Introduction

Patterns in nature emerge from the selection of an intrinsic scale determined by the particular properties of the system. However, there is little understanding of how patterns interact with a secondary extrinsic length scale. In this scenario, counterintuitive behaviors emerge and it is relevant to ask which are the physical mechanisms leading them. We focused our research on locally driven Faraday-wave patterns, where the extrinsic length scale is determined by a Gaussian-profiled drive [1]. The surface stroboscopic dynamics have been successfully described by the Parametrically driven and damped nonlinear Schrödinger equation (pdnlS) [2]. In this work, we report experimental and theoretical evidence of drift instabilities in localized Faraday patterns induced at the surface of a fluid under a localized parametric drive.

Results

We found experimentally that the drive amplitude threshold for the drift is $\Gamma_D = 0{,}691$, at a forcing frequency of $f = 14{,}8$ Hz. Normal form theory was used to obtain an amplitude equation for the locally driven Faraday-wave patterns, revealing the mechanisms triggering the drift instabilities. We show that such drift is entirely induced by the nonuniform nature of the vertical drive at the bottom of the fluid container and thus cannot be observed under uniform driving. By averaging methods, we found that the pattern velocity follows a square root power-law for amplitudes greater than the threshold, suggesting a saddle-node bifurcation. The experimental characterization fits well with the square root power-law. Apart from the drift instability, unexpected phenomena such as pattern zigzagging motion, mode competition, and branching phenomenon are also reported in experiments and simulations.

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Referencias

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