Spirals, Hexagons, and All That through Hydrodynamic Coupling with a Zero Mode

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We consider hydrodynamic systems developing spatially periodic patterns. Specifically, we present a study on a generalized, conserved-order-parameter Swift-Hohenberg model [1].

Without advective effects of a mean flow, the striped pattern is a steady state for our system. Sensitivity of the striped pattern formation to long range coupling to the mean-flow field is investigated. Besides stripes, we have found in numerical simulations a surprisingly rich variety of patterns, such as spiral-defect chaos, targets, and a pattern consisting of patches of up- and down-flow hexagons (Figs. 1 and 2). The appearance of symmetry-degenerate hexagons is explained in terms of weakly nonlinear analysis, and is ascribed to the presence of a neutrally stable zero-mode (Goldstone) branch of the spectrum originated in the conservation law.

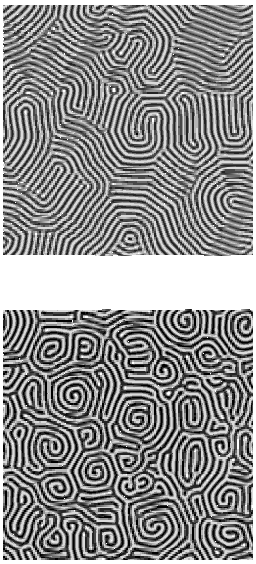

Figure 1: Striped (top) and spiral-defect patterns (bottom) that form in the numerical simulations of our model; the white regions denote positive values of the order parameter and the gray ones negative values.

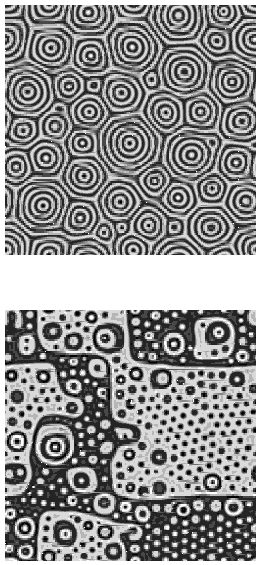

Figure 2: Target patterns (top), and coexisting up- and down-flow hexagonal patterns (bottom)

References

[1] Y. Shiwa, Phys. Rev. E **72** (2005) 016204.