Wave Number Selection and Defect Dynamics in Patterns with Hexagonal Symmetry

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We report quantitative measurements of wave number selection, secondary instability and defect dynamics in hexagonal patterns. A novel optical technique ("thermal laser writing") is used to imprint initial patterns with selected characteristics in a Bénard-Marangoni convection experiment. Initial patterns of ideal hexagons are imposed to determine the band of stable-pattern wave numbers. For small values of control parameter ε, the measured stable band is found to agree quantitatively with theoretical predictions at the low-wave-number side of the band, and qualitatively at the high-wave-number side. Long-wavelength perturbations of ideal hexagonal patterns suggested by theory are imposed for $\varepsilon = 0.46$, and their growth rates are measured to investigate the mechanisms of secondary instability. Our results suggest a transverse-phase instability limits stable hexagons at low wave number while a longitudinal-phase instability limits high-wave-number hexagons. Initial patterns containing an isolated penta-hepta defect are imprinted to study defect propagation directions and velocities. The experimental results agree well with theoretical predictions. The experimental investigations are discussed in the context of patterns with hexagonal symmetry formed under nonequilibrium external driving conditions.