

Pattern Formation and Spatiotemporal Complex Dynamics in Extended Anisotropic Systems

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This research is particularly motivated by the spatiotemporal complex dynamics, especially the spatiotemporal chaos (STC), observed in the nematic electroconvection, a well-known example of a non-equilibrium driven anisotropic system. Since in anisotropic systems the minima on the neutral stability surfaces are isolated, they admit a unique reduced description through Ginzburg-Landau type amplitude equations. Phase equations can be extracted from such amplitude equations governing a pattern-forming system near onset, if solutions in the form of perfect patterns undergo long-wave instabilities. On the other hand, phase equations have also been derived as model equations for physical systems, e.g. Kuramoto-type equations for snowcup patterns and ion bombardment.

We present a comprehensive and systematic theoretical approach, through the study of Ginzburg Landau type amplitude and phase equations extracted from them, in the analysis of the specific mechanisms and features of the formation and dynamics of complex spatiotemporal patterns in anisotropic systems, such as the nematic electroconvection, and the formation of suncups. In the nematic electroconvection, as the patterns bifurcate at onset, theoretical results from normal form analysis are available in the characterization of the mechanisms generating them. Key questions we will address include what is the role of symmetry breaking of a chaotic attractor in the creation of STC, what are the routes to STC, what is the role of nonlinear interactions of wave patterns in the creation of spatiotemporal complex patterns, and which anisotropies are involved in their occurrence.

This approach therefore allows for quantitative and qualitative comparison between the solutions of the model evolution equations and the experimental results, which should significantly increase the understanding of spatiotemporal complex patterns in anisotropic systems.

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