LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Sommerfeld Theory Colloquium

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Towards a theory of pattern formation in reaction-diffusion systems

Self-organized pattern formation typically studied in terms of spatially extended dynamical systems is as ubiquitous in nature as it is difficult to deal with conceptually and mathematically. We build on the phase space geometric methods of Nonlinear Dynamics, using geometric structures like nullclines and fixed points, to develop a comprehensive theory for pattern formation in mass-conserving reaction-diffusion systems. A dissection of space into (notional) compartments enables us to characterize the spatio-temporal dynamics based on the ODE phase space of local reactions. Diffusive coupling leads to mass redistribution between the compartments which, in turn, changes the local phase space properties. Within this conceptual framework all aspects of pattern formation, from linear instability and excitability to the bifurcations of stationary patterns, can be extracted from the geometric features of the line of chemical equilibria in phase space.

In this talk I will demonstrate the application of this framework to study Min protein system, a paradigmatic model system for self-organized protein pattern formation. One of the key predictions are transitions between chaotic, standing, and travelling wave patterns induced by variations in the system geometry or protein numbers. Moreover, the theoretical framework enables us to forecast the entire time evolution of patterns and their dynamic transitions in systems with heterogeneous geometry. Strikingly, the theory predicts the coexistence of patterns in large heterogeneous systems, which we confirm experimentally.

Wednesday, 23 January 2019, 16:15h, Room A348, Theresienstr. 37 / III

Prof. E. Frey