DY 33: Nonlinear Dynamics II

Time: Friday 10:45–12:30 Location: H46

DY 33.1 Fri 10:45 H46

Control of phase separation in binary mixtures — •Alexei Krekhov, Vanessa Weith, and Walter Zimmermann — Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany

The results on new effective mechanisms to create periodic stripe patterns during the phase separation process in binary mixture will be presented. Pattern selection mechanism operating in the process of phase separation under directional quenching will be discussed. It will be demonstrated that the wavelength of periodic stripe patterns is uniquely selected by the velocity of quench interface. Theoretical analysis of phase separation in the presence of spatially periodic forcing will be presented. In this case stripe patterns with the periodicity slaved to the externally imposed one can be stabilized against coarsening above some critical modulation amplitude. The results will be compared with the experiments on thermal patterning in polymer blends. Another possibility to create regular structures in the phase-separating binary mixture by adding Janus particles will be discussed. It will be shown that due to a novel type of dynamic interparticle interaction equally oriented Janus particles form a periodic array of interfaces. The results might promote the development of tools to fabricate regular structures in material science and gain better insight into the basic mechanisms to control the spontaneous pattern formation processes in other nonequilibrium systems.

DY 33.2 Fri 11:00 H46

Correlations in complex nonlinear systems and quantum information theory — •Otfried Gühne[1] and Tobias Galla[2] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, A-6020 Innsbruck, Austria — [2]School of Physics and Astronomy, The University of Manchester, Manchester M13 9PL, UK

The dynamical evolution of classical complex systems such as coupled logistic maps or simple models of lattice gases and cellular automata can result in correlations between distant parts of the system. For the understanding of these systems, it is crucial to develop methods to characterize and quantify these multi-party correlations.

On the other hand, the study of correlations between distant particles is also a central problem in the field of quantum information theory. There, correlations are often viewed as a resource and many tools have been developed for their characterization. In this talk, we will explore the extent to which the tools from quantum information can be applied to study classical complex systems and whether they allow to study complex systems from a different perspective.

DY 33.3 Fri 11:15 H46

Directing Brownian Motion on a Periodic Surface by Spontaneous Symmetry Breaking — •David Speer[1], Ralf Eichhorn[2], and Peter Reimann[1] — [1]Universität Bielefeld, Fakultät für Physik, 33615 Bielefeld, Germany — [2]NORDITA, Roslagstullsbacken 23, 10691 Stockholm, Sweden

We consider an overdamped Brownian particle, exposed to a two-dimensional, square lattice potential and a rectangular ac drive. Depending on the driving amplitude, the linear response to a weak dc force along a lattice symmetry axis consist in a mobility in basically any direction. In particular, motion exactly opposite to the applied dc force may arise. Upon changing the angle of the dc force relatively to the square lattice, the particle motion remains predominantly opposite to the dc force. The basic physical mechanism consists in a spontaneous symmetry breaking of the unbiased deterministic particle dynamics [1].

[1] D. Speer et al, Phys. Rev. Lett. 102, 124101 (2009)

DY 33.4 Fri 11:30 H46

Diagrammatic semiclassical laser theory — •Oleg Zaitsev[1] and Lev Deych[2] — [1]Physikalisches Institut der Universität Bonn, Nußallee 12, 53115 Bonn, Germany — [2]Physics Department, Queens College of City University of New York, Flushing, NY 11367, U.S.A.

We derive semiclassical laser equations valid in all orders of nonlinearity. With the help of a diagrammatic representation, the perturbation series in powers of electric field can be resummed in terms of a certain class of diagrams. The resummation makes it possible to take into account a weak effect of population-inversion pulsations in a controlled way, while treating the nonlinearity exactly. The proposed laser theory reproduces the all-order nonlinear equations in the approximation of constant population inversion and the third-order equations with population-pulsation terms, as special cases. The theory can be applied to arbitrarily open and irregular lasers, such as random lasers.

DY 33.5 Fri 11:45 H46

Dynamics of Janus particles in a phase-separating binary mixture — •Vanessa Weith, Alexei Krekhov, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

Adding particles to a binary mixture induces an interesting dynamic coupling between the wetting of the particles and the phase separation of the mixture. Recently a new class of colloidal particles, so-called Janus particles, have been synthesized in large quantities [1]. Janus particles, named after the Roman god Janus, represent colloids with a different chemical composition of the surface of the two halves of a particle. Accordingly each half of a particle may be wetted preferentially by one component of the mixture.

We present the results of numerical simulations of the dynamics of Janus particles immersed in a phase-separating binary mixture based on a mean-field approach. When the two constituents of a binary mixture wet the two sides of a Janus particle differently, the particle induces a spatial variation of the concentration in their neighborhood. Accordingly, Janus particles in phase separating mixtures are trapped to interfaces, which leads to a complex dynamics.

Due to the strong localization of an interface, the diffusion of Janus particles is much more pronounced compared with isotropic particles. As a result of this fast diffusion the Janus particles placed initially at large distances may effectively approach each other and they can remain coupled in the case of an appropriate orientation.

[1] A. Walther and A. H. E. Müller, Soft Matter 4, 663-668 (2008)

DY 33.6 Fri 12:00 H46

Mobility enhances synchronization — Fernando Peruani[1], Ernesto M. Nicola[2], and •Luis G. Morelli[3,4] — [1]CEA-Service de Physique de l'Etat Condense', Centre d'Etudes de Saclay, 91191 Gif-sur-Yvette, France — [2]IFISC (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain — [3]Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany — [4]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

When coupled oscillators hold fixed positions in space, local interactions can drive the organization of spatial and temporal patterns, as for instance in the cardiac tissue. A different situation occurs when the oscillators are not fixed in space but are able to move around. We study synchronization of locally coupled noisy phase oscillators which move diffusively in a one-dimensional ring. We show that together with the disordered and the globally synchronized states, the system also exhibits several wave-like states which display local order. We use a statistical description valid for a large number of oscillators to show that for any finite system there is a critical spatial diffusion above which all wave-like solutions become unstable. Through Langevin simulations, we show that the transition to global synchronization is mediated by the relative size of attractor basins associated to wave-like states. By disrupting these states, spatial diffusion paves the way for the system to attain global synchronization. Our theoretical framework allows for an interpretation of recent experiments with small porous particles that behave as individual chemical oscillators.

DY 33.7 Fri 12:15 H46

Phase space focusing in dissipative driven elliptical billiards — Christoph Petri[1], •Florian Lenz[1], Fotis Diakonos[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece

It is known that the driven elliptical billiard exhibits Fermi acceleration. Here, we demonstrate that due to the introduction of dissipation the acceleration of an ensemble of particles is present during a transient regime only, asymptotically, the energy will saturate, even for very small dissipation rates. The saturation value can be tuned by adjusting the parameters of the system, like the dissipation rate, the driving amplitude or frequency, appropriately. The presence of dissipation causes the emergence of attractors and limit cycles on which the particles get focused in their evolution. By introducing surface roughness at certain regions of the elliptical boundary, specific attractors and limit cycles can be destroyed, thus allowing to populate for example just a single attractor of interest.