DY 23: Nonlinear Waves/ Nonlinear Lattices

Time: Wednesday 14:00–16:15 Location: ZEU 255

Topical Talk DY 23.1 Wed 14:00 ZEU 255

Nonlinear waves in localizing media — •Sergej Flach — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

Linear wave propagation is inhibited in a variety of structured media, such as disorder potentials (Anderson localization), Wannier-Stark ladders (Bloch oscillations), quantum kicked rotors (dynamical localization), and quasiperiodic potentials (Aubry-Andre localization). All cases were experimentally studied with light and/or matter waves, and confirmed the expected localization of waves. An additional nonlinear response couples the localized eigenmodes of the linear equations and makes them nonintegrable. Wave packets tend to spread subdiffusively. I will review recent theoretical studies of the dynamical details of wave packet spreading, and discuss recent experimental data obtained with interacting matter waves.

DY 23.2 Wed 14:30 ZEU 255

Strong and weak chaos regimes of wave spreading in nonlinear disordered media — •Tetyana Laptyeva, Joshua Bodyfelt, Dmitry Krimer, Charalampos Skokos, and Sergej Flach — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, D-01187 Dresden, Germany

The spreading behavior of multiple-site excitations was analyzed for anharmonic disordered 1-D lattices with cubic nonlinearity, where all linear modes are exponentially localized by disorder. Due to chaotic nonlinear interaction, the initial localization is destroyed and a finite part of the wave packet spreads subdiffusively [1]. In addition to our previous results [1], we find a qualitatively new dynamical regime, where the second moment m_2 of the wave packet grows as $t^{1/2}$, with a crossover to an asymptotic $t^{1/3}$ law at larger times [2]. This novel effect is attributed to the strong chaos regime, in contrast to the previously observed weak chaos. The crossover between the regimes is controlled by the ratio of the nonlinear frequency shift and the average eigenvalue spacing of the linear problem eigenstates within one localization volume. The details of these spreading regimes were analyzed using extensive numerical simulations over large times with ensemble averaging [2].

[1] S Flach DO Krimer Ch Skokos, Phys. Rev. Lett. **102**, 024101 (2009); Ch. Skokos DO Krimer S Komineas S Flach, Phys. Rev. E **79**, 056211 (2009)

[2] TV Laptyeva JD Bodyfelt DO Krimer Ch Skokos S Flach, EPL **91**, 30001 (2010)

DY 23.3 Wed 14:45 ZEU 255

A generalized spreading conjecture in 2*D* nonlinear disordered media — •Joshua Bodyfelt and Sergej Flach — Max Planck Institut für Physik komplexer Systeme, Dresden

It is generally accepted that the presence of nonlinearity in a random lattice couples the lattice's localized Anderson modes. This coupling then allows mode resonances, which in turn are responsible for spreading of initially compact, localized wavepackets. The spreading is measurable via several moments, all showing a characteristic subdiffusive behavior of t^α, where $\alpha < 1$. Numerical investigations confirm the validity of these measures, including a recent work [1] which discusses the novel appearance of a dynamical crossover from strong to weak resonances (please see talk by T.V. Laptyeva). The concept of a tunable nonlinearity (with power order of $\sigma > 0$) also holds great interest [2], in that a critical power order is observed seperating the two regimes of strong and weak resonances. However, these works mainly focus on 1*D* systems. Within [3] a generalization was made to multidimensional lattices, with resonances on a wavepacket's surface (as opposed to those within the internal volume) being claimed as the main mechanism for spreading. Here, we present for 2*D* lattices further numerical investigations into this claim.

[1] T.V. Laptyeva et al., *Europhys. Lett.* **91**, 30001 (2010).

[2] Ch. Skokos & S. Flach, *Phys. Rev. E* **82**, 016208 (2010); M. Mulansky & A. Pikovsky *Europhys. Lett.* **90**, 10015 (2010); H. Veksler et al., *Phys. Rev. E*, **80** 037201 (2009).

[3] S. Flach, *Chemical Physics* **375**, 548 (2010).

DY 23.4 Wed 15:00 ZEU 255

A Coupled-Map Lattice Model for the Puff-Slug-Transition in Turbulent Pipe Flow — Christian Marschler and •Jürgen Vollmer — Max Planck Institute for Dynamics and Self-Organizaton, 37073 Göttingen

Pipe flow shows long-lived localised turbulent regions (*puffs*) that are convected down the flow when increasing the Reynolds number $\mathrm{Re} = UL/\nu$ beyond $\mathrm{Re} \gtrsim 1500$. Here Re is the flow velocity U nondimensionalized by the pipe diameter L and the kinematic viscosity ν. Beyond $\mathrm{Re} \simeq 2300$ the turbulent regions start to grow in size. Eventually, they can fill macroscopic portions of the pipe. The resulting turbulent regions are called *slugs*. Recent experiments and simulations have provided a wealth of data on the life-time of puffs [1], and the structure and growth of slugs [2].

In order to contribute to understanding the nature of the transition from puffs to slugs, we constructed a coupled-map lattice where laminar flow is mimicked by a fixed point of the on-site dynamics, and turbulence amounts to long-lived chaotic structures that propagate through the lattice. In this model the transitions from puffs to slugs is related to an intermittency crisis of the dynamics. Implications for the interpretation of pipe-flow data will be given.

[1] B. Hof, et al, *Phys Rev Lett* **101** (2008) 214501.

[2] D. Moxey and D. Barkley, PNAS **107** (2010) 8091.

DY 23.5 Wed 15:15 ZEU 255

Controlling the non-equilibrium particle density in block-structured driven lattices — •Christoph Petri[1], Florian Lenz[1], Benno Liebchen[1], Fotis Diakonos[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Department of Physics, University of Athens, GR-15771 Athens, Greece

We study the dynamics of noninteracting particles loaded into a one-dimensional lattice formed by laterally oscillating barriers. By tuning parameters of the driven barriers it is possible to create blocks in the lattice with locally different transport or localization properties. At the interfaces between these blocks crossovers of trajectories from chaotic to ballistic dynamics and vice versa are observed. Thereby different time-scales are introduced which leave their hallmark in properties of the system like the spatial density of particles for an ensemble propagating in the lattice.

DY 23.6 Wed 15:30 ZEU 255

Using symmetry breaking for the directed transport of paramagnetic colloids on garnet films — •Saeedeh Aliaskarisohi[1], Tom.H Johansen[2], and Thomas.M Fischer[1] — [1]Institut für Experimentalphysik, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Department of Physics, University of Oslo, P.O.Box 1048, Blindern, 0316 Oslo, Norway

The transport behavior of paramagnetic particles on top of a ferrimagnetic garnet film is investigated in a modulated external magnetic field. Broken symmetries are required to direct the transport of the particles. We provide such symmetry breaking by tilting the external field modulation with respect to the garnet film normal and by the intrinsic geometrical symmetry breaking of the garnet film magnetic pattern. The interplay of both symmetry breaking mechanisms cause a rich variety in transport behavior and direction. We corroborate our experimetal transport directions by comparing experimental with theoretical transport phase diagrams. Directing the transport of paramagnetic colloids will be useful when they are loaded with biomedical cargo on a magnetic lab-on-a-chip device.

DY 23.7 Wed 15:45 ZEU 255

Synchronization in monolayer transfer onto prepatterned substrates: A novel perspective for controlled nanopatterning of surfaces — •Michael H. Köpf, Svetlana V. Gurevich, and Rudolf Friedrich — Institut für Theoretische Physik, Universität Münster

Solid substrates can be endued with self-organized regular stripe patterns of nanoscopic lengthscale by Langmuir-Blodgett transfer of organic monolayers [1]. Here, we present an extension of the recent theoretical description of these phenomena [2,3], considering the effect of periodically prepatterned substrates on this process of spatiotemporal pattern formation. It leads to a time periodic forcing of the oscillatory behavior at the meniscus. Utilizing higher order synchronization with this forcing, complex periodic patterns of predefined wavelength can be created. The dependence of the synchronization on the amplitude and the wavelength of the wetting contrast is investigated in one and two spatial dimensions and the resulting patterns are discussed. Furthermore, the effect of prepatterned substrates on the pattern selection process is investigated [4].

[1] M. Gleiche, L. F. Chi, H. Fuchs, *Nature*, **403** (2000) 173-175

[2] M. H. Köpf, S. V. Gurevich, R. Friedrich, *EPL (Europhysics Letters)*, **86** (2009) 66003 (6 pages)

[3] M. H. Köpf, S. V. Gurevich, R. Friedrich, L. F. Chi, *Langmuir*, **26** (2010) 10444-10447

[4] M. H. Köpf, S. V. Gurevich, R. Friedrich, *submitted to PRE*, arXiv:1011.1140v1 [nlin.PS] (2010)

DY 23.8 Wed 16:00 ZEU 255

Lattice dynamics in the itinerant helical magnet MnSi — •Daniel Lamago[1,2], Evgeni Clementyev[3,4], Alexander Ivanov[5], Rolf Heid[1], Jean-Michel Mignot[2], A.E. Petrova[6], and Pavel A. Alekseev[3] — [1]Karslruhe Institut für Technologie (KIT), Institut fuer Festkoerperphysik, P.O.B. 3640, 76021 Karlsruhe, Germany — [2]Laboratoire Leon Brillouin, CEA Saclay, 91191 Gif sur Yvette Cedex, France — [3]ISSSPh, Russian Research Centre Kurchatov Institute, 123182 Moscow, Russia — [4]LNS, Institute for Nuclear Research, Russian Academy of Sciences, Troitsk, Moscow Region, Russia — [5]Institut Laue Langevin, 38042 Grenoble Cedex 9, France — [6]Institute for High Pressure Physics, Russian Academy of Sciences, Troitsk 142190, Moscow Region, Russia

The phonon dispersion relations in MnSi were measured using inelastic neutron scattering. At the same time, calculations of the lattice dynamics of MnSi were carried out in the framework of the density-functional theory using both the local-density and the generalized gradient approximations. The calculations match most of the phonon modes in the frequency range up to 40 meV, if they are performed using the experimental lattice constant. Spin-polarized calculations for ferromagnetic ground states result in subtle modifications of the dispersion curves, which further improve the description, in particular, for the acoustic branches.