DY 14: Statistical physics II (general)

Time: Tuesday 14:00–16:00 Location: MA 004

Invited Talk DY 14.1 Tue 14:00 MA 004

When it helps to be purely Hamiltonian: Acceleration of rare events, enhanced particle and energy transport — •Dirk Hennig[1], Lutz Schimansky-Geier[1], and Peter Hänggi[2] — [1]Institut für Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin — [2]Insitut für Physik, Universität Augsburg, Universitätsstr. 1, 86135 Augsburg

In the first part we present a deterministic escape of chains of interacting units from a metastable state over an anharmonic potential barrier. The underlying dynamics is conservative and noise-free. The mutual interplay between nonlinearity and interaction causes that an initially uniform lattice state becomes unstable, leading to energy redistribution with strong localization. As a result a spontaneously emerging localized mode grows into a critical nucleus. By surpassing this transition state, the nonlinear chain manages a self-organized, deterministic barrier crossing. Most strikingly, these noise-free, collective nonlinear escape events proceed generally by far faster than the transitions assisted by thermal noise when the ratio between the average energy supplied per unit in the chain and the potential barrier energy assumes small values.

In the second part we discuss the formation of directed transport in driven Hamiltonian systems. Most crucially,the overall system dynamics is unbiased in the sense that the force averaged over time and space vanishes. Nevertheless we demonstrate that for adiabatic time-periodic modulations of the tilt of a symmetric and spatially periodic potential a giant transient directed current is induced.

DY 14.2 Tue 14:30 MA 004

Memory effects in the particles' clustering in the Mean Field Hamiltonian model — •Angelo Facchini[1], Hiroko Koyama[2], and Stefano Ruffo[3] — [1]Center for the Study of Complex Systems, University of Siena, Italy — [2]Department of Physics, Nagoya University, Nagoya 464-8602, Japan — [3]Dipartimento di Energetica "S. Stecco", University of Florence, INFN and CSDC, Italy

We investigate the memory effects in the dynamics of cluster in the Hamiltonian Mean Field model. In a preliminary paper, Koyama and Ruffo found that the life times, i.e. the time interval for which all the particles are trapped in the cluster, were distributed according to a power law. Here we extend this preliminar result investigating the power law distribution for energies ranging from $U = 0.3$ to $U = 0.65$ and particle number $N = 8, 16, 32, 64, 128, 256, 512$. For a given N, we have computed the scaling index of the life-time distribution at different energies, showing that the phenomenon depends on both N and U. Furthermore, for a fixed N, Ruffo and Antoni [PRE,52,2361, 1995] showed that in the interval $U = 0 - 0.75$, there is a specific value, $U = 0.3$, for which the cluster begins to melt. Increasing U, the cluster continues to melt and the liquid phase disappears for $U_c = 0.75$, the critical transition energy. By means of simulations in the microcanonical ensemble, we show that in the interval $U = 0.3 - 0.75$, there is an energy range $0.3 - U_{pl}$ for which the power law exists.

We show that this is a non thermodynamic effect, retraceble in the dynamics of the long range interaction between a small number of particles.

DY 14.3 Tue 14:45 MA 004

Estimating fixed points of complex dynamical systems - with an application to wind energy research — •Julia Gottschall and Joachim Peinke — Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg

We present a method to estimate the fixed points of complex dynamical systems and show its robustness against different sources of noise. Assuming that the considered process can be described by a Langevin or Fokker-Planck equation, Friedrich et al. [1] proposed some years ago a procedure how to reconstruct its deterministic and stochastic dynamics, separately, directly from the data. Recently, it has been investigated how the reconstruction is affected by measurement noise as well as by a finite sampling frequency of the data, and more or less complex corrections have been suggested [2].

We have studied the reconstruction of the deterministic dynamics and the influence of the proposed corrections in more detail. In particular, we could show that a reliable estimation of the characteristic points is still possible with the uncorrected procedure, even when the system is spoilt by different kinds of noise. Therewith, we have a very efficient method to estimate the fixed points of a complex system.

This conclusion allows to apply the method to a variety of fields of interest. We present an application to wind energy research, namely the estimation of power performance curves for wind turbines.

[1] R. Friedrich et al., Physics Letters A 271 (2000), 217-222
[2] F. Böttcher et al., Physical Review Letters 97, 090603 (2006)

DY 14.4 Tue 15:00 MA 004

Numerical estimation of Baxter-Wu critical amplitudes — •Wolfhard Janke[1] and Lev N. Shchur[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany — [2]Landau Institute for Theoretical Physics, 142432 Chernogolovka, Russia

We report a Monte Carlo simulation study of the critical and off-critical behaviour of the Baxter-Wu model. The critical temperature window is estimated by using known exact results for the specific heat and magnetization. This helps us to extract the universal ratio Γ_+/Γ_- of the susceptibility amplitudes. Such ratios have recently been determined numerically for the 2D q-state Potts model with $q = 2$, 3, and 4, where deviations from the theoretical predictions by Delfino and Cardy were found for $q = 4$. It was speculated that this deviation could be explained by the relatively strong multiplicative logarithmic corrections to the leading scaling behaviour. Since the Baxter-Wu model belongs to the same universality class as the 4-state Potts model, but does *not* exhibit logarithmic corrections, our results for the ratio Γ_+/Γ_- of the Baxter-Wu model shed some new light on this puzzle.

DY 14.5 Tue 15:15 MA 004

Critical Adsorption and Critical Casimir Force at Geometrically Structured Substrates — •Matthias Tröndle[1,2], Ludger Harnau[1,2], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart — [2]Universität Stuttgart, Institut für Theoretische und Angewandte Physik, Pfaffenwaldring 57, 70569 Stuttgart

We study the behavior of fluids close to geometrically structured substrates upon approaching a critical point at $T = T_C$ in their bulk phase diagram. The substrate surfaces are modeled by periodic arrays of wedges and ridges.

Guided by general scaling considerations we calculate, within the mean field approximation, the order parameter profiles of a fluid close to a single structured substrate for $T > T_C$, $T = T_C$, and $T < T_C$. Universal amplitudes for a suitably defined excess adsorption are discussed.

Universal scaling functions for forces between geometrically structured substrates mediated by critical fluids are calculated within mean field theory. Normal forces between flat and structured substrates as well as lateral forces between two identically structured substrates are studied.

DY 14.6 Tue 15:30 MA 004

Free energy barriers of spin glasses — Andreas Nussbaumer, •Elmar Bittner, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany

The Ising spin glass in the Sherrington-Kirkpatrick (SK) mean-field and the Edwards-Anderson (EA) nearest-neighbour formulations are investigated by means of Monte Carlo simulations. To this end, we employ a combination of the multioverlap algorithm with the parallel tempering method. We investigate the finite-size scaling behaviour of the free-energy barriers which are visible in the probability density of the Parisi overlap parameter. Assuming that the mean barrier height diverges with the number of spins N as N^α, our data for the SK model show good agreement with the theoretical value $\alpha = 1/3$. We compare the scaling behaviour to the data from the EA model.

DY 14.7 Tue 15:45 MA 004

Non-Fermi liquid regime in the 2D Hubbard model at weak-to-moderate coupling — •Hermann Freire[1], Eberth Correa[2], and Alvaro Ferraz[2] — [1]Max-Planck-Institute for Solid State Research, D-70569 Stuttgart, Germany — [2]International Center for Condensed Matter Physics, Universidade de Brasilia, Caixa Postal 04667, 70910-900 Brasilia-DF, Brazil

We analyze the two-dimensional Hubbard model on a square lattice at weak-to-moderate coupling by implementing the functional field-theoretical renormalization group (RG) up to two-loop order. This approach is essential to evaluate the effect of the anomalous dimension induced by interactions on the low-energy single-particle excitations. As a result, we find evidence of a non-Fermi liquid (NFL) regime near half-filling before the $d_{x^2-y^2}$-wave singlet superconducting instability becomes dominant. To characterize the nature of this NFL phase, we perform a systematic two-loop RG study of several susceptibilities of interest in the model.