DY 40 Statistical Physics (General) I

Zeit: Dienstag 10:00–13:00 Raum: TU H3010

Hauptvortrag DY 40.1 Di 10:00 TU H3010

Exploring Complex Dynamics with Transition Path Sampling — •Christoph Dellago — University of Vienna, Institute for Experimental Physics, Boltzmanngasse 5, A-1090 Vienna, Austria

Numerous processes occurring in complex systems are governed by rare but important dynamical trajectories. Examples include the nucleation of first order phase transitions, chemical reactions and transport in and on solids. Such processes can be studied with transition path sampling, a computational methodology capable of bridging the time scale gap arising in these systems. Within this perspective, ensembles of trajectories can be sampled and manipulated in close analogy to standard techniques of statistical mechanics. I will discuss the statistical view of dynamics underlying the method and then report on the application of transition path sampling to the calculation of equilibrium free energies from nonequilibrium transformations on the basis of Jarzynski's theorem.

DY 40.2 Di 10:30 TU H3010

Non equilibrium dynamics below the super-roughening transition — •Gregory Schehr and Heiko Rieger — Theoretische Physik Universitat des Saarlandes 66041 Saarbrucken

The non equilibrium relaxational dynamics of the solid on solid model on a disordered substrate and the Sine Gordon model with random phase shifts is studied numerically. Close to the super-roughening temperature T_g our results for the autocorrelations, spatial correlations and response function as well as for the fluctuation dissipation ratio (FDR) agree well with the prediction of a recent one loop RG calculation, whereas deep in the glassy low temperature phase substantial deviations occur. The change in the low temperature behavior of these quantities compared with the RG predictions is shown to be contained in a change of the functional temperature dependence of the dynamical exponent $z(T)$, which relates the age t of the system with a length scale $\mathcal{L}(t)$: $z(T)$ changes from a linear T-dependence close to T_g to a $1/T$-behavior far away from T_g. By identifying spatial domains as connected patches of the exactly computable ground states of the system we demonstrate that the growing length scale $\mathcal{L}(t)$ is the characteristic size of thermally fluctuating clusters around "typical" long-lived configurations.

DY 40.3 Di 10:45 TU H3010

The driven mathematical pendulum revisited: precision analysis of the stability — •C. Jung, S. Hankemeier, H. Hübener, A. Struck und B. Kramer — 1. Institut für theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg, Germany

The dynamics of the damped mathematical pendulum with a periodic driving force renders the important features in many even non-classical systems suchs as Josephson junctions or Bose-Einstein condensates. The nonlinear equation of motion reveals periodic and chaotic motion for different choices of parameters and initial conditions.

We investigate the stability of trajectories by integrating the equation of motion using highly accurate numerical algorithms. The dependence of the Lyapunov exponents on the damping constant and amplitude A and frequency ω of the driving force is systematically analyzed.

Regions of regular and chaotic motion are identified. We discuss a possible self-similar structure in a systematic map of Lyapunov exponents in the A-ω-plane.

DY 40.4 Di 11:00 TU H3010

Mechanism of spontaneous symmetry breaking in a driven system with short range interaction — •Gunter M. Schütz[1], Richard Willmann[1], and Stefan Grosskinsky[2] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich — [2]Zentrum Mathematik, TU München, 85747 Garching

A one-dimensional two-species model with short-range interaction driven by an external field is considered. Although the dynamics is symmetric with respect to the two species, the steady state has a region in parameter space with broken symmetry which has no analogue in thermal equilibrium. We determine the exact phase diagram and describe quantitatively the dynamics of symmetry breaking by amplification of fluctuations. Our results are confirmed by Monte-Carlo simulations.

DY 40.5 Di 11:15 TU H3010

Nonlinear Tikhonov regularization for inverse problems with random noise — •Nicolai Bissantz[1], Thorsten Hohage[2], and Axel Munk[1] — [1]Institut für Mathematische Stochastik der Universität Göttingen — [2]Institut für Numerische und Angewandte Mathematik der Universität Göttingen

We consider nonlinear statistical inverse problems described by operator equations $F(a) = u$. Here a is an element of a Hilbert space which we want to estimate, and u is an L^2-function. The given data consist of measurements of u at n points, perturbed by random noise. We construct an estimator $\hat{a}_n$ for a by a combination of a local polynomial estimator and a nonlinear Tikhonov regularization and establish consistency in the sense that the mean integrated square error $E|\hat{a}_n - a|^2$ (MISE) tends to 0 as $n \to \infty$ under reasonable assumptions. Moreover, if a satisfies a source condition, we show for $\hat{a}_n$ a convergence rate result for the MISE, as well as almost surely. Further, it is shown that a cross validated parameter selection yields a fully data driven consistent method for the reconstruction of a. Finally, the feasibility of our algorithm is investigated in a numerical study for a groundwater filtration problem and an inverse obstacle scattering problem.

DY 40.6 Di 11:30 TU H3010

Universal energy distribution for interfaces in a random field environment — •Semjon Stepanow and Andrei Fedorenko — Martin-Luther-Universität Halle, Fachbereich Physik, D-06099

We study the energy distribution function $\rho(E)$ for interfaces in a random field environment at zero temperature by summing the leading terms in the perturbation expansion of $\rho(E)$ in powers of the disorder strength, and by taking into account the non perturbational effects of the disorder using the functional renormalization group. We have found that the average and the variance of the energy for one-dimensional interface of length L behave as, $< E >\sim L \ln L$, $\Delta E \sim L$, while the distribution function of the energy tends for large L to the Gumbel distribution of the extreme value statistics. We have also computed the energy distribution in the presence of a constant driving force.

DY 40.7 Di 11:45 TU H3010

Test of Replica Theory: Thermodynamics of 2D systems with quenched disorder — •Thorsten Emig — Institut für Theoretische Physik, Universität zu Köln, Zülpicher Str. 77, 50937 Köln

The so-called replica trick is a common tool to study disordered systems like spin glasses or elastic objects in a random potential. It relies on assumptions as, e.g., the analyticity in the replica number, which in general are uncontrolled. Therefore it is important to study sufficient simple but generic model glasses for which the general concepts can be tested.

Here we provide one of the first detailed tests of replica theory. We study a planar lattice of elastic strings pinned by disorder and the random bond dimer model on a square lattice are examined. Whereas the first system can be studied by Replica Bethe ansatz, the latter system is studied numerically by a polynomial algorithm which circumvents slow glassy dynamics. A mapping between the two systems is established which allows for the detailed quantitaive comparison of the replica theory predictions to simulation data. Over a wide range of disorder strength excellent agreement for various thermodynamic quantities is found. Realizations of the studied models include vortex lattices in superconductors, domain walls in incommensurate systems, rough crystal surfaces or frustrated Ising spin systems.

[1] T. Emig and S. Bogner, Phys. Rev. Lett. 90, 185701 (2003). [2] T. Emig and M. Kardar, Nucl. Phys. B 604, 479 (2001).

DY 40.8 Di 12:00 TU H3010

Crystallization and glass transition in a hard-core lattice gas model — •Martin Weigt[1], Hendrik Hansen-Goos[2], and Alexander K. Hartmann[2] — [1]Institute for Scientific Interchange, Viale S. Severo 65, I-10133 Torino - Italy — [2]ITP, Uni Göttingen, F.-Hund-Platz 1, 37077 Göttingen

We introduce a hard-core lattice-gas model on generalized Bethe lattices and investigate its compaction behavior analytically via the cavity method and numerically via Monte-Carlo simulations. If compactified slowly, the system undergoes a first-order crystallization transition. If compactified much faster, the system stays in a meta-stable liquid state and undergoes a discontinuous glass transition under further compaction. We also find two additional, more exotic metastable phases, a so-called inverse crystalline and a crystalline glass phase.

DY 40.9 Di 12:15 TU H3010

Approximations to phase transition dynamics of a diluted system — •Hendrik Hansen-Goos[1] and Martin Weigt[2] — [1]Institut für Theoretische Physik, Universität Göttingen — [2]Institute for Scientific Interchange, Torino

The dynamics of systems close to liquid-crystalline or liquid-amorphous phase tansition points is studied within a Bethe lattice gas model. We approach the flow of macroscopic observables by a projective approximation scheme (PAS) based on the use of generalized Gibbs ensembles for selected sets of observables which allows for a treatment of non-equilibrium configurations under the restricting assumption of microscopic equipartition.

PAS is applied to a system in the coexistence regime of liquid and crystalline phases for different sets of observables. Comparison with MC-simulated data shows that even a minimal description yields qualitatively good approximations.

Furthermore, PAS correctly predicts the divergence of stuctural relaxation time at the spin-glass instability for a system with a continuous glass-transition. When going to more detailed observables, PAS can be applied with an additional simplification causing a loss of the criticality.

We can conclude that PAS, which can be connected with ideas of dynamical replica theory [1], offers a normalisation for the general procedure "approximation via rate-equations" as recently introduced for diluted spin-systems [2].

[1] S.N. Laughton, A.C.C. Coolen and D. Sherrington, J. Phys. A **29**, 763 (1996); [2] G. Semerjian and M. Weigt, J. Phys. A **37**, 5525 (2004).

DY 40.10 Di 12:30 TU H3010

$1/f^\alpha$ spectra in elementary cellular automata and fractal signals — •Jan Nagler[1] and Jens Christian Claussen[2] — [1]Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee, 28334 Bremen, Germany — [2]Institut für Theoretische Physik und Astrophysik, Universität Kiel, Leibnizstraße 15, 24098 Kiel, Germany

We systematically compute the power spectra of the one-dimensional elementary cellular automata introduced by Wolfram. On the one hand our analysis reveals that one automaton displays $1/f$ spectra though considered as trivial, and on the other that various automata classified as chaotic/complex display no $1/f$ spectra. We model the results generalizing the recently investigated Sierpinski signal to a class of fractal signals that are tailored to produce $1/f^\alpha$ spectra. Because of the widespread applications of (elementary) cellular automata our findings may be relevant in chemistry, physics and computer sciences.

DY 40.11 Di 12:45 TU H3010

Generation of spatiotemporal correlated noise in 1+1 dimensions — •Arne Traulsen[1], Karen Lippert[2], and Ulrich Behn[2] — [1]Institut für Theoretische Physik und Astrophysik, Christian Albrechts Universität Kiel, Leibnizstrasse 15, D-24098 Kiel — [2]Institut für Theoretische Physik, Universität Leipzig, Augustusplatz 10-11, D-04109 Leipzig

We propose a generalization of the Ornstein-Uhlenbeck process in 1+1 dimensions which is the product of a temporal Ornstein-Uhlenbeck process with a spatial one and has exponentially decaying autocorrelation factorizing into a spatial and a temporal part [A. Traulsen, K. Lippert, and U. Behn, Phys. Rev. E 69, 026116 (2004)]. The process is an alternative to a spatiotemporal correlated model process proposed in [J. García-Ojalvo et al., Phys. Rev. A 46, 4670 (1992)] for which we calculate explicitely the hitherto not known autocorrelation function in real space.