DY 6: Critical phenomena and phase transitions

Time: Monday 14:45–16:45 Location: ZEU 118

DY 6.1 Mon 14:45 ZEU 118

Exact solution of an Ising model with magnetic friction — •Alfred Hucht and Dietrich E. Wolf — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

A driven Ising model with friction due to magnetic correlations has recently been proposed by Kadau *et al.* [1]. The non-equilibrium phase transition present in this system is investigated in detail using Monte Carlo simulations and analytical methods. It turns out that in the limit of high driving velocities the model can be solved exactly for various geometries.

[1] D. Kadau, A. Hucht, and D. E. Wolf, Phys. Rev. Lett. **101**, 137205 (2008)

DY 6.2 Mon 15:00 ZEU 118

Exact ground states in 6d random-field Ising magnets — •Björn Ahrens and Alexander Karl Hartmann — Universität Oldenburg, Germany

We calculate exact ground states of random-field Ising magnets (RFIM) in 6 dimensions up to lattice sizes of $L = 10$. We calculate some critical exponents and compare them with previously obtained mean-field exponents.

The RFIM is a disordered system. It consists of ferromagnetically coupled Ising spins with an additional quenched local magnetic field. Here the field is Gaussian distributed with a fixed mean = 0 and a tuneable standard deviation.

To obtain a ground state of a realisation of the disorder we map the random field to a graph with suitible chosen edge capacities [Picard and Ratliff, 1975]. For these graphs we calculate the maximum flow using a fast max-flow/min-cut algorithm, recently developed in algorithmic graph theory. The minimum cut corresponds to a ground state configuration of the system. We can measure the bond energy, the magnetisation and the susceptibility by applying a small extern field . Using finite-size scaling we can calculate t he specific heat exponent α, the order parameter exponent β, the susceptibility exponent γ and the correlation length exponent ν. They are compared with the mean-field exponents of the RFIM, because $d_u \leq 6$ is the upper critical dimension [Tasaki, 1989] from which on the mean-field exponents should hold.

DY 6.3 Mon 15:15 ZEU 118

Multicanonical Monte Carlo study of the order-parameter distribution of the two-dimensional Ising model — •Anjan Prasad Gantapara[1] and Rudolf Hilfer[1,2] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Institute for Physics, University of Mainz, 55099 Mainz, Germany

The exact order parameter distributions are computed for the two dimensional Ising Model with various boundary conditions for finite lattice sizes up to 256 at temperatures above, below, and at the critical point. All the results are fully converged with respect to the number of Monte Carlo steps. For critical systems the approach to the Gaussian behavior is generally slow. For large system sizes the fat tails observed in Ref [1] are found to appear also for temperatures approaching critical point from below. The effect of the boundary conditions at criticality in the far tail regime are studied with high precision. Our results provide benchmarks for numerical and analytical studies. This study suggest that the critical order parameter distribution must be considered to be unknown at present.

[1]Hilfer R, Biswal B, Mattutis H G, and Janke W Phys. Rev. E 68,046123 (2003).

DY 6.4 Mon 15:30 ZEU 118

Cross-correlations in scaling analyses of phase transitions — •Martin Weigel[1] and Wolfhard Janke[2] — [1]Institut für Physik, KOMET 331, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Institut für Theoretische Physik and Centre for Theoretical Sciences (NTZ), Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

Thermal or finite-size scaling analyses of importance sampling Monte Carlo time series in the vicinity of phase transition points often combine different estimates for the same quantity, such as a critical exponent, with the intent to reduce statistical fluctuations. We point out that the origin of such estimates in the same time series results in often pronounced cross-correlations which are usually ignored even in high-precision studies, generically leading to significant underestimation of statistical fluctuations. We suggest to use a simple extension of the conventional analysis taking correlation effects into account, which leads to improved estimators with often substantially reduced statistical fluctuations at almost no extra cost in terms of computation time.

DY 6.5 Mon 15:45 ZEU 118

Probability density function at the 3D Anderson transition — •Louella J. Vasquez, Alberto Rodriguez, and Rudolf A. Roemer — Department of Physics and Centre for Scientific Computing, University of Warwick, CV47AL United Kingdom

The probability density function (PDF) for the wavefunction amplitudes is studied at the metal-insulator transition of the 3D Anderson model, for very large systems up to $L^3 = 240^3$. The implications of the multifractal nature of the state upon the PDF are presented in detail. A formal expression between the PDF and the singularity spectrum $f(\alpha)$ is given. The PDF can be easily used to carry out a numerical multifractal analysis and it appears as a valid alternative to the more usual approach based on the scaling law of the general inverse participation rations.

DY 6.6 Mon 16:00 ZEU 118

Monte-Carlo simulations of nucleation and phase transitions in small systems — •Manuel Schrader, Peter Virnau, and Kurt Binder — Institut für Physik, Johannes-Gutenberg-Universität Mainz, Staudingerweg 7, 55099 Mainz, Germany

Subcritical isotherms are obtained from grandcanonical Monte Carlo simulations of small systems inside the coexistence region. We observe sharp transitions from a homogeneous state to a droplet, a cylinder, and a slablike configuration with increasing density. The droplet phase is employed to investigate the free energy of a droplet as a function of its radius. Results agree well with a simple model derived from classical nucleation theory.

DY 6.7 Mon 16:15 ZEU 118

Polymer chains in confined geometries: massive field theory approach. — •Dirk Romeis[1] and Zoryana Usatenko[2] — [1]Leibniz-Institut fur Polymerforschung Dresden e.V., Germany — [2]Institute for Condensed Matter Physics, NASU, 79011 Lviv, Ukraine

The massive field theory approach at fixed space dimensions d=3 is applied to investigation of dilute solution of long- flexible polymer chains in a good solvent between two parallel repulsive walls, two inert walls and for the mixed case of one inert and one repulsive wall. The well known correspondence between the field theoretical ϕ^4 $O(n)$-vector model in the limit $n \to 0$ and the behavior of long-flexible polymer chains in a good solvent is used to calculate the depletion interaction potential and depletion force up to one-loop order. Our investigations include modification of renormalization scheme for the case of two inert walls. The obtained results confirm that the depletion interaction potential and the resulting depletion force between two parallel repulsive walls are weaker for chains with excluded volume interaction (EVI) than for ideal chains, because the EVI effectively reduces the depletion effect near the walls. Our results for two repulsive walls are in qualitative agreement with previous theoretical investigations [1], experimental results [2] and with results of Monte Carlo simulations [3]. [1].F.Schlesener,A.Hanke,R.Klimpel,and S.Dietrich, Phys.Rev.E **63**, 041803 (2001). [2]. D.Rudhardt, C.Bechinger, and P.Leiderer, Phys.Rev.Lett. **81**,1330 (1998). [3].H.-P.Hsu and P.Grassberger, J.Chem.Phys. **120**, 2034, 2004.

DY 6.8 Mon 16:30 ZEU 118

Capillary Condensation and Hysteresis in Porous Silicon: Network Effects within Independent Pores — Sergej Naumov[1], Alexey Khokhlov[1], •Rustem Valiullin[1], Jörg Kärger[1], and Peter A. Monson[2] — [1]Department of Interface Physics, University of Leipzig, D-04103 Leipzig, Germany — [2]Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003, USA

The ability to exert a significant degree of pore structure control in porous silicon materials has made them attractive materials for the experimental investigation of the relationship between pore structure, capillary condensation and hysteresis phenomena. Using both experimental measurements and a lattice gas model in mean field theory, we have investigated the role of pore size inhomogeneities and surface roughness on capillary condensation of N2 at 77 K in porous silicon with linear pores. Our results resolve some puzzling features of earlier experimental work. We find that this material has more in common with disordered materials such as Vycor glass than the idealized smooth-walled cylindrical pores discussed in the classical adsorption literature. We provide strong evidence that this behavior comes from the complexity of the processes within independent linear pores, arising from the pore size inhomogeneities along the pore axis, rather than from cooperative effects between different pores.