DY 20: Phase Transitions and Critical Phenomena I

Time: Wednesday 14:30–16:15 Location: H47

DY 20.1 Wed 14:30 H47

Monte Carlo simulations of the 3d-Ising model in cylindrical geometry — •Dorothea Wilms, Peter Virnau, and Kurt Binder — Johannes Gutenberg-Universität, Mainz

The three dimensional Ising model in cylindrical geometry can be regarded as a model system for the study of nanopores. As a quasi one dimensional system, it also exhibits a rather interesting "phase behavior": At low temperatures, the tube is either filled with liquid or gas and the densities are similar to those in the bulk. When we approach a "pseudo-critical point" (below the critical point of the bulk) several interfaces appear and the tube contains both liquid and gas phases. As expected, the transition depends on the size of the tube and occurs at lower temperatures for larger cylinders.

DY 20.2 Wed 14:45 H47

MC simulations regarding the melting transition in a 2d hard disc fluid — •Marc Radu[1] and Tanja Schilling[2] — [1]Johannes Gutenberg Universität, Mainz, Deutschland — [2]Université du Luxembourg, Luxembourg, Luxembourg

We present a computer simulation study on the two-dimensional hard disc fluid. We prepared configurations inside the liquid, the hexatic and the solid phase in which the particles were coupled to the sites of a triangular lattice via a harmonic potential. The spring constant was decreased so that we could observe transitions from a state with long-ranged positional and orientational order to the state with the particular ordering characteristic. We compared our results with recent experiments carried out using colloidal particles in an optical trap. Finally we calculated the defect free energies of dislocations by using an algorithm to compute free energies of disordered structures.

DY 20.3 Wed 15:00 H47

Free-energy barrier of the evaporation/condensation transition — •Elmar Bittner, Andreas Nussbaumer, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, D-04009 Leipzig, Germany

The formation and dissolution of equilibrium droplets at a first-order phase transition is one of the longstanding problems in statistical mechanics. Quantities of particular interest are the size and free energy of a "critical droplet" that needs to be formed before the decay of the metastable state via homogeneous nucleation can start. To study this phenomenon, we performed several Monte Carlo simulations of the 2D Ising model with nearest-neighbour couplings on a square lattice. By using Jarzynski's equality [Phys. Rev. Lett. 78, 2690 (1997)], we measured the free-energy barrier in a nonequilibrium setup and compare the data with results obtained by equilibrium simulation techniques.

DY 20.4 Wed 15:15 H47

Flat histogram Monte Carlo study of the order parameter distribution — •Anjan Prasad Gantapara[1], Wolfhard Janke[2], and Rudolf Hilfer[1,3] — [1]Institute for Computational Physics, University of Stuttgart, 70569 Stuttgart, Germany — [2]Institute for Theoretical Physics, University of Leipzig, D-04009 Leipzig, Germany — [3]Institute for Physics, University of Mainz, 55099 Mainz, Germany

The order parameter distribution of the two dimensional Ising model is studied using a flat histogram Monte Carlo method. Periodic, free and fixed boundary conditions are considered in our simulations. The effect of the boundary conditions on the order parameter distribution is studied at temperatures below, above, and at the critical point. These finite lattice size simulations corroborate some theoretically predicted results [1,2]. The accuracy of the Monte Carlo results is discussed by comparing them with exactly enumerated values for small lattice sizes.
[1] R. Hilfer and N. B. Wilding, Journal of Physics A: Mathematical and General **28**, L281 (1995).
[2] S. Shlosman, Communications in Mathematical Physics **125**, 81 (1989).

DY 20.5 Wed 15:30 H47

The thermodynamic Casimir effect in the neighbourhood of the λ-transition: A Monte Carlo study of an improved three-dimensional lattice model — •Martin Hasenbusch — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany

We discuss the thermodynamic Casimir effect in thin films in the three dimensional XY universality class. Based on the results of Monte Carlo simulations of an improved lattice model we compute the universal finite size scaling function θ that characterizes the behaviour of the thermodynamic Casimir force in the neighbourhood of the critical point. We discuss corrections to the universal finite size scaling behaviour. We compare with experiments on films of ^{4}He near the λ-transition, previous Monte Carlo simulations of the XY model on the simple cubic lattice and field-theoretic results.

DY 20.6 Wed 15:45 H47

Critical Casimir forces under external control — •Ursula Nellen[1], Laurent Helden[1], and Clemens Bechinger[1,2] — [1]2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart — [2]Max-Planck-Insitut für Metallforschung, Heisenbergstr. 3, 70563 Stuttgart

That a confinement of critical fluctuations exerts a force on the boundaries was predicted by Fisher and de Gennes in 1978. However the first direct measurement of these critical Casimir forces could be obtained only recently [1]. Beside their exquisite temperature dependence critical Casimir forces respond to external fields. Here we study the variety of control parameters opening up novel perspectives for e.g. self assembly of colloidal particles or microfluidic systems. Using total internal reflection microscopy (TIRM) we measure forces acting on a colloidal particle suspended in a critical water-2,6-lutidine mixture. We demonstrate how a continuous variation in the chemical surface properties changes amplitude and sign of the critical Casimir force [2]. From temperature scans the scaling behavior for weak surface fields can be extracted. In addition we explore how critical Casimir forces can be influenced by external electric fields.
[1] C. Hertlein et al., Nature 451 (2008) 172,
[2] U. Nellen et al., EPL 88 (2009) 26001

DY 20.7 Wed 16:00 H47

Critical exponents of the three-dimensional Anderson transition from multifractal analysis — •Louella Judy Vasquez[1], Alberto Rodriguez[1], Rudolf Römer[1], and Keith Slevin[2] — [1]Department of Physics and Centre for Scientific Computing, University of Warwick, Coventry CV47AL, United Kingdom — [2]Department of Physics, Graduate School of Science, Osaka University, 1-1 Machikaneyama, Toyonaka, Osaka 560-0043, Japan

We use high-precision, large system-size wavefunction data to analyse the scaling properties of the multifractal spectra around the disorder-induced three-dimensional Anderson transition in order to extract the critical exponent ν of the localisation length. We study the scaling law around the critical point of the generalized inverse participation ratios $P_q = \langle|\psi_i|\rangle^2$ and the singularity exponent α_0, defined as the position of the maximum of the multifractal spectrum, as functions of the degree of disorder, the system size, and the box-size used to coarse-grained the wavefunction amplitudes. The values of α_0 are calculated using a new method entirely based on the statistics of the wavefunction intensities [Phys. Rev. Lett. 102, 106406 (2009)]. Using finite size scaling analysis, we find agreement with the values of ν obtained from transfer matrix calculations.