DY 21: Finite size effects at phase transitions II (session accompanying the symposium of the same name)

Time: Wednesday 14:00–15:30 Location: H3

DY 21.1 Wed 14:00 H3

Nonequilibrium relaxation and critical Casimir forces — •Andrea Gambassi and Siegfried Dietrich — Max-Planck-Institut fuer Metallforschung, Heisenbergstrasse 3, 70569 Stuttgart and Institut fuer Theoretische und Angewandte Physik, Pfaffenwaldring 57, 70569 Stuttgart

Fluctuation-induced forces play a relevant role in the physics of soft matter. Among them, those induced by confined critical fluctuations (thermodynamic Casimir effect) are characterized by a certain degree of universality which makes them actually independent of many microscopic details of the specific system and therefore it allows for theoretical investigations in terms of simplified models. In this contribution we focus on some dynamical aspects of the thermodynamic Casimir effect and in particular on the way this force builds up in time when the fluctuating medium is rapidly quenched to its critical point.

DY 21.2 Wed 14:15 H3

On the breakdown of finite-size scaling in high dimensional periodical systems — •Alfred Hucht and Sven Lübeck — Theoretische Physik, Universität Duisburg-Essen, D-47048 Duisburg

Finite-size scaling functions of continuous phase transitions exhibit a scaling anomaly above the upper critical dimension d_c. This so-called breakdown of finite-size scaling is well-established on the basis of field theoretical and numerical approaches for system with periodic boundary conditions (BC), both in equilibrium (e.g. the Ising model) and non-equilibrium (e.g. directed percolation [1]). Less work was done for geometric phase transitions and for Dirichlet BC. Therefore, we numerically investigate the bond percolation transition in $2 \leq d \leq 10$ dimensions with various boundary conditions. For $d < d_c = 6$ the spatial correlation length is limited by the systems size at criticality for all BCs, whereas it exceeds the systems size in systems with periodic BC above d_c, the hallmark of the breakdown of finite-size scaling. We present, to our knowledge for the first time, a phenomenological and descriptive interpretation of this breakdown of finite-size scaling. Furthermore, we show that the high-dimensional behavior depends strongly on the boundary conditions.

[1] S. Lübeck and H.-K. Janssen, Phys. Rev. E 72, 016119 (2005)

DY 21.3 Wed 14:30 H3

High precision Monte Carlo analysis of tails for the order-parameter distribution of the two-dimensional Ising model — •Rudolf Hilfer[1], Bibudhananda Biswal[1], Hans-Georg Mattutis[2], and Wolfhard Janke[3] — [1]ICP, Universitaet Stuttgart, Pfaffenwaldring 27, 70569 Stuttgart, Germany — [2]Tokyo University of Electro-communications, Dept. of Mechanical and Control Engineering, Chofu, Tokyo 182-8585, Japan — [3]Institut für Theoretische Physik, Universität Leipzig, Augustusplatz 10/11, D-04109 Leipzig, Germany

The tails of the critical order-parameter distribution of the two-dimensional Ising model have been investigated through extensive multicanonical Monte Carlo simulation. Results for fixed boundary conditions are reported here, and compared with known results for periodic boundary conditions. Clear numerical evidence for "fat" stretched exponential tails exists below the critical temperature, indicating the possible presence of fat tails at the critical temperature. Our results suggest that, contrary to common belief, the true order parameter distribution at the critical temperature must be considered to be unknown at present.

DY 21.4 Wed 14:45 H3

Fisher renormalized exponents in an Ising fluid? — •Wolfgang Fenz[1], Reinhard Folk[1], Igor Mryglod[1,2], and Igor Omelyan[1,2] — [1]Institute for Theoretical Physics, Linz University, A-4040 Linz, Austria — [2]Institute for Condensed Matter Physics, 1 Svientsitskii Street, UA-79011 Lviv, Ukraine

We study the ferromagnetic order-disorder phase transition in Ising spin fluids with hard-core Yukawa interaction truncated at various cut-off radii r_c. We have performed extensive Monte Carlo simulations in the canonical ensemble at a fixed density, making use of the histogram reweighting technique and finite-size scaling methods. The system sizes range up to 10000 particles.

We focus our interest on the dependence of critical quantities such as the Binder cumulant and various exponent ratios on the value of r_c, and on the question whether the Fisher-renormalized exponents expected for these systems can be observed in the simulations. It turns out that the corrections to scaling decaying with a rather small exponent make it impossible to reach the asymptotic region with the limited computational power available. Thus, we observe only effective exponents, with different values depending on the chosen cut-off radius. The same dependence is also found for the critical Binder cumulant obtained with the crossing technique. Nevertheless, a closer investigation of γ_{eff} as a function of temperature seems to point towards a Fisher-renormalized asymptotic value.

Supported by the Austrian Fonds zur Förderung der wissenschaftlichen Forschung, project No P18592.

DY 21.5 Wed 15:00 H3

Finite-size effects on subcritical chemical potential isotherms in two- and three-dimensional square-well fluids — •Horst Vörtler[1], Katja Schäfer[1], and William Smith[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Germany — [2]Faculty of Science, UOIT Oshawa, Canada

We study the influence of system size on chemical potentials of bulk square-well fluids and planar square-well films under subcritical conditions over wide ranges of densities and particle numbers using canonical MC simulations with test particle insertions. In the range between the stable vapour and liquid densities we find van der Waals-like loops in the chemical potential isotherms which show distinct finite size effects. Similarly to recent findings (MacDowell et al., J. Chem. Phys. 120(2004)5293; 125(2006)034705) for bulk Lennard-Jones fluids we observe a significant shrinking of the van der Waals-like loops with increasing number of particles for both bulk fluids and planar monolayers. In the stable gaseous and liquid ranges the system size dependence is found to be quite weak. Estimating the vapour-liquid coexistence densities from the simulated chemical potential isotherms by integration via a Maxwell equal area rule (Vörtler, Smith, J. Chem. Phys. 112(2000)5168) we find for bulk fluids only weak finite size effects on the coexistence data and the obtained results are very close to the best-known literature data. In two-dimensional layers the size effects on the coexistence data are significantly larger than on bulk conditions.

DY 21.6 Wed 15:15 H3

Phase transitions of fluids in mesopores assessed by NMR — •Rustem Valiullin and Jörg Kärger — Department of Interface Physics, University of Leipzig, Germany

The adsorption hysteresis phenomenon is a classical example of a mesoscalic confinement effect upon macroscopical properties of fluids. It is suggested that the history-dependent character of the adsorbate accommodation in random nanoporous structures may result from a rugged free energy landscape with many local minima separated by free energy barriers. As it was inferred from computer simulation studies [1], activated crossing of these barriers leads to an extremely slow relaxation to the equilibrium state. In the present work, these predictions have been addressed experimentally using NMR methods. Based on a self-consistent set of experimental data provided by NMR, namely on adsorption kinetics and local self-diffusivities, the anomalously slow intra-pore density relaxation in mesoporous glasses with random porous structure has been proved in the hysteresis region [2]. At the same time, in the out-of-hysteresis region, as expected, the density relaxation has been measured to be diffusive. The observed slowing down of the density relaxation is discussed in the frame of a random field Ising model [3], which has been successfully used to describe critical phenomena of binary liquids in random glasses.

[1] H. J. Woo and P. A. Monson, Phys. Rev. E 67, 041207 (2003).
[2] R. Valiullin et al., Nature 443, 965 (2006).
[3] D. A. Huse, Phys. Rev. B 36, 5383 (1987).