DY 40 Critical Phenomena and Phase Transitions I

Time: Thursday 09:30–11:00 Room: HÜL 186

Invited Talk

DY 40.1 Thu 09:30 HÜL 186

Random polymers and depinning transitions — •Cecile Monthus and Thomas Garel — SPhT Saclay, France

According to recent progresses in the finite size scaling theory of disordered systems, thermodynamic observables are not self-averaging at critical points whenever disorder is relevant. This lack of self-averageness at criticality is directly related to the scaling properties of the probability distribution of pseudo-critical temperatures $T_c(i, L)$ over the ensemble of samples i of size L. This framework is very useful to characterize various depinning transitions involving random polymers:
(i) wetting transition in dimension $1 + 1$,
(ii) Poland-Scheraga model of DNA denaturation
(iii) the selective interface model.

DY 40.2 Thu 10:00 HÜL 186

On the breakdown of finite-size scaling in high dimensional 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, both in equilibrium (e.g. the Ising model, see [1] for an overview) and non-equilibrium (e.g. directed percolation [2]). Less work was done for geometric phase transitions and for Dirichlet boundary conditions. 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, whereas it exceeds the systems size 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] X. S. Chen and V. Dohm, Phys. Rev. E 63, 016113 (2000)
[2] S. Lübeck and H.-K. Janssen, Phys. Rev. E 72, 016119 (2005)

DY 40.3 Thu 10:15 HÜL 186

Finite-size behaviour of the microcanonical specific heat — •Hans Behringer[1] and Michel Pleimling[2] — [1]Fakultät für Physik, Universität Bielefeld, D-33615 Bielefeld — [2]Institut für Theoretische Physik I, Universität Erlangen-Nürnberg, D-91058 Erlangen

The basic quantity in the microcanonical approach to statistical properties of physical systems is the entropy $S(E) = \ln \Omega(E)$ where $\Omega(E)$ is the density of states as a function of the energy. The specific heat of the system is related to the inverse of the curvature of the entropy. The behaviour of the microcanonical specific heat of systems that undergo a continuous phase transition in the thermodynamic limit is investigated for finite systems. The numerical study of small Ising and Potts systems reveals a non-monotonic behaviour of the microcanonical specific heat as a function of the system size in contrast to a canonical treatment where the maximum of the specific heat increases monotonically with the system size. A general phenomenological theory is developed which permits a description of this peculiar behaviour of the microcanonical specific heat and allows in principle the determination of the microcanonical critical exponents from asymptotically large systems. In the case of the Baxter-Wu model the microcanonical analysis reveals a behaviour of the specific heat that suggests at first sight the appearance of a discontinuous phase transition in the infinite volume limit contrary to the known continuous character. However, the proposed phenomenological theory shows that this peculiar behaviour stems from a finite-size effect which disappears in the thermodynamic limit and therefore the observations are consistent with the continuous phase transition of in the Baxter-Wu model.

DY 40.4 Thu 10:30 HÜL 186

Critical Binder cumulant in two-dimensional Ising and Potts models — •Walter Selke[1], Lev N. Shchur[2], and Martin Holtschneider[1] — [1]Institut fuer Theoretische Physik, RWTH Aachen — [2]L.D. Landau Institute for Theoretical Physics, Chernogolovka, Russia

The Binder cumulant is known to be a very interesting quantity to characterize phase transitions. We report new results, using Monte Carlo techniques, on the value of that cumulant at the critical point, in particular in square lattice Ising (see W. Selke and L.N. Shchur, J. Phys. A 38, L739-L744 (2005)) and Potts models. The role of anisotropy, boundary condition, aspect ratio, and of the order of the phase transition is emphasized. Universal and nonuniversal features as analyzed recently by X. S. Chen and V. Dohm (Phys. Rev. E 70, 0566136 (2004)) are discussed.

DY 40.5 Thu 10:45 HÜL 186

Neutron optics of confined liquids near the critical point — •Alexander Chalyi[1], Leonid Bulavin[2], and Kyrylo Chalyy[3] — [1]Department of Physics, National Medical University, 13, Shevchenko Blvd., 01601 Kiev, Ukraine — [2]Department of Molecular Physics, Kiev Taras Shevchenko National University, 6, Acad. Glushkov Boulevard, 03022 Kiev, Ukraine — [3]Department of Medical Informatics, Kiev Medical Academy, 9, Dorogozhytska Str., 04112 Kiev, Ukraine

The neutron optics methods are applied to theoretical studies of the critical properties of confined liquids. In frame of this approach, analytical calculations are carried out for the density profile together with the neutron refractive index profile for non-uniform liquids at restricted geometry. Special attention is paid to gravity effects on properties of liquid systems. New results are obtained for the shifts of the critical temperature on the phase coexistence curve and positions of inflection points on the critical isotherm in confined liquids. The problem of propagation of the neutron beam in a non-uniform liquid at restricted geometry is solved. Special attention is paid to peculiarities of the refraction of neutrons due to the spatial limitation of a liquid system (namely, the corresponding formula for refractive angle of neutrons in finite-size individual and binary liquids are obtained and analyzed). The form of refractive index ellipsoid is studied and possible experimental consequences of neutron refraction in confined liquids are discussed. Dependence of the neutron propagation and elastic scattering in finite-size liquids on temperature (field) variables and geometrical factors is studied with confinement effects taken into account.