DY 42 Critical Phenomena and Phase Transitions II

Time: Thursday 11:00–13:00 Room: HÜL 186

DY 42.1 Thu 11:00 HÜL 186

Fortuin-Kasteleyn versus geometrical cluster — •Wolfhard Janke[1] and Adriaan M.J. Schakel[2] — [1]Institut für Theoretische Physik, Universität Leipzig, Augustusplatz 10/11, 04109 Leipzig — [2]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin

We discuss how suitably defined geometrical objects encode in their fractal structure thermal critical behaviour [1]. Emphasis will be placed on the two-dimensional Potts model for which two types of spin clusters can be defined. Whereas the Fortuin-Kasteleyn clusters describe the standard critical behaviour of the pure model, the geometrical clusters describe the tricritical behaviour that arises when including vacant sites in the pure Potts model. The close connection between the two models respectively the two cluster types can be explained by a "dual map" that conserves the central charge, so that both model/cluster types are in the same universality class. The geometrical picture is supported by Monte Carlo simulations.

[1] W. Janke and A.M.J. Schakel, Nucl. Phys. **B700**, 385 (2004); Phys. Rev. **E71**, 036703 (2005); Phys. Rev. Lett. **95**, 135702 (2005); and e-print cond-mat/0508734.

DY 42.2 Thu 11:15 HÜL 186

Casimir effect in the presence of van-der-Waals-type interactions: exact results for the spherical model with periodic boundary conditions — •Daniel Grüneberg[1], Daniel Dantchev[1,2], and H. W. Diehl[1] — [1]Fachbereich Physik, Universität Duisburg-Essen, D-45117 Essen, Germany — [2]Institute of Mechanics—BAS, Acad. G. Bonchev St. bl. 4, 1113 Sofia, Bulgaria

It is studied how the Casimir effect in d-dimensional slabs with $2 < d < 4$ and periodic boundary conditions is affected at and near the bulk critical temperature $T_{c,\infty}$ by long-range pair interactions whose potential decays as $bx^{-(d+\sigma)}$ as $x \to \infty$, with $2 < \sigma < 4$ and $2 < d + \sigma \leq 6$. While such interactions decay sufficiently fast to leave bulk critical exponents and other universal bulk quantities unchanged, they entail important modifications of the standard scaling behavior of the excess free energy and the Casimir force, and give algebraically decaying contributions that dominate the behavior of these quantities for $T \neq T_{c,\infty}$ as a function of the slab's thickness. An appropriate mean spherical model in a slab geometry with periodic boundary conditions is solved exactly. The scaling functions of the excess free energy and the Casimir force are determined, including the contributions to first order in the usual leading irrelevant scaling field g_ω and the scaling field g_σ to which the long-range interactions give rise. In the case $d + \sigma = 6$, which includes that of nonretarded van-der-Waals interactions in $d = 3$ dimensions, the power laws of the corrections to scaling $\propto b$ of the spherical model get modified by logarithms. The origin of these anomalies is clarified.

DY 42.3 Thu 11:30 HÜL 186

When topology triggers a phase transition — •Michael Kastner — Physikalisches Institut, Lehrstuhl für Theoretische Physik, Universität Bayreuth, 95440 Bayreuth

Two mathematical mechanisms, responsible for the generation of a thermodynamic singularity, are individuated. For a class of short-range, confining potentials, a topology change in some family of configuration space submanifolds is the only possible such mechanism. Two examples of systems in which the phase transition is *not* accompanied by such a topology change are discussed. The first one is a model with long-range interactions, namely the mean-field φ^4-model, the second example is a one-dimensional system with a non-confining potential energy function. For both these systems, the thermodynamic singularity is generated by a maximization over one variable (or one discrete index) of a smooth function, although the context in which the maximization occurs is very different.

DY 42.4 Thu 11:45 HÜL 186

Free-Energy Barriers in a Mean-Field Spin Glass — •Elmar Bittner and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig, Germany

The mean-field Sherrington-Kirkpatrick spin-glass model is investigated by means of Monte Carlo simulations employing multioverlap and parallel tempering methods. We investigate the finite-size scaling behaviour of the free-energy barriers which are visible in the probability density of the Parisi overlap parameter. Assuming that the mean barrier height diverges with the number of spins N as N^α, our data show good agreement with the theoretical value $\alpha = 1/3$. We also found that the free-energy barriers of the Sherrington-Kirkpatrick spin-glass model are non-self-averaging and distributed according to the Fréchet extremal value distribution.

DY 42.5 Thu 12:00 HÜL 186

Observation of the critical regime near Anderson localization of light — •Martin Störzer, Peter Gross, Christof Aegerter, and Georg Maret — Fachbereich Physik Universität Konstanz; Universitätstrasse 10; 78457 Konstanz

Diffusive transport is among the most common phenomena in nature. However, as predicted by Anderson, diffusion may break down due to interference. The transition from diffusive transport to localization of waves should occur for any type of classical or quantum wave in any media as long as the wavelength becomes comparable to the transport mean free path ℓ^*. The signatures of localization and those of absorption, or bound states, can however be similar, such that an unequivocal proof of the existence of wave localization in disordered bulk materials is still lacking. Here we present time resolved measurements of light transport through strongly scattering samples with $k\ell^*$ values as low as 2.5. In transmission, we observe deviations from diffusion which cannot be explained by absorption, sample geometry or reduction in transport velocity. Furthermore, the deviations from classical diffusion increase strongly with decreasing ℓ^* as expected for a phase transition. This constitutes an experimental realization of the critical regime in the approach to Anderson localization.

DY 42.6 Thu 12:15 HÜL 186

Numerical Results for the 3D Edwards-Anderson-Ising Model — •Andreas Nussbaumer, Elmar Bittner, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, Augustusplatz 10/11, 04109 Leipzig

We investigate the three-dimensional Edwards-Anderson-Ising model using a combination of the multicanonical method for the overlap parameter q (multi-overlap) with parallel tempering in temperature. To obtain the barrier heights in the overlap parameter q an effective one-dimensional Markov chain is constructed reproducing the distribution of q. From the eigenvalue spectrum of the resulting transition matrix the autocorrelation time can be calculated, leading to the sought barrier height [1].

The results for different temperatures well below the freezing point are compared to theoretical predictions ("replica" theory and "droplet" theory).

[1] B.A. Berg, A. Billoire, W. Janke, *Spin Glass Overlap Barriers in Three and Four Dimensions*, Phys. Rev. B **61** (2000) 12143.

Invited Talk

DY 42.7 Thu 12:30 HÜL 186

Universal scaling behavior of non-equilibrium phase transitions — •Sven Lübeck — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg

In contrast to equilibrium, a complete classification of the universal scaling behavior of non-equilibrium critical phenomena is still lacking. Thus the rich and often surprising variety of non-equilibrium phase transition has to be studied for each system individually. Here, we discuss the critical behavior of several systems exhibiting continuous phase transitions into absorbing states. By measuring certain universal scaling functions the systems can be grouped into universality classes, similar to equilibrium. It is the aim of this work to demonstrate the usefulness of universal scaling functions for the analysis non-equilibrium phase transitions. Determining the universal behavior it is often a more accurate test to consider scaling functions rather than the values of the critical exponents. While for the latter ones the variations between different universality classes are often tiny the scaling functions usually differ significantly. Additionally to the manifestation of universality classes, universal scaling functions are useful in order to check renormalization group results quantitatively.