DY 2: Statistical physics I (general)

Time: Monday 10:30–13:00 Location: MA 001

DY 2.1 Mon 10:30 MA 001

Variational Resummation of Effective Potential in Φ^4-Theory with Proper Goldstone Modes — •Sonja Overesch[1], Axel Pelster[2], and Hagen Kleinert[1] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

The Hartree-Fock-Bogoliubov approximation, which is very good for electrons, cannot be applied to a Bose gas in the condensed phase since it makes Goldstone modes massive. We investigate this problem within $O(N)$-symmetric Φ^4-Theory by performing a resummation of the renormalized two-loop effective potential in $D = 3$ dimensions by *Variational Perturbation Theory* (VPT). Using both a longitudinal and a transversal mass as two independent variational parameters, we obtain a resummed effective potential which preserves the Goldstone theorem. Since it takes simultaneously Hartree-, Fock-, and Bogoliubov channels into account, VPT can be regarded as a proper generalization of the Hubbard-Stratonovich transformation to all values of N.

DY 2.2 Mon 10:45 MA 001

Dynamics of the Bose-Einstein condensation: analogy with the collapse dynamics of a classical self-gravitating Brownian gas — •Julien Sopik[1], Clément Sire[2], and Pierre-Henri Chavanis[2] — [1]Jacobs University, Bremen, Germany — [2]Laboratoire de Physique Théorique, Toulouse, France

We investigate the dynamical properties in momentum space of the condensation of a gas of free bosons strongly coupled with a thermal bath. Since the temperature is kept fixed, we describe the Bose-Einstein condensation in the canonical ensemble. The dynamics of this condensation process exhibits striking analogies with the collapse dynamics of a self-gravitating Brownian system. We discuss these similarities and we compare our results with those of other works.

DY 2.3 Mon 11:00 MA 001

Comparison of arbitrary orthogonal, unitarily and unitary-symplectic invariant random matrix ensembles and supersymmetry — •Mario Kieburg and Thomas Guhr — University Duisburg-Essen, Faculty Physics, Theoretical Physics, research group Guhr

Supersymmetry is nowadays an indispensable tool for studies of models in mesoscopic physics and of random matrix models. It has been shown recently in [J.Phys. A39 (2006) 13191-13224] that the supersymmetry method can be generalized to arbitrary unitarily invariant random matrix ensembles. In this presentation we will extend this approach to the models of orthogonal and unitary-symplectic invariance. Connections and differences to the method of superbosonization presented in [arXiv:0707.2929v1, math-ph (2007)] will be discussed.

DY 2.4 Mon 11:15 MA 001

Untersuchungen über die inverse verallgemeinerte Mittag-Leffler-Funktion — •Thomas Müller[1] und Rudolf Hilfer[1,2] — [1]ICP, Universität Stuttgart, 70569 Stuttgart, Germany — [2]Institut für Physik, Universität Mainz, 55099 Mainz, Germany

Fraktionale Differenzialgleichungen gewinnen in der Physik zunehmend an Bedeutung, beispielsweise bei der Beschreibung von Relaxationsprozessen glasartiger Stoffe [1] oder in anomalen Diffusionsprozessen [2]. Hierbei spielt die verallgemeinerte Mittag-Leffler-Funktion eine herausragende Rolle, ähnlich der der Exponentialfunktion bei herkömmlichen Differenzialgleichungen. Sie wurde bereits in der Vergangenheit eingehend beschrieben und numerisch berechnet [3]. Nun wurde zum ersten Mal die inverse verallgemeinerte Mittag-Leffler-Funktion in der komplexen Ebene für verschiedene Parameter ausführlich untersucht, beschrieben und visualisiert. Es wurden die Haupt- und Nebenzweige sowie deren Schnitte und Verzweigungspunkte definiert.

[1] R. Hilfer, Chem. Phys., **284**, 399 (2002)
[2] R. Hilfer und L. Anton, Phys. Rev. E, **51**, 848 (1995)
[3] R. Hilfer und H.J. Seybold, Integral Transforms and Special Functions, **17**, 637 (2006)

DY 2.5 Mon 11:30 MA 001

The effect of shear flow on conductivity of polymer-carbon nanotube composites: an anisotropic percolation theory — •Fedor Semeriyanov, Marina Grenzer, and Gert Heinrich — Leibniz-Institut für Polymerforschung, Hohe Str. 6, D-01069 Dresden, Germany

In explaining the conductivity properties of carbon-nanotube (CNT) polymer composites the percolation approach looks the most suitable. The objective of the study is to investigate the effect of shear flow on formation of the percolating cluster of CNTs that spans in the direction of the preferred orientation. We consider a system of rods dispersed in a homogenous media in which the orientational order is induced by the shear flow. The problem is theoretically approached by a random contact model making use of a shear-dependent excluded volume per rod. The anisotropic percolation probability is calculated on Husimi cactus, an infinitely ramified fractal lattice. A detailed comparison of the results for conductivity to those for viscosity as a function of shear rate near percolation threshold is done, providing an insight into the role of orientational order.

DY 2.6 Mon 11:45 MA 001

Temperature-dependent self-avoiding walks on Sierpinski carpets — •Miriam Fritsche[1], H. Eduardo Roman[2], and Markus Porto[1] — [1]Institut für Festköperphysik, Technische Universität Darmstadt, Hochschulstr. 8, 64289 Darmstadt, Germany — [2]Dipartimento di Fisica, Universitá di Milano - Bicocca, Piazza della Scienza 3, 20126 Milano, Italia

Self-avoiding walks (SAWs) on fractal structures constitute a valuable model of polymers absorbed on a disordered surface and give intriguing insights in their statistical properties. We study the temperature-dependent structural behaviour of self-avoiding walks on two-dimensional Sierpienski carpets [1]. Thereby, the Sierpinski carpet defines two types of sites with energy 0 and $\epsilon > 0$, respectively, yielding a deterministic fractal energy landscape with 'infinite ramification'. In the limiting cases of temperature $T \to 0$ and $T \to \infty$, the known behaviours of SAWs on Sierpinsky carpets and on regular square lattices, respectively, are recovered. For finite temperatures, the structural behaviour is found to be intermediate between the two limiting cases. The characteristic exponents, however, display a non-trivial dependence on temperature.

[1] M. Fritsche, H.E. Roman, and M. Porto, Phys. Rev. E (in print)

DY 2.7 Mon 12:00 MA 001

Phase transitions from saddle points of the potential energy landscape — •Michael Kastner — Physikalisches Institut, Universität Bayreuth, 95440 Bayreuth

The relation between saddle points of the potentials of classical many-particle systems and the analyticity properties of thermodynamic functions is studied. For finite systems, each saddle point is found to cause a nonanalyticity in the entropy, and the functional form of this nonanalytic term can be derived explicitly. With increasing system size, the order of the nonanalytic term grows unboundedly, leading to an increasing differentiability of the entropy. Nonetheless, a distribution of an unboundedly growing number of saddle points may cause a phase transition in the thermodynamic limit. Analyzing the contribution of the saddle points to the density of states in the thermodynamic limit, conditions on the distribution of saddle points and their curvatures are derived which are necessary for a phase transition to occur. For several spin models, the absence or presence of a phase transition is predicted from saddle points and their local curvatures in microscopic(!) configuration space.

DY 2.8 Mon 12:15 MA 001

Adjusting dynamic material properties by a thermostat — •Christoph Junghans, Matej Praprotnik, and Kurt Kremer — Max-Planck-Institut für Polymerforschung, Ackermannweg 10, D-55128 Mainz, Germany

An advanced thermostat for molecular dynamics is proposed, which on the one side keeps the stabilizing and hydrodynamic properties, but on the other side allows to control the dynamic properties of the system. This extension of the dissipative particle dynamics thermostat [1] treats the friction for the transversal and longitudinal components of the relative velocities of interacting pairs separately and enables to adjust diffusion constant and shear viscosity to the desired value. Nu-

merical studies on Lennard-Jones fluid and the TIP3P water model show a very sensitive dependency of the viscosity and diffusion constant on the strength of the friction [2].

[1] T. Soddemann, B. Dünweg and K. Kremer, *Phys. Rev. E* **68**, 046702 (2003).
[2] C. Junghans, M. Praprotnik and K. Kremer, *Soft Matter* 2008, DOI:10.1039/b713568h.

Invited Talk DY 2.9 Mon 12:30 MA 001

New Results on Water in Bulk, Nanoconfined, and Biological Environments — •H. Eugene Stanley — Department of Physics, Boston University, Boston, MA 02215 USA

This talk will introduce some of the 63 unsolved mysteries of water, and will demonstrate some recent progress in solving them combining information provided by water in bulk, nanoconfined, and biological environments. In particular, we will present evidence from experiments designed to test the hypothesis that water displays "polymorphism" in that it can exist in two different phases. The concept of liquid polymorphism is also proving useful in understanding some of the anomalies of other liquids with local tetrahedral symmetry, such as silicon, silica, and carbon.

In particular, the talk will discuss changes in dynamic transport properties [1], and water in biological environments, including a possible physical explanation for the phenomenon known as the protein glass transition [2].

[1] P. Kumar, S. V. Buldyrev, S. L. Becker, P. H. Poole, F. W. Starr, and H. E. Stanley, "Relation between the Widom line and the Breakdown of the Stokes–Einstein Relation in Supercooled Water," Proc. Natl. Acad. Sci. USA 104, 9575-9579 (2007).

[2] P. Kumar, Z. Yan, L. Xu, M. G. Mazza, S. V. Buldyrev, S.-H. Chen. S. Sastry, and H. E. Stanley, "Glass Transition in Biomolecules and the Liquid-Liquid Critical Point of Water," Phys. Rev. Lett. 97, 177802 (2006).