DY 44: Statistical Physics (general)

Time: Thursday 10:00–12:15 Location: ZEU 147

DY 44.1 Thu 10:00 ZEU 147

Measurement of second-order response without perturbation — •Laurent Helden[1], Urna Basu[2], Matthias Krüger[3,4], and Clemens Bechinger[1,4] — [1]2. Physikalisches Institut, Universität Stuttgart, 70550 Stuttgart, Germany — [2]SISSA - International School for Advanced Studies and INFN, Trieste, Italy — [3]4th Institute for Theoretical Physics, Universität Stuttgart, Germany — [4]Max Planck Institute for Intelligent Systems, 70569 Stuttgart, Germany

We study the second order response functions of a colloidal particle being subjected to an anharmonic potential. Contrary to typical response measurements which require an external perturbation, here we experimentally demonstrate that the system's susceptibilities up to second order can be obtained from the particle's equilibrium fluctuations as theoretically outlined in [Basu et al. PCCP **17**, 6653 (2015)]. The measured susceptibilities are in quantitative agreement with those obtained from the response to an external perturbation.

DY 44.2 Thu 10:15 ZEU 147

Interface propagation in fiber bundles: Local, mean-field and intermediate range-dependent statistics — •Soumyajyoti Biswas[1] and Lucas Goehring[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Am Faßberg 17, 37077 Göttingen, Germany — [2]School of Science and Technology, Nottingham Trent University, Clifton Lane, Nottingham, NG 11 8NS, UK

The fiber bundle model is an array of elements that break when sufficient load is applied on them. With a local loading mechanism, this can serve as a model for a one-dimensional interface separating the broken and unbroken parts of a solid in mode-I fracture. The interface can propagate through the system depending on the loading rate and disorder present in the failure thresholds of the fibers. For quasistatic driving, the intermittent dynamics of the interface mimic front propagation in disordered media. Such situations appear in diverse systems such as crack propagation, magnetic domain walls, charge density waves, contact lines in wetting etc. We study the effect of the range of interaction, i.e. the neighborhood affected following a local perturbation, on the statistics of the intermittent dynamics of the front. There exists a crossover from local to global behavior as the range of interaction grows and a continuously varying universality in the intermediate range, implying that the interaction range is a relevant parameter here. This is interesting in view of the scatter in experimentally observed scaling exponents, in even idealized experiments on fracture fronts, and also a possibility in changing the interaction range in real samples.

DY 44.3 Thu 10:30 ZEU 147

Hyperuniformity of Quasicrystals — •Erdal C. Oğuz — School of Mechanical Engineering and The Sackler Center for Computational Molecular and Materials Science, Tel Aviv University, Israel

Density fluctuations in many-body systems are of fundamental importance throughout various scientific disciplines, including physics, materials science, number theory and biology. Hyperuniform systems, which include crystals and quasicrystals, have density fluctuations that are anomalously suppressed at long wavelengths compared to the fluctuations in typical disordered point distributions such as in ideal gases and liquids. Quantitatively speaking, hyperuniform systems are characterized by a local number variance of points within a spherical window of radius R that grows more slowly than the window volume in the large-R limit.

In this talk, we provide the first rigorous hyperuniformity analyses of quasicrystals by employing a new criterion for hyperuniformity to quantitatively characterize quasicrystalline point sets. We reveal that one-dimensional quasicrystals produced by projection from a two-dimensional lattice fall into two distinct classes with respect to their large-scale density fluctuations. Depending on the width of the projection window, the number variance is either uniformly bounded in the one class for large R, or it scales like $\ln R$ in the other class. This distinction provides a new classification of one-dimensional quasicrystalline systems and suggests that measures of hyperuniformity may define new classes of quasicrystals in higher dimensions as well.

DY 44.4 Thu 10:45 ZEU 147

Event-chain Monte Carlo algorithms for three- and many-particle interactions — •Tobias A. Kampmann[1], Julian Harland[1], Manon Michel[2,3], and Jan Kierfeld[1] — [1]TU Dortmund University, Dortmund, Germany — [2]Orange Labs, Chatillon, France — [3]Laboratoire de Physique Statistique, Paris, France

We generalize the rejection-free event-chain Monte Carlo algorithm from many particle systems with pairwise interactions to systems with arbitrary three- or many-particle interactions. We introduce generalized lifting probabilities between particles and obtain a general set of equations for lifting probabilities, the solution of which guarantees maximal global balance. We validate the resulting three-particle event-chain Monte Carlo algorithms on three different systems by comparison with conventional local Monte Carlo simulations: (i) a test system of three particles with a three-particle interaction that depends on the enclosed triangle area; (ii) a hard-needle system in two dimensions, where needle interactions constitute three-particle interactions of the needle end points; (iii) a semiflexible polymer chain with a bending energy, which constitutes a three-particle interaction of neighboring chain beads. The examples demonstrate that the generalization to many-particle interactions broadens the applicability of event-chain algorithms considerably.

DY 44.5 Thu 11:00 ZEU 147

On the influence of interaction softness on crystallization of soft particles in 2D: A systematic DFT study — •Alexander Kraft and Sabine H. L. Klapp — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin

We investigate a system of soft particles with varying steepness of the interaction potential in a 2D system within the framework of density functional theory (DFT) and dynamical density functional theory (DDFT). Depending on system parameters, we find a homogeneous fluid phase or crystallization. In contrast to previous studies on 3D systems [1,2], here we focus on a 2D system in order to gain access to the behaviour in flat geometries or on surfaces, which was started in Ref. [3,4]. Furthermore, we systematically study the influence of the steepness of the interaction potential. We compare calculations based on free minimization within DFT with estimates based on linear stability analysis of the fluid state, which yields good agreements for all steepness values. Furthermore, we investigate the crystal-liquid coexistence and discuss possible control strategies by external potentials or prestructured substrates on crystallization.

[1] A. A. Louis et al. **62**, 7961 (2000)

[2] A. J. Archer and R. Evans, Phys. Rev. E **64** (2001)

[3] S. Prestipino and F. Saija, J. Chem. Phys. **141**, 184502 (2014)

[4] A. J. Archer and A. Malijevský, J. Phys.: Condens. Matter **28**, 244017 (2016)

15 min. break

DY 44.6 Thu 11:30 ZEU 147

The microfoundation of deflation; simulations based on the Ising model in industrial networks — •Kei Murakami, Fujio Toriumi, and Hirotada Ohashi — The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan

Deflation, the phenomenon that the overall price level decreases with the negative inflation rate, is one of the most serious problems in modern economy, especially in Japan in these 20 years. It has been deeply discussed why deflation occurs and price levels fluctuate by using macroeconomic models, which describe macroscopic prices as the integrations of microscopic prices. However, these models generally fail to explain actual price fluctuations so far, and it might need to introduce perspectives of statistical physics including complex systems. This study attempts to reveal mechanisms of macroscopic price fluctuations in the framework of statistical physics considering interactions among microscopic prices. We make networks from actual data of industrial interrelationships in Japan and apply the ferromagnetic Ising model in them to deal with such interactions among price fluctuations of industries and to express the macroeconomic price index as well. The results show that under some parameters the phase transition occurs, and then most prices of industries decrease or increase all together. This phase transition can be considered as the indication of deflation or inflation. This study could provide new insights into the mechanisms of deflation and help make appropriate economic policies.

DY 44.7 Thu 11:45 ZEU 147

Domain wall dimers in a lattice of half vortices — •Beñat Mencia Uranga and Austen Lamacraft — Theory of condensed matter, University of Cambridge, UK

We study the thermodynamics of a lattice of half vortices and strings. The response of a superfluid to mechanical rotation demonstrates one of the most remarkable features of these systems. Rather than rotate like a classical fluid, a superfluid will instead nucleate quantised vortices which carry angular momentum. In the limit of many vortices, a vortex lattice will form. Depending on the type of superfluid and the experimental parameters, different kinds of vortices can be found as the equilibrium configuration of the rotating superfluid: integer vortices and half vortices. In the half vortex lattice with the presence of an easy-axis anisotropy, a state which is phenomenologically equivalent to having strings with finite tension pairing up half vortices arises. Hence, we develop a description of the system based on interacting point vortices and strings.

DY 44.8 Thu 12:00 ZEU 147

Statistics and dynamic in the cosmology — •Norbert Sadler — Wasserburger Str, 25a ; 85540 Haar

To understand and to evaluate the universe in its collective and complex codition methods of the statistic physics, of the exploraive factor analisis and the group theory, especial the exzeptional symmetry group E8 can be applied.

If the universe is considered as a closed thermodynamic system, the accessible Phase space volume and the entropy of the universe can be determined.

Results: The accessible phase space volume is 5/6. The non-accessible phase space volume is therfore 1/6 and corresponds to the dark matter and the dark energy. The entropy of the Universe S(Univ.)=-(5/6)x log(5/6)=0.066.

Further Information: www.cosmology-harmonices-mundi.com