DY 16: Statistical Physics 3 - organized by Barbara Drossel (Darmstadt), Sabine Klapp (Berlin) and Thomas Speck (Mainz)

Time: Monday 16:30–17:50 Location: DYb

DY 16.1 Mon 16:30 DYb

Aging in the Long-Range Ising Model — •Henrik Christiansen[1], Suman Majumder[1], Malte Henkel[2,3,4], and Wolfhard Janke[1] — [1]Institut für Theoretische Physik, Universität Leipzig, IPF 231101, 04081 Leipzig, Germany — [2]Laboratoire de Physique et Chimie Théoriques (CNRS UMR 7019), Université de Lorraine Nancy, 54506 Vandœuvre-lès-Nancy Cedex, France — [3]Centro de Física Teórica e Computacional, Universidade de Lisboa, 1749-016 Lisboa, Portugal — [4]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Straße 38, 01187 Dresden, Germany

The current understanding of aging phenomena is mainly confined to the study of systems with short-ranged interactions. Little is known about the aging of long-ranged systems. Here, the aging in the phase-ordering kinetics of the two-dimensional Ising model with power-law long-range interactions is studied via Monte Carlo simulations. The dynamical scaling of the two-time spin-spin autocorrelator is well described by simple aging for all interaction ranges studied. The autocorrelation exponents are consistent with $\lambda = 1.25$ in the effectively short-range regime, while for stronger long-range interactions the data are consistent with $\lambda = d/2 = 1$. For very long-ranged interactions, strong finite-size effects are observed. We discuss whether such finite-size effects could be misinterpreted phenomenologically as sub-aging.

[1] H Christiansen, S Majumder, W Janke, Phys. Rev. E 99, 011301(R) (2019)
[2] H Christiansen, S Majumder, M Henkel, W Janke, Phys. Rev. Lett. 125, 180601 (2020)

DY 16.2 Mon 16:50 DYb

Ageing and linear response in a mean field elastoplastic model — •Jack T. Parley[1], Suzanne M. Fielding[2], and Peter Sollich[1,3] — [1]Institut für Theoretische Physik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Science Laboratories, Department of Physics, Durham University, South Road, Durham DH1 3LE, United Kingdom — [3]Department of Mathematics, King's College London, London WC2R 2LS, United Kingdom

Elastoplastic descriptions, based on the alternating elastic/plastic deformation of mesoscopic regions, provide key insights into the complex dynamics of athermal amorphous solids. These systems have recently also been found to display non-trivial ageing dynamics, driven by plastic events and the ensuing Eshelby (quadrupolar) stress redistribution. Here we construct a mean-field elastoplastic model for studying time-dependent perturbations and ageing dynamics, building on the work of Lin and Wyart (2016) for steady shear. Local stresses are driven by power-law distributed mechanical noise, characterised by the exponent μ. We study the ageing behaviour in the glassy regime, where the form of the yield rate decay varies for different values of the exponent μ, reflecting the relative importance of far-field and near-field events as the range of the stress propagator is varied. Moreover, a comparison of the mean-field predictions with ageing simulations of a lattice elastoplastic model shows excellent agreement. Finally, we obtain expressions for the linear stress response in the ageing regime, which will allow to test the theoretical predictions against stress measurements from experiments or simulations of model athermal systems.

DY 16.3 Mon 17:10 DYb

Evaluation of memory effects at phase transitions — •Hugues Meyer — Department of Theoretical Physics and Center for Biophysics, Universität des Saarlandes, Saarbrücken, Germany

Modeling the dynamics of order parameters at phase transitions is often done in terms of stochastic equations of motion but there is to this day no consensus about a systematic strategy to tackle this problem. In particular, the detailed structure of the equations that needs to be used is still debated. Motivated by recent works on crystal nucleation, we propose to describe the dynamics of phase transitions in terms of a non-stationary Generalized Langevin Equation for the order parameter. By construction, this equation is non-local in time, i.e. it involves memory effects whose intensity is governed by a memory kernel. Here we do not aim at investigating the physical origin of memory effects at phase transitions in general, but rather to relate the extent of the memory kernel to quantities that are experimentally observed such as the induction time and the duration of the phase transformation process. Using a simple kinematic model and a recently developed numerical procedure, we show that the extent of the memory kernel is positively correlated with the duration of the transition and of the same order of magnitude, while the distribution of induction times does not have an effect. This theoretical observation is finally tested at the example of several model systems.

DY 16.4 Mon 17:30 DYb

Emergent memory and kinetic hysteresis in strongly driven networks — •David Hartich and Aljaz Godec — MPI BPC, Göttingen, Germany

Stochastic network-dynamics are typically assumed to be memoryless. Involving prolonged dwells interrupted by instantaneous transitions between nodes such Markov networks stand as a coarse-graining paradigm for chemical reactions, gene expression, molecular machines, spreading of diseases, protein dynamics, diffusion in energy landscapes, epigenetics and many others. However, as soon as transitions cease to be negligibly short, as often observed in experiments, the dynamics develops a memory. That is, state-changes depend not only on the present state but also on the past. Here, we establish the first thermodynamically consistent mapping of continuous dynamics onto a network, which reveals ingrained dynamical symmetries and an unforeseen kinetic hysteresis [1]. These symmetries impose three independent sources of fluctuations in state-to-state kinetics that determine the 'flavor of memory'. The hysteresis between the forward/backward in time coarse-graining of continuous trajectories implies a paradigm shift for the thermodynamics of active molecular processes beyond the assumption of local detailed balance. Our results provide a new understanding of fluctuations in the operation of molecular machines as well as catch-bonds involved in cellular adhesion.

[1] DH, A Godec, arXiv:2011.04628 (2020).