DY 43: Poster: Statistical Physics

Time: Wednesday 15:00–18:00 Location: P5

DY 43.1 Wed 15:00 P5

Extended classical nucleation theory for active phase separation in the reversed Ostwald regime — •Wanja Becker[1], Cesare Nardini[2,3], and Michael te Vrugt[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55128 Mainz, Germany — [2]Service de Physique de l'Etat Condensé, CEA, CNRS Université Paris-Saclay, CEA-Saclay, 91191 Gif-sur-Yvette, France — [3]Sorbonne Université, CNRS, Laboratoire de Physique Théorique de la Matière Condensée, 75005 Paris, France

Classical nucleation theory (CNT) is a model to describe how rare fluctuations lead to nucleation and thus describes the kinetics of phase transitions. In Ref. [1], CNT was extended to describe phase separation in Active Model B+ - a scalar field theory for active matter - for the case of positive active surface tension. Here, we further extend the theory to be applicable for negative active surface tensions. In this regime a stable fixed-point radius is expected to be found. Droplets smaller than this radius grow and droplets larger than this radius shrink, i.e. reverse Ostwald ripening. In Ref. [1], the theory was formulated by expanding the order parameter in powers of 1/R, up to order 1/R. Here, terms of order 1/R^2 are included to describe nucleation for negative surface tension. In doing this the effective potential acquires an additional linear contribution. We calculate the prefactor of the linear contribution numerically to determine whether it suffices to capture the nucleation of droplets at negative surface tension that afterwards grow by reversed Ostwald processes.

[1] M. E. Cates and C. Nardini, Phys. Rev. Lett. 130, 098203 (2023)

DY 43.2 Wed 15:00 P5

Classical fractionally charged quasiparticles in kagome lattices and at interfaces — •Jannis Waldmann, Malte Grunert, and Erich Runge — Theoretical Physics I, Institute of Physics, Technische Universität Ilmenau, 98693 Ilmenau, Germany

Interacting systems of charged particles can show fractionally charged excitations, as is well known from the Fractional Quantum Hall Effect of electrons in a magnetic field. Fractionally charged excitations have also been predicted in the absence of magnetic fields for certain lattices with geometric frustrations, e.g., for quantum mechanical models of spinless fermions on the criss-crossed checkerboard lattice [1,2]. Here, we present results on the transport properties of classical particles with nearest-neighbor repulsion on a kagome lattice including Andreev-like reflection at interfaces between frustrated and 'normal', i.e., non-frustrated matter. This involves a coupling between kagome lattice and an infinite particle reservoir via transport channels. Through kinetic Monte Carlo simulations, we study the transition from classical hopping at high temperatures and electric fields to transport dominated by half-charged quasiparticles at low temperatures and special filling factors.

[1] P. Fulde et al., Ann. Phys. 514, 892-900 (2002)
[2] F. Pollmann et al., J. Magn. Magn. Mat. 310, 966-968 (2007)

DY 43.3 Wed 15:00 P5

Non-markovian master equation for Thioacetylacetone Coupled to bosonic bath — •Zahra Sartipi[2], Richard Gundermann[1], Janet Anders[2,3], and Peter Saalfrank[1] — [1]University of Potsdam, Institute of Chemistry, Theoretical Chemistry, Karl-Liebknecht-Str. 24-25, D-14476 Potsdam, Germany — [2]University of Potsdam, Institute of Physics and Astronomy, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany — [3]Physics and Astronomy, University of Exeter, Exeter EX4 4QL, United Kingdom

The Canonically Consistent Quantum Master Equation (CCQME) is used to address intramolec-ular proton transfer in thioacetylacetone , with an N -level quantum system coupled to an organic solvent. In this setup, the solvent is modeled as a harmonic bath (a continuum of oscillators) characterized by a Drude-cutoff Ohmic spectral density.

The results highlight that while the Redfield and CCQME (canonical consistent quantum master equation) approaches agree in the weak-coupling regime, they diverge at stronger couplings. Redfield incorrectly drives the system toward the canonical Gibbs state of the bare system Hamiltonian, neglecting the influence of correlations, and may thus yield thermodynamically inconsistent predictions. By contrast, CCQME incorporates the bath's effect on the system's energy landscape, ensuring relaxation toward the correct mean-force Gibbs state. This guarantees both positivity and consistency with statistical mechanics, even at stronger coupling.

DY 43.4 Wed 15:00 P5

An O(logN) Kinetic Monte Carlo Algorithm for Transport Simulation with Long-Range Interactions — •Bat-Amgalan Bat-Erdene, Roya Ebrahimi Viand, Karsten Reuter, and Sebastian Matera — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin

When transport is controlled by activated events, kinetic Monte Carlo (kMC) simulation is the method of choice. However, a characteristic of charge transport is the presence of long-range Coulomb interactions, leading to a complexity of $O(N)$ in the system size N for the updates of the transition rates. In contrast, kMC with only short-range interactions can be made to scale as $O(\log N)$ per step, and thus Coulomb interactions cause a significant computational overhead. We address this issue by a novel time discretization approach. Starting with exact values for the rates, the approach conducts fast incremental updates ($O(\log N)$) in every step based on a truncated short-range potential. Inevitably, this leads to a deviation of the rates from their true values as simulation proceeds. Therefore, a full $O(N \log N)$ recalculation is conducted once every $O(N)$ steps, resulting in an average cost of $O(\log N)$ per step. We demonstrate the scheme for charge transport on a cubic lattice using our in-house kMC framework. Special emphasis is placed on the balance between discretization error and efficiency, as well as the influence of the truncation radius on both.

DY 43.5 Wed 15:00 P5

Quantifying stochastic resonance in bistable systems: a new measure based on passive observation — •Christian Muñoz[1], Bart Vos[1], Till Münker[1], Dorian Marx[1], Matthias Krüger[2], and Timo Betz[1] — [1]Third Institute of Physics - Biophysics, Georg August University Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Theoretische Physik, Georg August University Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Stochastic resonance (SR) is a noise-assisted phenomenon of broad relevance whose complexity motivates its study in simple and controllable systems. In this work, SR is investigated using a single Brownian particle confined in a bistable potential created with optical tweezers. In such a system, SR emerges from the interplay between thermal fluctuations and the periodic modulation of the potential landscape. First, several well-established approaches from literature are revised to determine under which conditions SR is enhanced. In particular, the strength of the first peak of the residence time distribution displays a clear maximum. Additionally, we propose a new protocol to quantify SR based on the novel quantity of the mean back relaxation (MBR). The new quantifier, which measures the amplitude of the oscillations that MBR displays, shows quantitative agreement with the average work done by the system. Our findings may provide a new approach for analyzing the stochastic energetics of a system by mere passive observation.

DY 43.6 Wed 15:00 P5

Random Organization in a Many-Body Reaction System — •Mishael Derla and Michael Schmiedeberg — Soft Matter Theory Group, Theoretical Physics: Lab for Emergent Phenomena, Friedrich-Alexander-Universität Erlangen-Nürnberg, 91058 Erlangen

Random organization refers to certain simplified simulation protocols of the reversibility-irreversibility transition in sheared colloid suspensions. It displays an absorbing state transition believed to be in the conserved directed percolation universality class. We present a related analytical time-continuous many-body reaction-diffusion model. It features two species of spherical grains (of diameter σ): diffusing active grains A (with diffusion constant D), and motionless inactive grains I. A spontaneously decay $A \to I$ with rate μ and overlapping grains react with $A + I \to 2A$ and $I + I \to 2A$, respectively at rate λ. When $\lambda \gg \mu \gg D\sigma^{-2}$ overlapping grains are almost certainly active and non-overlapping ones almost certainly inactive and hence a time-continuous (or small step-size) version of random-organization is recovered.

DY 43.7 Wed 15:00 P5

Stochastic Simulation Algorithm for Spatiotemporal Chemical Master Equations — •Fatemeh Tavakkoli, Roya Ebrahimi Viand, Bat-Amalgam Bat-Erdene, Karsten Reuter, and Sebastian Matera — Fritz-Haber-Institut der MPG, Berlin

Spatiotemporal chemical master equations (SCME) have a number of applications ranging from biochemistry to sociodynamics, and have gained interest in mathematical physics. Describing high-dimensional Markov jump processes, SCMEs are typically not solvable, neither analytically nor numerically, but need to be addressed by stochastic simulation using kinetic Monte Carlo methods. We present a software framework for this purpose based on the Berlin Extended Stochastic Simulation Software (BeESSS). A simple to use Python frontend allows to define an SCME model and the software generates efficient backend C++ code (controllable by the Python frontend). The sparse nature of BeESSS allows to exploit the local nature of SCMEs where space is decomposed into compartments and only neighboring compartments interact. We demonstrate the tool on Lottka-Volterra-type predator-prey models and use it to evaluate the time complexity and memory limitations of our simulation approach.

DY 43.8 Wed 15:00 P5

Bottom-Up DPD Thermostat Parameterization for Coarse-Grained Molecular Liquids — •Karan Venkatesh and Nico F. A. van der Vegt — Technische Universität Darmstadt

Coarse-grained (CG) models substantially accelerate molecular dynamics simulations but often yield dynamical properties that diverge from those of fine-grained (FG) systems. We introduce a dynamic coarse-graining framework that bottom-up parameterizes a Markovian Dissipative Particle Dynamics (DPD) thermostat in conjunction with a CG model of liquid cyclohexane, enabling more consistent reproduction of FG dynamical behavior. We determine the Markovian friction for the DPD thermostat by extracting its distance dependence from the fluctuations of pair forces measured in the FG simulations. The resulting distance-dependent friction is subsequently scaled by an amplitude optimized through an iterative procedure to match the long-time diffusion coefficient[1]. Compared to standard DPD[2], our bottom-up parameterized model significantly improves the reproduction of velocity autocorrelation functions (VACFs) on all time scales. It also yields a closer match to the frequency-dependent viscosity. Overall, this method offers a physically grounded, systematic route to parameterizing DPD thermostats for molecular liquids, preserving the efficiency of single-site coarse-graining while delivering improved dynamics across all time scales.

[1] V. Klippenstein; N F A van der Vegt; J. Chem. Theory Comput. 2023, 19(4), 1099-1110. [2] C. Junghans; M. Praprotnik; K. Kremer; Soft Matter 2008, 4(1), 156-161.

DY 43.9 Wed 15:00 P5

Reduction of interaction order in hard combinatorial optimization through conditionally independent degrees of freedom — •Alexandru Ciobanu[1], David Dahmen[1], John Paul Strachan[2], and Moritz Helias[1] — [1]Forschungszentrum Jülich, Jülich, Germany — [2]Peter Grünberg Institut (PGI-14), Aachen, Germany

Combinatorial optimization problems have a broad range of applications and map to physical systems with complex dynamics. Among them, the 3-SAT problem is prominent due to its NP-complete nature. In physics terms, its solution corresponds to finding the ground state of a disordered Ising spin Hamiltonian with third-order, or tensor, interactions. The large growth of the number of third-order interactions with number of variables poses technical difficulties for the physical implementation of minimizers. In this work, we employ the renormalization group to create a pairwise interacting system from the original third-order system while preserving the free energy. Our procedure utilizes additional degrees of freedom that now exhibit conditional independence. A step-wise trace of the extra variables while running the minimization is therefore computable, yielding a state-dependent effective interaction. We use the effective interaction to reconstruct the original third-order energy spectrum.

DY 43.10 Wed 15:00 P5

From Gradients to Flux: Towards A General Strategy for Non-Equilibrium Molecular Dynamics Simulations — •Daniel Padilla-González, Diego Veloza-Diaz, Mauricio Sevilla, Kurt Kremer, and Robinson Cortes-Huerto — Max Planck Institute for Polymer Research, Mainz, Germany

The numerical simulation of molecular systems under external gradients is crucial for understanding processes in which local solvation and diffusion play a central role, common to applications in nanofluidics and biological transport. Few computational methods can handle the stationary non-equilibrium, open-boundary conditions present in reality while consistently sampling the grand canonical (GC) ensemble in equilibrium. The Hamiltonian Adaptive resolution simulation (AdResS) provides a framework for this purpose by coupling a fully atomistic region to a coarse-grained reservoir that acts as a thermodynamic bath. AdResS can be combined with particle insertion (PI) steps [1] to reproduce GC conditions and to impose controlled gradients by connecting the atomistic region to multiple reservoirs at different state points [2]. This strategy enables the study of non-equilibrium situations in which particle fluxes appear across the system. In this project, by considering simple liquids and mixtures, we aim to evaluate the applicability of the AdResS+PI methodology to the study of stationary flows generated by temperature, density, and concentration gradients.

[1] J. Chem. Phys. 162, 080901 (2025)
[2] J. Chem. Phys. 152, 194104 (2020)

DY 43.11 Wed 15:00 P5

Coexistence in chemically driven mixtures — •Ellen Meyberg[1], Joshua Robinson[2,3], and Thomas Speck[1] — [1]Institute for Theoretical Physics IV, University of Stuttgart, Stuttgart, Germany — [2]STFC Hartree Centre, Sci-Tech Daresbury, Warrington, United Kingdom — [3]H. H. Wills Physics Laboratory, University of Bristol, United Kingdom

Underlying virtually any biological function is the organization of proteins and other molecules in time and space. A current challenge in statistical physics is to uncover universal principles governing the self-organization of macromolecules in crowded environments and driven away from equilibrium. Usually, Ostwald ripening leads to the macroscopic phase separation. In contrast, aggregates of proteins in living cells typically show "size control" and are stable over an extended time without coarsening, which can be rationalized in terms of reverse Ostwald ripening. We study a thermodynamically consistent, chemically driven two component reaction-diffusion system in which particles of one species attract each other. Combining insights from stochastic thermodynamics and active field theories, we aim to understand how phase coexistence is modified by the chemical activity.

DY 43.12 Wed 15:00 P5

Coarsening in the $1D$ XY model with long-range interactions — •Dustin Warkotsch, Fabio Müller, and Wolfhard Janke — Institut für Theoretische Physik, Universität Leipzig, 04103 Leipzig, Germany

We investigate the phase-ordering kinetics of the $1D$ XY model with long-range interactions using a simplified version of the recently established fast, hierarchical Metropolis algorithm. Owing to the sparse predictions concerning the nonequilibrium dynamics of this model in one dimension, we seek to close this gap via Monte Carlo simulations with our highly efficient method. Regarding the scaling behavior of correlation function $C(r,t)$, the structure factor $S(k,t)$ and the characteristic length scale $\ell(t)$, we find consistent behavior for all studied growth exponents $\sigma \leq 1$.

DY 43.13 Wed 15:00 P5

Strong coupling phases of conserved growth models are crumpled — •Debayan Jana and Abhik Basu — Saha Institute of Nuclear Physics (SINP), Kolkata, India

We show that stochastically driven nonequilibrium conserved growth models admit generic strong coupling phases for sufficiently strong nonlocal chemical potentials underlying the dynamics. The models exhibit generic roughening transitions between perturbatively accessible weak coupling phases satisfying an exact relation between the scaling exponents in all dimensions d, and strong coupling phases. In dimensions below the critical dimension d_c, the latter phases are unstable and argued to be crumpled, and thus distinct from the well-known strong coupling rough phase of the Kardar-Parisi-Zhang equation in dimensions $d \geq 2$. At d_c, conventional spatio-temporal scaling in the weak coupling phase is logarithmically modulated and are exactly obtained.

DY 43.14 Wed 15:00 P5

Universality of shocks in conserved driven single-file motion with bottlenecks — •Sourav Pal and Abhik Basu — Theory Division, Saha Institute of Nuclear Physics, a CI of Homi Bhabha National

Institute, Kolkata, India

Driven single-file motion, in which particles move unidirectionally along one-dimensional channels, sets the paradigm for wide variety of one-dimensional directed movements, ranging from intracellular transport and urban traffic to ant trails and controlled robot swarms. Motivated by the phenomenology of these systems in closed geometries, regulated by number conservation and bottlenecks, we explore the domain walls (DWs) or shocks in a conceptual one-dimensional cellular automaton with a fixed particle number and a bottleneck. For high entry and exit rates of the cellular automaton, and with sufficiently large particle numbers, the DWs formed are independent of the associated rate parameters, revealing *universality* in their *shapes*, which are however enclosed by nonuniversal boundary layers. In contrast, the DWs do depend upon these parameters, if they are small, and hence have nonuniversal shapes, but without boundary layers. Nonuniversal delocalized DWs can be formed by additional tuning of the control parameters. Experimental verification of our theoretical predictions can be performed via high-resolution ribosome profiling on mRNA loops with slow codons, or video imaging of vehicular flow, ant trails, and robotic swarms on confined tracks.

DY 43.15 Wed 15:00 P5

Dynamics of dense phase separation — •Bibhut Sahoo[1] and Peter Sollich[1,2] — [1]Institut für Theoretische Physik, Georg-August-Universität Göttingen, 37077 Göttingen — [2]Department of Mathematics, King's College London, London

Phase separation in mixtures is a ubiquitous phenomenon in nature. In dense systems, it involves an intriguing interplay of phase separation dynamics with slowing down due to crowding effects. We investigate such systems by encoding the approach to dynamic arrest in the kinetic coefficient at the level of a continuum description. We predict the phase behaviour of such kinetically constrained multicomponent mixtures, including density and composition of both mobile and arrested phases, using a suitable constrained free energy minimization. We probe the coarsening dynamics numerically and find, for the baseline one-component case, a crossover between two distinct domain growth power laws. For binary mixtures with three equilibrium phases (one gas and two demixed liquids), we see a Warren-like scenario where collective diffusion first leads to gas-liquid phase separation without fractionation, before the mixture components eventually start to demix. Surprisingly, this demixing dynamics is interface-induced, i.e. it begins at the interfaces of the initial gas-liquid domains. We rationalize this by controlled numerical experiments starting from constrained (without demixing) gas-liquid equilibria and by theoretical analysis of the local spinodal growth rates.

DY 43.16 Wed 15:00 P5

Linear coupling reduces entropy production in nonequilibrium multicomponent systems — •Vansh Kharbanda[1,2], Anton Burnet[1,2], and Benedikt Sabass[1,2] — [1]Faculty of Physics and Center for NanoScience, Ludwig-Maximilians-Universität München, 80752 Munich, Germany — [2]Fakultät Physik, Technische Universität Dortmund, 44227 Dortmund, Germany

Many biological and synthetic systems operate far from equilibrium and pay an energetic cost quantified by the steady-state entropy production rate (EPR). We investigate how linear coupling between subsystems modifies this dissipation in a class of Hurwitz-stable Langevin dynamics. For networks of diffusively coupled Ornstein-Uhlenbeck processes, we derive closed-form expressions for the EPR of n-coupled two-dimensional units and show that any attractive symmetric coupling reduces the EPR, which monotonically approaches the single-unit value in the strong-coupling limit. This behaviour is traced to a suppression of probability currents, driving the collective closer to detailed balance. We then generalize to higher dimensions and arbitrary symmetric coupling topologies and conjecture a structural criterion: commuting coupling and diffusion matrices together with negative semidefinite coupling are sufficient for a monotonic EPR decrease. Violating this criterion generates mismatch-induced irreversible currents, which can increase EPR. Finally, we illustrate this mechanism in nonlinear biological models of bacterial chemotaxis and inner-ear hair bundles, where coupling substantially lowers dissipation without hindering performance metrics.

DY 43.17 Wed 15:00 P5

Energetics of coupled stochastic circular limit-cycle oscillators — •Anton Francis Burnet[1,2], Vansh Kharbanda[1,2], David Tobias[1], and Benedikt Sabass[3,1,2] — [1]Faculty of Physics and Center for NanoScience, Ludwig-Maximilians-Universität München, 80752 Munich, Germany — [2]Department of Veterinary Sciences, Ludwig-Maximilians-Universität München, 80752 Munich, Germany — [3]Fakultät Physik, Technische Universität Dortmund, 44227 Dortmund, Germany

Stochastic oscillations serve important functions in many biological systems, including hair-cell bundles of the inner ear and neuronal activity. Sustaining coherent cycles in noisy environments requires continuous energy dissipation, quantified by the steady-state entropy production rate (EPR). We study an idealized, analytically tractable model of a stochastic circular limit cycle and examine how mutual diffusive coupling in pairs and populations alters dissipation. Three factors contribute to the EPR: intrinsic frequency asynchrony, tangential velocity fluctuations, and mean tangential velocity. The dynamics are characterized by an effective temperature, which depends on diffusion and intrinsic relaxation timescales. For radial (amplitude), phase (Kuramoto-like), and Cartesian couplings, we derive analytical expressions for the EPR and confirm them numerically. Varying the effective temperature and system size strongly influences how the EPR depends on coupling strength and, in some cases, results in qualitatively distinct behaviors. Moreover, the coupling types affect the tangential velocity distributions differently.

DY 43.18 Wed 15:00 P5

Localized Driving of the Jamming Transition in a Quasi-2D Colloidal Platform — •Jordan D. Groh, Timo Betz, and Bart Vos — Drittes Physikalisches Institut, Göttingen, Deutschland

The jamming transition marks the abrupt emergence of rigidity when a dense assembly of particles is compressed beyond a critical packing fraction. Decades of experiments and simulations have identified its static signatures, a sharp rise of the shear modulus and contact-network percolation, for globally driven systems. What remains largely unexplored is how a jammed material reacts to localized perturbations and whether they can steer the system into new metastable states.

We therefore construct a reproducible quasi-2D colloidal chamber that confines a binary mixture of polyacrylamide hydrogel beads (elastic stress sensors) and polystyrene beads (optically addressable active centres). A small fraction of temperature-responsive pNIPAm beads allows us to tune the effective packing fraction; cooling below the LCST swells them, thereby raising the global packing fraction with high precision. High-speed confocal microscopy provides particle trajectories, from which we locate the jamming point and perform contact-network analysis.

The platform enables calibrated optical forces on single beads and local heating-induced volume changes, yielding full spatiotemporal maps of displacement and stress fields. This testbed will allow us to map a local-driving jamming phase diagram, study force-propagation lengths, and ultimately design amorphous metamaterials with programmable mechanical heterogeneity.

DY 43.19 Wed 15:00 P5

Critical behaviour of ferroelectrics with divergence-free polarization — •Svitlana Kondovych[1], Asle Sudbø[2], and Flavio S. Nogueira[1] — [1]Institute for Theoretical Solid State Physics, Leibniz Institute for Solid State and Materials Research Dresden, Helmholzstr. 20, D-01069 Dresden, Germany — [2]Center for Quantum Spintronics, Department of Physics, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

Unconventional phase transitions often display unusually large anomalous dimensions, often attributed to fractionalization and emergent gauge fields [1]. Here we show that similar behaviour can arise without fractionalization when the order parameter is constrained to be divergence-free, as occurs in ferroelectrics where the polarization $\vec{P}$ remains locally charge-neutral, div$\vec{P}$=0 [2]. This constraint forces polarization into loop-like textures and reshapes the critical behaviour.

Our analysis reveals a new universality class in which internal symmetry becomes intrinsically linked to spatial dimensionality [3]. The resulting critical point exhibits strongly enhanced fluctuations and a remarkably large anomalous dimension. These findings show that conventional ferroic materials can exhibit non-Landau criticality driven by local conservation laws. This reveals a new conceptual pathway for unconventional critical phenomena and suggests nanoscale ferroelectrics as experimentally accessible platform for exploring these ideas.

[1] T. Senthil, et al., Science 303:1490 (2004). [2] I. A. Lukyanchuk, et al., Phys. Rep. 1110:1 (2025). [3] S. Kondovych, A. Sudbø, F. S. Nogueira, arXiv:2510.13960 (2025).

DY 43.20 Wed 15:00 P5

Nonequilibrium phase transition in single-file transport at high crowding — •Annika Vonhusen[1], Sören Schweers[1], Artem Ryabov[2], and Philipp Maass[1] — [1]Universität Osnabrück, Institut für Physik, Germany — [2]Charles University, Faculty of Mathematics and Physics, Czech Republic

In driven single-file Brownian motion across periodic energy landscapes, fast particle transport can occur for potential barriers orders of magnitude larger than the thermal energy. The fast transport is mediated by solitary cluster waves forming at high crowding of interacting particles [1]. Cluster waves were first predicted theoretically for hard spheres [2] and shortly after confirmed in experiments [3]. Here we show that persistent cluster wave propagation sets in at a critical density and gives rise to a nonequilibrium phase transition that manifests itself in a singular point of the current-density relation [4]. The critical density varies in a complex manner with the particle size and temperature, which can be understood from a simple geometric principle.

[1] A. P. Antonov, A. Vonhusen, A. Ryabov, P. Maass, Nonlinear Dyn. 113, 31529 (2025).
[2] A. P. Antonov, A. Ryabov, P. Maass, Phys. Rev. Lett. 129, 080601 (2022).
[3] E. Cereceda-López, A. P. Antonov, A. Ryabov, P. Maass, and P. Tierno, Nat. Commun. 14, 6448 (2023).
[4] A. Vonhusen, S. Schweers, A. Ryabov, P. Maass, arXiv:2511.16234 (2025), to appear in Chaos.

DY 43.21 Wed 15:00 P5

Sampling of ground states for the bimodal random-field Ising model — •Jana Lukin, Tony Albers, and Martin Weigel — Institut für Physik, TU Chemnitz, 09107 Chemnitz, Germany

The Gaussian random-field Ising model (RFIM) is well understood, largely because its ground state is non-degenerate and can therefore be computed efficiently using polynomial-time optimization methods. In contrast, the bimodal RFIM exhibits degenerate ground states, which has hindered precise numerical investigations of its critical behavior. Here, we introduce a perturbation to lift this degeneracy. This approach enables the application of a max-flow algorithm to obtain exact ground states and thereby allows a more accurate characterization of the phase transition in the bimodal RFIM.

DY 43.22 Wed 15:00 P5

Critical behaviour of non-reciprocal Ising models — •Max Haessler and Martin Weigel — TU Chemnitz Institut für Physik, Chemnitz, Germany

Equilibrium statistical physics is based on symmetric, Hamiltonian interactions fulfilling Newton*s Third Law. On the other hand, active matter like bacteria or bird flocks, predator-prey relations in nature and social systems violate time-reversal symmetry due to non-reciprocal interactions, hence they are non-equilibrium systems.

We try to investigate the fundamental mechanisms that govern such systems by investigating non-reciprocal modifications of the Ising model.

We especially focus on investigating the impact of the non-reciprocal interactions on the critical behaviour of those models.

DY 43.23 Wed 15:00 P5

Analysis of phase transitions in the random-field Blume-Capel model via exact ground state calculations — •Tony Albers, David Müller-Bender, and Martin Weigel — Institute of Physics, Chemnitz University of Technology, Chemnitz, Germany

The random-field Blume-Capel model is a generalization of the well-known Ising model, where spin variables can take three values (-1,0,1) corresponding to three orientations of the spins with respect to an external field. We perform exact ground-state calculations of this 3-label problem using a suitable transformation to a 2-label problem [1] and an advanced graph-cut method called generic cuts [2]. The obtained ground states can be used to study phase transitions in dependence on the zero-field splitting parameter and the strength of the random field resulting in a phase diagram which is compared to the one obtained by a mean-field approximation [3]. Preliminary results suggest the presence of first- and second-order phase transitions. With the help of a finite-size scaling analysis, we obtain a set of critical exponents for the latter and compare them with the exponents of related universality classes.

[1] C. Arora and S. N. Maheshwari, 2014 IEEE Conf. Comput. Vis. Pattern Recognit., 1346 (2014)
[2] C. Arora, S. Banerjee, P. K. Kalra, and S. N. Maheshwari, IEEE Trans. Pattern Anal. Mach. Intell. 37, 1323 (2015)
[3] S. Mukherjee and Sumedha, J. Stat. Phys. 188, 22 (2022)

DY 43.24 Wed 15:00 P5

Shear-driven diffusion process and its generalizations — •Trifce Sandev — Macedonian Academy of Sciences and Arts, Skopje, Macedonia — Ss. Cyril and Methodius University in Skopje, Macedonia — Korea University, Seoul, Korea

We consider different generalizations of the shear-driven diffusion process, which represents a two-dimensional Brownian motion in presence of a linear shear flow. One possible generalization is the shear-driven anomalous diffusion motion which occurs due to the long-tailed waiting time of the particle, effect described by a two-dimensional Fokker-Planck equation with memory kernel. Another possible generalization is the shear-driven finite-velocity diffusion, that is a shear-driven motion, but now, at random times, the walker changes its direction to the opposite one. The corresponding process can be described by a two-dimensional telegrapher's-like equation. We also explore the corresponding processes under stochastic resetting and find that the systems reach non-equilibrium stationary states in the long time limit that also result in saturation of the evolution of the corresponding mean squared displacement, variance, skewness and kurtosis.