DY 32: Posters DY - Statistical Physics, Brownian Motion and Nonlinear Dynamics

Time: Tuesday 16:30–19:00 Location: DYp

DY 32.1 Tue 16:30 DYp

Jarzynski equality for conditional stochastic work — •Akira Sone[1] and Sebastian Deffner[2] — [1]Aliro Technologies, Inc, Boston, MA 02135, USA — [2]University of Maryland, Baltimore County, Baltimore, Maryland 21250, USA

We present our recent work on the fluctuation theorems of conditional stochastic work for classical Hamiltonian dynamics. The notion of conditional stochastic work is inspired by the one-time measurement paradigm, and built upon the change of energy expectation value, which is conditioned on the surface of the initial energy. This notion leads to the generalized Jarzynski equality and a modified second law of thermodynamics, whose sharper bound characterizes the adiabaticity of the thermodynamic process of interest.

DY 32.2 Tue 16:30 DYp

Anharmonic lattice dynamics in large thermodynamic ensembles with machine-learning force fields: the breakdown of the phonon quasipartic le picture in CsPbBr3 — •Jonathan Lahnsteiner and Menno Bokdam — University of Twente, Enschede, Netherlands

The harmonic approximation is a very powerful method for describing phonon dispersion relations. However, when the temperature is raised and the potential energy landscape exhibits more anharmonicity, the approximation fails to capture all crystal lattice dynamics properly. Here we study, for the first time, the phonon dispersion of a complex "Dynamic Solid" with machine-learning force fields, by simulating the dynamic structure factor (DSF) S(q,omega) and the projected velocity autocorrelation function (PVACF) trough large-scale molecular dynamics. These force fields have near first-principles accuracy and the linear scaling computational cost of classical potentials. To asses the strengths and weaknesses of the three methods we start with an analysis based on the classical Morse potential. Hereafter, the methods are applied to the inorganic perovskite: CsPbBr3. This perovskite serves as an archetypal example of a wider class of novel perovskite solar-cell materials. Imaginary modes in the harmonic picture of the CsPbBr3 structure are absent in the calculated DSF and PVACF, indicating a dynamic stabilization of the crystal. The anharmonic nature of the potential and the presence of rattling Cs+ cations, result in the breakdown of the phonon quasi-particle picture.

DY 32.3 Tue 16:30 DYp

Long-range correlations in musical time-series? — •Corentin Nelias and Theo Geisel — MPI for Dynamics and Self-Organization, Goettingen, Germany

Musical pitch time-series seem to present long-range correlations reflected in 1/f-type power-spectral densities. The existence, nature, and shape of these correlations have remained unclear as conflicting results were reported in the literature. The present work is clarifying the existing controversy by a careful analysis of power-spectral densities on a corpus 256 compositions and improvised pieces. Generally we do find 1/f-type spectra, but they show up on limited spectral scales only, corresponding to time scales typically up to a few musical bars.

DY 32.4 Tue 16:30 DYp

Voltage Dynamics in Power Grids — •Hannes Vogel — Stockholm University, Stockholm, Sweden

Understanding the stability of voltage dynamics in power grids is essential to the development of decentralized power networks for renewable energy sources. Current voltage dynamics models are motivated by physics and control theory. We formulate the power grid dynamics in terms of complex voltages, which combine the dynamics of rotor angle, frequency and voltage amplitude. To get a better overview of the properties of different models and to find criteria for classification, a common general formulation is needed.

Indeed, such a formulation is obtained by writing the differential equations in a complex power series. Therefore, the mathematical structure of the Stuart-Landau equation functions as a prototype.

DY 32.5 Tue 16:30 DYp

Satellite instability in Passively Mode-Locked Integrated External-Cavity Surface Emitting Lasers — Christian Schelte[1,2], •Denis Hessel[2], Julien Javaloyes[1], and Svetlana Gurevich[2,3] — [1]Departament de Física, Universitat de les Illes Balears & Institute of Applied Computing and Community Code (IAC-3), Cra. de Valldemossa, km 7.5, E-07122 Palma de Mallorca, Spain — [2]Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Str. 9, D-48149 Münster, Germany — [3]Center for Nonlinear Science (CeNoS), University of Münster, Corrensstrasse 2, D-48149 Münster, Germany

We are interested in a pulse instability appearing in passively modelocked integrated external-cavity surface-emitting lasers (MIXSELs) modelled by delayed algebraic differential equations (DADEs). The micro-cavity geometry induces third order dispersion (TOD) that can lead to a train of satellites on the leading edge of a pulse. We show that those can become unstable due to carrier interaction. The resulting limit cycle is born in a global bifurcation of the saddle-node infinite period (SNIPER) type and exhibits behavior characteristic of excitable systems.

DY 32.6 Tue 16:30 DYp

Spectral theory of fluctuations in time-average statistical mechanics of reversible and driven systems — •Alessio Lapolla, David Hartich, and Aljaz Godec — Mathematical BioPhysics group, Max Plack Institute for Biophysical Chemistry, Goettingen, Germany

Time-averaged observables are one of the building blocks for the analysis of both theoretical and experimental systems. We present a spectral-theoretic approach to derive exact results for the mean, fluctuations, and correlations of time-average observables for ergodic stochastic processes, with continuous or discrete dynamics and with reversible or irreversible dynamics. The emergence of the universal central limit law is shown explicitly on large- deviation timescales. Our results are directly applicable to a diverse range of phenomena underpinned by time-average observables and additive functionals in physical, chemical, biological, and economical systems.

[1] Alessio Lapolla, David Hartich, and Aljaž Godec Phys. Rev. Research 2, 043084 (2020)

DY 32.7 Tue 16:30 DYp

Near and far field of coupled microresonators — •Julia Unterhinninghofen and Lasse Rosskamp — Hochschule Koblenz, Konradd-Zuse-Str. 1, 56075 Koblenz

Wavelength-scale microresonators have various applications as sensors, in nonlinear optics, as filters and micro-laser cavities. Multiple interference effects can be seen in microresonator ensembles, both concerning the far (change in far field emission directions, directional emission [1]) and the near field (formation of new cavity modes [2,3]). We compare microresonator arrays of different geometries and their far field emission properties both in a wave and a ray model as well as the near field of strongly coupled ensembles. The effects of surface roughness on the near and far fields is also investigated.

[1] J. Kreismann et al., Superdirectional light emission and emission reversal from microcavity arrays, Phys. Rev. Research 1 (2019) [2] J. Unterhinninghofen et al., Interplay of Goos-Hänchen shift and boundary curvature in deformed microdisks, Phys. Rev. E 82 (2010) [3] J.-W. Ryu et al., Abnormal high-Q modes of coupled stadium-shaped microcavities, Opt. Lett. 39 (2014)

DY 32.8 Tue 16:30 DYp

Critical exponent ν of the Ising model in three dimensions with long-range correlated site disorder analyzed with Monte Carlo techniques — •Stanislav Kazmin[1,2] and Wolfhard Janke[2] — [1]Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany — [2]Universität Leipzig, Institute for Theoretical Physics, Leipzig, Germany

We study the critical behavior of the Ising model in three dimensions on a lattice with site disorder by using Monte Carlo simulations [1]. The disorder is either uncorrelated or long-range correlated with correlation function that decays according to a power law r^{-a}. We derive the critical exponent of the correlation length ν and the confluent correction exponent ω in dependence of a by combining different concentrations of defects $0.05 \leq p_d \leq 0.4$ into one global fit ansatz and applying finite-size scaling techniques. We simulate and study a wide range of different correlation exponents $1.5 \leq a \leq 3.5$ as well as the uncorrelated case $a = \infty$ and are able to provide a comprehensive picture not yet known from previous works. Additionally, we perform a dedicated analysis of our long-range correlated disorder ensembles and provide estimates for the critical temperatures of the system in dependence of the correlation exponent a and the concentrations of defects p_d. We compare our results to known results from other works and to the conjecture of Weinrib and Halperin: $\nu = 2/a$ and discuss the occurring deviations.

[1] S. Kazmin and W. Janke, Phys. Rev. B 102, 174206 (2020)

DY 32.9 Tue 16:30 DYp

Haldane Insulator in the 1D Nearest-Neighbor Extended Bose-Hubbard Model with Cavity-Mediated Long-Range Interactions — •Johannes Sicks and Heiko Rieger — Theoretical Physics, Saarland University, Campus E2.6, 66123 Saarbrücken, Germany

In the one-dimensional Bose-Hubbard model with on-site and nearest neighbor interactions, a gapped phase characterized by an exotic nonlocal order parameter emerges, the Haldane insulator. Bose- Hubbard models with cavity-mediated global range interactions display phase diagrams, which are very similar to those with nearest neighbor repulsive interactions, but the Haldane phase remains elusive there. Here we study the one-dimensional Bose-Hubbard model with nearest-neighbor and cavity-mediated global- range interactions and scrutinize the existence of a Haldane Insulator phase. With the help of extensive quantum Monte-Carlo simulations we find that in the Bose-Hubbard model with only cavity-mediated global-range interactions no Haldane phase exists. For a combination of both interactions, the Haldane Insulator phase shrinks rapidly with increasing strength of the cavity-mediated global-range interactions. Thus, in spite of the otherwise very similar behavior the mean-field like cavity-mediated interactions strongly suppress the non-local order favored by nearest neighbor repulsion in some regions of the phase diagram.

DY 32.10 Tue 16:30 DYp

Depinning of confined colloidal dispersions under oscillatory shear — •Marcel Hülsberg and Sabine H.L. Klapp — ITP, Technische Universität Berlin, Germany

Strongly confined colloidal dispersions under shear exhibit a variety of dynamical phenomena, including a depinning transition similar to single particles that are driven over a periodic substrate potential [1]. Here, we investigate the depinning behavior of these systems under pure oscillatory shearing with shear rate $\dot{\gamma}(t) = \dot{\gamma}_0 \cos(\omega t)$, as it is a common scenario in rheological experiments [2]. The colloid's depinning behavior is assessed from a microscopic level based on particle trajectories, which are obtained from overdamped Brownian Dynamics simulations. The numerical approach is complemented by an analytic one based on a single-particle model in the limit of weak driving. We determine the frequency-dependent critical shear rate amplitude $\dot{\gamma}_{0,crit}(\omega)$, which marks the onset of the depinning transition. Furthermore, we identify the dominant system-intrinsic time scale that dictates the scaling behavior of $\dot{\gamma}_{0,crit}$ with driving frequency ω. Finally, we discuss potential consequences of the depinning behavior on the system's rheological properties [2].

[1] S. Gerloff and S.H.L. Klapp, Phys. Rev. E **94**(6), 062605 (2016)
[2] J.M. Brader, et al., Phys. Rev. E **82**(6), 061401 (2010)

DY 32.11 Tue 16:30 DYp

Subharmonic oscillations in stochastic systems under periodic driving — •Lukas Oberreiter[1], Andre Cardoso Barato[2], and Udo Seifert[1] — [1]II. Institut für Theoretische Physik, Universität Stuttgart, 70550 Stuttgart, Germany — [2]Department of Physics, University of Houston, Houston, Texas 77204, USA

We investigate the conditions under which subharmonic oscillations can persist for a long time in open systems with stochastic dynamics due to thermal fluctuations. In contrast to stochastic autonomous systems in a stationary state, for which the number of coherent oscillations is fundamentally bounded by the number of states in the underlying network [1], we demonstrate that in periodically driven systems, subharmonic oscillations can in principle remain coherent forever, even in networks with a small number of states [2]. By interpreting our finite state model as a single subharmonically oscillating spin, we construct an interacting spin system [3]. The mean-field model displays the phenomenon of subharmonic synchronization, which corresponds to collective subharmonic oscillations of the individual units. The 2D model does not display synchronization but it does show a time-crystalline phase, which is characterized by a power-law behavior of the number of coherent subharmonic oscillations with system size.

[1] A. C. Barato and U. Seifert *Phys. Rev. E* **95**, 062409, (2017)
[2] L. Oberreiter, U. Seifert, and A. C. Barato *Phys. Rev. E* **100**, 012135, (2019)
[3] L. Oberreiter, U. Seifert, and A. C. Barato *Phys. Rev. Lett.* **126**, 020603, (2021)

DY 32.12 Tue 16:30 DYp

Propagator for a driven Brownian particle in step potentials — •Volker Weissmann, Matthias Uhl, and Udo Seifert — II. Institute for Theoretical Physics , University of Stuttgart

Although driven Brownian particles are ubiquitous in stochastic dynamics and often serve as paradigmatic model systems for many aspects of stochastic thermodynamics, fully analytically solvable models are few and far between. In [1], we introduce an iterative calculation scheme, similar to the method of images in electrostatics, that enables one to obtain the propagator if the potential consists of a finite number of steps. For the special case of a single potential step, this method con- verges after one iteration, thus providing an expression for the prop- agator in closed form. In all other cases, the iteration results in an approximation that holds for times smaller than some characteristic timescale that depends on the number of iterations performed. This method can also be applied to a related class of systems like Brownian ratchets, which do not formally contain step potentials in their definition, but impose the same kind of boundary conditions that are caused by potential steps.

[1]: Matthias Uhl et al 2021 J. Phys. A: Math. Theor. 54 065002 https://doi.org/10.1088/1751-8121/abc21f

DY 32.13 Tue 16:30 DYp

Phase separation: from colloids to biological mixtures — •Filipe C. Thewes — Institute for Theoretical Physics, Georg-August-Universität Göttingen, 37077 Göttingen, Germany

Understanding the dynamics of phase separation in complex mixtures remains a profound challenge. In this work, we aim to build a bridge between the well-studied area of phase separation in colloidal systems and its intriguing and complex biological counterpart. We first introduce a model that interpolates between the two limiting cases and investigate the phase diagram using techniques of random matrix theory. Second, in order to understand the competing mechanisms leading to phase separation, we perform lattice simulations within a mean-field approximation and analyse the time evolution of the system in different regions of the parameter space. In the colloidal limit the model reproduces known results from the existing literature. On the biological side, our simulations provide new insights into the competing scaling obtained by early and late time analysis in the random interaction model. The intermediate regime shows new crossovers between condensation and demixing-dominated kinetics. Time permitting, results will be shown from further exploration of the model with a focus on crowding effects.

DY 32.14 Tue 16:30 DYp

The narrow escape problem in two-shell circular domains — •Matthieu Mangeat and Heiko Rieger — Saarland University, Saarbrücken, Germany

The stochastic motion of particles in living cells is often spatially inhomogeneous with a higher effective diffusivity in a region close to the cell boundary due to active transport along actin filaments [1,2]. As a first step to understand the consequence of the existence of two compartments for stochastic search problems we consider here a Brownian particle in a circular domain with different diffusivities and potentials in the inner and the outer shell. We focus on the narrow escape problem and compute the mean first passage time (MFPT) for Brownian particles starting at some pre-defined position to find a small region on the outer reflecting boundary (cell membrane). We find that the MFPT can be minimized for a specific value of the width of the outer shell only if the particle is sufficiently attracted in the outer shell whereas the MFPT depends monotonously on all model parameters without attraction. A criterion on the difference of potential between the two shells can be calculated analytically with respect to the escape region size and the ratio of diffusivities. Moreover we show that the limit of small width of the outer shell is equivalent to the surface-mediated diffusion problem [3].

[1] K. Schwarz *et al.*, Phys. Rev. Lett. **117**, 068101 (2016).
[2] A. E. Hafner and H. Rieger, Phys. Biol. **13**, 066003 (2016); Biophys. J **114**, 1420-1432 (2018).
[3] J.-F. Rupprecht *et al.*, Phys. Rev. E **86**, 041135 (2012).

DY 32.15 Tue 16:30 DYp

Clustering and emergence of collective motion in two dimensional colloidal systems with delayed feedback — •Robin A. Kopp and Sabine H. L. Klapp — ITP, TU Berlin, Berlin, Germany

In recent years, delayed feedback in colloidal systems has become an active and promising field of study [1,2], key topics being history dependence and the manipulation of transport properties.

Here we study the dynamics of a two-dimensional colloidal suspension, subject to time-delayed feedback. To this end we perform overdamped Brownian dynamics simulations, where the particles interact through a Weeks-Chandler-Andersen (WCA) potential. Furthermore, each particle is subject to a Gaussian, repulsive feedback potential [1], that depends on the difference of the particle position at the current time, $x(t)$ and the particle position at an earlier time, $x(t-\tau_{\mathrm{delay}})$.

We show that the introduction of this type of delayed feedback leads to clustering and the emergence of collective motion in Brownian WCA systems. Depending on the particle density, the cluster size and the propagation speed can be tuned by adjusting the delay time, the strength and the range of the repulsive feedback potential.

We also analyze the effects of time-delayed feedback on the mean-squared displacement (MSD) and, thus, the diffusion of one particle, as well as the effects on the MSD in the two-dimensional many-particle system described above.

[1] S. Tarama, S. U. Egelhaaf, and H. Löwen, Phys. Rev. E 100, 022609 (2019).
[2] R. Gernert and S. H. L. Klapp, Phys. Rev. E 92, 022132 (2015).

DY 32.16 Tue 16:30 DYp

The Role of Resampling in Population Annealing — •Denis Gessert[1,2] and Martin Weigel[1,3] — [1]Applied Mathematics Research Centre, Coventry University, Coventry, CV1 5FB, United Kingdom — [2]Institut für Theoretische Physik, Leipzig University, Postfach 100920, D-04009 Leipzig, Germany — [3]Institut für Physik, Technische Universität Chemnitz, D-09107 Chemnitz, Germany

Population Annealing (PA) is a population-based Monte Carlo algorithm that can be used for equilibrium simulations of thermodynamic systems with a rough free energy landscape. The algorithm has a number of parameters that can be fine-tuned to improve performance. While there is some theoretical and numerical work relating the parameters, little is known to date about the effect of choosing specific resampling protocols.

The 2d Ising model is used as a benchmarking system for this study. At first various resampling methods are implemented and numerically compared using a PA implementation on GPUs. In a second part the exact solution of the Ising model is utilized to create an artificial PA setting with effectively infinite Monte Carlo updates at each temperature as well as an infinite population. This allows one to look at resampling in isolation from other parameters and draw some general conclusions about the effects of the choice of resampling scheme.

DY 32.17 Tue 16:30 DYp

A Mapping between the Spin and Fermion Algebra — •Felix Meier, Daniel Waltner, Petr Braun, and Thomas Guhr — University Duisburg-Essen, Duisburg, Germany

We derive a formalism to express the spin algebra $\mathfrak{su}(2)$ in a spin s representation in terms of the algebra of L fermionic operators that obey the Canonical Anti-commutation Relations. We also give the reverse direction expressing the fermionic operators of many-body systems as non-linear expressions in the spin operators of a single spin. We extend here to further spin values the previous investigations by Dobrov [J.Phys.A: Math. Gen 36 L503, (2003)] who in turn clarified on an inconsistency within a similar formalism in the works of Batista and Ortiz [Phys. Rev. Lett. 86, 1082 (2001)]. Then we consider a system of L fermion flavors and apply our mapping in order to express it in terms of the spin algebra. Furthermore we investigate a possibility to simplify certain Hamiltonian operators by means of the mapping [1].

[1] arXiv:2101.10119 (2021)

DY 32.18 Tue 16:30 DYp

Percolation Properties of Spin Glasses — •Lambert Münster and Martin Weigel — TU Chemnitz, Institute of Physics, Chemnitz, Germany

In the Ising model there exists a direct interrelation between percolation of Fortuin-Kasteleyn clusters and the ferromagnetic phase transition. Percolation of Fortuin-Kasteleyn clusters in spin glasses occurs at a higher temperature than the spin-glass transition [1,2]. Even when looking at the Fortuin-Kasteleyn percolation in two replicas simultaneously the percolation temperature remains above the critical one [3].

In this work we consider Fortuin-Kasteleyn percolation also in more than two replicas. Since the utilization of multiple replicas shifts the percolation transition to lower temperatures this can possibly provide an Ansatz to develop new cluster algorithms for spin glasses. To adress the question of how the percolation threshold behaves as a function of the number of replicas we perform Monte Carlo simulations of the two-dimensional Ising spin glass.

[1] L. de Arcangelis, A. Coniglio, and F. Peruggi, Europhys. Lett. **14** 515 (1991).
[2] H. Fajen, A. K. Hartmann, and A. P. Young, Phys. Rev. E **102**, 012131 (2020).
[3] J. Machta, C. M. Newman, and D. L. Stein, J. Stat. Phys. **130**, 113 (2008).

DY 32.19 Tue 16:30 DYp

How to control a cooperative co-infection dynamics — Adib Khazaee[1] and •Fakhteh Ghanbarnejad[1,2] — [1]Sharif University of Technology, Tehran, Iran — [2]Technische Universität Dresden, Dresden, Germany

In previous studies, it has been shown that the cooperation between pathogens in co-infection spreading dynamics may lead to a discontinuous transition. Here, we are investigating how interventions like quarantine or vaccination with certain rates can turn the discontinuous transitions into continuous ones while increasing the threshold. We have used symmetric coupled Susceptible-Infectious-Recovered (SIR) equations to model the dynamics of co-infection spreading in a well-mixed population. Then we have intervened the epidemic dynamics by decreasing the susceptible population at a given rate, which means that the decreased susceptible compartment will be either quarantined or immunized at the same rate. Firstly, we have solved the equations numerically for a wide range of parameters and different initial conditions. We have illustrated how these interventions can change the type of the transition when the outflow rate gets large enough. Secondly, we have also solved the equations analytically for a special case in which the outflow rate varies with the size of the infectious compartment. Using the exact results for this special case, we can show how the characteristics of the fixed points change when the parameters change. Thirdly, we have explored the same dynamics on metapopulations and also agent based networks to examine how the topology of networks affects the effectiveness of interventions on the co-infection spread.

DY 32.20 Tue 16:30 DYp

In search for defining structural measures of real-world complex networks — •Máté Józsa[1], Alpár Sándor Lázár[2], and Zsolt Iosif Lázár[1] — [1]Department of Physics, Babeş-Bolyai University, M. Kogălniceanu nr. 1, 400084, Cluj-Napoca, Romania — [2]Faculty of Medicine and Health Sciences, University of East Anglia, NR4 7TJ, Norwich, UK

Based on a large dataset containing thousands of real-world networks ranging from genetic, protein interaction, and metabolic networks to brain, language, ecology, and social networks we search for defining structural measures of the different complex network domains (CND). We calculate 208 measures for all networks and investigate the limitations and possibilities of identifying the key graph measures of CNDs. Relevant features are identified based on their role in classifying CNDs by machine learning algorithms. The approach presented here managed to identify well distinguishable groups of network domains and confer their relevant features. Instead of being universal these feature spaces turn out to be specific to each CND and not unique, i.e., depeding on the CND several network measures can be substituted for another. Based on: Józsa et al. Opportunities and challenges in partitioning the graph measure space of real-world networks. accepted for publication in Journal of Complex Networks.

DY 32.21 Tue 16:30 DYp

Kauffman NK models interpolated between K=2 and K=3 — •James Sullivan, Dmitry Nerukh, and Jens Christian Claussen — Department of Mathematics, Aston University, Birmingham, UK

The NK model was introduced by Stuart Kauffman and coworkers [1] as a model for fitness landscapes with tunable ruggedness, to understand epistasis and pleiotropy in evolutionary biology. In the original formulation, fitness is defined as a sum of fitness functions for each locus, each depending on the locus itself and K other loci. Varying K

from $K = 0$ to $K = N - 1$ leads to different ruggedness of the landscape. In previous work we introduced a generalization that allows to interpolate between integer values of K by allowing K_i to assume different values for each locus. We focus on the interpolation between the most widely studied cases of $K = 2$ and $K = 3$ and characterize the landscapes by study of their local minima. Here we transfer this approach to Random Boolean Networks and investigate attractor basins and limit cycles where the average K assumes integer and noninteger values. Relaxing the assumption of degree-homogeneity is an important step towards more realistic boolean network models, relevant to a broad range of applications in the dynamics of social systems and in systems biology.
[1] Kauffman, S.; Levin, S., Journal of Theoretical Biology. 128, 11 (1987); Kauffman, S.; Weinberger, E., Journal of Theoretical Biology. 141, 211 (1989).

DY 32.22 Tue 16:30 DYp

Multiple Singularities of the Equilibrium Free Energy in a One-Dimensional Model of Soft Rods — •Juliane U. Klamser[1], Sushant Saryal[2], Tridib Sadhu[3], and Deepak Dhar[2] — [1]Gulliver UMR CNRS 7083, ESPCI Paris, Université PSL, 75005 Paris, France — [2]Indian Institute of Science Research and Education, Pashan, Pune 411008, India — [3]Tata Institute of Fundamental Research, Mumbai 400005, India

The Landau-Peierls argument and the Perron-Frobenius theorem are frequently used to argue against the existence of equilibrium phase transitions in one dimension. We present a new mechanism for the emergence of singularities in the thermodynamic free energy even in one dimension. This mechanism is observed in an instructive model of thin, rigid, linear rods of equal length 2ℓ whose centers lie on a one-dimensional lattice, of lattice spacing a. The interaction between rods is a soft-core interaction, having a finite energy U per overlap of rods. By solving the model analytically, we show that the equilibrium free energy per rod $\mathcal{F}(\frac{\ell}{a}, \beta)$, at inverse temperature β, has an infinite number of singularities, as a function of $\frac{\ell}{a}$. A two-dimensional extension of this model shows an interesting combination of two kinds of phase transitions, which we understand by an exact solution on the Bethe lattice.

DY 32.23 Tue 16:30 DYp

Interfaces beyond the elastic approximation — •Nirvana Caballero and Thierry Giamarchi — Department of Quantum Matter Physics, University of Geneva, 24 Quai Ernest-Ansermet, CH-1211 Geneva, Switzerland

The framework of disordered elastic systems is widely used to describe the physics of very diverse systems with typical scales ranging from nanometers to kilometers. However, this approach has the limitation that is only applicable to univalued and smooth interfaces, thus inducing uncontrolled approximations. Solving interface dynamics and statics in more realistic systems beyond the elastic approximation is still a largely open theoretical/analytical problem. We propose to address this problem by analyzing a Ginzburg-Landau model that allows us to extend the theory of disordered elastic systems. We show the connection of our approach with the disordered elastic systems theory [1]. In addition, we show how through this connection it is possible to explain otherwise not-understood experimental results in ferromagnetic interfaces [2]. [1] N. Caballero, E. Agoritsas, V. Lecomte, T. Giamarchi. PRB 102, 104204 (2020) [2] N.Caballero. arXiv:2009.14205 (cond-mat).

DY 32.24 Tue 16:30 DYp

Dynamical Casimir interactions with a body in uniform motion and the connection to nonreciprocal media — •Philip Rauch and Matthias Krüger — Institute for Theoretical Physics, Georg-August-Universität, 37077 Göttingen, Germany

The field of the dynamical Casimir effect opened up with the discovery of the phenomenon of vacuum friction acting on accelerated objects in a quantum electrodynamic vacuum. It was later shown that a cold body in vacuum, rotating along it's axis of symmetry, experiences a frictional force and spontaneously radiates energy.

However, the dynamical Casimir effect is not limited to setups with accelerated bodies. Even two parallel plates in relative lateral constant motion experience a frictional force without being in direct contact. The described phenomenas can be explained through the appearance of fluctuating electromagnetic fields, of thermal and quantum nature, in the respective system.

In the context of this work, we intend to extend and generalize the configuration of two parallel plates in relative motion. We study the setup of a translationally invariant body in uniform motion, relative to a body of arbitrary geometry and of reciprocal or nonreciprocal media. The goal is to compute the frictional force between the bodies, which is of relevance for recently developed Casimir engines [1]. As a framework we choose the Rytov formalism, complemented with scattering theory.

[1] David Gelbwaser-Klimovsky, Noah Graham, Mehran Kardar and Matthias Krüger, arXiv preprint arXiv:2012.12768 (2020)