128th STATISTICAL MECHANICS CONFERENCE
SHORT TALK SCHEDULE

SESSION A: Monday May 19, 2025 8:30 am - 9:45 am

A1: Carlo Vanoni, Princeton University

Title: Dynamical properties of dense disordered stealthy hyperuniform packings

Coauthors: Jaeuk Kim, Paul J. Steinhardt, Salvatore Torquato

Abstract : Stealthy hyperuniform (SHU) many-particle systems are distinguished by a structure factor that vanishes not only at zero wavenumber (as in ``standard'' hyperuniform systems) but across an extended range of wavenumbers near the origin. We generate disordered SHU packings of identical spheres using a modified collective-coordinate optimization algorithm that incorporates a soft-core repulsion between particles in addition to the standard stealthy pair potential [J. Kim and S. Torquato, PNAS,117, (2020)]. Compared to the SHU systems without soft-core repulsions, such SHU packings exhibit significantly higher packing fractions, spanning a broad spectrum of structures depending on the stealthiness parameter χ. Here we examine the physical properties of two-phase composites having such dense SHU packings as one of the phases in two and three dimensions, including their effective dynamic dielectric constant and time-dependent diffusive spreadability. We analyze systems of varying sizes, stealthiness parameters (χ), and volume fractions (ϕ) of the soft-core repulsion. We show that two-phase media obtained from such dense SHU packings display faster interphase diffusion, as a consequence of the higher packing fractions achievable. Moreover, for the same values of the packing fraction, the microstructural arrangement obtained with soft-core repulsion provides faster interphase diffusion. The imaginary part of the effective dynamic dielectric constant of SHU packings vanishes for small wavenumber, implying perfect transparency for the corresponding wavevectors. A larger packing fraction corresponds to a smaller transparency interval, but, as we show, it also displays a smaller absorption peak. Our results demonstrate that disordered SHU packings with soft-core repulsion exhibit advantageous transport and optical behaviors of both theoretical and experimental significance.

A2: Jaeuk Kim, Princeton University

Title: **Generation of Ultradense Disordered Stealthy Hyperuniform Packings in Two and Three Dimensions**

Coauthors: Salvatore Torquato

Abstract: Disordered stealthy hyperuniform (SHU) packings of identical particles are defined by a structure factor that is equal to zero for wavenumbers ranging from zero to a positive number. These exotic amorphous two-phase materials are endowed with novel optical, transport, and mechanical properties. We create such packings via a modified collective-coordinate optimization scheme that includes a soft-core repulsion in addition to the standard "stealthy" pair potential. Here, we demonstrate that for a given stealthiness parameter χ, compared to the packings without soft-core repulsions, the soft-core packings attain substantially higher

packing fractions, at which an SAT-UNSAT transition occurs. The resulting ultradense SHU packings form a variety of structures from jammed packings to polymer-like linear hard-particle chains as χ varies. Thus, our results offer a new route for discovering novel disordered hyperuniform two-phase materials with unprecedentedly high density. References: arXiv:2504.16924 and arXiv:2504.10310

A3: Amer Al-Hiyasat, MIT
Title: **A Cold Tracer in a Hot Bath: In and Out of Equilibrium**
Coauthors: Amer Al-Hiyasat, Sunghan Ro, Julien Tailleur
Abstract: We study the dynamics of a zero-temperature overdamped tracer in a bath of Brownian particles. As the bath density is increased, the passive tracer transitions from an effectively active dynamics, characterized by boundary accumulation and ratchet currents, to a bona-fide equilibrium regime. To account for this, we eliminate the bath degrees of freedom under the assumption of linear coupling to the tracer and show convergence to equilibrium in the large density limit. We then develop a perturbation theory to characterize the tracer's departure from equilibrium at large but finite bath densities, revealing an intermediate time-reversible yet non-Boltzmann regime, followed by a fully irreversible one. Finally, we show that when the bath particles are connected as a lattice, mimicking a gel, the cold tracer drives the entire bath out of equilibrium, leading to a long-ranged suppression of bath fluctuations.

A4: Frederik Ravn Klausen, Princeton University
Title: Impossibility Theorem for Two-Tier Electoral Systems
Coauthors: Sebastian Tim Holdum
Abstract: Two-tier electoral systems aim to balance regional representation and proportionality. Recently, the mathematical mechanisms of several Northern European two-tier systems have been challenged by increasing political party fragmentation, as evidenced by the expanding German parliament and the majority-deciding disproportionality of Denmark's 2022 election. This study develops a mathematical framework for two-tier systems, regionality, and proportionality, which identifies the common cause behind these complications through the formulation of an impossibility theorem: no two-tier system with fixed parliament size can guarantee both proportional and geographic representation. Finally, a new method—geographically ranked guaranteed proportionality—is proposed to circumvent the impossibility theorem.

A5: Omer Granek, University of Chicago
Title: Universal Fluctuations in Local Measurement as a Direct Probe of Effective Diffusivity
Abstract: Probes perform local measurements by interacting with their environment. In many cases, measurements occur in a dilute system whose effective macroscopic dynamics is diffusive. This work analytically demonstrates that the normalized autocorrelation function of any such

local measurement converges to a universal power law in the long-time limit. The dynamical exponent depends on the dimension, while the prefactor is determined solely by the bulk density and the effective diffusivity. Consequently, for dimensions two or less, the fluctuations in time-averaged local measurements exhibit long-time anomalous diffusion. Moreover, the relative uncertainties of the time-averaged measurements converge to a universal power law that depends solely on the bulk density and the effective diffusivity. The two universal forms apply in and out of equilibrium and for a wide range of observables ranging from thermodynamic state variables to active currents. Simulations of six different microscopic models support these findings. The results provide a direct method for measuring effective diffusivities locally, independent of the system's details or probe choice. They can be readily applied to existing methods for measuring effective diffusivities, such as Dynamic Light Scattering or Fluorescence Correlation Spectroscopy, extending their usage beyond their original context and set of assumptions. Lastly, the results imply that local measurements cannot saturate thermodynamic and kinetic uncertainty relations, with the distance to the bound growing at an asymptotically universal rate.

A6: Alex Plyukhin, Saint Anselm College

Title: Can a system get hotter after temporal contact with colder thermal bath?

Abstract: The heat exchange fluctuation theorem (XFT) by Jarzynski and Wojcik [Phys. Rev. Lett. 92, 230602 (2004)] addresses the setting where two systems with different temperatures are brought in thermal contact at time $t = 0$ and then disconnected at later time τ . The theorem asserts that the probability of an anomalous heat flux (from cold to hot), while nonzero, is exponentially smaller than the probability of the corresponding normal flux (from hot to cold). As a result, the average heat flux is always normal. The XFT was proved under the assumption that the coupling work required to connect and then disconnect the systems is small compared to the change of the internal energies of the systems. That condition is often valid for macroscopic systems, but may be violated for microscopic ones. We examine the validity of the XFT's assumption for a specific model of the Caldeira-Leggett type, where one system is a single classical harmonic oscillator and the other is a thermal bath comprised of a large number of oscillators. The coupling between the system and the bath, which is bilinear, is instantaneously turned on at $t = 0$ and off at $t = \tau$. For that model, we found that the assumption of the XFT can be satisfied only for a rather restricted range of parameters. In general, the work involved in the process is not negligible and the energy exchange may be anomalous in the sense that the internal energy of the system, which is initially hotter than the bath, may further increase.

A7: Chi-Ning Chou, Flatiron Institute

Title: **Beyond the Lazy versus Rich Dichotomy: Geometry Insights in Feature Learning from Task-Relevant Manifold Untangling**

Coauthors: Hang Le, Yichen Wang, SueYeon Chung

Abstract: The ability to integrate task-relevant information into neural representations is a

fundamental aspect of both human and machine intelligence. Recent studies have explored the transition of neural networks from the lazy training regime (where the trained network is equivalent to a linear model of initial random features) to the rich feature learning regime (where the network learns task-relevant features). However, most approaches focus on weight matrices or neural tangent kernels, limiting their relevance for neuroscience due to the lack of representation-based methods to study feature learning. Furthermore, the simple lazy-versus-rich dichotomy overlooks the potential for richer subtypes of feature learning driven by variations in learning algorithms, network architectures, and data properties. In this talk, I'll present a framework based on representational geometry to study feature learning. The key idea is to use the untangling of task-relevant neural manifolds as a signature of rich learning. We employ manifold capacity—a representation-based measure—to quantify this untangling, along with geometric metrics to uncover structural differences in feature learning. Our contributions are threefold: First, we show both theoretically and empirically that task-relevant manifolds untangle during rich learning, and that manifold capacity quantifies the degree of richness. Second, we use manifold geometric measures to reveal distinct learning stages and strategies driven by network and data properties, demonstrating that feature learning is richer than the lazy-versus-rich dichotomy. Finally, we apply our method to problems in neuroscience and machine learning, providing geometric insights into structural inductive biases and out-of-distribution generalization. Our work introduces a novel perspective for understanding and quantifying feature learning through the lens of representational geometry.

A8: Benjamin Sorkin, Princeton University
Title: Effective synchronization amid noise-induced chaos
Coauthors: Thomas A. Witten
Abstract: Noise-induced synchronization occurs when noninteracting oscillators are subjected to common, weak, stochastic perturbations. If the perturbations are too strong, the phases evolve chaotically instead of synchronizing. We show that effective synchronization can still be achieved under strong noise due to two key findings. (i) Although the phases of the two clocks vary erratically, their probability distributions become identical over time. (ii) These shared phase distributions attain arbitrarily low entropy, enabling two independent agents to identify closely matching effective phases. We discuss how this synchronization of ensembles broadens the range in which noise-induced synchronization can be used.

A9: Sam Dawley, Princeton University
Title: Evolution of Various Initial Many-Particle Configurations to Disordered Stealthy Hyperuniform Ground States
Coauthors: Samuel J. Dawley and Salvatore Torquato
Abstract: Systems of particles interacting via stealthy potentials, a family of soft, long-ranged, isotropic pair potentials, possess infinitely degenerate disordered hyperuniform classical ground states of fundamental and practical interest, highlighted by their novel optical and mechanical

properties. The configurational dimensionality of the ground-state manifold depends on a dimensionless parameter χ that measures the number of independently constrained degrees of freedom in a ground state. Starting from a wide class of initial two-dimensional point configurations, we study the evolution of trajectories of the collective-coordinate optimization procedure to their corresponding disordered stealthy hyperuniform ground states as a function of χ. Initial conditions studied span a wide class of disordered systems, including antihyperuniform, nonhyperuniform, and hyperuniform ones. The evolution of the trajectories is quantified by computing a translational order metric and configurational proximity metric as a function of the computational time for selected values of χ. The rate at which trajectories approach the ground-state manifold is fastest for those evolved from hyperuniform states and slowest for those evolved from antihyperuniform states. We observe that ground state ensembles with distinct pair statistics are sampled by different initial conditions across a broad range of χ and that these pair statistics are generally effected by higher-order spatial correlations characterizing the initial condition.

A10: Murray Skolnick, Princeton University
Title: Effective Transport and Mechanical Properties of Two-Phase Materials Across the Order-Disorder Spectrum
Coauthors: Salvatore Torquato
Abstract: Two-phase heterogeneous materials arise in a plethora of natural and synthetic situations, such as alloys, composites, geological media, complex fluids, and biological media, exhibit a wide-variety of microstructures, and thus display a broad-spectrum of effective physical properties. Elucidating how microstructural details (e.g., specific surface, phase volume fractions, geometries, and topologies) influence two-phase materials' effective transport and mechanical properties enhances our fundamental understanding of microstructure-property relationships, and is of great practical use in the design of structural and functional materials. Here, we compute the three-point microstructural parameters zeta_2 and eta_2 for phase 2 to evaluate bounds and accurate approximation formulas on the effective thermal/electrical conductivities as well as the bulk and shear moduli of a wide class of disordered 2D and 3D material microstructures; including various dispersions of hard and penetrable particles, certain amorphous dispersions, and networks. Our results reveal that zeta_2 and eta_2 are sensitive to the phase-connectedness properties of microstructures. Using numerical simulations and rigorous approximations that incorporate zeta_2 and eta_2, we show that certain disordered microstructures nearly realize the Hashin-Shtrikman lower and upper bounds on the effective conductivity and elastic moduli across volume-fractions.

A11: Sunghan Ro, Harvard University
Title: Rectification of active particles by an obstacle on a conical surface
Coauthors: Lara Braverman, Cheng Long, and David Nelson
Abstract: When an asymmetric obstacle is placed in the middle of a swarm of active particles, it

can rectify a steady current with a scale-free density modulation. Due to scale invariance, the characteristics of the modulation may depend on boundary conditions or geometric features of the space, such as curvature. To illustrate the effect of curvature, we examine active particles interacting with an obstacle on a surface with localized Gaussian curvature, namely, a conical surface. I will demonstrate that this setup induces a power-law density modulation, with an exponent determined by the geometry of the cone.

A12: Jonathan Bauermann, Harvard University
Title: Interfaces at the frontier of soft expanding colonies
Coauthors: David Nelson
Abstract: When two neutral microbial strains are placed on a Petri dish, the colony demixes as it expands, and homogeneous sectors are formed. In this short talk, we discuss what sets the width of interfaces between the two different strains at the colony's frontier for motile mirobes that can diffuse in space.

A13: Richard Huang, Harvard University
Title: **Thermalized buckling of extensible, semiflexible polymers**
Coauthors: David Nelson and Suraj Shankar
Abstract: The Euler buckling instability in rods is a topic with a rich history, and it remains relevant to this day, as the constituent components in many biological and physical systems are linear polymers, such as microtubules or carbon nanotubes. At finite temperature, if a polymer is shorter than its persistence length, the polymer is semiflexible, and its elasticity remains rod-like. But polymers can also stretch due to their finite extensibility, which can couple to energetically cheap bending deformations in nonlinear ways when a load is applied to the system. We show how the interplay between thermal fluctuations and nonlinear elasticity dramatically modifies the buckling instability for compressed semiflexible polymers. Thermal fluctuations delay the buckling transition to a higher critical compression compared to classical Euler buckling. By using a Ginzburg criterion, we find a length scale beyond which thermally excited undulations lead to a softened Young’s modulus, yet the polymer remains semiflexible. Beyond this length scale but below the persistence length, the scaling properties of an extensible, semiflexible polymer near the buckling transition differ qualitatively from that of classical Euler buckling. Our results shed new light on a finite temperature mechanical instability, with relevance for single molecule biophysics and nanomechanical metrology.

A14: Eugene Kolomeisky, University of Virginia
Title: **Enhancement of superconductivity near Abrikosov vortex in a tightly bound Cooper pair superconductor**
Coauthors: Mia Kyler, Ishaan U. Patel, and Joseph P. Straley
Abstract: Abrikosov vortices play a central role in the disruption of superconductivity in type-II superconductors. It is commonly accepted that as one moves away from the vortex's axis, the

density of superconductive electrons gradually increases from zero to its bulk value. However, we demonstrate that this behavior is qualitatively altered in the zero-temperature limit provided that the Cooper pairs comprising the superconductive liquid are sufficiently tightly bound. Specifically, outside the vortex core, the density of superconductive electrons reaches a maximum surpassing its bulk value. The latter is approached from above as one moves away from the vortex axis. This phenomenon has electrostatic origins: since normal electrons are absent and there exists a charged ionic background, the spatial variation of the charge density of superconductive electrons violates local neutrality, leading to the generation of an electric field. This electric field shrinks the vortex core and turns the density profile into that with a maximum, ensuring global neutrality. The effect is most pronounced in the limit of strong electrostatic screening, where the field configurations describing the vortex attain a universal form, with the electric field screened over a length scale determined by the London penetration depth.

A15: Cheng Long, Harvard University
Title: **Liquid Crystal Ground States on Cones with Antitwist Boundary Conditions**
Abstract: Geometry and topology play a fundamental role in determining pattern formation on 2D surfaces in condensed matter physics. For example, local positive Gaussian curvature of a 2D surface attracts positive topological defects in a liquid crystal phase confined to the curved surface while repelling negative topological defects. Although the cone geometry is flat on the flanks, the concentrated Gaussian curvature at the cone apex geometrically frustrates liquid crystal orientational fields arbitrarily far away. The apex acts as an unquantized pseudo-defect interacting with the topological defects on the flank. By exploiting the conformal mapping methods of F. Vafa et al., we explore a simple theoretical framework to understand the ground states of liquid crystals with p-fold rotational symmetry on cones, and uncover important finite size effects for the ground states with boundary conditions that confine both plus and minus defects to the cone flanks. By combining the theory and simulations, we present new results for liquid crystal ground states on cones with anti-twist boundary conditions at the cone base, which enforce a total topological charge of -1. We find that additional quantized negative defects are created on the flank as the cone apex becomes sharper via a defect unbinding process, such that an equivalent number of quantized positive defects become trapped at the apex, thus partially screening the apex charge, whose magnitude is a continuous function of cone angle.

SESSION B: Tuesday, May 20, 2025 8:30 am- 9:30 am

B1: Shaobing Yuan, Princeton University
Title: Spreadability as a measure of the microstructure across length scales
Coauthors: Salvatore Torquato
Abstract: The diffusion spreadability ${\cal S}(t)$ is defined as the time-dependent fraction of the solute that has diffused from an initially solute-rich phase into a solute-free phase. It is exactly determined by the spectral density of the heterogeneous microstructure, with its short-time behavior being sensitive to the local microstructure and its long-time behavior being sensitive to the global microstructure. Previous work used the asymptotic long-time behavior of ${\cal S}(t)$ to determine the small-wavenumber scaling exponent of the spectral density for a variety of disordered nonhyperuniform and hyperuniform media. We show that by considering additional terms in the long-time expansion of ${\cal S}(t)$, one can extract more accurate estimates of the scaling exponents.

B2: Daniel Swartz, MIT
Title: How host mobility patterns shape antigenic escape during viral-immune co-evolution
Coauthors: Natalie Blot, Caelan Brooks, Eslam Abdelaleem, Martin Garic, Andrea Iglesias-Ramas, Michael Pasek, Thierry Mora, and Aleksandra M. Walczak
Abstract: Viruses like influenza have long coevolved with host immune systems, gradually shaping the evolutionary trajectory of these pathogens. Host immune systems develop immunity against circulating strains, which in turn avoid extinction by exploiting antigenic escape mutations that render new strains immune from existing antibodies in the host population. Infected hosts are also mobile, which can spread the virus to regions without developed host immunity, offering additional reservoirs for viral growth. While the effects of migration on viral persistence have been investigated, we know little about how antigenic escape coupled with migration changes the survival and spread of emerging viruses. By considering the two processes on equal footing, we show that on short timescales an intermediate host mobility rate increases the survival probability of the virus through antigenic escape. We show that more strongly connected migratory networks decrease the survival probability of the virus. Using data from high traffic airports we argue that current human migration rates are beneficial for viral survival.

B3: Peter Morse, Seton Hall University
Title: A fully geometric approach to hard sphere jamming by way of the random Lorentz gas
Coauthors: Giampaolo Folena and Patrick Charbonneau
Abstract: Jamming algorithms have long sought after the true inherent state of a given equilibrium liquid. The concept of the inherent state has existed since the 1960s. While it is well

established as the limit of infinitely slow gradient decent in soft sphere algorithms, in hard spheres the terminal state depends heavily on the protocol due to the non-analyticity of the landscape. There is, however, one model where the inherent state can be found through purely geometric means: the random Lorents gas (RLG). In the RLG, one tracer particle is allowed to move, while all other particles act as immovable obstacles. The inherent state can then be

B4: Maxwell Flores, Seton Hall University
Title: Ranking jammed packings by the number of constraints
Coauthors: Peter Morse
Abstract: Jamming in hard sphere systems is both a local and global constraint satisfaction problem. The process of taking a low density equilibrium hard sphere liquid to a jammed configuration is inherently non-equilibrium, and yet we find that certain properties of the equilibrium liquid are inherited by the final jammed configuration through the locally available pathways in configuration space. It stands to reason that by constraining some of the degrees of freedom of the equilibrium liquid, we arrive at a different jammed state with a different terminal density. Using motivation from two mean-field liquid models (Mari-Kurchan and the random Lorentz gas), we find that a coherent picture emerges regarding the number of constraints applied to a system and the final jamming density: the further a system is constrained, the lower the terminal density. This naïve result allows us to rank the jamming density of a variety of models in agreement with numerical observations.

B5: Collin Doyle, Seton Hall University
Title: A Minimal Memory in a Disordered Material
Coauthors: Peter Morse and Elisabeth Agoritsas
Abstract: : Jammed packings have long been used to model return point memory. In this process, a cyclic shear is applied for several training cycles at a given amplitude to establish a memory. The system will retain this memory if smaller amplitude oscillations are applied, however, as soon as a perturbation is applied with an amplitude larger than that of the training amplitude, the system forgets the original memory. While theoretically and experimentally useful, this setup can only hold one memory at a given time. Several recent studies have sought to extend this model by applying perpendicular oscillations, but these efforts are met with limited success and a fundamental upper limit of 2 stored memories in a 3D system. Here we describe a localized perturbative scheme which allows several spatially independent memories to be stored, thus vastly expanding the utility of mechanical memory storage in disordered systems.

B6: Yicheng Tan, Rutgers University
Title: Multi-Channel Kondo behavior in the quantum XX chain with boundary defects
Coauthors: Pradip Kattel, J. H. Pixley, and Natan Andrei
Abstract: : We demonstrate that a boundary defect in the single spin- 1/2 quantum XX chain

exhibits two- channel Kondo physics. Due to the presence of the defect, the edge spin fractionalizes into two Majorana fermions, out of which one decouples, and one is overscreened by the free fermion in bulk, leading to non-trivial boundary behavior characteristic of the two-channel Kondo model. When the boundary-to-bulk coupling ratio exceeds a critical value of $\sqrt{2}$, a massive boundary-bound mode is exponentially localized near the impurity site for strong impurity coupling. This leads to unusual behavior in physical quantities, such as the g-function not being monotonic. We compute the g−function of the impurity from thermodynamic and entanglement entropy calculations and show that it takes a non-integer value of $\sqrt{2}$ just as in the two-channel Kondo problem.

B7: Abdulkadir Canatar, Flatiron Institute
Title: Statistical Mechanics of Support Vector Regression
Coauthors: SueYeon Chung
Abstract: A key problem in deep learning and computational neuroscience is relating the geometrical properties of neural representations to task performance. Here, we consider this problem for continuous decoding tasks where neural variability may affect task precision. Using methods from statistical mechanics, we study the average-case learning curves for ε-insensitive Support Vector Regression (ε-SVR) and discuss its capacity as a measure of linear decodability. Our analysis reveals a phase transition in the training error at a critical load, capturing the interplay between the tolerance parameter ε and neural variability. We uncover a double-descent phenomenon in the generalization error, showing that ε acts as a regularizer, both suppressing and shifting these peaks. Theoretical predictions are validated both on toy models and deep neural networks, extending the theory of Support Vector Machines to continuous tasks with inherent neural variability.

B8: Lara Braverman, Harvard University
Title: Transition to chaos with conical billiards
Coauthors : David Nelson
Abstract : We adapt ideas from geometrical optics and classical billiard dynamics to consider particle trajectories with constant velocity on a cone with specular reflections off an elliptical boundary formed by the intersection with a tilted plane, with tilt angle γ. We explore the dynamics as a function of γ and the cone deficit angle χ that controls the sharpness of the apex, where a point source of positive Gaussian curvature is concentrated. We find regions of the (γ, χ) -parameter space where, depending on the initial conditions, either (A) the trajectories sample the cone base and avoid the apex region; (B) sample only a portion of the base region while again avoiding the apex; or (C) sample the entire cone much more uniformly, suggestive of ergodicity. The special case of an untilted cone displays only type A trajectories which form a ring caustic at the distance of closest approach to the apex. However, we observe an intricate transition to chaotic dynamics dominated by Type (C) trajectories for sufficiently strong χ and γ. A \Poincare map that summarizes trajectories decomposed into the geodesic segments interrupted by specular reflections

provides a powerful method for visualizing the transition to chaos. We then analyze the similarities and differences of the path to chaos for conical billiards with other area-preserving conservative maps.

B9: Debendro Mookerjee, NYU
Title: Exact closed-form recurrence probabilities for biased random walks at any step number
Coauthors: Dr. Sarah Kostinski
Abstract: We report on a closed-form expression for the survival probability of a discrete 1D biased random walk to not return to its origin after N steps. Our expression is exact for any N , including the elusive intermediate range, thereby allowing one to study its convergence to the large N limit. In that limit we recover Poly´a's recurrence probability, i.e. the survival probability equals the magnitude of the bias. We then obtain a closed-form expression for the probability of last return. In contrast to the bimodal behavior for the unbiased case, we show that the probability of last return decays monotonically throughout the walk beyond a critical bias. We obtain a simple expression for the critical bias as a function of the walk length, and show that it saturates at $1/\sqrt{3}$ for infinitely long walks. This property is missed when using expressions developed for the large N limit. Finally, we discuss application to molecular motors' biased random walks along microtubules, which are of intermediate step number.

B10: Jessica Metzger, MIT
Title: Revisiting the Ratchet Principle: When Hidden Symmetries Prevent Steady Currents
Coauthors: Sunghan Ro, Julien Tailleur
Abstract: The "ratchet principle", which states that non-equilibrium systems violating parity symmetry generically exhibit steady-state currents, is one of the few generic results outside thermal equilibrium. However, we have found that for some active and passive systems, an emergent conservation law for the momentum field prevents steady currents. I show how the presence of this conservation law can be tested analytically and characterize the onset of ratchet currents in its absence. Our results show that the ratchet principle should be amended to preclude parity symmetry, time-reversal symmetry, and bulk momentum conservation.

B11: Sabrina Chern, Harvard University
Title: Long-ranged correlations from a localized fluctuating potential
Coauthors: Nativ Maor, Yariv Kafri, Sunghan Ro
Abstract: The ratchet effect is the basis for many nonequilibrium phenomena. A notable example is the current generated by an asymmetric passive body in a bath of active particles, which leads to long-range density modulations. These modulations can mediate generic long-range forces between asymmetric objects that violate the action-reaction principle, potentially leading to non-reciprocal behavior. In this short talk, I will show that an object that is isotropic on average but has shape fluctuations can also generate long-range density modulations whose

correlations show power-law decay. Our results thus predict a generic long-range force between objects if their shapes fluctuate, either due to intrinsic factors such as thermal fluctuations or external influences such as collisions with particles in the surrounding medium.