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PROMIT GHOSAL, Columbia University
Coulomb gas electrostatics control large fluctuation of the KPZ equation

We establish a large deviation principle for the Kardar-Parisi-Zhang (KPZ) equation, providing precise control over the left tail of the height distribution for narrow wedge initial condition. Our analysis exploits an exact connection between the KPZ one-point distribution and the Airy point process – an infinite particle Coulomb-gas which arises at the spectral edge in random matrix theory. We develop the large deviation principle for the Airy point process and use it to compute, in a straight-forward and assumption-free manner, the KPZ large deviation rate function in terms of an electrostatic problem (whose solution we evaluate). In addition to these long-time estimates, we provide rigorous proof of finite-time tail bounds on the KPZ distribution which demonstrate a crossover between exponential decay with exponent 3 (in the shallow left tail) to exponent 5/2 (in the deep left tail). The full-space KPZ rate function agrees with the one computed in Sasorov et al. [J. Stat. Mech, 063203 (2017)] via a WKB approximation analysis of a non-local, non-linear integro-differential equation generalizing Painleve' II which Amir et al. [Comm. Pure Appl. Math. 64, 466 (2011)] related to the KPZ one-point distribution.

EUNGHYUN LEE, Nazarbayev University
Explicit formulas for the transition probabilities of the multispecies asymmetric simple exclusion process (ASEP)

The multispecies ASEP is a stochastic particle model on $\mathbb{Z}$, where particles may belong to different species, labelled $1, \cdots, M$. For a N-particle system, a state is represented by a pair (X, π) where $X = (x_1, \cdots, x_N)$ with $x_1 < \cdots < x_N, x_i \in \mathbb{Z}$ and π is a *word*, represented by $\pi_1 \pi_2 \cdots \pi_M$ where $\pi_i \in \{1, 2, \cdots, M\}$. The state (X, π) implies the ith particle from the left is located at x_i and it belongs to species π_i. The rule of the multispecies ASEP is as follows: each particle waits an exponential time. Then, the particle tries to jump one step to the right with probability p and one step to the left with probability q. If a particle of species l tries to jump to a site occupied by a particle of species l' with $l \leq l'$, the move is prohibited. If a particle of species l tries to jump to a site occupied by a particle of species l' with $l > l'$, the particles interchange positions.

Let $P_{(Y,\nu)}(X, \pi; t)$ be the transition probability from state (Y, ν) to state (X, π) after time t. Tracy and Widom established a formula for $P_{(Y,\nu)}(X, \pi; t)$ but the formula was not completely explicit as noted in their paper [Tracy-Widom,2013]. In this talk, we provide an explicit formula of $P_{(Y,\nu)}(X, \pi; t)$ and some further results from the explicit formula. It is expected that our algorithm to find the explicit formula can be used in studying the generalization of any other exactly solvable models to their multispecies versions.

YAO LI, University of Massachusetts
Polynomial convergence rate to nonequilibrium steady state

In this talk I will present my recent result about the ergodic properties of nonequilibrium steady-state (NESS) for a stochastic energy exchange model. The energy exchange model is numerically reduced from a billiards-like deterministic particle system that models the microscopic heat conduction in a 1D chain. By using some new techniques, we proved the existence, uniqueness, polynomial speed of convergence to the NESS, and polynomial speed of mixing for the stochastic energy exchange model. All of these are consistent with the numerical simulation results of the original deterministic billiards-like system.

JUAN MARGALEF, Universidad Carlos III de Madrid
The distribution of the eigenvalues of the area operator: A game of partitions?

The area operator, that appears in the context of Loop Quantum Gravity, has as eigenvalues all possible numbers of the form

$$\sum_{i=1}^{n} \sqrt{n_i(n_i+2)}$$

for some natural numbers n_i. Several approximate methods have been proposed along the years to study the distribution of these eigenvalues. They rely on approximations to get rid of the square root and known results about integer partitions, in particular the classic asymptotic estimates due to Hardy, Ramanujan and Rademacher. The main problem with these approaches is that different approximations lead to different results and, hence, are not conclusive.

In this talk I will present a method that we developed, based on Laplace transforms, that provides a very accurate solution to this problem. The representation that we get is valid for any area and can be used, in particular, to obtain its asymptotics in the large area limit.

TRIPTI MIDHA, Indian Institute of Technology Ropar

The Analysis of Interacting Exclusion Processes for Particles of Arbitrary Size: Theoretical and Computational Techniques

Molecular motors are enzymatic molecules that aid many non-equilibrium biological processes such as intracellular transport, translation, etc. These motors carry vesicles ($\geq$ 50 nm) and move with $\sim$ 5nm steps along microtubules. For performing the mechanical work, they convert the chemical energy derived from the hydrolysis of ATP. Experiments reveal that the motor proteins behave cooperatively and interact locally among themselves.

Motivated by the above phenomena, we developed a theoretical framework to analyze the dynamics of interacting oligomers on one-dimensional lattices. We modified the totally asymmetric simple exclusion process (TASEP) describing the unidirectional motion of monomers to include the role of interactions between particles of arbitrary size. We analyzed the periodic as well as the open system using the cluster mean field theory in complement with Monte Carlo simulations. We found that the nature of the current-density relation depends on the strength of interactions, on the size of oligomers and on the way interactions influence particles' transition rates. To explain the dynamic behavior of the system we explicitly obtained the stationary phase diagrams and calculated the particles density correlations for different ranges of parameters. We noticed a good agreement of our theoretical calculations with computer simulations, suggesting that our method correctly describes the main features of the molecular mechanisms of the transport of interacting oligomers.

DOMENICO MONACO, Università degli Studi di Roma Tre

Derivation of a Kubo-like formula for charge and spin transport

We study the linear response of a gapped periodic quantum system to a small electric field, modelled by a potential εX_j, $\varepsilon \ll 1$, by measuring the conductivity σ_{ij} of a current operator in the form $J_i = \mathrm{i}[H_0, SX_i]$, where H_0 is the Hamiltonian of the unperturbed system and S is an operator acting on the internal degrees of freedom only (e.g. on spins). This is of relevance for 2-dimensional quantum (spin) Hall systems, where S is the identity operator (resp. S is the third component of the spin operator). The expected current is computed in a non-equilibrium almost-stationary state, defined via space-adiabatic perturbation theory. When S is a conserved quantity, i.e. $[H_0, S] = 0$, we recover a generalized Kubo formula for the conductivity, and consequently its quantization in appropriate units. When instead $[H_0, S] \neq 0$, we show that further correction terms appear in the Kubo-like formula for σ_{ij}.

PER MOOSAVI, KTH Royal Institute of Technology

Heat transport in quantum systems with and without conformal invariance

Recently, conformal field theory (CFT) has been used to study isolated one-dimensional many-body systems out of equilibrium. In this talk I will present exact analytical results for heat transport in such systems described by CFT and by exactly solvable models with broken conformal invariance. Our methods allow us to obtain explicit results for the full time evolution starting from a large class of non-equilibrium initial states. This can be used to study in detail universal and non-universal properties of such systems at finite times and the way in which they tend to non-equilibrium steady states.

Based on works together with K. Gawedzki, E. Langmann, J. L. Lebowitz, and V. Mastropietro.

THOMAS MOSER, IST Austria

Stability of fermionic particle systems with point interactions

Unlike the bosonic case where point interactions lead to instability because of the Thomas/Efimov effect, stability can be proven for a system of fermions under suitable conditions. In particular, the 2+1 fermionic system is well understood, and it turns out that there is a critical mass ratio (between the two species of particles) determining stability. We were able to extend this result to the N+1 system, i.e. many fermions and one impurity, showing that the energy of this many-body system is bounded from below uniformly in the particle number for certain mass ratios. Beside these impurity problems we were also able to show a stability result for the 2+2 system, i.e. two species of fermions with two particles each. In my talk I will introduce the point interacting fermion model, discuss the arising difficulties and the recent developments for the N+1 and the 2+2 case.

ANNALISA PANATI, Centre de Physique Théorique, Luminy et Université de Toulon
Heat fluctuations in the two-time measurement framework and ultraviolet regularity

Since Kurchan's seminal work (2000), two-time measurement statistics (also known as full counting statistics) has been shown to have an important theoretical role in the context of quantum statistical mechanics, as they allow for an extension of the celebrated fluctuation relation to the quantum setting. In this contribution, we consider two-time measurement statistics of heat for a locally perturbed system, and we show that the description of heat fluctuation differs considerably from its classical counterpart, in particular a crucial role is played by ultraviolet regularity conditions. For bounded perturbations, we give sufficient ultraviolet regularity conditions on the perturbation for the moments of the heat variation to be uniformly bounded in time, and for the Fourier transform of the heat variation distribution to be analytic and uniformly bounded in time in a complex neighborhood of 0. On a set of canonical examples, with bounded and unbounded perturbations, we show that our ultraviolet conditions are essentially necessary. If the form factor of the perturbation does not meet our assumptions, the heat variation distribution exhibits heavy tails. The tails can be as heavy as preventing the existence of a fourth moment of the heat variation. This phenomenon has no classical analogue.

(Based on joint work with T.Benoist, R. Raquépas, https://arxiv.org/abs/1802.02073)

ALEX PLYUKHIN, Saint Anselm College
Langevin dynamics with a nonlinear thermal bath: basics and applications to motors

Conventional Langevin models of stochastic dynamics assume that the system of interest is weakly coupled to a thermal bath which is linear in the sense that it produces a dissipative force linear in the system velocity. With the notable exception of harmonic oscillator baths, the assumption of a linear bath can be justified only as an approximation of the lowest order in a relevant small weak coupling parameter λ characterizing the intensity of the system-bath interaction. To higher orders in λ the Langevin equation contains additional dissipative terms which are nonlinear in the system velocity and described by additional fluctuation-dissipation relations. We discuss the structure of these nonlinear fluctuation-dissipation relations, show that they guarantee thermalization of the system to a Maxwell equilibrium distribution to any order in λ, and emphasize the non-Gaussian nature of corresponding random forces.

While nonlinear dissipation forces (being of higher order in λ) are usually much smaller than the linear one, they may give rise to important physical effects which do not show up in the linear bath approximation. Among other examples, we consider intrinsic ratchets: a family of Brownian motors archetyped by an asymmetric Brownian particle subjected to an external unbiased (e.g. harmonic or noisy) time-dependent force. Directional motion of an intrinsic ratchet is a nonlinear effect of order λ^3, and the approximation of a linear bath (of order λ^2) is not sufficient for its description.

LEA SANTOS, Yeshiva University
Nonequilibrium many-body quantum dynamics: from full random matrices to real systems

We study numerically and analytically the quench dynamics of isolated many-body quantum systems. Using full random matrices from the Gaussian orthogonal ensemble, we obtain analytical expressions for the evolution of the survival probability, density imbalance, and out-of-time-ordered correlator. They are compared with numerical results for many-body quantum systems with two-body interactions and shown to bound the decay rate of these realistic systems. Power-law decays are seen

at intermediate times, and dips below the infinite time averages (correlation holes) occur at long times for all three quantities when the systems exhibit level repulsion. For the real systems, we also study the number of states participating in the evolution after a quench. It increases exponentially in time, provided the eigenstates are delocalized in the energy shell. The rate of the exponential growth is defined by the width Γ of the local density of states (LDOS) and is associated with the Kolmogorov-Sinai entropy for systems with a well defined classical limit.