Talk details

Week 1

1. Kedar Damle

Title: Vacancy-induced crossovers in the chiral orthogonal universality class: Implications for low temperature response of a diluted Majorana spin liquid.

Abstract: In a tractable example of an SU(2) symmetric *Majorana spin liquid* phase of $S = 1/2$ moments on the honeycomb lattice, we demonstrate that a nonzero concentration n_v of randomly-located non-magnetic defects (vacancies) leads to a singular low-temperature susceptibility $\chi(T)$ that can serve as a signature of this phase. We find $\chi(T) = \frac{\mathcal{C}}{4T} + \frac{N(\Gamma_T)}{4T}$, where $\Gamma_T \equiv \log(T/J)$ and J is the exchange-energy scale. The nonuniversal n_v-dependent Curie constant $\mathcal{C}$ remains generically nonzero even in the compensated case (with exactly equal number of vacancies on the two sublattices), while $N(\Gamma_T)$ displays an interesting crossover from the power-law form $N_{1\mathrm{D}}(\Gamma_T) \sim \Gamma_T^{-y}$ with nonuniversal n_v-dependent exponent y for not-too-low T/J to the much faster decaying form $N_{\mathrm{GW}}(\Gamma_T) \sim \Gamma_T^{1/3} \exp(-b\Gamma_T^{2/3})$ below a nonuniversal n_v-dependent crossover scale $T_c \equiv J \exp(-\Gamma_{\mathrm{c}})$ that is several orders of magnitude smaller than J even for moderate values of n_v. A closely related crossover dominates the density of states of the tight-binding model for graphene with vacancy disorder.

Schedule: 26th October (10:20 - 11:00)

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2. Chulan Kwon

Title: Molecular dynamics study on a nonequilibrium motion of a colloidal particle driven by an external torque.

Abstract: We investigate the motion of a colloidal particle driven out of equilibrium by an external torque. We use the molecular dynamics simulation that is alternative to the simulation based on the Langevin equation and is expected to mimic an experiment more realistically. We choose a heat bath composed of about a thousand particles interacting to each other through the Lennard-Jones potential and impose the Langevin thermostat to maintain it in equilibrium. We prepare a colloidal particle to interact with the particles of the heat bath also by the Lenard-Jones potential while any dissipative force and noise are not employed explicitly. We study the stochastic properties of the nonequilibrium fluctuation for work and heat produced incessantly in the steady state. We accurately confirm the fluctuation theorem for the work production. We also investigate the motion beyond the overdamped limit by varying the size and the mass of the colloidal particle. We compare our result with a previous theoretical result in the overdamped limit based on the Langevin equation.

Schedule: 26th October (11:20 - 12:00)

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3. Sudip Haldar

Title: Statistical relaxation of many-body systems following a random quench.

Abstract: The investigation of statistical relaxation in interacting quantum many-body system has emerged as a major research area in recent past. Here we will discuss the fidelity decay and entropy production, with time, of a many particle system of fermions (or bosons) in a mean-field and quenched by a random two-body interaction by random matrix theory. Results for the fidelity decay compare well not only with the EGOE formula in the Gaussian domain but also with a new formula for the BW to Gaussian transition region. Applying the approximation suggested by Flambaum and Izrailev, formula for entropy production for EGOE(1+2) in the Gaussian region with extension into BW region is derived along with an analytical expression for the time t_{sat} for onset of saturation of entropy. These EGOE results are in good agreement with numerical calculations.The findings of a recent many-body study on the quench dynamics of interacting trapped Bose in one dimension is also discussed in this connection.

1. S.K. Haldar, N.D. Chavda, V.K.B. Kota, arXiv: 1509.01392

Schedule: 26th October (12:40 - 13:00)

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4. David Huse

Title: Quantum thermalization and many-body Anderson localization.

Abstract: I will discuss the dynamics of closed many-body quantum systems in the thermal phase, the localized (MBL) phase, and at and near the novel quantum phase transition between these two phases. The distinction between these two phases is whether or not thermal equilibrium is emergent from the systems dynamics. For a recent review, see Nandkishore and Huse, Ann. Rev. Cond. Matt. Phys., Vol. 6: 15-38 (2015); arXiv:1404.0686.

Schedule: 26th October (14:30 - 16:00), 27th October (09:30 - 11:00), 28th October (12:30 - 13:10)

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5. Colm Connaughton

Title: Instantaneous gelation and explosive condensation in non-equilibrium cluster growth.

Abstract: The kinetics of various mechanisms of non-equilibrium cluster growth such as aggregation or exchange-driven growth are characterised by an interaction kernel, K(x,y), which specifies the average rate of interaction of particles having sizes x and y respectively. If the kernel increases quickly enough as a function of cluster size, then the second moment of the cluster size distribution can diverge in a finite time. This singularity, known as the gelation transition, is interpreted as signifying the formation of clusters of infinite size within a finite time. It has been known for some time that there exists a subclass of kernels for which the gelation transition occurs instantaneously. It is not the case that such behaviour is a mathematical pathology since there exist physically reasonable models which exhibit this behaviour such as coagulation driven by differential settling of liquid droplets in the Stokes regime. It was considered unlikely however that such behaviour could survive in spatially extended systems. A counter example was given by Waclaw and Evans in 2012 in which a total asymmetric

version of a mass transport model on a one-dimensional lattice in the spirit of the zero-range process was shown to exhibit condensation of all of the particles onto a single site in a time which vanishes as the system size grows, a phenomenon known as "explosive condensation". In this talk I will discuss the relationship between instantaneous gelation and explosive condensation in the light of what is known about cluster growth models such as aggregation and exchange-driven growth. I will also show that a symmetric variant of Waclaw and Evans' model can exhibit the same behaviour provided that the rate of particle exchange is high enough. The fact that the model is spatially extended allows a second regime to exist for lower rates of particle exchange in which clusters grow algebraically by clustering, an regime which is absent at mean-field level.

Joint work with S. Grosskinsky and Y.-X. Chau

Schedule: 27th October (11:30 - 12:10)

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6. David Mukamel

Title: Long-Range correlations in nonequilibrium systems.

Abstract: The existence of long-range correlations is a generic feature of nonequilibrium systems. Two simple examples of such correlations induced in the steady state of driven systems will be presented and discussed. In the first example the density correlation function of a system with a local drive in an otherwise diffusing environment is analyzed [1]. In the second example heat transport in a one dimensional model whose dynamic locally conserves both momentum and energy is discussed and the deviations of the resulting steady state from local equilibrium is presented [2]. Close correspondence of these nonequilibrium steady states to electrostatic potentials induces by charge distribution will be pointed out.

(1) Tridib Sadhu, Satya N Majumdar and David Mukamel, PRE 84, 051136 (2011);
PRE 90, 012109 (2014)

(2) Anupam Pundu, Ori Hirschberg and David Mukamel, arXiv:1510.02264

Schedule: 27th October (12:10 - 12:50)

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7. Marielle Simon

Title: Equilibrium fluctuations for one-dimensional conservative systems.

Abstract: The study of fluctuations for one-dimensional conservative systems (like, for instance, exclusion-type processes) often involves the so-called Boltzmann-Gibbs principle which states that the space-time fluctuations of any local field associated to a conservative mode can be written as a linear functional of the conservative field. A second-order Boltzmann-Gibbs principle has been introduced in 2014 by Gonalves and Jara in order to investigate the first-order correction of this limit, in which case is given by a quadratic functional of the conservative field. The proof of that result was based on a multiscale analysis assuming that the underlying particle system is of exclusion type and for which a spectral gap inequality holds. With P. Gonalves and T. Franco, we gave a new proof of that second-order Boltzmann-Gibbs principle in order to fit exclusion processes with one slow bond.

Schedule: 27th October (15:00 - 15:20)

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8. Jae Dong Noh

Title: Efficiency of a linear Brownian heat engine.

Abstract: A heat engine operates between two heat baths at different temperatures T_H and $T_C(< T_H)$ and extracts a work. The efficiency η of a heat engine is measured by the ratio of the extracted work to the absorbed heat from a hotter heat bath. According to the thermodynamic second law, it is bounded from above by the Carnot efficiency $\eta_C = 1 - T_C/T_H$ that can be achieved only by the reversible heat engines. There are two general statements concerning the efficiency of nonequilibrium heat engines: (i) The efficiency of a heat engine operating at the maximum power could be universal and given by $\eta_{EMP} = 1 - \sqrt{1 - \eta_C}$. This result is derived in so-called endoreversible heat engines. (ii) The probability density for the efficiency of a heat engine with a time-symmetric protocol is minimum at $\eta = \eta_C$, that is to say, the Carnot efficiency is least probable. This result is derived for systems with bounded energy. In this talk, we introduce an exactly solvable model for a Brownian heat engine. When one varies model parameters, the model acts as a heat engine or a heat pump. We find that the efficiency at maximum power is given by the universal form $\eta_{EMP} = 1 - \sqrt{1 - \eta_C}$ even though the engine is not endoreversible. This result indicates that the proposed form of η_{EMP} is more universal than expected. Relying on the solvability, we can calculate the large deviation function for the efficiency. The analytic solution shows that the Carnot efficiency is not least probable. This exemplifies the importance of the energy fluctuations in nonequilbrium systems.

Schedule: 28th October (11:50 - 12:30)

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9. Sakuntala Chatterjee

Title: Fast coarsening in strong phase separation

Abstract: We study strong phase separation (SPS) in a one-dimensional periodic system that forms pure domains at all temperatures. Starting from a disordered state, the system shows algebraic coarsening, and in the long time limit, part of the system develops compact phases with sharp boundaries. The remaining part behaves like a nonequilibrium open system whose ends are connected to those pure phases. The domain boundaries show rich steady state dynamics. Our results are qualitatively different from earlier widely studied systems like ABC model or Lahiri-Ramaswamy model that showed SPS.

Schedule: 29th October (11:20 - 12:00)

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10. Yariv Kafri

Title: Pressure in Non-equilibrium (Active) Systems.

Abstract: Pressure is the mechanical force per unit area that a confined system exerts on its container. In thermal equilibrium, the pressure depends only on bulk properties (density, temperature, etc.) through an equation of state. The talk will show that in active systems containing self-propelled particles, the pressure instead can depend on the precise interactions between the system's contents and its confining walls. This implies that generic active systems have no equation of state. Other anomalous attributes of pressure will also be discussed.

Finally, it will be shown that in certain fine tuned cases an equation of state can be recovered. The physics behind the equation of state in a specific example will be discussed.

Schedule: 29th October (12:00 - 12:40)

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11. Manas Kulkarni

Title: The Nonlinear Schrodinger Equation, Nonlinear Fluctuating Hydrodynamics and the Kardar-Parisi-Zhang Universality Class

Abstract: We discuss a deep connection [1] between the low-temperature dynamical phenomenon in a discrete Nonlinear Schrodinger Equation (DNLS), a.k.a., Gross–Pitaevskii equation and nonlinear fluctuating hydrodynamics (NFH). We show that the resulting nonlinear stochastic field theory can be recast as a set of coupled KPZ-like equations. The behavior of these equations most often fall under Kardar-Parisi-Zhang (KPZ) universality class. We also discuss interesting cases which give rise to coupled stochastic equations which display non-KPZ behavior [3]. The results we obtain via mapping to stochastic equations are benchmarked against exact Hamiltonian numerics [1,2] on DNLS by investigating the non-zero temperature dynamical structure factor and its scaling form and exponent. We also discuss consequences of approaching integrability and deviation from NFH [3].

(1) M. Kulkarni, D. A. Huse, H. Spohn, Phys. Rev. A 92, 043612 (2015)
(2) M. Kulkarni and A. Lamacraft, Phys. Rev. A 88, 021603 (2013)
(3) M. Kulkarni (unpublished, 2015)

Schedule: 30th October (09:30 - 10:10)

12. Mustansir Barma

Title: Fluctuation-dominated phase ordering.

Abstract: In a class of nonequilibrium systems, fluctuations are anomalously strong but coexist with long-range order, leading to fluctuation-dominated phase ordering (FDPO). The signature — a singularity in the scaled two-point function — occurs in models of active biological systems and granular media, and in experiments on vibrated rods. A single order parameter is insufficient to characterize the order, and a larger set is required. For a 2-component driven diffusive system, namely a passive scalar driven by a fluctuating surface, the order parameter set comprises long-wavelength Fourier modes of the passive density. These modes are anti-correlated, and static and dynamic scaling laws obeyed by their probability distributions and moments are found through numerical simulation.

Schedule: 30th October (10:10 - 10:50)

13. Pablo Hurtado

Title: Violation of universality in anomalous Fourier's law?

Abstract: Since the discovery of long-time tails, it has been clear that Fourier's law in low dimensions is typically anomalous, with a size-dependent heat conductivity, though the nature of the anomaly remains puzzling. The conventional wisdom, supported by recent results from nonlinear fluctuating hydrodynamics, is that the anomaly is universal in 1d momentum-conserving systems and belongs in the Kardar-Parisi-Zhang universality class. Here we challenge this picture by using a novel scaling method to show unambiguously that universality breaks down in the paradigmatic 1d diatomic hard-point fluid. Hydrodynamic profiles for a broad set of gradients, densities and sizes all collapse onto an universal master curve, showing that (anomalous) Fourier's law holds even deep into the nonlinear

regime. This allows to solve the macroscopic transport problem for this model, a solution which compares flawlessly with data and, interestingly, implies the existence of a bound on the heat current in terms of pressure. These results question the use of standard fluctuating hydrodynamics to understand anomalous Fourier's law in 1d, offering a new perspective on transport in low dimensions.

P.I. Hurtado and P.L. Garrido, arXiv:1506.03234

Schedule: 30th October (11:20 - 12:00)

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14. Baruch Meerson

Title: Fluctuations of current in non-stationary diffusive lattice gases.

Abstract: We employ Macroscopic Fluctuation Theory (MFT) to study the statistics of integrated current of a lattice gas through the origin on an infinite line. We develop three different perturbative approaches for solving the MFT equations. The main results are published in these papers:

1. B. Meerson and P. V. Sasorov, PRE (R) 89, 010101 (2014)
2. A. Vilenkin, B. Meerson and P.V. Sasorov, J. Stat. Mech. P06007 (2014)
3. B. Meerson and P. V. Sasorov, J. Stat. Mech. P12011 (2013)

Schedule: 30th October (12:00 - 12:40)

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15. Jaegon Um

Title: Total cost of operating an information engine.

Abstract: We study a two-level system controlled in a discrete feedback loop, modeling both the system and the controller in terms of stochastic Markov processes. We find that the extracted work, which is known to be bounded from above by the mutual information acquired during measurement, has to be compensated by an additional energy supply during the measurement process itself, which is bounded by the same mutual information from below. Our results confirm that the total cost of operating an information engine is in full agreement with the conventional second law of thermodynamics. We also consider the efficiency of the information engine as function of the cycle time and discuss the operating condition for maximal power generation. Moreover, we find that the entropy production of our information engine is maximal for maximal efficiency, in sharp contrast to conventional reversible heat engines.

Schedule: 30th October (12:40 - 13:00)

Week 2

1. Cédric Bernardin

Title: Current and Density large deviations for 2d asymmetric systems.

Abstract: We consider a generic conservative driven diffusive system (e.g. a 2D weakly asymmetric lattice gas) whose macroscopic behavior of the conservative quantity (say the density) is described by a diffusion equation with a conservative drift term and a conservative white noise in dimension 2. We study the current/density large deviations functional in the large drift regime (asymmetric system) where a dynamical phase transition occurs. We generalize in 2D some works of Bodineau-Derrida and Bellettini-Bertini-Mariani-Novaga and give a generalization of the Jensen-Varadhan functional in 2D.

Joint work with J. Barr and R. Chetrite

Schedule: 2nd November (09:30 - 10:10), 3rd November (09:30 - 11:00)

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2. Punyabrata Pradhan

Title: Additivity property and mass fluctuations in conserved-mass transport processes.

Abstract: Understanding fluctuations is fundamental to the formulation of statistical mechanics. Unlike in equilibrium, where fluctuations are obtained from the Boltzmann distribution, there is no unified principle to characterize fluctuations in nonequilibrium. In this talk, we aim to provide a statistical mechanics framework to characterize steady-state mass fluctuations in conserved-mass transport processes. We demonstrate that mass distributions in a broad class of nonequilibrium mass-transport processes can arise simply from an additivity property, the tenet of equilibrium thermodynamics.

Schedule: 2nd November (10:10 - 10:50)

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3. Stefano Olla

Title: Energy diffusion and superdiffusion in acoustic and non-acoustic chains.

Abstract: I will present some rigorous result about the macroscopic evolution of energy and the other balanced quantities in unpinned one-dimensional harmonic chains with random momentum exchange. Energy superdiffusion is characteristic of acoustic chains, while non-acoustic ones have normal diffusivity.

Schedule: 2nd November (11:50 - 12:30)

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4. Jiao Wang

Title: Computing thermopower of interacting systems.

Abstract: A numerical approach for computing the thermopower of a general interacting system is proposed. It consists of two steps: First, by using the grand-canonical Monte Carlo method, the relation between the density and the electrochemical potential is established. Next, based on this relation and by the molecular dynamics simulation, we can determine the thermopower, as well as the

electrical conductivity, the thermal conductivity, and in turn the thermoelectric figure of merit ZT. The advantage of the method is that it does not involve open heat baths that exchange particles with the system, and as a consequence, it can be employed to study a system with more general interaction. As an example, a one dimensional gas model with (screened) Coulomb interparticle interaction is studied. The results confirm the general theoretical predictions for momentum-conserving systems and show that ZT may increase linearly with the system size.

Schedule: 2nd November (12:30 - 01:10)

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5. Dimitrios Tsagkarogiannis

Title: Non-equilibrium systems with current reservoirs.

Abstract: Stationary non-equilibrium states are characterized by the presence of steady currents flowing through the system as a response to external forces. We model this process considering the simple exclusion process in one space dimension with appropriate boundary mechanisms which create particles on the one side and kill particles on the other. The system is designed to model Fick's law which relates the current to the density gradient. In this talk we review some results obtained in collaboration with Anna De Masi, Errico Presutti and Maria Eulalia Vares. For this process, the hydrodynamic limit is given by the linear heat equation with Dirichlet boundary conditions obtained by solving a nonlinear equation which fixes the values of the density at the boundary. The rescaled limiting density profile of the (unique) invariant measure of the process coincides with the unique stationary solution of the hydrodynamic equation. Last, we show a spectral gap estimate for the (non equilibrium) stationary process uniformly on the system size.

Schedule: 3rd November (11:30 - 12:10)

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6. Gabriel Stoltz

Title: Error estimates on the computation of transport coefficients.

Abstract: I will present error estimates for transport coefficients, which can be obtained either by the linear response of appropriately perturbed stochastic dynamics, or, equivalently, through the time integration of correlation functions. I will consider Langevin dynamics, numerically integrated with splitting schemes; and overdamped Langevin dynamics, possibly corrected by a Metropolis/Hastings procedure in order to remove the bias on the invariant measure.

Schedule: 3rd November (12:10 - 12:50)

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7. Yongjoo Baek

Title: Density fluctuations of two-box models.

Abstract: As minimal models of boundary-driven transport, we study density fluctuations of stochastic lattice gases in systems composed of two connected boxes, each of which is coupled to an external particle bath. A suitable coarse-graining procedure allows us to study large deviation properties of these models, which are found to be toy realizations of known systems. We also present some clues hinting at the possible existence of nonequilibrium-to-equilibrium mapping in our models, which have been found so far only in the continuum limit.
Schedule: 3rd November (12:50 - 13:10)

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8. Yonatan Dubi

Title: Interplay between dephasing and geometry and directed heat flow in exciton transfer complexes.

Abstract: The striking efficiency of energy transfer in natural photosynthetic systems and the evidence of long-lived quantum coherence in biological light harvesting complexes has triggered much excitement, due to the evocative possibility that these systems - essential to practically all life on earth use quantum mechanical effects to achieve optimal functionality. A large body of theoretical work has addressed the role of local environments in determining the transport properties of excitons in photosynthetic networks and the survival of quantum coherence in a classical environment. Nonetheless, understanding the connection between quantum coherence, exciton network geometry and energy transfer efficiency remains a challenge. Here we address this connection from the perspective of heat transfer within the exciton network. Using a non-equilibrium open quantum system approach and focusing on the Fenna-Matthews-Olson complex (the fruit-fly of exciton transfer), we demonstrate that finite local dephasing can be beneficial to the overall power output. The mechanism for this enhancement of power output is identified as a gentle balance between quantum and classical contributions to the local heat flow, such that the total heat flow is directed along the shortest paths and dissipation is minimized. Strongly related to the spatial network structure of the exciton transfer complex, this mechanism elucidates how energy flows in photosyntetic excitonic complexes.

Schedule: 4th November (11:50 - 12:30)

9. Patricia Gonçalves

Title: Crossover to the stochastic Burgers equation from the WASEP with a slow bond.

Abstract: We consider the weakly asymmetric simple exclusion process with a slow at $\{-1, 0\}$ starting from equilibrium. Depending on the rate of the slowness of the bond and the strength of the asymmetry the fluctuations are given by Ornstein-Uhlenbeck processes or by energy solutions of the stochastic Burgers equation.

Schedule: 4th November (12:30 - 13:10)

10. Raphael Chetrite

Title: Nonequilibrium Markov processes conditioned on large deviations.

Abstract: I will present a general approach for constructing a Markov process that describes the dynamics of a nonequilibrium process when one or more observables of this process are observed to fluctuate in time away from their typical values.

Schedule: 5th November (09:20 - 10:00)

11. Tim Halpin-Healy

Title: 2+1 KPZ Class: Universal Distributions & Correlators.

Abstract: We review, briefly, some recent numerical, experimental, and theoretical work done w/collaborators on the 2+1 Kardar-Parisi-Zhang problem. The focus is on higher dimensional analogs of the universal limit distributions, TWGUE & TWGOE, discussed by Herbert Spohn in his inaugural Chandrasekhar Lecture on random matrices & nonequilibrium interfacial growth. The talk also ties into others here on KPZ/ASEP- related matters; e.g., Van Beijeren, Sasamoto, Mallick, Kulkarni, Jain, etc., and touches base with previous beautiful works of Majumdar, Schehr, Rosso, Schutz.

Reference:
1. THH, PRL 109, 170602 (2012); PRE 88, 042118 (2013).
2. T. Kloss, et al., PRE 86, 051124 (2012);ibid, 88, 069903 (2013).
3. THH/Y. Lin, PRE 89, 010103 (2014).
4. THH/G. Palasantzas, EPL 105, 50001(2014).
5. THH/K. Takeuchi, JSP 160, 794 (2015); for 1+1 KPZ mathematical developments, see J. Quastel & H. Spohn, JSP 160, 965 (2015). These 2 papers are part of the special August 2015 JSP issue devoted to The KPZ Equation in Statistical Mechanics.

Schedule: 5th November (11:50 -12:30)

12. Alberto Rosso

Title: Dynamic nuclear polarization and the paradox of quantum thermalization

Abstract: In this talk we consider a specific technique to hyperpolarize nuclear spins, known as dynamic nuclear polarization (DNP). In a DNP setting, the interacting spin system is quasi-isolated and brought out-of-equilibrium by microwave irradiation. Here we show that the resulting stationary state strongly depends on the ergodicity properties of the spin many-body eigenstates. In particular dipolar interactions compete with disorder resulting in two distinct dynamical phases characterised by a very different DNP efficiency. We argue that these two phases are intimately related to the problem of quantum thermalization and many-body localisation in in closed systems.

Schedule: 5th November (12:30 - 13:10)

13. Henk van Beijeren

Title: Some problems with mode coupling from fluctuating hydrodynamics and possible solutions.

Abstract: Obtaining mode coupling expansions straightforwardly, but slightly naively from fluctuating hydrodynamic equations, one runs into problems, such as apparent violations of time reversal symmetry.

These can be avoided by working carefully with functions forming an orthogonal set in an appropriate function space. Most simply this is illustrated by working in micriscopic phase space, but it may also be done within the function space of fluctuating hydrodynamics.

Schedule: 5th November (14:00 - 15:00)

14. Dahai He

Title: Thermal transport in low-dimensional lattices: negative temperature jump and impacts of thermal expansion.

Abstract: In this talk, I will report our recent studies on thermal transport in low-dimensional systems. In particular, we will first present our studies on interfacial thermal conduction in one-dimensional harmonic and ϕ^4 lattices. Interestingly, there exists a non-trivial negative temperature jump between the interfacial particles in particular parameter regimes. In the second part of my talk, I will show the impacts of thermal expansion, arising from the asymmetric interparticle potential, on thermal conductance in the FPU-$\alpha - \beta$ model. A nonmonotonic dependence of the temperature gradient and thermal conductance on the cubic interaction parameter are shown, which corresponds to the variation of the coefficient of thermal expansion. Three domains with respect to can be identified. A self-consistent phonon theory, which can capture the effect of thermal expansion, is developed to support our explanation in a quantitative way.

References:

(1) X. Cao, D. He, Phys. Rev. E 92, 032135 (2015).
(2) J. Wang, D. He, Y. Zhang, J. Wang, and H. Zhao, Phys. Rev. E 92, 032138 (2015).
(3) X. Cao, K. Chen and D. He, J. Phys.: Condens. Matter 27, 166003 (2015).
(4) X. Cao, D. He, H. Zhao, and B. Hu, AIP Advances 5, 053203 (2015).
(5) W. Fu, T. Jin, D. He, S. Qu, Physica A 433, 211 (2015).
(6) H.-K. Chan, D. He, B.Hu, Phys. Rev. E 89, 052126 (2014).

Schedule: 6th November (09:30 - 10:10)

15. Hong Zhao

Title: Hard-disk gas revisit

Abstract: The hard spheres and hard disks are simplest models of a fluid. The study of such models has general importance for gases since their structures do not differ in any significant way from that corresponding to more complicated interatomic potentials. However, fundamental problems are still remained. (a) How to bridging the kinetic and hydrodynamics to get a global correlation function instead of the piecewise ones. (b) How to check theoretical predictions by conclusive simulations. (c) How to determine quantitatively the influence of the long-time tail on the observed values of transport coefficients. Our recent studies have found partial solutions to these questions. In my talk, I report our recent study of the velocity and energy current autocorrelation functions in hard-disk gas by large-scale simulations. The exponential, t^{-1z} power-law as well as the logarithmic decay stages are evidenced definitely. Based on these results, the validity range of several essential hydrodynamics and kinetics predictions are checked with varying the gas density. The significant difference between the two autocorrelation functions are revealed. The long-time tail of the velocity autocorrelation is derived using an intuitive picture, based on which a global formula of the correlation function is presented to bridge the kinetics and hydrodynamics.

Schedule: 6th November (10:10 - 10:50)

16. P. N. Gajjar

Title: Thermal transport in various 1D structures.

Abstract: Use of monoatomic, diatomic, mass graded, and defect induced materials in controlling heat flow will be presented in the talk. Our simulation results on temperature profiles, interface resistance and thermal conductivity in sandwich structures will also be presented. The model of preparing a composite material of different masses and our investigation of heat transport suggests that proper composites allow us to tailor materials. The model of 1D Thermal Diode, 1D Thermal Transistor will also be explored during the presentation.

Schedule: 6th November (10:50 - 11:30)

17. Yong Zhang

Title: Phonons in 1D anharmonic chains.

Abstract: We systematically investigate the effects of anharmonicity on phonons in one dimensional chains via molecular dynamic simulations. We develop a simple and intuitive method to quickly extract frequency and lifetime of the long wavelength phonons. Compared to current various theories, our results demonstrate that the asymmetry of interaction potentials produce a significant impact on phonon dynamics, which current theories fail to capture. For the anharmonic phonon frequencies, simulations shows a smaller change than the theoretical predictions at large symmetry. For linewidth broadening, simulations reveal obvious departures from theoretical predictions in a range where the interaction potentials have asymmetry but vanishing nonlinearity. More interestingly, a combination of asymmetry and nonlinearity induce a Ioffe-Regel crossover for long wavelength phonons, which is typical characteristic of phonons in glass solids.

Schedule: 6th November (11:50 - 12:30)

Week 3

1. Joel Lebowitz

Title: Fluctuations, large deviations and rigidity for Coulomb systems and other non-Gibbsian measures.

Schedule: 9th November (09:30 - 10:10)

2. Arvind Ayyer

Title: R-trivial Markov processes: Exact results for convergence to stationarity

Abstract: In nonequilibrium physics, one is often interested in not just the long-time behaviour of a system, given by its steady state, but also in its approach to stationarity. While this is a hard problem in general, the problem becomes tractable for certain systems due to their algebraic structure.

We study nonequilibrium interacting particle systems where the transition operators satisfy a property known as R-triviality, a concept borrowed from the theory of semigroups. The most well-studied example of such a system is the Tsetlin library. Starting with this example, we will illustrate how the representation theory of semigroups can be used to make precise statements about the time taken to converge to stationarity in nonequilibrium systems. We will end with applying this other natural nonequilibrium models, such as the 1D Toom model and a directed nonabelian sandpile model.

This is based on joint works with S. Klee, A. Schilling, B. Steinberg and N. Thiery.

Schedule: 9th November (10:10 - 10:50)

3. Hyunggyu Park

Title: Information thermodynamics for a feedback with time delay: Cold damping

Schedule: 9th November (12:00 - 12:40)

4. Gunter Schutz

Title: Exact matrix product solution for the boundary-driven Lindblad XXZ chain.

Abstract: We demonstrate that the exact nonequilibrium steady state of the one-dimensional Heisenberg XXZ spin chain driven by boundary Lindblad operators can be constructed explicitly with a matrix product ansatz for the nonequilibrium density matrix where the matrices satisfy a quadratic algebra. This algebra turns out to be related to the quantum algebra $U_q[sl(2)]$. For the isotropic Heisenberg chain, coupled with strength Ω at the ends to boundary reservoirs polarized in different directions with angle θ, we calculate the exact magnetization profiles and magnetization currents in the nonequilibrium steady state of a chain with N sites. For large N the in-plane steady-state magnetization profiles are harmonic functions with a frequency proportional to the twisting angle θ. Transport is anomalous: In-plane steady-state magnetization currents are subdiffusive and vanish like $1/\Omega$ as

the coupling increases, while the transverse current is ballistic and saturates to $2\theta/N$ as the coupling strength Ω becomes large.

Schedule: 10th November (09:30 - 10:10)

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5. Arnab Das

Title: Statistical Mechanics of Periodically Driven Closed Quantum Systems.

Abstract: Here we discuss some general scenarios which arise when one considers the fate of a periodically driven closed many-body system at (asymptotically infinite) long times.

Schedule: 10th November (10:10 - 10:50)

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6. Udo Seifert

Title: Current fluctuations in biomolecular systems.

Abstract: Stochastic thermodynamics provides a conceptual framework for describing, inter alia, biomolecular systems in a thermodynamically consistent way [1]. After briefly recalling the main principles, I will describe our recent work dealing with current fluctuations. First, I will show how spatial periodicity together with the presence of a hidden slow degree of freedom leads to a "fine-structured" fluctuation theorem for molecular motor/cargo complexes [2]. Second, I will show that any biomolecular process of high precision, i.e. with small fluctuations, requires a minimum amount of free energy input which can be quantified through a universal "thermodynamic uncertainty relation".

(1) Stochastic thermodynamics, fluctuation theorems, and molecular machines. U. Seifert, Rep. Prog. Phys. 75, 126001, 2012
(2) Fine-structured large deviations and the fluctuation theorem: Molecular motors and beyond. P. Pietzonka, E. Zimmermann, and U. Seifert, EPL 107, 20002, 2014
(3) Thermodynamic uncertainty relation for biomolecular processes. A. C. Barato and U. Seifert, Phys. Rev. Lett. 114, 158101, 2015

Schedule: 10th November (11:20 - 12:00)

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7. Florencia Carusela

Title: Work and heat for two-level systems in dissipative environments: Strong driving and non-Markovian dynamics.

Abstract: Work, moments of work and heat flux are studied for the generic case of a strongly driven two- level system immersed in a bosonic heat bath in domains of parameter space where perturbative treatments fail. This includes particularly the interplay between non-Markovian dynamics and moderate to strong external driving. Exact data are compared with predictions from weak coupling approaches. Further, the role of system-bath correlations in the initial thermal state and their impact on the heat flux are addressed. The relevance of these results for current experimental activities on solid state devices is discussed. (Phys. Rev. B 91, 224303(2015)).

Schedule: 10th November (12:00 - 12:20)

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8. Kirone Mallick

Title: Matrix Ansatz and Algebraic Bethe Ansatz for the Exclusion Process.

Abstract: In this talk, we shall explain how the stationary measure of multi-species exclusion processes on a ring can be expressed by using a matrix product representation. The algebras involved are constructed recursively by performing tensor products of the fundamental quadratic algebra that appeared in the solution of the archetypal ASEP problem (Derrida et al. 1993). In the second part, we explain how to define multi-species models in systems with open boundaries without breaking integrability. This will allow us to clarify the relation between the algebraic Bethe Ansatz and matrix product representations.

Schedule: 11th November (11:20 - 12:00)

9. Tomohiro Sasamoto

Title: Application of duality to stochastic non-equilibrium models.

Abstract: (Self-)duality has been known to be a useful tool for studying stochastic interacting particle systems. A well-known example is the self-duality for symmetric simple exclusion process(SEP). It implies that the n-point correlation functions satisfy the n-particle evolution equation of the same process and is known to be related to the SU(2) symmetry of the process. Another example with a self-duality is the Kipnis-Marchioro-Pressutt(KMP) model with SU(1,1) symmetry.

There had been much less studies on (self-)dualities for processes with asymmetry, but recently it turned out that the self-duality for the one-dimensional asymmetric simple exclusion process (ASEP), which is related to the q-deformed symmetry $U_q(sl_2)$, provides a very effective way to study fluctuations of the current and other quantities.

Recently we have presented a rather general scheme to construct asymmetric interacting processes with a given deformed symmetry[CGRS] and found a few applications. In this talk, we first review the duality for SEP, KMP and ASEP, and then explain our recent results with a few examples.

[*CGRS*] G. Carinci, C. Giardina, F. Redig and T. Sasamoto, A generalized Asymmetric Exclusion Process with $U_q(sl_2)$ stochastic duality, arXiv: 1407.3367; Asymmetric stochastic transport models with $U_q(su(1,1))$ symmetry, 1507.01478.

Schedule: 11th November (12:00 - 12:40)

10. Gregory Schehr

Title: Large time zero temperature dynamics of the spherical p=2-spin model of finite size.

Abstract: We revisit the long time dynamics of the spherical fully connected spin-glass model, i.e. the spherical p=2-spin model, when the number of spins N is large but finite. At T=0 where the system is in a (trivial) spin-glass phase, and on long time scale we show that the behavior of physical observables, like the energy, correlation and response functions, is controlled by the density of near-extreme eigenvalues at the edge of the spectrum of the coupling matrix, and are thus non self-averaging. We show that the late time decay of these observables, once averaged over the disorder, is controlled by

new universal exponents which we compute exactly.

Schedule: 13th November (09:30 - 10:10)

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11. Anupam Kundu

Title: Exact gap statistics for the random average process on a ring with a tracer.

Abstract: I will talk about statistics of the gaps in Random Average Process (RAP) on a ring with particles hopping symmetrically, except one tracer particle which could be driven. These particles hop either to the left or to the right by a random fraction of the space available till next particle in the respective directions. The random fraction $\eta \in [0, 1)$ is chosen from a distribution $R(\eta)$. For non-driven tracer, when $R(\eta)$ satisfies a necessary condition, the stationary joint distribution of the gaps between successive particles takes an universal form that is factorized except for a global constraint. Some interesting explicit forms of $R(\eta)$ are found which satisfy this condition. In case of driven tracer, the system reaches a current-carrying steady state where such factorization does not hold. Analytical progress has been made in the thermodynamic limit, where we computed the single site mass distribution inside the bulk can be computed. I will show that the two point gap-gap correlation can also be obtained exactly in that limit. To support our analytical results I will present numerical simulations.

Schedule: 12th November (09:30 - 10:10)

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12. Keiji Saito

Title: Rigorous bound on energy absorption and generic relaxation in periodically driven quantum systems.

Abstract: We discuss the universal nature of relaxation in isolated many-body quantum systems subjected to global and strong periodic driving. Our rigorous Floquet analysis shows that the energy of the system remains almost constant up to an exponentially long time in frequency for arbitrary initial states and that an effective Hamiltonian obtained by a truncation of the Floquet-Magnus expansion is a quasi-conserved quantity for long time scale. These two general properties lead to intriguing classification on the initial stage of relaxation, one of which is similar to the prethermalization phenomenon in quasi-integrable systems.

Schedule: 12th November (10:10 - 10:50)

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13. Subroto Mukerjee

Title: Many-body localization in the presence of a single particle mobility edge.

Abstract: In one dimension, noninteracting particles can undergo a localization-delocalization transition in a quasiperiodic potential. Recent studies have suggested that this transition transforms into a many body localization transition upon the introduction of interactions. It has also been shown that mobility edges can appear in the single particle spectrum for certain types of quasiperiodic potentials. Here we investigate the effect of interactions in models with such mobility edges. Employing the technique of exact diagonalization for finite-sized systems, we calculate the level spacing distribution, time evolution of entanglement entropy, optical conductivity and return probability to characterize the nature of localization. The localization that develops in the presence of interactions in these systems appears to be different from regular Many-Body Localization (MBL) in that the growth of entanglement entropy with time is linear (like in a thermal phase) but saturates to a value much smaller than the thermal value (like for MBL). All other diagnostics seem consistent with regular MBL.

Schedule: 13th November (10:10 - 10:50)

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14. Tridib Sadhu

Title: Dynamical properties of a tagged particle in single file.

Abstract: Diffusion of impenetrable particles in a crowded one-dimensional channel is referred as the single file diffusion. The particles do not pass each other and this leads to subdiffusion of a tagged particle. In the first half I shall talk about a simple realization of the single file problem where one dimensional Brownian particles interact only by hard-core repulsion. I shall show that the large deviation function of the tagged particle displacement can be computed in a simple way via a mapping to a problem of non-interacting Brownian particles. Our method is easily extended to calculate multi-time correlations. In the second half I shall device a formalism using Macroscopic Fluctuation Theory giving the cumulant generating functional which contains all multi-time correlation functions. This formulation applies to a broad class of single file systems. I shall finish my talk presenting an exact relation between the distribution of the tagged particle position and the distribution of the current. This allows us to get the full statistics of the tracer position for the symmetric simple exclusion process at density half in the fixed initial ensemble.

References
(1) Tridib Sadhu, and Bernard Derrida, JSTAT, (2015) P09008
(2) P L Krapivsky, Kirone Mallick, and Tridib Sadhu, JSTAT, (2015) P09007

Schedule: 13th November (11:20 - 12:00)

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15. Suman Das

Title: Understanding normal transport in one-dimension: The case of the Coupled Rotator Model.

Abstract: Translationally invariant classical systems in one dimension are known to exhibit anomalous diffusion of energy, characterized by diverging transport coefficients. A tantalizing exception is the coupled rotator model, where numerical simulations clearly show normal transport. We study the model through a simple hydrodynamic analysis, and demonstrate that it indeed belongs to a different class owing to fewer conserved variables. We propose some general criteria for normal transport based on this analysis.

Schedule: 13th November (12:00 - 12:20)

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16. Bijay Kumar Agarwalla

Title: Charge transport and thermoelectric efficiency in vibrationally assisted molecular junction.

Abstract: We study charge, energy transport and thermoelectric efficiency in Aviram-Ratner donor-acceptor type molecular junction where the transport is assisted by a molecular vibrational mode. To understand the role of mode harmonicity/anharmonicity on transport behaviour, we consider two limiting situations : (i) the molecular mode is assumed to be harmonic, (ii) we truncate the mode spectrum to include only two vibrational levels, to represent an anharmonic molecular mode. We analyze the counting statistics, linear response and nonlinear performance of the junction of these two models and demonstrate that while the electrical and thermal conductances are sensitive to the modes properties, the Seebeck coefficient, the thermoelectric figure-of-merit and the thermoelectric efficiency, beyond linear response, conceal this information. The talk will be based on the following papers

1. Bijay. K. Agarwalla, J. -H. Jiang, D. Segal, ArXiv: 1508.02475
2. Bijay. K. Agarwalla, J.H. Jiang and D. Segal, ArXiv: 1506.03102
3. J.H. Jiang, Bijay. K. Agarwalla and D. Segal, Phys. Rev. Lett 115 040601 (2015).

Schedule: 13th November (12:20 - 12:40)

Week 4

1. Urna Basu

Title: How Statistical Forces Depend on the Thermodynamics and Kinetics of Driven Media.

Abstract: The statistical force of a nonequilibrium environment on a quasistatic probe is studied. In the linear regime around equilibrium, the isothermal work on the probe equals the excess work for the medium to relax to its new steady condition with a displaced probe. Also, the relative importance of reaction paths can be measured via statistical forces, and from second order onwards the force on the probe reveals information about nonequilibrium changes in the reactivity of the medium. We also show that statistical forces for nonequilibrium media are generally nonadditive, in contrast with the equilibrium situation.

Schedule: 16th November (10:00 - 10:30)

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2. Arghya Dutta

Title: Modelling aggregation and fragmentation phenomena using the Smoluchowski equation.

Abstract: In nature, there are a number of physical phenomena whose dynamics are dominated by transport, aggregation and fragmentation. Examples include formation of raindrops, polymerization and the formation of the planetary rings. In this talk, I will present results from an analysis of a model with collision dependent fragmentation, based on the Smoluchowski equation. For a general class of collision kernels, I will derive the scaling limits of the mass distribution using moment and singularity analysis of the generating functions, and exact solutions for special cases. We will identify a new regime (relevant for ballistic collision) where the exponents depend non-trivially on the kernel.

Schedule: 16th November (10:30 - 11:00)

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3. Abhiram Soori

Title: Quantum charge pumping - Flouquet states and topological pumping.

Abstract: This talk comprises of two parts: (1) Charge pumped in an isolated ring driven by time-dependent potentials is analysed. While the system described by purely unitary time evolution never reaches a steady state, the charge pumped on an average can still be calculated. The current is essentially carried by the Floquet states. (2) A time dependent scatterer coupled to two leads can pump charge from one lead to the other. A class of scatterers where in the instantaneous transmission amplitude at all times is exponentially suppressed can still pump a quantum of charge in one full cycle. A possible realization of this situation in topological insulators will be discussed.

Schedule: 17th November (10:30 - 11:00)
