WWU
MÜNSTER

Quantum many body systems and interacting particles: in honor of Herbert Spohn

June 20-24, 2022
Münster

Organizing Committee:

Gerold Alsmeyer
Chiranjib Mukherjee
Raimar Wulkenhaar

General information

Venue. *Registration*: Second floor of the SRZ (Orléans-Ring 12, cf. Map A) on Monday. *Lecture room*: SRZ 217.
You can find the latest information on the homepage of the conference.

Wi-Fi access. If you are part of the eduroam community, you may connect to the network "eduroam" as usual. Otherwise you can connect to the SSID "GuestOnCampus" and start any web browser. You will automatically be redirected to the login page. Confirm the terms of use and click on "log in for free". 1 GB data volume is available per device and day. Please note that the connection is not encrypted.

Talks. If your presentation needs a **projector**, please try to send a copy of your slides **the day before your talk** to chiranjib.mukherjee@uni-muenster.de.

Coffee break/Lunch. We provide coffee and snacks during the coffee breaks. There are a couple of restaurants for lunch in the vicinity:

- Canteen - Mensa am Ring, Domagkstraße 61 (most convenient option, even if not the most idyllic place)
- Ristorante Milano (Italian), Wilhelmstraße 26 (closed on Monday)
- Il Gondoliere (Italian), Von-Esmarch-Straße 28 (closed on Monday)
- Buddha Palace (Indian), Von-Esmarch-Straße 18
- La Gondola D'oro (Italian), Hüfferstraße 34
- A2 am See (German), Annette-Allee 3
- Gustav Grün (Green Fast Food), Wilhelmstraße 1
- Áro (Green Fast Food), Neutor 3

Conference dinner. The conference dinner takes place on Wednesday at 6.30 p.m. at the Mövenpick Hotel (Kardinal-von-Galen-Ring 65, cf. Map B).

Public transportation. You can check the bus schedule on the website of Stadtwerke-Münster (in German and English), or use Google maps.

Free afternoon on Wednesday. There will be a free afternoon on Wednesday and here are some suggestions: Go see the castle, its garden and/or the included botanic garden. Visit a museum, e.g. the LWL Museum of Art and Cultural History or the Picasso-Museum. Have a walk around the Aasee lake or make yourself familiar with European history at the Historical City Hall where the peace of the Thirty Years' War was negotiated. Further information will follow during the conference.

Questions. In case of further questions, please ask Chiranjib Mukherjee:
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Phone/ WhatsApp: +49 157 50 11 99 18

Acknowledgements

The conference is funded by the German Research Foundation (DFG) and the Cluster of Excellence "Mathematics Münster" (MM).

Schedule

Monday, June 20

08:30-09:00 Registration

09:00-09:50 **Jeremy Quastel**: Polynuclear growth and the Toda lattice

09:50-10:40 **Marek Biskup**: Invariance principle for random walks in dynamical random environments

10:40-11:10 Coffee

11:10-12:00 **Mario Pulvirenti**: Some consideration on the derivability of some kinetic equations from particle systems

12:00-14:00 Lunch

14:00-14:50 **Chiara Saffirio**: Mean-field evolution and semiclassical limit of many interacting fermions

14:50-15:40 **Sergio Simonella**: Cluster expansion on cluster paths

15:40-16:10 Coffee

16:10-17:00 **Jani Lukkarinen**: Cumulant hierarchy and kinetic theory of the spatially homogeneous discrete non-linear Schrödinger equation

17:00-17:50 **Ivan Corwin**: How do boundaries and perturbations influence stochastic growth? (online)

18:30 Wine and cheese reception, open end

Tuesday, June 21

09:00-09:50 **Bernard Derrida**: Travelling waves and disordered systems

09:50-10:40 **Jean-Dominique Deuschel**: An isomorphism theorem for anharmonic fields and scaling limits

10:40-11:10 Coffee

11:10-12:00 **Stefan Grosskinsky**: Poisson-Dirichlet asymptotics in condensing particle systems

12:00-14:00 Lunch

14:00-14:50 **Robert Seiringer**: Ground state energy and effective mass of a strongly coupled polaron

14:50-15:40 **Christian Hainzl**: Bosonic features of fermionic systems

15:40-16:10 Coffee

16:10-17:00 **Stefan Teufel**: Towards bulk edge correspondence in microscopic models of interacting fermion systems

17:00- 17:50 **Stephan Luckhaus**: Two scale graphs in epidemiology

Wednesday, June 22

08:45-09:35 **Tadahisa Funaki**: KPZ limit for 1D Ginzburg-Landau model (online)

09:35-10:25 **Massimiliano Gubinelli**: Towards stochastic quantisation of Euclidean Fermions

10:25-11:15 **Anton Bovier**: Fluctuations of the free energy in p-spin SK models on two scales

11:15-11:40 Coffee

11:40-12:30 **S.R.S. Varadhan**: The Polaron measure, the Pekar process and its properties

12:30-14:00 Lunch

14:00 Free afternoon

18:30 Conference dinner, Mövenpick Hotel

Thursday, June 23

09:00-09:50 **Frank den Hollander**: Switching interacting particle systems (online)

09:50-10:40 **Sunder Sethuraman**: On atypical motions of a tagged particle in asymmetric simple exclusion

10:40-11:10 Coffee

11:10-12:00 **Claudio Landim**: An analytical view on metastability (online)

12:00-13:30 Lunch

13:30-14:20 **Stefano Olla**: Heat flow in a system in contact with a thermal bath subjected to periodic forcing

14:20-15:10 **Wolfgang König**: The free energy of a box version of the interacting Bose gas

15:10-16:00 **Benjamin Schlein**: Dynamics of extended Fermi gases at high densities

16:00-16:30 Coffee

16:30-17:20 **Michael Aizenman**: Random loop ensembles as a common mathematical scaffolding of some quantum and classical stat. mech. models (Lecture building, M2)

17:20- 18:10 **Simone Warzel**: Recent progress in quantum spin glasses (Lecture building, M2)

Friday, June 24

08:45-09:35 **Fabio Toninelli**: Logarithmic super-diffusivity for 2-dimensional out of equilibrium systems

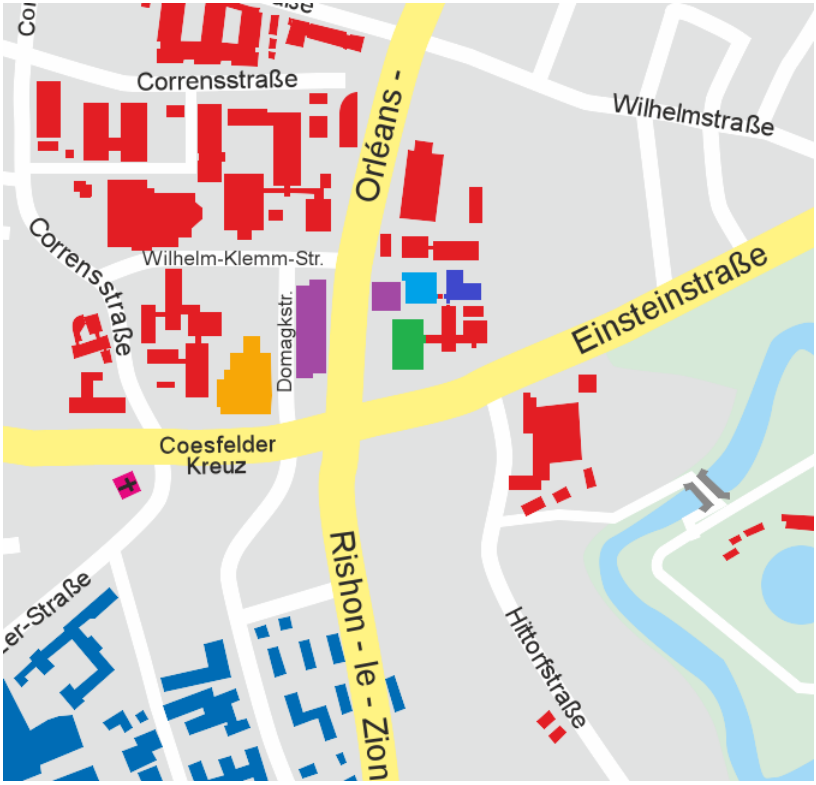
09:35-10:25 **Erwin Bolthausen**: Approximate message passage and the TAP equation

10:25-11:15 **Giambattista Giacomin**: Disordered systems and random matrix products

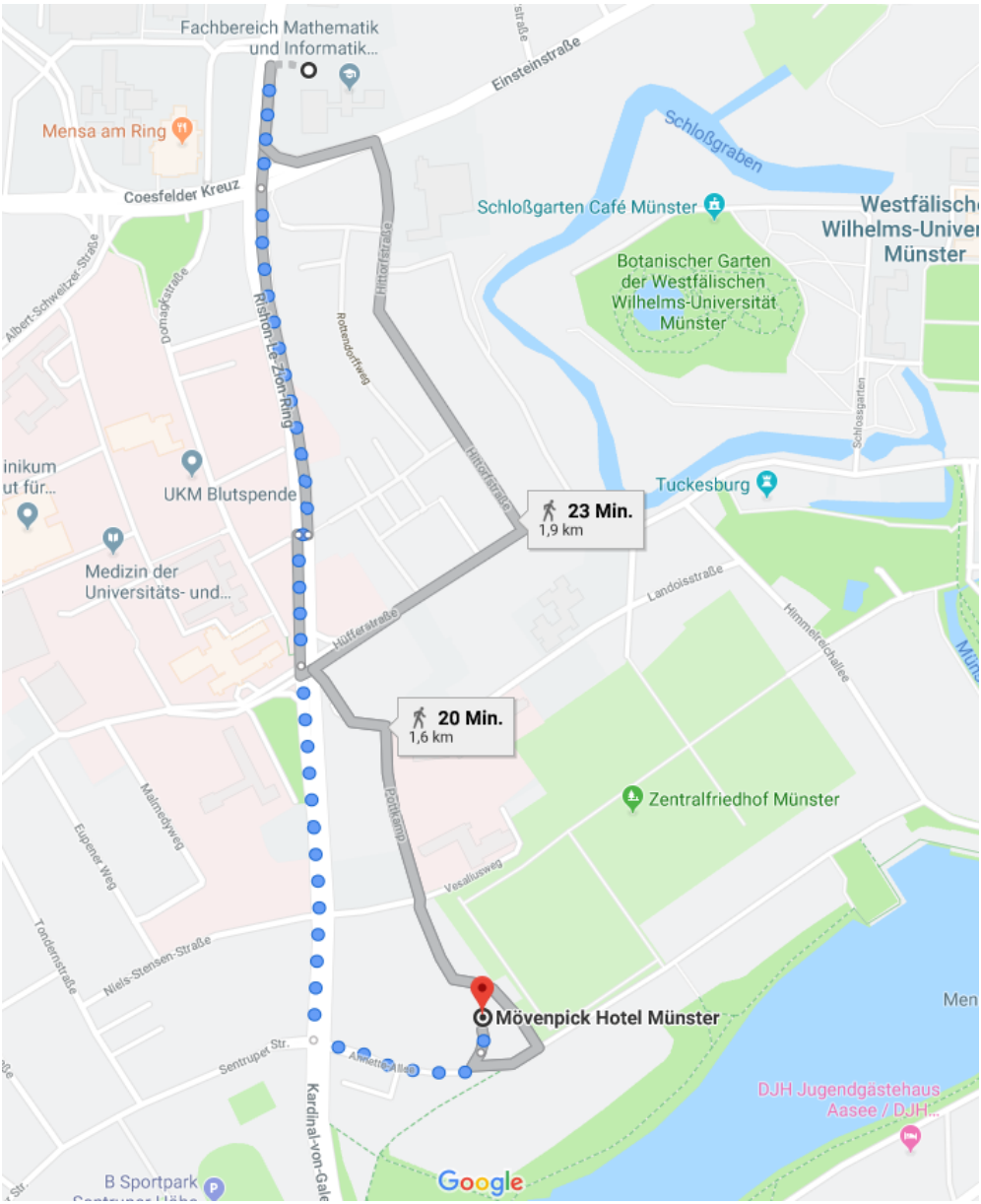
11:15-11:40 Coffee

11:40-12:30 **Patrik Ferrari**: Space-time correlations in the KPZ universality class

Maps and locations



Map A: Lecture building, canteen, SRZ, MM building, parking lot.



Map B: Route to Mövenpick Hotel.

Book of abstracts

Random loop ensembles as a common mathematical scaffolding of some quantum and classical stat. mech. models

Michael Aizenman Thu 16:30

Abstract. For a number of quantum and classical spin models the partition function admits a mathematical representation in terms of random loop ensembles. The latter's emergent stochastic geometry is then of relevance for topics of direct interest in physics. Among those one finds the conditions for the possible existence of long range order, symmetry breaking, dimerization, and the dichotomy between the possible existence of spectral gap and the divergence of (magnetic) susceptibility. Through such scaffoldings, very different physics phenomena are found to share common mathematical roots, and in turn the mathematics of loop ensembles is enriched through the considerations of the related physics.

Invariance principle for random walks in dynamical random environments

Marek Biskup Mon 9:50

Abstract. I will discuss convergence to Brownian motion for random walks in space-time ergodic dynamical random environments focusing on the situations when the jump rates can be zero with positive probability. Such walks arise in studies of gradient models with convex, but not strictly so, interactions as well as natural probabilistic models such as the random walk on dynamical percolation. I will discuss the stated convergence in three specific contexts. The first one, worked out jointly with Pierre-Francois Rodriguez, concerns bounded conductances subject to a moment condition on the time when a unit conductance is accumulated on an edge. The second one is for one-dimensional models with conductances that are positive and finite with finite first positive and negative moments. The third, worked out

very recently with Minghao Pan who is an undergraduate at UCLA, is also for one-dimensional random walks but conductances that are bounded and can be zero with positive probability subject to, as for the first one, a moment condition on the time to accumulate conductance one.

Approximate message passage and the TAP equation

Erwin Bolthausen Fri 10:25

Abstract. Message passage is a method to approximately compute marginals of probability distributions having an underlying graphical structure. One of its first appearances was in decoding algorithms for error correcting codes. Depending on the underlying graphical structure, it is possible to reduce the algorithmic complexity by an approximation step which results in what is called "Approximate Message Passage". The efficiency of the corresponding algorithms was first observed in computer experiments in compressed sensing. A theoretical understanding was first obtained in spin glass theory where the AMP equations are closely related to the Thouless-Anderson-Palmer equations. More recently, it lead also to a new proof of the Gardner formula for the perceptron, extending results previously obtained by Talagrand. This is joint work with Shuta Nakajima, Nike Sun, and Changji Xu. The talk is mainly an overview.

Fluctuations of the free energy in p-spin SK models on two scales

Anton Bovier Wed 10:25

Abstract. 20 years ago, Bovier, Kurkova, and Löwe proved a central limit theorem (CLT) for the fluctuations of the free energy in the p-spin version of the Sherrington-Kirkpatrick model of spin glasses at high temperatures. In this paper we improve their results in two ways. First, we extend the

range of temperatures to cover the entire regime where the quenched and annealed free energies are known to coincide. Second, we identify the main source of the fluctuations as a purely coupling dependent term, and we show a further CLT for the deviation of the free energy around this random object. (Joint work with Adrien Schertzer).

How do boundaries and perturbations influence stochastic growth?

Ivan Corwin Mon 17:00 (online)

Abstract. What does a stochastically growing interface in contact with a boundary look like after a long time? How does a small perturbation to an initial height profile propagate in time? These questions have a rich history in the study of stochastic growth models as well as the closely related realms of interacting particle systems and directed polymers models. In this talk I will report on two recent developments – the first provides a characterization of the stationary measure for the KPZ equation in contact with boundaries on an interval and on the half-line while the second provides a law of large numbers for the motion of a second class (or defect) particle in ASEP. This talk will be based on my joint work with a number of collaborators including Amol Aggarwal, Guillaume Barraquand, Promit Ghosal, Alisa Knizel, Shalin Parehk and Hao Shen, and also draws on pivotal earlier work of many others.

Switching interacting particle systems

Frank den Hollander Wed 10:25 (online)

Abstract. In this talk we consider three classes of interacting particle systems on the integers: dependent random walks, the exclusion process, and the inclusion process. Particles can switch their jump rate between a fast rate and a slow rate. The limit equations for the macroscopic densities of

the fast and the slow particles is the well-studied double diffusivity model, a system of reaction-diffusion equations.

In order to investigate the microscopic out-of-equilibrium properties, we analyse a system consisting of two finite layers, for the fast and the slow particles, and add boundary reservoirs in both layers. Inside each layer particles move as before, but particles are injected at the left and absorbed at the right at prescribed rates that depend on the layer. We compute the steady-state distribution and the steady-state current. It turns out that uphill diffusion is possible, i.e., the total flow can be opposite to the gradient imposed by the total injection rate and the total absorption rate. This phenomenon, which cannot occur in a single-layer system, is a violation of Fick's law made possible by the switching between the layers. Joint work with Simone Floreani, Cristian Giardina, Shubhamoy Nandan and Frank Redig.

Travelling waves and disordered systems

Bernard Derrida Tue 9:00

Abstract. A joint work with Herbert in 1988 on the mean field theory of directed polymers triggered my interest for traveling wave equations like the Fisher -KPP equation. In this talk, I will try to review a number of past and present developments on the Bramson shift, on the noisy F-KPP equation, on the N-BBM, on the extrema of the BBM (Branching Brownian Motion) and on some exactly soluble travelling wave equations.

An isomorphism theorem for anharmonic fields and scaling limits

Jean-Dominique Deuschel Tue 9:50

Abstract. We introduce a natural measure on bi-infinite random walk trajectories evolving in a time-dependent environment driven by the Langevin dynamics associated to a gradient Gibbs measure with convex potential. We

derive an identity relating the occupation times of the Poissonian cloud induced by this measure to the square of the corresponding gradient field, which generically is not Gaussian. In the quadratic case, we recover a well-known generalization of the second Ray-Knight theorem. We further determine the scaling limits of the various objects involved in dimension 3, which are seen to exhibit homogenization. In particular, we prove that the renormalized square of the gradient field converges under appropriate rescaling to the Wick-ordered square of a Gaussian free field on $\mathbb{R}^3$ with suitable diffusion matrix, thus extending a celebrated result of Naddaf and Spencer regarding the scaling limit of the field itself. Joint work with Pierre-Francois Rodriguez.

Space-time correlations in the KPZ universality class

Patrik Ferrari Fri 11:40

Abstract. We consider models in the Kardar-Parisi-Zhang universality class of stochastic growth models in one spatial dimension. We study the correlations in space and time of the height function. In particular we present results on the decay of correlations of the spatial limit processes and on the universality of the first order of the covariance at macroscopically close times.

KPZ limit for 1D Ginzburg-Landau model

Tadahisa Funaki Wed 8:45 (online)

Abstract. Diehl-Gubinelli-Perkowski studied KPZ limit for 1D Ginzburg-Landau model with a weak asymmetry in a setting of energy solution. Our goal is to apply a path-wise approach based on the paracontrolled calculus. For this purpose, we establish the (equilibrium) Boltzmann-Gibbs principle of first and second orders in L^p-sense. Littlewood-Paley-Stein inequality plays a role.

Disordered systems and random matrix products

Giambattista Giacomin Fri 9:35

Abstract. Transfer matrices are a classical tool in statistical mechanics and, in presence of disorder, one is lead to consider random matrix products and the arising Lyapunov exponents. In this context a number of predictions have been set forth by physicists and many of them remain (mathematically) open problems. I will overview some of these questions, choosing to give more attention to disordered Ising chains, and I will present recent results on singular behavior of Lyapunov exponents for random transfer matrix products that yield a precise control on some statistical physics observables. Comparison with the physical predictions will be (hopefully) discussed in detail.

Poisson-Dirichlet asymptotics in condensing particle systems

Stefan Grosskinsky Tue 11:10

Abstract. Abstract: We study measures on random partitions, arising from condensing stochastic particle systems with stationary product distributions. We provide fairly general conditions on the stationary weights, which lead to Poisson-Dirichlet statistics of the condensed phase in the thermodynamic limit. The Poisson-Dirichlet distribution is known to be the unique reversible measure of split-merge dynamics for random partitions, which we use to characterize the limit law for the stationary result. We also describe the limiting dynamics of the condensed phase in the inclusion process as a measure-valued diffusion, which coincides with the well-known Poisson-Dirichlet diffusion in a particular scaling regime. This is joint work with Simon Gabriel and Paul Chleboun.

Towards stochastic quantisation of Euclidean Fermions

Massimiliano Gubinelli Wed 9:35

Abstract. I will discuss recent developments on Grassmann stochastic analysis which allow to discuss stochastic quantisation of Gibbs measures over Grassmann Gaussian random variables. One application of such a formalism is the construction of Euclidean correlation functions for Fermionic QFTs. I will present preliminary results on the removal of the UV in a simple model (Joint work with Luca Fresta and Francesco de Vecchi).

Bosonic features of fermionic systems

Christian Hainzl Tue 14:50

Abstract. I present recent results on many body fermi systems, and argue that in the high density fermi gas as well as in the low density gas the correlation energy can be recovered by interpreting pairs of fermions as bosons.

The free energy of a box version of the interacting Bose gas

Wolfgang König Thu 14:20

Abstract. The interacting quantum Bose gas is a random ensemble of many Brownian bridges (cycles) of various lengths with interactions between any pair of legs of the cycles. It is one of the standard mathematical models in which a proof for the famous Bose–Einstein condensation phase transition is sought for. We introduce a simplified version of the model in $\mathbb{Z}^d$ instead of $\mathbb{R}^d$ and with an organisation of the particles in deterministic boxes instead of Brownian cycles as the marks of a reference Poisson point process.

We derive an explicit and interpretable variational formula in the thermodynamic limit for the canonical ensemble for any value of the particle density. In this formula, each of the microscopic particles and the macroscopic part of the configuration are seen explicitly (if they exist); the latter receives the interpretation of the condensate. The methods comprises a two step large-deviation approach for marked Poisson point processes and an explicit distinction into microscopic and macroscopic marks. We discuss the condensate phase transition in terms of existence of minimizer. (based on joint works with Adams/Collevecchio (2011) and Collin/Jahnel (preprint 2022).)

An analytical view on metastability

Claudio Landim Thu 11:10 (online)

Abstract. In this talk we discuss some analytical approaches to metastability. We present the resolvent method and a large deviations perspective, showing that the large deviations rate function Γ-converges at different speeds, each of which corresponds to the depth of the wells.

Two scale graphs in epidemiology

Stephan Luckhaus Tue 17:00

Abstract. TBA

Cumulant hierarchy and kinetic theory of the spatially homogeneous discrete non-linear Schrödinger equation

Jani Lukkarinen Mo 16:10

Abstract. Wick polynomials of random variables provide a convenient regularization scheme of the corresponding monomials. In this talk, we apply the Wick polynomial regularization to the discrete nonlinear Schrödinger evolution (DNLS) with suitable random, spatially homogeneous initial data, and show how they can be employed to simplify the cumulant hierarchy of the system. In particular, we use the simplified hierarchy to study evolution of the corresponding Wigner functions. We discuss how recent advances in the study of such hierarchies might be combined to both derive a finite volume version of the kinetic evolution equation, and to control its accuracy for large volumes and sufficiently small couplings. The talk is based on joint work with Aleksis Vuoksenmaa, and earlier works with Matteo Marcozzi, Alessia Nota, and Herbert Spohn.

Heat flow in a system in contact with a thermal bath subjected to periodic forcing

Stefano Olla Thu 13:30

Abstract. We investigate the properties of a harmonic chain in contact at its left end with a thermal bath and subjected at its right end to a periodic force. The particles are also subjected to a random velocity reversal action. The latter gives the system a finite heat conductivity. We prove the approach of the system to a time periodic state and compute the heat current, equal to the time averaged work done on the system, in that state. Rescaling space, time and the strength of the force leads to a continuum heat equation with Neumann boundary condition on the right, fixing the amount of heat current flowing into the system, and Dirichlet condition on the left,

fixing the temperature in accord to the one of the thermal bath. Works in collaboration with Tomasz Komorowski (Polish Academy of Science) and Joel Lebowitz (Rutgers).

Some consideration on the derivability of some kinetic equations from particle systems

Mario Pulvirenti Mo 11:10

Abstract. In this talk I discuss the problem of the derivation of some kinetic equations (Boltzmann, Enskog, BGK) from mechanical and stochastic particle systems, under suitable scaling limits. The emphasis will be mostly on open problem and perspectives.

Polynuclear growth and the Toda lattice

Jeremy Quastel Mo 9:00

Abstract. The polynuclear growth model is one of the most important models in the KPZ universality class. Generally it has been studied in the droplet geometry, where it is equivalent to the longest increasing subsequence of a random permutation, whose solution sparked the KPZ revolution. We study it for general initial data and show that it is an integrable Markov process sharing the key structures of the KPZ fixed point, determinantal formulas for the transition probabilities and fixed time n-point distributions governed by completely integrable equations, the non-Abelian 2D Toda lattice. Joint with Konstantin Matetski and Daniel Remenik.

Mean-field evolution and semiclassical limit of many interacting fermions

Chiara Saffirio Mo 14:00

Abstract. We will review recent progresses in the derivation of effective evolution equations for the dynamics of many weakly interacting fermions. We will focus on the mean-field regime and couple it with a semiclassical limit to obtain the Hartree-Fock and the Vlasov equations. A particular emphasis will be given on the class of singular interactions and ”regular” (in the semiclassical limit) quantum states that we are able to treat. Based on joint works with J. Chong and L. Lafléche.

Dynamics of extended Fermi gases at high densities

Benjamin Schlein Thu 15:10

Abstract. We consider systems of N fermions initially trapped in a volume V, at high density. We show that, for initial data close to Slater determinants exhibiting an appropriate semiclassical structure, the solution of the many-body Schrödinger equation can be approximated by the solution of the nonlinear Hartree equation, up to errors that are small, for large density, uniformly in N and V. This is joint work with L. Fresta and M. Porta.

Ground state energy and effective mass of a strongly coupled polaron

Robert Seiringer Tue 14:00

Abstract. We explain recent bounds on the quantum corrections to the (classical) Pekar approximation of the ground state energy of the Frölich

polaron model in the strong coupling limit, and their consequence on the effective mass.

On atypical motions of a tagged particle in asymmetric simple exclusion

Sunder Sethuraman Thu 9:50

Abstract. In one dimensional ASEP, starting from a stationary state, we study the 'typical' behaviors of a tagged particle, conditioned to deviate to 'atypical' positions at a fixed time. This is work-in-progress with S.R.S. Varadhan.

Cluster expansion on cluster paths

Sergio Simonella Mon 14:50

Abstract. We consider the hard sphere gas at low density with random initial data away from equilibrium, and study the dynamical correlations. We develop an alternative strategy to the BBGKY hierarchy, focusing on the clustering process of physical trajectories. This method is used to derive a fluctuation theory around the Boltzmann equation.

Towards bulk edge correspondence in microscopic models of interacting fermion systems

Stefan Teufel Tue 16:10

Abstract. I will briefly discuss a recent result on the bulk-edge correspondence for random magnetic Schrödinger operators modeling quantum Hall

systems of non-interacting fermions. Then I will describe how the approach developed there can also be applied to systems of interacting fermions and what mathematical issues arise. (Joint work with Horia Cornean, Jonas Lampart, Massimo Moscolari, and Tom Wessel).

Logarithmic super-diffusivity for 2-dimensional out of equilibrium systems

Fabio Toninelli Fri 8:45

Abstract. Logarithmic corrections to super-diffusivity have been conjectured to occur in several 2-dimensional out-of-equilibrium systems (interacting particle systems, self-interacting diffusions, tracers in fluids etc). A famous case where this has been predicted (by van Beijeren-Kutner-Spohn) and then proven (by Yau) is 2-dimensional Asymmetric Simple Exclusion Process (ASEP). I will present recent results with G Cannizzaro, D Erhard and L Haunschmid on logarithmic superdiffusion for a 2d Brownian particle in divergence-free random field, and for the 2d anisotropic KPZ equation.

The Polaron measure, the Pekar process and its properties

S. R. S. Varadhan Wed 11:40

Abstract. We will report on some results on the construction of the Polaron measure, and its convergence to Herbert Spohn's Pekar process in the strong coupling limit. Joint work with Chiranjib Mukherjee.

Recent progress in quantum spin glasses

Simone Warzel Thu 17:20

Abstract. I will give an overview over recent results on mean-field spin-glass models with a transversal magnetic field. For such models both thermodynamic quantities such as the free energy and its fluctuations, as well as spectral and localization properties of eigenvectors are of interest to a diverse list of communities. A full mathematical analysis of properties is completed for the simplest, yet ubiquitous quantum random energy model. For models with a more complicated (classical) correlation structure such as the Sherrington-Kirkpatrick model, a more qualitative analysis proves the existence of a phase transition.