Conference
in Honor of the 75th Birthday of S.R.S. Varadhan

August 15–19, 2016, TU Berlin

Book of Abstracts

Inés Armendáris:

Metastability in condensing zero-range processes

We consider zero-range processes with jump rates that decrease with the occupation number, which are known to exhibit a condensation phenomenon where a fraction of all particles concentrates on a single lattice site. We derive a scaling limit for the asymptotic stationary dynamics of the condensate location in the thermodynamic limit on a one-dimensional torus. Our proof follows previously developed methods using potential theory and a martingale approach. Joint work with A. de Masi, S. Grosskinsky, M. Loulakis and E. Presutti.

Gérard Ben Arous:

Scaling limit for the ant in some labyrinths

I will report on recent work with Manuel Cabezas and Alexander Fribergh, giving general conditions for proving the scaling limit for the random walk on large critical random graphs in large dimensions.

Erwin Bolthausen:

Gaussian random fields with local pinning

We give an overview on some recent results concerning a class of random fields defined on the hypercubic lattice which have slowly decaying correlations. Examples are the lattice versions of the free fields, and the so-called membrane models. A local pinning means that the random field is modified in a way to have a preference to stay close to a deterministic "wall". This typically drastically modifies the character of the random field. We will focus on two recent results, the first one with Taizo Chyonobu and Tadahisa Funaki on the behavior in the presence of two possible candidates for the global behavior, and the second one with Alessandra Cipriani and Noemi Kurt on the exponential decay of correlations for the membrane model.

Peter Friz:

A Stroock-Varadhan support theorem for a singular SPDE

We consider the generalized parabolic Anderson equation (gPAM) in 2 dimensions with periodic boundary. This is an example of a singular semilinear stochastic partial differential equation in the subcritical regime, which can be understood either via Hairer's regularity structures or paracontrollled distributions due to Gubinelli, Imkeller and Perkowski. Using the paracontrolled machinery we obtain a Stroock–Varadhan support theorem. In the spirit of rough paths, the crucial step is to identify the support of the enhanced noise in a sufficiently fine topology. The renormalization is seen to affect the support description in a delicate way. (Joint work with K. Chouk)

Martin Hairer:

Algebraic aspects of renormalisation

We will discuss the algebraic structure underpinning much of perturbative renormalisation and will see how two instances of this structure intertwine in the context of regularity structures.

Elena Kosygina:

Homogenization of viscous Hamilton-Jacobi equations: a remark and an application

It has been pointed out in the seminal work of P.-L. Lions, G. Papanicolaou, and S.R.S. Varadhan that for the first order Hamilton-Jacobi (HJ) equation, homogenization starting with affine initial data should imply homogenization for general uniformly continuous initial data. The argument utilized the properties of the HJ semi-group, in particular, the finite speed of propagation. The last property is lost for viscous HJ equations. We remark that the above mentioned implication holds under natural conditions for both viscous and non-viscous Hamilton-Jacobi equations. As an application of our result, we show homogenization in a stationary ergodic setting for a special class of viscous HJ equations with a non-convex Hamiltonian in one space dimension. This is a joint work with Andrea Davini, Sapienza Università di Roma.

Claudio Landim:

Metastability and reaction-diffusion equations

We present some recent progresses in the theory of large deviations of reaction-diffusion models and in the metastable behavior of interacting particle systems.

Michail Loulakis:

A stochastic control problem for the deposition of phosphorus in shallow lakes

Shallow lake systems provide conflicting services as clear water resources and as a waste sinks to agricultural activities. We study the welfare function of a control problem for the deposition of phosphorus in shallow lakes. Stochastic analysis provides crucial properties for the welfare function e.g., boundary behaviour, regularity, monotonicity and asymptotic behaviour. We use these estimates to show that the welfare function is the unique constrained viscosity solution to the proper Hamilton-Jacobi-Bellman equation with the correct asymptotic behaviour at infinity.

Terry Lyons:

From Hopf algebras to machine learning via rough paths

Rough path theory aims to build an effective calculus that can model the interactions between complex oscillatory (rough) evolving systems. At its mathematical foundations, it is a combination of analysis blended with algebra that goes back to LC Young, and to KT Chen. Key to the theory is the essential need to incorporate additional non-commutative structure into areas of mathematics we thought were stable. At its high points, there are the regularity structures of Martin Hairer that allow robust meaning to be given to numerous core nonlinear stochastic pdes describing evolving interfaces in physics.

Classic results, by Clark, Cameron and Dickinson, demonstrate that a nonlinear approach to the data is essential. Rough path theory lives up to this challenge and can be viewed as providing fundamentally more efficient ways of approximately describing complex data; approaches that, after penetrating the basic ideas, are computationally tractable and lead to new scalable ways to regress, classify, and learn functional relationships from data. One non-mathematical application that is already striking is the use of signatures on a daily basis in the online recognition of Chinese Handwriting on mobile phones.

Chiranjib Mukherjee:

The polaron path measure for strong coupling and its mean-field approximation

In a reasonable topological space, large deviation estimates essentially deal with probabilities of events that are asymptotically (exponentially) small, and in a certain sense, quantify the rate of these decaying probabilities. In such estimates, upper bounds for such small probabilities often require compactness of the ambient space, which is often absent in problems arising in statistical mechanics (for example, distributions of local times of Brownian motion in the full space $\mathbb{R}^d$). Motivated by such a problem, we present a robust theory of "translation-invariant compactification" of probability measures in $\mathbb{R}^d$. Thanks to an inherent shift-invariance of the underlying problem, we are able to apply this abstract theory painlessly and solve an interesting problem in statistical mechanics, the mean-field polaron problem.

This talk is based on joint works with S. R. S. Varadhan (New York) as well as Erwin Bolthausen (Zurich) and Wolfgang König (Berlin).

Stefano Olla:

Entropic hypocoercivity and hydrodynamic limits

Entropic hypocoercivity provides estimates independent of the dimensions of the system. It seems to be the right tool to extend relative entropy methods to degenerate dynamics where noise acts only on velocities. I will provide some examples that were untreatable before.

Ross Pinsky:

A natural probabilistic model on the integers and its relation to Dickman-type distributions and Buchstab's function

Let $\{p_j\}_{j=1}^{\infty}$ denote the set of prime numbers in increasing order, let $\Omega_N \subset \mathbb{N}$ denote the set of positive integers with no prime factor larger than p_N and let P_N denote the probability measure on Ω_N which gives to each $n \in \Omega_N$ a probability proportional to $\frac{1}{n}$. This measure is in fact the distribution of the random integer $I_N \in \Omega_N$ defined by $I_N = \prod_{j=1}^{N} p_j^{X_{p_j}}$, where $\{X_{p_j}\}_{j=1}^{\infty}$ are independent random variables and X_{p_j} is distributed as Geom$(1-\frac{1}{p_j})$. Let $D_{\text{nat}}(A)$ denote the natural density of $A \subset \mathbb{N}$, if it exists, and let $D_{\text{log-indep}}(A) = \lim_{N\to\infty} P_N(A \cap \Omega_N)$ denote the density of A arising from $\{P_N\}_{N=1}^{\infty}$, if it exists. We show that the two densities coincide on a natural algebra of subsets of $\mathbb{N}$. We also show that they do not agree on the sets of "smooth" numbers $\{n \in \mathbb{N} : p^+(n) \leq n^{\frac{1}{s}}\}$, $s > 1$, where $p^+(n)$ is the largest prime divisor of n. This last consideration concerns distributions involving the Dickman function. We also consider the sets of "rough" numbers $\{n \in \mathbb{N} : p^-(n) \geq n^{\frac{1}{s}}\}$, $s > 1$, where $p^-(n)$ is the smallest prime divisor of n. We show that the probabilities of these sets, under the uniform distribution on $[N] = \{1, \ldots, N\}$ and under the P_N-distribution on Ω_N, have the same asymptotic decay profile, although their rates are necessarily different. This profile is given by the Buchstab function. We also prove a new representation for the Buchstab function.

Alejandro Ramirez:

Asymptotic expansion of the invariant measure for ballistic random walks in random environment in the low disorder regime

We consider a random walk in random environment in the low disorder regime on $\mathbb{Z}^d$. That is, the probability that the random walk jumps from a site x to a nearest neighboring site xe is given by $p(e)\epsilon\xi(x,e)$, where $p(e)$ is deterministic, $\{\{\xi(x,e) : e_1 = 1\} : x \in \mathbb{Z}^d\}$ are i.i.d. and $\epsilon > 0$ is a parameter which is eventually chosen small enough. We establish an asymptotic expansion in ϵ for the invariant measure of the environmental process whenever a ballisticity condition is satisfied. As an application of our expansion, we derive a numerical expression up to first order in ϵ for the invariant measure of random perturbations of the simple symmetric random walk in dimensions $d = 2$. This is a joint work with David Campos.

José Ramírez:

The hard edge of beta ensemble, spiking and transitions

We characterize the limiting smallest eigenvalue distributions (or hard edge laws) for sample covariance type matrices drawn from a spiked population. The limit laws are described in terms of random integral operators, and partial differential equations satisfied by the corresponding distribution functions are derived as corollaries. We also show that, under a natural limit, all spiked hard edge laws derived here degenerate to the critically spiked soft edge laws (or deformed Tracy-Widom laws).

Firas Rassoul-Agha:

KPZ wandering exponent for random walk in i.i.d. dynamic Beta random environment

We condition random walk in an i.i.d. dynamic Beta random environment to escape at an atypical velocity. The conditioned process converges to another random walk in random environment (RWRE). The new environment is a Doob transform of the original one by a harmonic function that is a Busemann type limit and solves a variational formula for the quenched large deviation rate function. Along the way we construct the stationary Beta polymer and prove fluctuation bounds for it. The Doob conditioned RWRE is in duality with this polymer and as a result it has a KPZ wandering exponent of 2/3.

Fraydoun Rezakhanlou:

Hamilton-Jacobi equation, homogenization and beyond

Hamilton-Jacobi PDEs were originally formulated to study Hamiltonian ODEs. It turns out that many growth processes can be microscopically modeled by Hamilton-Jacobi equations associated with stochastic Hamiltonian functions. Macroscopic descriptions can be achieved by appropriate scaling limits. The passage from the microscopic details to the macroscopic equation is related to the homogenization phenomenon. In this talk I will give an overview of the existing results on the homogenization for Hamilton-Jacobi equations and their variants.

Insuk Seo:

Large deviation principle for interacting Brownian motions

In the last decade, Varadhan and his coworkers developed a robust framework to investigate the hydrodynamic limit and the large deviation principle for the empirical process of interacting particle systems on the lattice. Recently, corresponding results have been obtained for a system of interacting Brownian motions. In this talk, I will present the findings of this research, which was carried out under the guidance of professor Varadhan.

Sunder Sethuraman:

On deriving a long-range stochastic Burgers equation

We consider a class of stochastic interacting particle systems on Z where the single particle jump rates are weakly-asymmetric and long-range. For such systems, the scaled space-time hydrodynamic) limit of the mass density empirical measure is known. In this talk, we discuss the associated fluctuations, in certain reference frames, when the initial condition is given by an invariant measure. The 'limit', depending on the strength of the weak-asymmetry and long-range parameters, can be seen formally to satisfy a type of long-range stochastic Burgers equation.

Herbert Spohn:

Directed polymers in a two-dimensional random medium with complex weights

In the context of integrable probability directed polymers on $\mathbb{Z}^2$ have been studied extensively. The local random weights are always assumed to be positive. Physically of interest are also weights which are negative or even complex. I discuss the current status of the fluctuations of the logarithm of the partition sum.

Horng-Tzer Yau :

Spectral statistics of random graphs

We will review the recent progress in the spectral statistics for the adjacency matrices of random sparse graphs. We'll focus on Erdös-Rényi graphs and d-regular graphs with d finite. In addition to eigenvalues, we will also discuss the eigenvector statistics.

Atilla Yilmaz:

Averaged vs. quenched large deviations and entropy for random walk in a dynamic random environment

In this talk, I will present recent joint work with F. Rassoul-Agha and T. Seppalainen. We consider random walk with bounded jumps on a hypercubic lattice of arbitrary dimension in a dynamic random environment. The environment is temporally independent and spatially translation invariant. We study the rate functions of the level-3 averaged and quenched large deviation principles from the point of view of the particle. In the averaged case the rate function is a specific relative entropy, while in the quenched case it is a Donsker-Varadhan type relative entropy for Markov processes. We relate these entropies to each other and seek to identify the minimizers of the level-3 to level-1 contractions in both settings. Motivation for this work comes from variational descriptions of the quenched free energy of directed polymer models where the same Markov process entropy appears.

Ofer Zeitouni:

Sum rules via large deviations

Sum rules are relations between a probability measure (on the unit circle) and the associated Verblunsky coefficients, which are coefficients in the recursion defining orthogonal polynomials. In a recent breakthrough, Gamboa, Nagel and Rouault showed that such sum rules can be obtained as a consequence of a large deviations principle for the spectral measure of certain matrix models. I will describe a conjecture of Lukic concerning a general sum rule and some recent partial results, obtained using large deviations, supporting the conjecture.

Joint work with Jonathan Breuer and Barry Simon.

Nikos Zygouras:

Scaling limits of disordered systems

We consider statistical mechanics models defined on a lattice, such as pinning models, directed polymers, random field Ising model, in which disorder acts as an external “random field”. Such models are called disorder relevant, if arbitrarily weak disorder changes the qualitative properties of the model. Via a Lindeberg principle for multilinear polynomials we show that disorder relevance manifests itself through the existence of a disordered high-temperature limit for the partition function, which is given in terms of Wiener chaos and is model specific.

When disorder becomes *marginally* relevant a fundamentally new structure emerges, which leads to universal phenomena across all different (currently of directed polymer type) models that fall in this class, including also the two dimensional stochastic heat equation with multiplicative space-time white noise.

Based on joint works with Francesco Caravenna and Rongfeng Sun.