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INVITED TALKS AND SHORT TALKS

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INVITED TALKS

Scott Armstrong (Courant Institute, New York University)
ANOMALOUS DIFFUSION FOR PASSIVE SCALARS BY MONOFRACTAL HOMOGENIZATION

I will present some details of recent work with Vlad Vicol exploring the phenomenon of anomalous diffusion for passive scalar equations. Our main result is the construction of an explicit, deterministic example of an incompressible vector field which is Holder continuous in space and time and exhibits the anomaly: that is, the ”passive scalar”–the solution of the corresponding advection-diffusion equation–will lose half of its L^2 norm in unit time, no matter how small the molecular diffusivity is (as long as it is positive). Moreover, we show that the solution has the Holder regularity predicted by the Corrsin-Obukhov theory of passive scalar turbulence. The incompressible vector field we construct has a fractal nature and, in particular, exhibits features across an infinite sequence of small scales (these properties are also inherited by the passive scalar, as we show). To prove our results, we propagate homogenization estimates scale-by-scale up the inertial-convection subrange, until we reach the macroscopic scale. We thus indirectly show that an energy cascade occurs by analyzing the reverse cascade of effective (or ”eddy”) diffusivities.

Roland Bauerschmidt (University of Cambridge)
SPIN SYSTEMS WITH HYPERBOLIC SYMMETRY

Spin systems with hyperbolic symmetry originated as simplified models for the Anderson metal–insulator transition, and were subsequently found to exactly describe probabilistic models of linearly reinforced walks and random forests. We discuss the main features of these models, recent results, relations to other models, and some of the many open questions.

Jacob Bedrossian (University of Maryland, College Park)
LAGRANGIAN CHAOS, ALMOST SURE EXPONENTIAL MIXING, AND THE BATCHELOR SPECTRUM

In this talk we will discuss joint work with the Alex Blumenthal and Sam Punshon-Smith which proves that Lagrangian trajectories in a variety of stochastically-forced fluid equations are chaotic and, moreover, that one can prove almost-sure, exponential correlation decay which leads to exponential mixing of any passive scalar transported by the flow. We will briefly discuss how to use these facts to make mathematically rigorous some of the classical predictions of the statistical theory of “passive scalar turbulence” in a certain, especially simple regime. In particular, we verify the power spectrum predicted by Batchelor in 1959 in the settings we study. This prediction had long been observed to be consistent with experiments and scalar statistics in nature, however, it had previously lacked any mathematical justification. More recent progress on “Eulerian chaos” will be discussed if time permits.

Thierry Bodineau (CNRS and École Polytechnique, Institut Polytechnique de Paris)

CONVERGENCE OF A DILUTE GAS TO THE FLUCTUATING BOLTZMANN EQUATION

Since the seminal work of Lanford, it is known that the empirical measure of a Newtonian dynamics associated with a hard sphere gas converges, in the low density limit, towards the solution of the Boltzmann equation (at least for a short time). In this talk, we are going to study the fluctuations of the empirical measure around the solution of the Boltzmann equation and show that for a short time, it converges to a Gaussian process: the fluctuating Boltzmann equation. Furthermore, starting from the equilibrium measure, this convergence can be derived for arbitrarily long times.

Paul Bourgade (Courant Institute, New York University)

THE FYODOROV–HIARY–KEATING CONJECTURE

Fyodorov–Hiary–Keating proposed very precise asymptotics for the maximum of the Riemann zeta function in almost all intervals along the critical axis. After reviewing the origins of this conjecture through the random matrix analogy, I will explain a proof up to tightness, building on an underlying branching structure. This work with Louis-Pierre Arguin and Maksym Radziwill relies on a multiscale analysis and twisted moments of zeta.

Dmitry Chelkak (ENS Paris)

ISING AND DIMER MODELS ON PLANAR GRAPHS VIA EMBEDDINGS INTO MINKOWSKI SPACES

We will discuss a recent approach to understanding the ‘discrete conformal structure’ of big planar graphs carrying the Ising or the bipartite dimer model via the so-called s-/t-embeddings, which are also known as Coulomb gauges in the dimer model context. These embeddings are certain tilings of the complex plane; the related notion of discrete holomorphic functions generalizes the ideas of Kenyon, Smirnov and their co-authors from 2000s. As a ‘straightforward’ application, this construction allows one to better understand the universality in the critical Ising model, far beyond the usual setup of isoradial grids. More importantly, it brings a new geometric aspect to the analysis: the conformal structure describing the scaling limit of the model comes from that of the limit of certain space-like surfaces living in the 2+1 or 2+2 Minkowski spaces that are naturally associated to s-/t-embedding.

Ivan Corwin (Columbia University)
HOW DO BOUNDARIES AND PERTURBATIONS INFLUENCE STOCHASTIC GROWTH?

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.

Hugo Duminil-Copin (Université de Genève and IHES)
EMERGENT SYMMETRIES IN 2D STATISTICAL PHYSICS

A great achievement of physics in the second half of the twentieth century has been the prediction of conformal symmetry of the scaling limit of critical statistical physics systems. Around the turn of the millennium, the mathematical understanding of this fact progressed tremendously in two dimensions with the introduction of the Schramm–Loewner Evolution and the proofs of conformal invariance of Bernoulli percolation, the Ising model and dimers. Nevertheless, as for today the understanding remains restricted to very specific models. In this talk, we will introduce the notion of conformal invariance of lattice systems by taking the example of percolation models. We will also present some recent progress in the direction of proving full conformal invariance for a large class of such models. An important role will be played by a geometric interpretation of the notion of integrable system, and the notion of universality.

László Erdős (IST Austria)
ON THE RIGHTMOST EIGENVALUE OF NON-HERMITIAN RANDOM MATRICES

We establish a precise three-term asymptotic expansion, with an optimal estimate of the error term, for the rightmost eigenvalue of an $n \times n$ random matrix with independent identically distributed complex entries as n tends to infinity. All terms in the expansion are universal. This a joint work with Giorgio Cipolloni, Dominik Schroder and Yuanyuan Xu.

Christophe Garban (Université Claude Bernard Lyon 1)
EXIT SETS FOR VECTOR VALUED GFF AND INTERPLAY WITH PLANAR O(N) MODELS

The planar vector-valued Gaussian Free Field (GFF) is a Gaussian random field h from $\mathbb{Z}^2$ to $\mathbb{R}^n$ which arises naturally in the low-temperature analysis of planar spin-O(N) models $\sigma : \mathbb{Z}^2 \to S^n$ (with $n = N + 1$). The purpose of this talk is twofold:

- I will start by describing the geometry of the ”level sets” of the vector valued GFF $h : \mathbb{Z}^2 \to \mathbb{R}^n$ when $n \geq 2$.
- In the second part, I will explain how the behaviour of these level sets sheds some new light on the conjectural absence of phase transition for 2d spin-O(N) models when $N \geq 3$ (Polyakov's conjecture, 1975). Our description of the exit sets of the vector valued GFF allows us in particular to revisit a series of works by Patrascioiu-Seiler which questioned Polyakov's prediction.

This is a joint work with Juhan Aru (EPFL) and Avelio Sepúlveda (Universidad de Chili).

Alessandro Giuliani (Univ. Roma Tre and Centro Linceo Interdisciplinare “B. Segre”)
SCALING LIMITS AND UNIVERSALITY OF ISING AND DIMER MODELS

After having introduced the notion of universality in statistical mechanics and its importance for our comprehension of the macroscopic behavior of interacting systems, I will review recent progress in the understanding of the scaling limit of lattice critical models, including a quantitative characterization of the limiting distribution and the robustness of the limit under perturbations of the microscopic Hamiltonian. I will focus on results obtained for two classes of non-exactly-solvable two-dimensional systems: non-planar Ising models and interacting dimers. Based on joint works with Giovanni Antinucci, Rafael Greenblatt, Vieri Mastropietro, Fabio Toninelli.

Patricia Gonçalves (IST Lisbon)
ON HYDRODYNAMIC LIMITS OF FRACTIONAL PDES FROM INTERACTING PARTICLE SYSTEMS

In the seventies, Frank Spitzer introduced, in the mathematics community, systems of stochastic interacting particles, whose dynamics conserves a certain number of quantities. These systems were already known in the physics and biophysics communities and they are toy models for a variety of interesting phenomena. The goal, in the hydrodynamic limit, consists in deducing, by a scaling limit procedure, the macroscopic equations governing the space-time evolution of the conserved quantities of the system, from the underlying random motion of the microscopic system of particles. In this talk, I will focus on the latest advances around the derivation of these limits in the case where the space-time evolution is given by a fractional PDEs and with several boundary conditions.

Alice Guionnet (CNRS and ENS de Lyon)
RANDOM MATRICES, FREE PROBABILITY AND THE ENUMERATION OF MAPS

During the last century, large random matrices became a central mathematical object in many domains, including statistics, number theory, operator algebra theory, quantum physics, string theory, etc. As a consequence, the study of large random matrices has grown into a diverse and mature field, yielding answers to increasingly sophisticated questions. In this talk, I will discuss some classical results about large random matrices and emphasize their beautiful connections with the enumeration of maps and free probability.

Ewain Gwynne (University of Chicago)
THE LIOUVILLE QUANTUM GRAVITY METRIC

I will give an overview of what is and is not known about the Liouville quantum gravity metric (distance function). This will include a brief introduction to Liouville quantum gravity, a discussion of the construction and properties of the metric, and several conjectures and open problems.

Martin Hairer (Imperial College London)
STOCHASTIC QUANTISATION OF YANG–MILLS

We report on recent progress on the problem of building a stochastic process that admits the hypothetical Yang–Mills measure as its invariant measure. One interesting feature of our construction is that it preserves gauge-covariance in the limit even though it is broken by our UV regularisation. This is based on joint work with Ajay Chandra, Ilya Chevyrev, and Hao Shen.

Nina Holden (ETH Zurich and Courant Institute)
CONFORMAL WELDING IN LIOUVILLE QUANTUM GRAVITY: RECENT RESULTS AND APPLICATIONS

Liouville quantum gravity (LQG) is a natural model for a random fractal surface with origin in the physics literature. A powerful tool in the study of LQG is conformal welding, where multiple LQG surfaces are combined into a single LQG surface. The interfaces between the original LQG surfaces are typically described by variants of the random fractal curves known as Schramm-Loewner evolutions (SLE). We will present a few recent conformal welding results for LQG surfaces and their applications, which range from SLE and LQG to planar maps and random permutations. Based on joint works with Ang and Sun, with Lehmkuehler, and with Borga, Sun and Yu.

Svetlana Jitomirskaya (Georgia Institute of Technology)

SMALL DENOMINATORS AND MULTIPLICATIVE JENSEN'S FORMULA

Small denominator problems appear in various areas of analysis, PDE, and dynamical systems, including spectral theory of quasiperiodic Schrödinger operators, non-linear Schrödinger equations, and non-linear wave equations. These problems have traditionally been approached by KAM-type constructions. We will discuss the new methods, originally developed in the spectral theory of quasiperiodic Schrödinger operators, that are both onsiderably simpler and lead to results completely unattainable through KAM techniques. For one-dimensional quasiperiodic operators, these methods have enabled precise treatment of various types of resonances and their combinations, leading to proofs of sharp (arithmetic) spectral transitions, the ten martini problem, and the discovery of universal hierarchical structures of eigenfunctions. The related theory of the dynamics of corresponding linear cocycles leads to a surprising extension of the classical Jensen's formula.

Antti Knowles (University of Geneva)

SPECTRAL PHASES OF ERDŐS-RÉNYI GRAPHS

Disordered quantum systems exhibit a variety of spectral phases, characterized by the extent of spatial localization of the eigenvectors. Through their adjacency matrices, random graphs provide a natural class of models for such systems, where the disorder arises from the random geometry of the graph. The simplest random graph is the Erdös-Rényi graph $G(N, p)$, whose adjacency matrix is the archetypal sparse random matrix. The parameter $d = pN$ represents the expected degree of a vertex. A dramatic change in behaviour is known to occur at the scale $d \sim \log N$, which is the threshold where the degrees of the vertices cease to concentrate. Below this scale the graph becomes inhomogeneous and develops structures such as hubs and leaves which accompany the appearance of a localized phase.

I report on recent progress in establishing the phase diagram for $G(N, p)$ at and below the critical scale $d = \log N$. We show that the spectrum splits into a fully delocalized region in the middle of the spectrum and a semilocalized phase near the spectral edges. The transition between the phases is sharp in the sense of a discontinuity in the localization exponent of eigenvectors. Furthermore, we show that the semilocalized phase consists of a fully localized region and in addition, for some values of d, a complementary region that we conjecture to be nonergodic delocalized. Joint work with Johannes Alt and Raphael Ducatez.

Karol Kozlowski (Laboratoire de Physique, ENS de Lyon and CNRS)

CONVERGENCE OF FORM FACTOR SERIES IN THE SINH-GORDON QUANTUM FIELD THEORY

The S-matrix bootstrap program was devised in the late 70s and mid 80s as a possible path for a fully explicit construction of numerous massive integrable quantum field theories in 1+1 dimensions. Ultimately, it allows one to express the physically pertinent observables in these models -the multi-point correlation functions- in terms of form factor series expansion. On technical grounds, the latter correspond to fully explicit series of multiple integrals in which the n'th summand is given by a n-fold integral. While being formally effective from the point of view of various physical applications, so far, the question of convergence of such form factor series was essentially left open. Still, convergence results are necessary so as to reach the mathematical well-definiteness of this construction of massive integrable 1+1 dimensional quantum field theories and appear as necessary ingredients for the justification of numerous handlings that are carried out with the help of such series.

In this talk, I will describe the technique I recently developed that allows one to prove the convergence of the form factor series that arise in the context of the simplest massive integrable quantum field theory in 1+1 dimensions: the Sinh-Gordon model. The proof amounts to obtaining a sufficiently sharp estimate on the leading large-n behaviour of the n-fold integral arising in this context. This appeared possible by refining some of the techniques that were fruitful in the analysis of the large-n behaviour of integrals over the spectrum of $n \times n$ random Hermitian matrices.

Hubert Lacoin (IMPA - Rio de Janeiro)

MIXING TIME AND CUTOFF FOR ONE DIMENSIONAL PARTICLE SYSTEMS

A fundamental result in the theory of Markov chains states that for any initial condition, the distribution at time t of an irreducible continuous Markov chain on a finite state converges to the unique invariant measure when t tends to infinity. The study of mixing time for Markov chain explores some quantitative aspects of this convergence. In particular a substantial amount of work has been dedicated to the study of the cutoff phenomenon: an abrupt convergence to equilibrium. In our talk we will survey recent results concerning the total-variation mixing time of the simple exclusion process on the segment (symmetric and asymmetric) and a continuum analog, the simple random walk on the simplex. We will put an emphasis on cutoff results.

Jean-Christophe Mourrat (ENS Lyon, CNRS)
MEAN-FIELD SPIN GLASSES: BEYOND PARISI'S FORMULA?

Spin glasses are models of statistical mechanics encoding disordered interactions between many simple units. One of the fundamental quantities of interest is the free energy of the model, in the limit when the number of units tends to infinity. For a restricted class of models, this limit was predicted by Parisi, and later rigorously proved by Guerra and Talagrand. I will first show how to rephrase this result using an infinite-dimensional Hamilton-Jacobi equation. I will then present partial results suggesting that this new point of view may allow to understand limit free energies for a larger class of models, focusing in particular on the case in which the units are organized over two layers, and only interact across layers.

Felix Otto (Max Planck Institute for Mathematics in the Sciences)
REGULARITY STRUCTURES WITHOUT FEYNMAN DIAGRAMS

Singular stochastic PDE are those stochastic PDE in which the noise is so rough that the nonlinearity requires a renormalization. Hairer's regularity structures provide a framework for the solution theory. His notion of a model can be understood as providing a (formal) parameterization of the entire solution manifold of the renormalized equation. In this talk, I will focus on the stochastic estimates of the model.

I shall present a more analytic than combinatorial approach: Instead of using trees to index the model, we consider all partial derivatives w.r.t. the function defining the nonlinearity (and thus work with multi-indices as index set). Instead of a Gaussian calculus guided by Feynman diagrams arising from pairing of trees, we consider first-order partial derivatives w.r.t. the noise, i.e. Malliavin derivatives.

We employ tools from quantitative stochastic homogenization like spectral gap estimates, which naturally complement the standard choice of renormalization, and annealed estimates, which as opposed to their quenched counterparts preserve scaling. The gain in regularity when taking a Malliavin derivative, and thus replacing one instance of the noise by an element of the Cameron-Martin space, is conveniently captured in terms of a modelled distribution.

This is joint work with P. Linares, M. Tempelmayr, and P. Tsatsoulis, based on work with J. Sauer, S. Smith, and H. Weber.

Eveliina Peltola (Aalto University and University of Bonn)
ON LOG-CFT FOR UST AND SLE(8)

I discuss the emergence of logarithmic CFT content associated to SLE(8) and non-local observables in the planar uniform spanning tree (UST) model, constructed via scaling limits of Peano curves and their crossing probabilities. In particular, with explicit correlation functions and their fusion thus obtained, one sees that any CFT describing the geometry of UST must be non-unitary (thus not reflection positive). This is of course no surprise – we give a systematic construction directly from the lattice model via its scaling limit, together with immediate relation to SLE(8).

István Prause (University of Eastern Finland)
LIMIT SHAPES OF RANDOM YOUNG TABLEAUX AND THE TANGENT PLANE METHOD

Limit shapes are deterministic surfaces in R^3 which arise in the scaling limit of discrete random surfaces associated to various probability models such as domino tilings, random Young tableaux or the 5-vertex model. The limit surface is a minimiser of a variational problem with a surface tension which encodes the local entropy of the model. I'll present a geometric "tangent plane method" for limit shapes which applies for a large variety of models, including non-free fermionic ones. In the second part of the talk, I'll use the method to solve the limit shape problem for random Young tableaux on a diagram of arbitrary shape. The talk is based in part on joint work with Rick Kenyon.

Daniel Remenik (Universidad de Chile)
INTEGRABLE FLUCTUATIONS IN ONE-DIMENSIONAL RANDOM GROWTH

This talk will review some recent results on asymptotic fluctuations in the KPZ universality class, a broad collection of probabilistic models including one- dimensional random growth, directed polymers and particle systems. Many of these models exhibit a remarkable degree of solvability, and explicit formulas can be derived for their transition probabilities. This extends, most prominently, to the KPZ fixed point, the scaling invariant Markov process which arises as the scaling limit of all models in the class. Using the explicit formulas for these processes it can be shown their transition probabilities satisfy classical integrable differential equations.

Nicolai Reshetikhin (Tsinghua University and University of California Berkeley)
TWO DIMENSIONAL YANG–MILLS THEORY ON SPACE TIMES WITH CORNERS

The two dimensional Euclidean Yang–Mills theory on surfaces with corners and open Wilson graphs will be introduced. It will be shown that it satisfies multi spin Calogero–Moser type heat equation. Semiclassical and large N limit for the sturural group $SU(N)$ will be discussed. Comparing to multiple prior work on two dimensional Yang–Mills open Wilson graphs and its connection to superintegrable multi-spin Calogero–Moser systems is a new feature.

Rémi Rhodes (Aix-Marseille University)
CONFORMAL BOOTSTRAP IN LIOUVILLE THEORY

Liouville field theory was introduced by Polyakov in the eighties in the context of string theory. Liouville theory appeared there under the form of a 2D Feynman path integral, which can be thought of as a measure (or expectation value) over the space of configurations of the system. Since then, this theory has been extensively studied in physics and this interest has more recently spread to the probabilistic community where it appears as a natural model of random Riemann surfaces. Liouville theory is a conformal field theory and, as such, the quantities of interest are the correlation functions. In this talk, we will explain some joint works with G. Baverez, C. Guillarmou and A. Kupiainen where we show that the correlation functions of Liouville conformal field theory on Riemann surfaces can be expressed in terms of products of 3-point correlation functions on the sphere and the conformal blocks, which are holomorphic functions on the moduli space of punctured Riemann surfaces.

Laure Saint-Raymond (IHES, France)
DYNAMICS OF DILUTE GASES: A STATISTICAL APPROACH

The evolution of a gas can be described by different models depending on the observation scale. A natural question, raised by Hilbert in his sixth problem, is whether these models provide consistent predictions. In particular, for dilute gases, it is expected that continuum laws of kinetic theory can be obtained directly from molecular dynamics governed by Newton's fundamental principle. In the case of hard sphere gases, Lanford showed that the Boltzmann equation emerges as the law of large numbers in the low density limit, at least for very short times. The objective of this talk is to present this limiting process, including recent results on the fluctuations.

Benjamin Schlein (University of Zurich)
CORRELATION ENERGY OF WEAKLY INTERACTION FERMI GASES

We consider a Fermi gas in a combined mean-field and semiclassical limit. To leading order, the ground state energy can be approximated, within the framework of Hartree-Fock theory, by the energy of a non-interacting Fermi sea. It turns out that the main excitations of the Fermi sea behave approximately like bosons. Thus, we can use rigorous Bogoliubov theory to estimate the correlation energy, describing corrections to Hartree-Fock theory. We recover a formula first predicted in the physics literature by Gell-Mann and Brueckner, in 1957. This talk is based on joint works with N. Benedikter, P.T. Nam, M. Porta and R. Seiringer.

Sylvia Serfaty (Courant Institute, New York University)
KOSTERLITZ–THOULESS TRANSITION FOR THE TWO-COMPONENT PLASMA

We study the two-dimensional two-component plasma or Coulomb gas. We obtain free energy expansions and Large Deviations Principles which reveal the well-known BKT transition from a system with free charges to a system with bound dipoles. Based on joint works with Jeanne Boursier, Thomas Leblé, Ofer Zeitouni.

Scott Sheffield (MIT)
WHAT IS A RANDOM SURFACE?

We will survey the modern theory of "random surfaces" while also reviewing the rich history of the subject and presenting numerous computer illustrations and animations. There are many ways to begin, but one is to consider a finite collection of unit equilateral triangles. There are finitely many ways to glue each edge to a partner, and we obtain a random sphere-homeomorphic surface by sampling uniformly from the gluings that produce a topological sphere. As the number of triangles tends to infinity, these random surfaces (appropriately scaled) converge in law. The limit is a "canonical" sphere-homeomorphic random surface, much the way Brownian motion is a canonical random path. Depending on how the surface space and convergence topology are specified, the limit is the Brownian sphere, the peanosphere, the pure Liouville quantum gravity sphere, the bosonic string or a certain conformal field theory. All of these objects have concise definitions, and are all in some sense equivalent, but the equivalence is highly non-trivial, building on hundreds of math and physics papers over the past half century. More generally, the "continuum random surface embedded in d-dimensional Euclidean space" makes a kind of sense for any $d \in (-\infty, 25]$.

This story can also be extended to higher genus surfaces, surfaces with boundary, and surfaces with marked points or other decoration. These constructions have deep roots in both mathematics and physics, drawing from classical graph theory, complex analysis, probability and representation theory, as well as string theory, planar statistical physics, random matrix theory and a simple model for two-dimensional quantum gravity. We present here a colloquium-level overview of the subject, which we hope will be accessible to both newcomers and experts. We aim to answer, as simply and cleanly as possible, the fundamental question. What is a random surface?

Jan Philip Solovej (University of Copenhagen)
THE GROUND STATE OF QUANTUM GASES

I will discuss the ground state of many-body quantum gases. In particular, I will discuss the asymptotics of the ground state energy of Bose gases in the dilute limit. The main focus will be the recent proof of the celebrated two term asymptotic formula suggested by Lee, Huang, and Yang in 1957. The formula can be understod from Bogolubov's celebrated theory of super fluidity and thus can be seen as a validation of this theory. This is joint work with Søren Fournais. I will also briefly discuss gases in dimensions one and two and related questions for fermions. For gases in dimension one this is joint work with Agerskov and Reuvers.

Fabio Toninelli (TU Vienna)
LOGARITHMIC SUPER-DIFFUSIVITY FOR 2-DIMENSIONAL OUT OF EQUILIBRIUM SYSTEMS

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 proven (by H.-T. Yau) is the 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 the curl of the 2-dimensional GFF, and for the 2d anisotropic KPZ equation. These models belong to a different universality class than 2-dimensional ASEP: in fact, the corrections are of order $(\log t)^{1/2}$ instead of $(\log t)^{2/3}$.

Eric Vanden-Eijnden (Courant Institute, New York University)
ENHANCING MARKOV CHAIN MONTE CARLO SAMPLING METHODS WITH DEEP LEARNING

Sampling high-dimensional probability distributions is a common task in computational chemistry, Bayesian inference, etc. Markov Chain Monte Carlo (MCMC) is the method of choice to perform these calculations, but it is often plagued by slow convergence properties. I will discuss how methods from deep learning (DL) can help enhance the performance of MCMC via a feedback loop in which we simultaneously use DL to learn better samplers based e.g. on generative models, and MCMC to obtain the data for the training of these models. I will illustrate these techniques via several examples, including the sampling of random fields, the calculation of reaction paths in metastable systems and the calculation of free energies and Bayes factors.

Fredrik Viklund (KTH Royal Institute of Technology)
WILSON LOOPS IN A LATTICE HIGGS MODEL

Lattice gauge theories were first considered in the 1970s as regularized (and rigorously defined) lattice approximations of continuum quantum field theories known as Yang-Mills theories, the latter which are still to this day lacking rigorous constructions in most physically relevant settings. In the last few years there has been a renewed interest in the rigorous analysis of 4D lattice gauge theories in the probability community. I will discuss some background and basic ideas in this area, including Wilson's pure gauge theory as well as the lattice Higgs model. I will then report on recent work on the behavior of Wilson loop expectations in a certain limit for these models. Based on joint work with Malin Forsström (KTH) and Jonatan Lenells (KTH).

Yilin Wang (IHES)
HOLOGRAPHY AND LOEWNER ENERGY

Loewner energy is a Mobius invariant quantity that measures the roundness of Jordan curves on the Riemann sphere. It arises from large deviation deviations of SLE0+ and is a Kahler potential on the Weil-Petersson Teichmuller space. Motivated by AdS/CFT correspondence and the fact that Mobius transformations extend to isometries of the hyperbolic 3-space H^3, we look for quantities defined geometrically in H^3 that equal the Loewner energy of a curve in the conformal boundary. We show that the Loewner energy equals the renormalized volume of a submanifold of H^3 constructed using the Epstein surfaces associated with the hyperbolic metric on both sides of the curve. This is a work in progress with Martin Bridgeman (Boston College) and Franco Vargas-Pallete (Yale).

Simone Warzel (TU München)
QUANTUM SPIN GLASSES

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.

Christian Webb (University of Helsinki)
BOSONIZATION OF THE CRITICAL ISING MODEL

I will discuss some ongoing joint work with B. Bayraktaroglu, K. Izyurov, and T. Virtanen about expressing correlation functions of the scaling limit of the critical Ising model in planar domains (with various types of boundary conditions) in terms of Gaussian free field correlation functions.

Wendelin Werner (ETH Zurich)
ON CONFORMAL LOOP ENSEMBLES

I will review (recent and less recent) features of Conformal Loop Ensembles, and describe some open questions about them.

Wei Wu (NYU Shanghai)
MASSLESS PHASES FOR THE VILLAIN MODEL IN $D \geq 3$.

The XY and the Villain models are models which exhibit the celebrated Kosterlitz-Thouless phase transitions in two dimensions. The spin wave conjecture, originally proposed by Dyson and by Mermin and Wagner, predicts that at low temperature, spin correlations of these models are closely related to Gaussian free fields. I will review the historical background and discuss some recent progress on this conjecture in $d \geq 3$. Based on the joint work with Paul Dario (Lyon).

SHORT TALKS

Guillaume Baverez (Humboldt-Universität zu Berlin)
LIOUVILLE CONFORMAL FIELD THEORY AND THE VIRASORO ALGEBRA

One of the basic outputs of a conformal field theory (CFT) is a Hilbert space together with an action of the Virasoro algebra. In Liouville CFT, the Hilbert space was introduced by Guillarmou, Kupiainen, Rhodes and Vargas as the L^2-space of the Gaussian free field on the circle (see R. Rhodes' talk). In joint work with these authors, we introduce a family of Markov semigroups on the Liouville Hilbert space, whose generators represent the Virasoro algebra. This gives a probabilistic interpretation of an algebraic result known as the "Sugawara construction", where the Virasoro algebra generates Markov processes with values in the space of distributions on the unit circle. As an application, we show that the eigenstates of the Liouville Hamiltonian extend analytically to the whole plane and that the scattering matrix is diagonal. Time permitting, I will also discuss some future applications related to the Liouville conformal blocks.

Jacopo Borga (Stanford University)
PERMUTONS, MEANDERS, AND SLE-DECORATED LIOUVILLE QUANTUM GRAVITY

In 1912 Henri Poincaré asked the following question: In how many different ways a simple loop in the plane, called meander, can cross a line a specified number of times? Despite many efforts, this question remains open after more than a century.

In this talk we construct and study the conjectural scaling limit of uniform meanders. More precisely, we present a natural procedure to construct a continuous permutation (i.e. a permuton) from a pair of space-filling Schramm-Loewner evolution (SLE) curves on a Liouville quantum gravity (LQG) surface. Using this procedure, we then explain how one can construct the meandric permuton, which we conjecture (building on some physics works) to describe the scaling limit of uniform meandric permutations, i.e., the permutations induced by meanders. Using the same techniques, one can also recover the skew Brownian permutons, which describe the scaling limit of various types of random pattern-avoiding permutations already studied in the literature. We prove several results on these permutons. For instance, (1) we show that for any sequence of random permutations which converges to one of the above random permutons, the length of the longest increasing subsequence is sublinear; (2) we prove that the closed support of each of the random permutons in our class has Hausdorff dimension 1.

Based on a joint work with Ewain Gwynne and Xin Sun.

Sanchit Chaturvedi (Stanford University)

THE INVISCID LIMIT OF VISCOUS BURGERS AT NONDEGENERATE SHOCK FORMATION

We study the vanishing viscosity limit of the one-dimensional Burgers equation near nondegenerate shock formation. We develop a matched asymptotic expansion that describes small-viscosity solutions to arbitrary order up to the moment the first shock forms. The inner part of this expansion has a novel structure based on a fractional space-time Taylor series for the inviscid solution. We obtain sharp vanishing viscosity rates in a variety of norms, including L^∞. Comparable prior results break down in the vicinity of shock formation. We partially fill this gap. Based on joint work with Cole Graham.

Catherine Wolfram (MIT)

LARGE DEVIATIONS FOR THE 3D DIMER MODEL

A dimer tiling of $\mathbb{Z}^d$ is a collection of edges such that every vertex is covered exactly once. A lot has been understood about the dimer model in dimension $d = 2$ using tools and exact formulas (e.g. the height function representation of a tiling or the Kasteleyn determinant formula) that are specific to dimension 2. The goal of this paper is to extend some of these results to higher dimensions using new methods, and without exact solvability. In any dimension d, a dimer tiling corresponds to a divergence-free flow (where the even-to-odd flow is $+1$ if on an edge in the tiling and $-1/2d$ otherwise). We prove a large deviations principle for the flow corresponding to a dimer tiling of $\mathbb{Z}^3$, interpreted as random divergence-free vector field. This is a higher-dimensional analog of a 2000 result of Cohn, Kenyon and Propp for dimension 2.