Provisional Timetable

	Monday 31.03.08	Tuesday 01.04.08	Wednesday 02.04.08	Thursday 03.04.08	Friday 04.04.08
0900-1000		**Sheffield**	**Johansson**	**Johansson**	**Johansson**
1000-1100		**Flandoli**	**Flandoli**	**Bertoin**	**Bertoin**
1100-1130	Registration	Coffee			
1130-1210	Smirnov	Biane	Zambotti	Beffara	Brzezniak
1210-1250	Hambly	Moerters	O'Connell	Norris	Friz
1250-1415	Lunch				
1415-1515	**Flandoli**	**Bertoin**	**Sheffield**	**Sheffield**	
1515-1555	König	Cerrai	Fournier	Rouault	
1555-1615	Tea				
1615-1655	Turner	Ferrari	Winkel	Goldschmidt	
1655-1735	Kyprianou	Goldscheid	Harris	Martin	
		Poster session			
	Dinner				

Timetable notes

- All the lectures will take place in the Maths & Statistics Building in lecture theatre MS.02. The poster session will take place in the Atrium outside the lecture theatre.

Abstracts of talks

Minicourses

Jean Bertoin

Coalescence and stochastic flows of bridges

I will present a series of joint works [1,2,3] with Jean-Francois Le Gall in which the connection between exchangeable coalescents (also known as coalescents with multiple collisions) and certain stochastic flows of bridges is developed. Exchangeable coalescents have been introduced as models for the genealogy of large populations with constant size [5,7,8], and include the celebrated coalescent of Kingman [4] as a most important example. The connection with stochastic flows yields several interesting applications, for instance to the asymptotic behavior of these coalescents, and to an interpretation of a version of Smoluchowski's coagulation equation [6] with multiple coagulations.

1 Bertoin, J. and Le Gall, J.-F. "Stochastic flows associated to coalescent processes." Probab. Theory Relat. Fields 126 (2003), 261-288.

2 Bertoin, J. and Le Gall, J.-F. "Stochastic flows associated to coalescent processes, II: Stochastic differential equation." Ann. Inst. Henri Poincar, Probabilits et Statistiques 41 (2005), 307-333.

3 Bertoin, J. and Le Gall, J.-F. "Stochastic flows associated to coalescent processes, III: Limits theorems." Illinois J. Math. 50 (2006), 147-181

4 Kingman, J. F. C. "The coalescent." Stochastic Process. Appl. 13 (1982), 235-248.

5 Moehle, M. and Sagitov, S. "A classification of coalescent processes for haploid exchangeable population models." Ann. Probab. 29 (2001), 1547-1562.

6 Norris, J. R. "Smoluchowski's coagulation equation: uniqueness, non-uniqueness and hydrodynamic limit for the stochastic coalescent." Ann. Appl. Probab. 9 (1999), 78109.

7 Pitman, J. "Coalescents with multiple collisions." Ann. Probab. 27 (1999), 1870-1902.

8 Schweinsberg, J. "Coalescents with simultaneous multiple collisions." Electron. J. Probab. 5-12 (2000), 1-50.

Franco Flandoli

SPDEs in fluid dynamics

1. Example of a non well posed linear PDE that becomes well-posed under random perturbations:
   It is well known that certain non well posed ODEs become well posed when non degenerate noise is added. A new proof of this fact is given providing existence of a differentiable stochastic flow for a class of non-Lipschitz drift. Based on this result, one can solve a linear transport equation with multiplicative noise (an SPDE) in spite of the fact that the same equation without noise in non well posed. It is interesting to notice that improvement of well-posed-ness is caused by non degenerate additive type noise for ODEs, while multiplicative noise looks better for SPDEs.
2. Partial progresses on well posedness of 3D stochastic Navier-Stokes equations:
   In 2003, Da Prato and Debussche gave a direct solution of the Kolmogorov equation associated to 3D stochastic Navier-Stokes equations. Among the interesting

byproducts, existence of a strong Feller Markov semigroup must be mentioned. But uniqueness remains an open problem. The lecture reviews this subject under the viewpoint developed later by Flandoli and Romito, including a result of equivalence of transition probabilities among possibly different Markov selections.

3. Scaling exponents in SPDEs:
   A formal computation based on a scaling argument seems to indicate that zero viscosity stochastic Navier-Stokes equations forced by infinitely large scale noise possesses the scaling exponent 2/3 for the so called second order structure function. One can show that such a result is not true in two dimensions. In dimension three it looks closer to reality but a correction is presumably needed. A review of the few rigorous results and the many open problems on this subject is presented, comparing also with other nonlinear SPDEs like a stochastic GOY model or Prouse equation with velocity-dependent viscosity.

Kurt Johansson

Scaling limits in random matrix theory and related models

Spectra of random matrices are natural sources of interesting limit laws, like the Gaudin and Tracy-Widom distributions, the sine-kernel point process and the Airy process. These limit laws occur not only in random matrix theory but also in other contexts, like combinatorial models, where there is no immediate spectral interpretation. When trying to understand problems related to these limit laws one sees that there are two sides to random matrix theory. One is the detailed analysis of solvable models and the other is the problem of proving the universality of these limit laws within families of models. In the lecture series I will attempt to give a survey of some aspects of these problems.

Scott Sheffield

Random geometry and the Schramm-Loewner evolution

Many “quantum gravity” models in mathematical physics can be interpreted as probability measures on the space of metrics on a Riemannian manifold. We describe several recently derived connections between these random metrics and certain random fractal curves called “Schramm-Loewner evolutions” (SLE).

Invited talks

V. Beffara:

Isotropic embeddings

In recent years, huge progress has been made in the understanding of critical 2D models of statistical physics, and especially about their scaling limits (through the use of SLE processes). However, one question remains widely open, and that is the reason for universality, i.e. the belief that similar system on different lattices, even though they have different critical points, nevertheless converge to the same scaling limit as the lattice mesh goes to 0. It seems that a key question along the way to understanding it is, given the combinatorics of a lattice, how to embed it in the plane in order to obtain a conformally invariant scaling limit - and a surprising fact is that the ”right” embedding depends not only on the lattice but also on the model. The particular case of percolation is of special interest and involves geometric objects called ”circle packings”, which in many ways are the correct notion of a discrete complex structure; my goal in this talk is to try and explain why.

Z. Brzezniak:

On the stochastic Landau-Lifshitz’ Equation

Motivated by a recent paper "Magnetic elements at finite temperature and large deviation theory" by R. V. Kohn, M. G. Reznikoff and E. Vanden-Eijnden, J. Nonlinear Sci. **15**, 223-253 (2005) we are interested in stochastic parabolic Landau-Lifschitz equations. We investigate existence and uniqueness of solutions, and possibly the Large Deviations principle and stability.

P. Biane:
Brownian motion on matrices and Pitman's theorem
I will make some remarks on Brownian motion on matrix spaces, especially regarding the distribution of the eigenvalue process, then describe related extensions of Pitman's theorem.

S. Cerrai:
Fast diffusion asymptotics for stochastic reaction-diffusion equations with boundary noise
I will consider a class of stochastic reaction-diffusion equations having also a stochastic perturbation on the boundary and we show that when the diffusion rate is much larger than the rate of reaction it is possible to replace the SPDE's by a suitable one-dimensional stochastic differential equation. This replacement is possible under the assumption of spectral gap for the diffusion and is a result of *averaging* in the fast spatial transport. Joint work with Mark Freidlin.

P. Ferrari:
Large time asymptotics of growth models on space-like paths
We consider a stochastic growth model, the polynuclear growth (PNG) model in $1+1$ dimension with flat initial condition and no extra constraints. The joint distributions of surface height at finitely many points at a fixed time moment are given as marginals of a signed determinantal point process. The long time scaling limit of the surface height is shown to coincide with the Airy_1 process. This result holds more generally for the observation points located along any space-like path in the space-time plane.

N. Fournier:
On giant particles in coagulation processes
The Marcus-Lushnikov process is a finite stochastic particle system in which each particle is entirely characterized by its mass. Each pair of particles with masses x and y merges into a single particle at a given rate K(x,y). We consider a strongly gelling kernel. In such a case, it is well-known that gelation occurs, that is, giant particles emerge. Then two possible models for hydrodynamic limits of the Marcus-Lushnikov process arise: the Smoluchowski equation, in which the giant particles are inert, and the Flory equation, in which the giant particles interact with finite ones. We show that, when using a suitable cut-off coagulation kernel in the Marcus-Lushnikov process and letting the number of particles increase to infinity, the possible limits solve either the Smoluchowski equation or the Flory equation. We also study the asymptotic behaviour of the largest particle in the Marcus-Lushnikov process without cut-off and show that there is only one giant particle. This single giant particle represents, asymptotically, the lost mass of the solution to the Flory equation.

Peter Friz:
On some applications of Rough Paths Analysis to Stochastic Partial Differential Equations
We consider a class of linear first and second order PDEs which include a multi-dimensional

driving signal. Passage to the limit in rough path metrics leads to a notion of rough PDE ("RPDE") with solutions that depend continuously on the rough input.

This applies "path-by-path" to the corresponding classes of SPDEs driven by Brownian motion (and beyond!) and allows for almost trivial proofs for a variety of probabilist properties of such SPDE solutions.

This is in work (in progress) with Michael Caruana, Cambridge.

I. Goldscheid:
Lingering random walks in random environments
The unusual asymptotic behaviour of a recurrent simple random walks in one-dimensional random environments is a classical result of Sinai. The aim of this talk is to describe a wide class of models for which this result holds and to discuss the techniques which lead, in a number of cases, to a complete solution of the problem. It turns out that it is important to study products of random transformations of the set of $m \times m$ stochastic matrices. These transformations are generated by the random environment and have remarkable contracting properties. In turn, these properties allow one to the control of products of related random matrices and the asymptotic behaviour of the walk.

C. Goldschmidt:
To be announced

B. Hambly:
Local limit theorems for random walks on sequences of graphs
The local limit theorem for simple random walks on the d-dimensional Euclidean lattice shows the transition probabilities for the simple random walk converge to the Gaussian heat kernel under suitable rescaling. We develop a version of this result for more general sequences of graphs and give applications to supercritical percolation clusters, sequences of trees converging to the continuum random tree and the random conductor model on fractal graphs.

S.C. Harris:
Branching Brownian motion and the perils of a quadratic potential We will consider a branching Brownian motion where each particle undergoes binary fission at a rate proportional to x^p with distance x from the origin, where p is some constant in $[0, 2]$. Particular difficulties arise in this model when $p = 2$ as quadratic breeding rate is critical in terms of population explosion. The numbers of particles following close to given paths will be discussed and the position of the right most particle will be found to grow polynomially in time when $p < 2$, but exponentially in time when $p = 2$. This is joint work with J.W.Harris (Bristol).

W. König:
Ordered Random Walks (joint work with Peter Eichelsbacher, Bochum)
We construct the conditional version of k independent and identically distributed random walks on the real line given that they stay in strict order at all times. This is a generalisation of so-called non-colliding or non-intersecting random walks, the discrete variant of Dyson's Brownian motions, which have been considered yet only for nearest-neighbor walks on the lattice. Our only assumptions are moment conditions on the steps and the validity of the local central limit theorem. The conditional process is constructed as a Doob h-transform with some positive regular function that is strongly related with the

Vandermonde determinant and reduces to that function for simple random walk. Furthermore, we prove an invariance principle, i.e., a functional limit theorem towards Dyson's Brownian motions, the continuous analogue.

A. Kyprianou:
Special, conjugate and complete scale functions for spectrally negative Levy processes
In the past 10 years, more and more studies which use the theory of spectrally negative L'evy processes have relied on the theory of scale functions. Such functions appear in virtually all identities concerning the fluctuations of the latter processes but historically very few concrete examples are known of these scale functions and an understanding of their general analytical properties is somewhat limited. I will talk about results from three recent parallel papers written concurrently in collaboration with Victor Rivero, Renming Song and Friedrich Hubalek which attempt to significantly improve on this situation.

J. Martin:
Crossing probabilities in asymmetric exclusion processes

P. Moerters:
A tale of two cities: on the parabolic Anderson model with heavy tailed potential
The parabolic Anderson problem is the Cauchy problem for the heat equation with random potential. In this talk we consider independent and identically distributed potentials with polynomial tails. We show that, as time goes to infinity the solution is completely localised in two points almost surely and in one point with high probability. We also identify the asymptotic behaviour of the concentration sites in terms of a weak limit theorem. The talk is based on joint work with Wolfgang Koenig (Leipzig), Hubert Lacoin (Paris) and Nadia Sidorova (London).

J.R. Norris:
A law of large numbers for coagulating Brownian motions
Consider a cloud of many small particles in three-dimensional space, moving randomly according to Brownian motion. We may suppose that the diffusivity of each particle is a function of its size – classically, according to Einstein, inversely proportional to its radius. Suppose that the particle collisions are totally inelastic. I will discuss the derivation of Smoluchowski's coagulation equation in this context.

N. O'Connell:
Exponential functionals of Brownian motion and class one Whittaker functions
Motivated by a problem concerning scaling limits for directed polymers, and recent extensions of Pitman's '2M-X' theorem including an analogue, due to Matsumoto and Yor, for exponential functionals of Brownian motion, we consider (multi-dimensional) Brownian motion conditioned on the asymptotic law of a family of exponential functionals and identify which laws give rise to diffusion processes. For particular families (with a lot of symmetry) these conditioned processes are related to class one Whittaker functions associated with semisimple Lie groups. The work of Matsumoto and Yor is related to the group GL(2,R) and the class one Whittaker function in this case is essentially the Macdonald function (or modified Bessel function of the second kind). For the group GL(3,R) many explicit formulae are available for understanding the behaviour of these processes. The directed polymer problem should correspond to the group GL(n,R) and the asymptotics of the corresponding Whittaker functions for large n, but there are significant technical hurdles to overcome before this can be made fully rigourous. This is based on joint work with Fabrice Baudoin.

A. Rouault:
Spectral measures of random matrices and moment problems
We study some connections between the random moment problem and the random matrix theory. A uniform pick in a space of moments can be lifted into the spectral probability measure of the pair (A, e) where A is a random matrix from a classical ensemble and e is a fixed unit vector. This random measure is a weighted sampling among the eigenvalues of A. We also study the large deviations properties of this random measure when the dimension of the matrix grows. The rate function for these large deviations involves the reversed Kullback information.

S. Smirnov:
Conformal invariance and universality in 2D Ising model

A. Turner:
Stochastic flows, planar aggregation and the Brownian web (Joint work with James Norris, Cambridge)
Diffusion limited aggregation (DLA) is a random growth model which was originally introduced in 1981 by Witten and Sander. This model is prevalent in nature and has many applications in the physical sciences as well as industrial processes. Unfortunately it is notoriously difficult to understand, and only one rigorous result has been proved in the last 25 years. We consider a simplified version of DLA known as the Eden model which can be used to describe the growth of cancer cells, and show that under certain scaling conditions this model gives rise to a limit object known as the Brownian web.

L. Zambotti:
Scaling limits of inhomogeneous polymers
We review some recent results on scaling limits of homogeneous and weakly inhomogeneous pinning and polymer models. The main tool is renewal theory applied to the study of the sharp asymptotic behaviour of the partition function. Joint work with F. Caravenna and G.Giacomin.

M. Winkel:
Regenerative tree growth