MONDAY 19 MARCH

-*13:30–14:00*, Michael Eyers, MASDOC, (Probability Theory),
Supervisor: Stefan Adams

-Conformally invariant scaling limits-

There are many mathematical models of statistical physics in 2 dimensions that are believed to benefit from conformal invariance. These predictions have foundations in physics but have more recently become accessible to mathematical study. In particular, Smirnov (2007) proved the asymptotic conformal invariance of a specific system: critical site percolation on the planar triangular lattice. Smirnov's proof can be used to motivate the definition of Stochastic Loewner evolutions (SLE). SLE appear as limits of interfaces or paths occurring in a variety of statistical mechanics models as the mesh of the grid on which the model is defined tends to zero.

-*14:00–14:30*, Bati Sengul, CCA, (Probability Theory),
Supervisor: Nathanael Berestycki

-An introduction to coalescent processes-

I will be introducing the theory of coalescent processes. These processes describe a system of particles coalescing in a random manner, which arose from the genetics models. The talk will focus on the theoretical aspects of these models. Only a basic understand of probability theory will be assumed.

-*14:30–15:00*, Christopher Pettitt, MASDOC, (Statistics/Epidemiology),
Supervisors: Dario Spanò, Gareth Roberts

-Importance sampling on genetic ancestries modelled with the Kingman coalescent-

Given a sample of genetic information for some set of individuals, population genetics is used to infer the ancestries most likely to correspond to the present-day population. Of particular interest are the mutation rate and the time to the most recent common ancestor (TMRCA) of the sample. In this talk I explain how the Kingman coalescent model arises as the limiting case of a certain set of exchangeable population genetics models and demonstrate its use in an importance sampling procedure for estimating the mutation rate.

-*15:00–15:30*: Coffee, tea biscuits! (Pavilion F common room)

-*15:30–16:00*, Kolyan Ray, CCA, (Statistics),
Supervisor: Richard Nickl

-Rates of contraction for Bayesian nonparametric models-

Due to a number of attractive properties, Bayesian nonparametric methods are increasingly finding use in applications (e.g. machine learning). However, a number of their theoretical properties are still not well understood. For example, in finite dimensional models the asymptotic performance of the Bayesian posterior distribution is linked to that of the maximum likelihood estimator via the Bernstein-von Mises theorem. However, in the nonparametric (infinite dimensional) setting this relationship breaks down and the asymptotic performance is very problem specific.

Over the last decade a theory has developed around this problem which is linked to nonparametric testing problems. I shall explain the problem in more detail and give a brief overview of some of the results in this area.

-*16:00-16:30*, Michael Scott, MASDOC, (Stochastic PDEs),
Supervisor: Martin Hairer

-Stochastic partial differential equations on evolving Riemannian manifolds-

The theory of SPDEs on evolving manifolds is devoid in the mathematical literature, at odds with the deterministic counter-part. The aim of this talk is to introduce the theory of SPDEs on evolving Riemannian manifolds, in the variational setting to the analysis of SPDEs. I will motivate the topic, look at the general theory of SPDEs in the variational setting before producing the theory in the simple case. Don't worry, there will be examples!

TUESDAY 20 MARCH

-*09:00–09:30*, Damon Civin, CCA, (General Relativity/PDE),
Supervisor: Mihalis Dafermos

-The wave equation in general relativity-

I will present my work on the stability of solutions of the Einstein Field Equations, regarded as a system of nonlinear evolution equations. In the journey towards resolution of a nonlinear stability problem, the first step is the study of an associated linearised problem. The simplest such problem is the question of decay of solutions of the wave equation on the background metric of interest. (The wave equation being thought of as a poor man's linearisation of the Einstein Field Equations). In particular, the essential details of the proof of linear stability of the Kerr–Newman family of black hole space-times will be discussed.

-*09:30–10:00*, Pravin Madhavan, MASDOC, (Numerical Methods for PDEs),
Supervisors: Andreas Dedner, Björn Stinner

-Analysis of the discontinuous Galerkin method for elliptic problems on surfaces-

Partial differential equations on surfaces have become an active area of research in recent years due to the fact that in many applications, problems do not reside on a flat Euclidean domain but on a curved surface. Exact solutions for such problems are rare, so we need to resort to numerical methods as an approximation. Finite element methods (FEM) have been successfully extended to surfaces from both a theoretical and numerical point of view. However, it is well-known that there are a number of situations where FEM may not be the appropriate numerical method and there has been comparatively little done to investigate alternative numerical methods. The talk aims to outline work done on extending the Discontinuous Galerkin (DG) framework onto surfaces. A priori error estimates are derived and verified numerically for various test problems.

-*10:00–10:30*: Coffee, tea biscuits! (Pavilion F common room)

-*10:30–11:00*, Sara Merino, CCA, (Kinetic Theory/Applied Probability),
Supervisors: James Norris, Clement Mouhot

-Analytic and probabilistic fractional diffusion limit for the Boltzmann equation-

The Boltzmann equation describes the dynamics of a gas, i.e., of a many particle collision system. Its level of description is between two scales; the microscopic scale, describing the dynamics of each particle using Newton's laws; and the macroscopic scale, which corresponds to hydrodynamical type equations that give the dynamics of the observable quantities of the gas.

A new tendency in the study of the Boltzmann equation and other kinetic models has arisen in the recent years. It brings together the study of fractional operators, on one hand, and the challenge of relating the models at the different scales, in particular, the derivation of macroscopic models from the Boltzmann equation. The main idea is to rescale space and time in the Boltzmann equation and perform a limiting process. Under particular assumptions, this procedure allows the derivation of diffusion and fractional diffusion equations. In this talk, we explain how this result has been proven using analytic methods by Mellet, Mischler and Mouhot; and using probabilistic tools by Jara, Komorowski and Olla. We also look towards the fractional diffusion of other kinetic models like the Fokker-Planck equation.

-*11:00–11:30*, David McCormick, MASDOC, (Theory of PDEs),
Supervisors: James Robinson, Jose Rodrigo

-Stationary Euler flows and ideal magnetohydrodynamics-

The Euler equations form one of the simplest possible models for fluid flow, in which the viscosity is neglected; yet, in three dimensions, there is no known result giving existence and uniqueness of solutions for all time. In this talk we consider stationary solutions of the Euler equations as a means of studying their long-time behaviour. In particular, we consider the "analogy" proposed by Moffatt (1985) between stationary Euler flows and stationary magnetic fields evolving under the ideal magnetohydrodynamics equations. We consider the work of Nez (2007) in making this analogy rigorous, and adapt it to a simplified model (which actually turns out to be harder).

-*13:30–14:00*, Anastasia Kisil, CCA, (Wiener-Hopf/PDEs),
Supervisor: Nigel Peake

-Wiener-Hopf method-

The talk will give a short review of the Wiener-Hopf method. Wiener-Hopf is a method of solving a class of partial differential equations. The applications of Wiener-Hopf technique are very diverse including electromagnetic theory, acoustic, hydrodynamics, elasticity, potential theory and finance.

-*14:00–14:30*, Maria Veretennikova, MASDOC, (Probability Theory),
Supervisors: James Robinson, Jose Rodrigo

-Control fractional dynamics-

Firstly, you will be introduced to fractional calculus which has recently gained popularity in a wide range of fields, in particular establishing itself useful in modeling anomalous diffusion by suitable continuous time random walks (CTRWs). Secondly, you will see how to write a dynamic programming equation for the payoff function for a process in our consideration which is derived from a controlled CTRW, and how scaling affects it. You will see the new equations derived in my research for the different versions on the process. We will then discuss resulting fractional Hamilton Jacobi Bellman type equations for the payoff functions.

-*14:30–15:00*, Bernd Kuhlenschmidt, CCA, (Statistics/Monte Carlo Methods),
Supervisor: Sumeetpal Singh

-Sequential Monte Carlo methods-

Sampling from random distributions that change over time can be difficult or even intractable using conventional Monte Carlo methods. One way of dealing with this problem is to sample sequentially, i.e. timestep by timestep. This approach is useful in a great variety of applications, in particular in real-time signal processing due to restrictions on computational power and memory capacity.

For instance, measurements of a system might arrive sequentially in time and one could be interested in performing Bayesian inference to estimate the hidden parameters for every new observation. Real-life applications include tracking of aircrafts from radar signals or estimating volatilities and correlations of financial instruments. Apart from that, Sequential Monte Carlo methods can be useful for optimal control problems.

-*15:00–15:30*: Coffee, tea biscuits! (Pavilion F common room)

-*15:30–16:00*, Spencer Hughes, CCA, (Geometric PDEs/Measure Theory),
Supervisor: Neshan Wickramasekera

-Two-valued solutions to the minimal surface equation-

Given a domain Ω in $\mathbb{R}^n$, we consider a subset G of $\Omega \times \mathbb{R}$ with the property that for each $x_0 \in \Omega$, the line $\{(x_0, y) : y \in \mathbb{R}\}$ intersects G in at most two points. Saying this line intersects G in exactly one point would mean that G were the graph of some function from Ω to $\mathbb{R}$, but we will think of G as the graph of a 'two-valued' function from Ω to $\mathbb{R}$. In this short talk I will introduce the idea of a 'two-valued' solution to the minimal surface equation and perhaps describe some of the features of and difficulties of problems involving such things.

-*16:00–16:30*, Andrew Lam, MASDOC, (Geometric PDEs),
Supervisors: Börn Stinner, Charlie Elliott

-Allen Cahn equation on surfaces-

The Allen Cahn equation, introduced by Allen & Cahn (1979) to model the motion of phase boundaries in solids, has the property to approximate mean curvature flow and is a core component of phase-field models. The aim of this talk is shift the equation from a planar domain to a smooth surface in 3D. Using the method of Chen (1992) and Alfaro et al. (2009) we will derive the behaviour for the surface Allen Cahn equation and show that it can be used to approximate geodesic curvature flow.

-*16:30–17:00*, Kostas Papafitsoros, CCA, (Mathematical Image Processing),
Supervisor: Carola Schönlieb

-Higher order regularisation for image reconstruction-

In this talk I will discuss the basic principles of mathematical image processing in a variational context. I will focus on total variation (TV) minimisation and how this can be applied for image denoising, deblurring and inpainting. I will then present my work on a higher order model that avoids some of the drawbacks of TV minimisation.

WEDNESDAY 21 MARCH

-*09:00–09:30*, Andrew Aylwin, MASDOC, (Probability Theory/Financial Mathematics),
Supervisor: Larbi Alili

-The Lamperti transformation-

The subject of Levy processes is one that has been greatly researched over the past century yielding vast quantities of literature. However, the fruits of this literature are often not only concerned with the Levy processes themselves, but also with the understanding they can provide in the fields of other stochastic processes. The Lamperti Transform provides just this: a bijection between Levy Processes and the, lesser-known but often more useful, positive self-similar Markov processes that can "carry across" certain properties.

-*09:30–10:00*, Edward Mottram, CCA, (Probability Theory),
Supervisor: Nathanael Berestycki

-Percolation with constant freezing-

Consider a graph (i.e. a set of vertices and edges), and suppose initially that each of the vertices represents a cluster of size 1. Now if we allow the edges to open at a constant rate, then over time the clusters will merge and become bigger. This describes a percolation process evolving in time. When our graph is the infinite lattice Z^2 then it is know that there is a critical time at which a unique infinite cluster will form.

We shall consider a modified process where the clusters are also made to freeze at a constant rate alpha - a frozen cluster is one which can no longer grow. We shall explore (mostly through pictures rather than proofs) how the introduction of freezing affects the size of the clusters, and claim that there is now a critical value of alpha which controls the existence of a unique infinite cluster.

-*10:00–10:30*: Coffee, tea biscuits! (Pavilion F common room)

-*10:30–11:00*, Adam Hall, MASDOC, (Statistics),
Supervisor: John Aston

-Pharmacokinetic modelling of derivatives of the anti-malarial drug artemisinin-

We motivate the need to generate and validate mathematical models for artemisinins and discuss the modelling process, a key feature of which is the (often overlooked) structural identifiability analysis.

Along the way, we introduce compartmental models, a class of models well-suited to pharmacokinetics. We then discuss the shortcomings of existing models before presenting a new model, constraining it to be structurally identifiable, and showing representative fits to data.

-*11:00–11:30*, Marc Briant, CCA, (Kinetic Theory),
Supervisor: Clement Mouhot

-A return journey from Boltzmann to Navier-Stokes equations-

The physical description of N particles in motion has been established at three different levels. One can look at each of those particles in order to yield a N-body problem thanks to Newton's law. This very intricate problem can be transposed in terms of density of particles being at a given point with a given velocity. This mesoscopic point of view is the realm of Boltzmann equation. In the same time, physicists studied fluid dynamics by applying Newton's law to an average sample of fluid particles. This raises the fluid dynamics equations, among them Euler, Stokes and Navier-Stokes equations. This talk will try to build a gap between the Boltzmann equation and the Incompressible Navier-Stokes on the torus. We will talk about how we can build a limit of solutions of the Boltzmann equation that have physical quantities satisfying the latter fluid dynamics equations. Finally, we will give a flavour of how we can reverse the process and in fact construct a solution to the Boltzmann equation starting from a solution of the Incompressible Navier-Stokes equations.

-*11:30–12:00*, Charles Brett, MASDOC, (Inverse Problems/PDEs),
Supervisors: Charlie Elliott, Andreas Dedner

-A phase field approach to image reconstruction-

We will talk about the inverse problem of reconstructing a piecewise constant function from blurred and noisy data. This has many applications, such as reading a barcode or finding the boundary between different types of tissue in a medical image. We will formulate the problem in a PDE setting using a phase field approach. We then discuss and demonstrate numerical methods for solving it.