Queen Mary
University of London

School of Mathematical Sciences
Postgraduate Research Day, Friday 17th May 2013

Please note that talks are in Maths 203, and posters and refreshments are in the Foyer.

Programme

11:30 Neville Ball, *Random Geometric Graphs.*

11:55 Gregor Dick, *Recognising finite exceptional groups of Lie type*

12:20 M. Iftakhar Alam, *Adaptive Dose Finding in Early Phase Clinical Trials Incorporating Pharmacokinetic Information*

12:45 – 14:15 Lunch/Poster session.

14:15 Heather Reeve-Black, *Asymptotic Behaviour in a Family of Discretised Rotations*

14:40 Julia Slipantschuk, *Transfer operator for analytic expanding circle maps*

15:05 – 15:45 Tea break.

15:45 Rodrigo Villavicencio Sanchez, *Fluctuation relation for currents in many-dimensional systems*

16:10 Shihan Miah, *Lagrangian Quantum Turbulence Model using Superstatistics*

16:35 onwards: Award of Ann Cook prize, followed by drinks/nibbles.

Abstracts

Neville Ball: *Random Geometric Graphs*

We consider variants of the k-nearest neighbour model of random geometric graphs as a model for a hub-less communication network, and seek to answer the question: What value of k will ensure that the network is connected (with high probability)?

Gregor Dick: *Recognising finite exceptional groups of Lie type*

Let G be a a group specified by a set of generators X. Suppose that G is known to be isomorphic to another group $\widehat{G}$ generated by $\widehat{X}$, where the properties of $\widehat{X}$ are well understood. We seek an isomorphism $\phi : \widehat{G} \to G$ such that $\phi(\widehat{g})$ can be computed efficiently for an arbitrary $\widehat{g} \in \widehat{G}$. We concentrate primarily on the case where $G \cong F_4(q)$ for q an odd prime power.

M. Iftakhar Alam: *Adaptive Dose Finding in Early Phase Clinical Trials Incorporating Pharmacokinetic Information*

Interest has grown in recent years in the development of dose finding methods incorporating both toxicity and efficacy as endpoints, as the dose of a new drug is acceptable only if it is safe and efficacious. This talk introduces one such new statistical method for phase I-II trials which additionally incorporates pharmacokinetic (PK) information in the dose escalation. The aim is to develop an efficient dose finding method that exposes not too many patients to either subtherapeutic or toxic doses and recommends the best dose for further studies in phase III.

Following the assignment of a current best dose to a cohort of patients, the concentration of a drug in the blood is measured at the D-optimal time points. The dose-response outcomes are also observed for each patient. Based on the updated information, we select a new dose for the next cohort so that the estimated probability of efficacy is maximum, subject to the condition that the estimated probability of toxicity is not more than a target value. Another condition for the dose selection is related to the total exposure of the drug in the body so that the curative purpose is likely to be achieved. This is expressed by the area under the concentration curve over time. The trial is stopped when the same dose is repeated for r cohorts or when it reaches the maximum number of m cohorts, whichever comes first. At the end, a complete analysis of the data is carried out and a dose is chosen to be recommended for further studies. The method is illustrated with an example of a one-compartment PK model with bolus input and first-order elimination. The parameters of the model are assumed to be random to account for the inter-patient variability. As the dose-response outcomes, we consider a trinomial response: neutral, efficacious or toxic, for each patient. The continuation ratio model is employed for modelling the dose-response data with uniform priors for the parameters. Thus we implement a Bayesian adaptive procedure.

The purpose of this study was to investigate the gain in efficiency of using PK measures in the dose escalation. Simulation results show that the method is capable

of identifying the optimal dose accurately without exposing patients to toxic doses and therefore can be used as a reliable dose finding procedure.

Heather Reeve-Black: *Asymptotic Behaviour in a Family of Discretised Rotations*

We consider a one-parameter family of invertible maps of a two-dimensional lattice, obtained by applying round-off to planar rotations. We let the angle of rotation approach $\pi/2$, and show that the limit of vanishing discretisation is described by an integrable piecewise-smooth Hamiltonian flow, whereby the plane foliates into families of invariant polygons with an increasing number of sides. Considered as perturbations of the flow, the lattice maps assume a different character; the flow is non-linear (unlike the rotation), and a suitably chosen Poincare return map behaves locally like a shear. We show that the unperturbed motion at infinity is in fact described a one-parameter family of shear maps, which features a singularity in the shear factor. We conclude by briefly demonstrating the consequences of this asymptotic behaviour in the perturbed dynamics.

Julia Slipantschuk: *Transfer operator for analytic expanding circle maps*

Transfer operators describe how a distribution of initial points evolves under the action of the underlying dynamical system. Their spectral data yield insight into fine statistical properties such as rates of mixing. In this talk I will describe a class of dynamical systems, namely a class of analytic expanding circle maps, for which the spectrum of the corresponding transfer operators is known explicitly.

Rodrigo Villavicencio Sanchez: *Fluctuation relation for currents in many-dimensional systems*

In statistical mechanics, there are a number of fluctuation relations which offer a tool to get a better understanding of systems in and out of equilibrium. I will briefly introduce the Gallavotti-Cohen fluctuation relation for particle currents and see how it can be generalised to many-dimensional systems.

Shihan Miah: *Lagrangian Quantum Turbulence Model using Superstatistics*

We consider the dynamics of small tracer particles in turbulent quantum fluids. The complicated interaction processes of vortex filaments, the quantum constraints on vorticity and the varying influence of both the superfluid and the normal fluid on the tracer particle effectively lead to a superstatistical Langevin-like model that in a certain approximation can be solved analytically. An analytic expression for the PDF of velocity v of the tracer particle is derived that exhibits not only the experimentally observed v^{-3} tails but also the correct behavior near the center of the distribution, in excellent agreement with experimental measurements and numerical simulations. Furthermore, the two-point correlation function $C(t) = \langle v(\tau)v(\tau+t)\rangle$ of the velocity components of the Lagrangian tracer particle is calculated analytically and numerically. Our results are universal and do not depend on details of the quantum fluid.