International Summer School

Large Fluctuations and Extreme Events – Theory and Applications

Dresden, 5th to 9th October 2015

Presentations / Abstracts

Monday, 5th October

Time	Event	Place
17:00 – 18:00	**3 short presentations by participants**	Lecture room I, MPIPKS
17:00	**Yohann Duguet**, LIMSI-CNRS, Université Paris-Sud, France *Subcritical transition to turbulence occurs in hydrodynamical situations* where turbulent motion can coexist with a laminar flow. Even in such cases, such as the flow of water down a pipe, the turbulent state is metastable and can suddenly disappear in favour of the laminar flow. Experimental or numerical estimation of the mean turbulent lifetime has led to numerous debates in the literature. I will discuss this problem under the point of view of extreme fluctuations.	
17:20	**Leonardo Grigorio**, École Normale Superière ENS, Lyon, France *Instantons in a Lagrangian model of turbulence* Large deviations of the velocity field differences are ubiquitous in high Reynolds number turbulence. Those large excursions of the velocity gradient put their fingerprints in the probability distribution function (pdf), where drastic deviations from gaussian behaviour are apparent. The role of the rare events can be revealed by means of the Martin Siggia Rose path-integral formulation. In this work we apply this technique in a model of Lagrangian turbulence called the Recent Fluid Deformation Closure (RFDC). This closure comprises a stochastic model of the velocity gradient based on short time correlations in the Lagrangian frame. Within the path-integral formalism the most probable trajectory that leads to an extreme event is called instanton which corresponds to the path that minimises the action. In this work we determine the instanton of the RFDC and also calculate its contribution to pdf. Analytical results can be obtained in the computation of the pdf of the diagonal component of the velocity gradient.	
17:40	**Rytis Paskauskas**, Inform. Science and Technologies Institute (ISTI), CNR, Pisa, Italy *Model-based assessment of aspects of user-satisfaction in bicycle sharing systems* A Markov Renewal Process Rational Agent Model of public transport systems is presented to argue that some events, occurring in public transport and affecting its users, can be interpreted as extreme events. The popularity of 3rd generation smart bike-sharing programs exploded worldwide, with hundreds of cities successfully operating up to tens of thousands of vehicles. Since bike-sharing programs are at least	

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	partially financed by the public sector, their long term success hinges on the perception of their utility, identified with the average load and its capability to lure users in from other modes, with a strong emphasis on private motorised ones. Our objective is understanding the utility of a bike-sharing mode from users' perspective. We use a rational agent assumption: a traveller's ultimate concern with public transport is to save travel time and reach her objectives at the expected time with high degree of certainty. The observed evidence apparently contrasts this assumption. It indicates the presence of surprisingly long cycling trips, extending from thirty minutes up to two hours. Moreover, the PDFs of cycling times in different cities are remarkable similar, this being also true for pairs of stations within a city. The range of long trips coincides with the so-called `algebraic tail' of a PDF that is well approximated by ~t-a with some a>0. The model suggests an explanation for the observed data. It predicts that an algebraically tapered PDF is a consequence of agents' willingness to limit the radius of a searched area. This decision bears risk of not finding available stations nearby, which is rational, given that it minimises the median trip duration. The model provides some insights which could be useful for the design of novel vehicle repositioning services. To end with, an interpretation of a public transport system as a betting system is given [3] References: 1. M. Massink and R. Paskauskas, "Model-based assessment of aspects of user-satisfaction in bicycle sharing systems," in Proceedings of the 18th IEEE International Conference on Intelligent Transportation Systems 2015. IEEE, 2015, to appear. 2. M. Massink, R. Paškauskas. Model-based Assessment of Aspects of User-satisfaction in Bicycle Sharing Systems. Extended Version. Tech. Rep. TR-QC-03-2015. May 27, 2015. http://milner.inf.ed.ac.uk/wiki/files/i0p9B70/TRQC032015pdf.html 3. R. Paskauskas. In preparation.	
18:00	**Poster session** *(with pizza and beverages)*	Foyer, MPIPKS

Tuesday, 6th October

Time	Event	Place
16:30 – 17:30	**3 short presentations** by participants	Lecture room I, MPIPKS
16:30	**Francisco Bernal**, Instituto Superior Tecnico, Lisbon, Portugal *Tackling unlikely events in stochastic differential equations – with application to cancer diagnosis* Diffuse Optical Tomography (DOT) is an non-invasive technique used to detect breast tumours, whereby photons emitted from a few light fibers are scattered inside the breast and the intensity of the radiation measured at a few point-wise detectors. Mathematically, the data are interpreted by means of an inverse problem model, the forward part of which is well-fitted to being solved with a Monte Carlo simulation involving the Feynman-Kac stochastic representation of the equation governing the intensity of radiation. In it, photons driven by a Brownian motion from the detector are reflected on the skin and possible tumours until hitting the position of the source. Due to its point-like dimensions, the hitting of the source can be seen as an unlikely event that greatly affects the performance of the numerical method. We will present a new idea, whereby a change of measure is introduced in the stochastic representation which is equivalent to an advection field. The drift is then modulated in real time, by means of a genetic algorithm, to push the photons towards the sources, and so speed up the simulations.	

16:50	**Veronika Stolbova**, Potsdam Institute for Climate Impact Research, Germany *Prediction of the Indian Summer Monsoon as a spatially organized critical transition* The prediction of the Indian Summer Monsoon onset and withdrawal is a vital question for more than one billion people. A slight deviation of the monsoon timing as delay (or early arrival) may lead to drastic droughts (floods) extremely affecting croplands, livelihood and prosperity of the inhabitants of the Indian subcontinent. As the onset of the Indian summer monsoon takes place abruptly, its predictability in advance (more than two weeks) remains a challenge, despite numerous deduction methods. In our study, we consider Indian Monsoon as a spatially organized critical transition from the sporadic rainfall (pre-monsoon state) to spatially organized and temporally sustained rainfall (monsoon state). Using critical phenomena associated with critical transitions, we detect areas on the Indian subcontinent sensitive to the approaching monsoon, and by monitoring dynamics in the detected areas we track arrival of Indian Summer Monsoon on the Indian subcontinent. Within this framework, we propose an early (more than one month in advance) predictability scheme for Indian Monsoon onset and withdrawal. Our approach allows to predict the onset date of the Indian Summer Monsoon two weeks earlier and withdrawal date more than a month earlier than existing methods for the period 1965-2015. In addition, our results provide information about the influence of El-Nino/Southern Oscillation on the Indian Monsoon in considered year. Our approach opens a perspective for prediction of critical transitions advancing in spatially organized systems in Climate, Physiology, and Neuroscience.	
17:10	**Tomas Tangarife**, Laboratoire de Physique, ENS Lyon, France *Large deviations of turbulent atmospheric jets* Rare or extreme events are of great interest in the climate system. No studies addressed yet these statistics from a dynamical or theoretical perspective. Classical statistical approaches, for instance closures or stochastic averaging usually describe typical states or low order statistics only [1, 2]. Large deviation theory is a very interesting alternative to these classical methods, in order to discuss the long time evolution of the jet and to predict the dynamics that may lead to change of regimes and change of attractors in atmospheric jet dynamics. We consider the dynamics of atmospheric jets in a quasi-geostrophic framework and compute the large deviation rate function of the zonally averaged Reynolds stress, the most interesting quantity for the dynamics of jets. In the limit of a time scale separation between the large scales and the surrounding turbulence, we expect a quasi-linear approximation to descibe accurately the mean flow statistics [1]. Then, we derive an explicit equation for the large deviation rate function within this quasi-linear dynamics. These theoretical results are compared with empirical measures of the rate function, obtained from direct numerical simulations of the quasi-linear equations of motion. References: F Bouchet, C Nardini, T Tangarife, Kinetic theory of jet dynamics in the stochastic barotropic and 2D Navier-Stokes equations. Journal of Statistical Physics, 153(4):572-625, (2013). F Bouchet, JB Marston, T Tangarife, Large deviations of Reynolds stresses in zonal jet dynamics, in preparation F Bouchet, T Tangarife, E Vanden-Eijnden Limiting equations and large deviation principle in fast-slow systems, in preparation see also http://perso.ens-lyon.fr/tomas.tangarife/	

Thursday, 8th October

Time	Event	Place
18:00 – 19:00	**3 short presentations by participants**	**Lecture room I, MPIPKS**
18:00	**Davide Azevedo**, Inst. of Mathematics, Polish Academy of Sciences (IM PAN), Poland *Clustering of extreme events created by multiple correlated maxima* We consider stochastic processes arising from dynamical systems by evaluating an observable function along the orbits of the system. We will consider observables that achieve a global maximum value at multiple points, all belonging to the orbit of the same point, which may be periodic or not. We will see what impact this has on the Extremal Index and clustering patterns when compared to the case where the maximum is achieved in a single point. In particular we will observe the appearance of clustering not caused by periodic orbits. (Joint work with A. C. M. Freitas, J. M. Freitas and F.B. Rodrigues.)	
18:20	**Mehrnaz Anvari**, University of Oldenburg, Germany *Disentangling the stochastic behavior of epileptic brain dynamics: Jump-Diffusion model* Jumps in stochastic processes can be considered as extreme events which are discontinuous events with some distributed amplitudes. With respect to heavy tail statistics both volatility (diffusion coefficient) and jumps could have similar impact. Disentangling the effects caused by the volatility from the effects caused by jumps is a main problem in detailed understanding of stochastic dynamics of complex systems. Here we introduce a non-parametric method to address this general problem and disintegrate the stochastic behavior of epileptic brain dynamics into its deterministic trend (drift), stochastic diffusive contribution (volatility) and short-term jumpy dynamics, and determine the jump amplitude variance.	
18:40	**Massimo Cavallaro**, School of Mathematical Sciences, Queen Mary University of London, UK *Temporally correlated zero-range process: non-equilibrium stationary state and current fluctuations* The zero-range process is a paradigmatic model of particle transport on lattice. We consider an open-boundary version of the model with temporal correlations that promote the accumulation of particles on a site, i.e., the congestion. We present the exact solution for the non-equilibrium steady state of the one-site system, as well as a mean-field approximation for large lattices, and also explore the large-deviation properties of the particle current. Analytical and numerical calculations show that, although the particle distribution is well described by an effective Markovian solution, the probability of rare currents differs from the memoryless case. In particular, we find evidence for a memory-induced dynamical phase transition.	