ZiF Research Group "Stochastic Dynamics: Mathematical Theory and Applications"

Workshop 4 "Fusion of Knowledge in Modelling of Large Stochastic Systems" (10–14 June 2013)

Programme (speakers in alphabetical order)

1. Akemann, Gernot (Bielefeld University, Germany)
   Singular Values of Products of Random Matrices

   Abstract: In this talk the spectral statistics of the singular values of the product of M complex non-Hermitian matrices with Gaussian distributions is derived. The joint probability distribution for the singular values is given by a nonstandard determinantal point process. All spectral correlation functions can be computed explicitly for finite matrix size N and a given finite product of M matrices, using the technique of bi-orthogonal polynomials. Our investigation was motivated from multi-layered scattering of MIMO channels in telecommunication and we will give an example for such an application.

2. van Baalen, Minus (Université Pierre et Marie Curie – Paris VI, France)
   Biological Information: Why We Need a Good Measure

   Abstract: Evolution can be characterized as a process that shapes and maintains information across generations. However, it is now widely acknowledged that information may also play a pivotal role in many other ecological processes. Most of the ecologically relevant information (and some important evolutionary information too) is of a very subjective and analogue kind: individuals use cues that may carry information only useful to them but not to others. This is a problem because most of information theory has been developed for objective and discrete information. Can information theory be extended to incorporate multiple forms of information, each with its own (physical) carriers and dynamics? Here I will not review all the possible roles information can play, but rather what conditions an appropriate theory should satisfy. The most promising starting point is provided by entropy measures of conditional probabilities (using the so-called Kullback–Leibler divergence) allowing an assessment of how acquiring information can lead to an increase in fitness. It is irrelevant (to a certain extent) where the information comes from, genes, experience or culture, but it is important to realize that information is not merely subjective but its value should be evaluated in fitness terms, and it is here that evolutionary theory has an enormous potential. A number of important stumbling points remain, however, namely the identification of whose fitness it concerns, and what role the spatio-temporal dynamics play (which is tightly linked to the nature of the physical carriers of the information and the processes that impact on it).

3. Burger, Martin (Münster University, Germany)
   Mathematical Models for Aggregation and Repulsion: Local vs. Nonlocal Effects

   Abstract: This talk will discuss models for interacting particle systems with short-range repulsion and long-range attraction. Such systems naturally arise in a variety of applications ranging from microscopic structures such as cell systems to macroscopic ones such as animal swarms. We will discuss microscopic stochastic models and their continuum limits obtained in a mean-field limit, which are characterized by local nonlinear diffusion effects and nonlocal aggregation terms. We provide several results on the structure of such systems and their long-time behaviour and also comment on segregation effects in multi-species systems.

4. Cantrell, Stephen (University of Miami at Coral Gables, USA)
Evolution of Dispersal in Patchy Environments: Continuous and Discrete Time Models
Abstract: In previous work, Chris Cosner, Yuan Lou and I (and others) have considered the question of when dispersal strategies that can be viewed as leading to an ideal free distribution at equilibrium are evolutionarily advantageous among some class of strategies. We have done so in numerous mathematical frameworks including reaction-diffusion, integro-difference and, for this discussion most particularly, discrete diffusion of an arbitrary number of competing species in an arbitrary number of patches [1]. A common feature in all these models is that dispersal and growth appear in separate terms. Of course, not all patch models (in discrete or continuous time) have such forms. In many cases dispersal and growth are intermingled. Kirkland, Schreiber and Li [2] considered the evolution of conditional and unconditional dispersers for a general such class of multi-patch difference equations. In this work, we build on the work of [2] in the discrete time multi-patch case utilizing the approach in [1] and then address some continuous time multi-patch models in which dispersal and growth are similarly intermingled, namely the Mouquet–Loreau metapopulation model [3] and a model with density dependent growth and dispersal studied by Schoener [4]. The discrete results cover a generalization of the models in [2] but for this talk I will focus on the models from [2] and on the Mouquet–Loreau model. This work is in collaboration with Chris Cosner, Yuan Lou and Sebastian Schreiber.

[1] Cantrell, R.S., Cosner, C. and Lou, Y. Evolutionary stability of ideal free dispersal strategies in patchy environments. *J. Math. Biology* **65** (2012), 943–965.

[2] Kirkland, S., Li, C.-K. and Schreiber, S.J. On the evolution of dispersal in patchy environments. *SIAM J. Appl. Math.* **66** (2006), 1366–1382.

[3] Mouquet N. and Loreau, M. Coexistence in metacommunities: The regional similarity hypothesis. *Am. Nat.* **159** (2002), 420–426.

[4] Schoener, T. Effects of density-restricted food encounter on some single-level competition models. *Theoret. Population Biology* **13** (1978), 365–381.

5. Cornell, Stephen (University of Liverpool, UK)
Stochastic Models in Community Ecology
Abstract: One of the most prominent conundrums in ecology is: why do so many species coexist, given that they typically interact in such antagonistic ways? An explanation going back to Darwin is that ecological communities are niche assembled, i.e. that species coexist because they exploit their environment in different ways. However, it has also been argued that dispersal assembly plays a role, i.e. that community composition can be understood from the dynamics of colonization and extinction. A recent, and extreme, example of a dispersal assembly theory is Stephen Hubbell's Neutral Theory of Biodiversity and Biogeography, where all individuals are ecologically identical irrespective of species. In this theory, all patterns of abundance are generated by stochasticity in the demographic processes alone. The theory has been criticized because of its underlying lack of biological realism, yet many empirical patterns of biodiversity match the predictions of the theory surprisingly well. I shall discuss how the model can be extended to be more biologically reasonable, and the extent to which ecological patterns can be understood and predicted by stochastic models such as these.

6. Da Prato, Giuseppe (Scuola Normale Superiore, Pisa, Italy)
Uniqueness for Continuity Equations in Hilbert Spaces with Weakly Differentiable Drift
Abstract: This is joint work with Franco Flandoli (Pisa) and Michael Röckner (Bielefeld).
Let H be a separable Hilbert space and let $F\colon [0,\infty) \times H \to H$ be Borel measurable. We present a new proof for uniqueness of solutions to the continuity equation

$$\int_0^T \int_H \mathcal{K}_F\, u(s,x)\, \mu_s(dx)\, ds = -\int_H u(0,x)\, \zeta(dx), \quad \forall\, u \in \mathcal{D}_T, \tag{1}$$

where for $(t,x) \in [0,T] \times H$, $\mathcal{K}_F$ is a (degenerate) Kolmogorov operator defined by

$$\mathcal{K}_F u(t,x) = \frac{\partial}{\partial t}\, u(t,x) + \langle F(t,x), Du(t,x)\rangle \tag{2}$$

and ζ is a given Borel probability measure on H.

In contrast to the Fokker–Planck equation where the differential operator has a second order part (in x), and uniqueness is known even for just measurable F, for the continuity equation at least weak differentiability of F is required to hope to have uniqueness of solutions, even in finite dimensions. We shall define weak differentiability with respect to a Gaussian measure. This choice of a Gaussian measure as reference measure was proposed in recent papers by L. Ambrosio and A. Figalli (*J. Funct. Anal.*, 2009) and S. Fang and D. Luo (*Bull. Sci. Math.*, 2010). They proved existence and uniqueness of solutions to (1) under certain conditions on the weak derivative and exponential μ-integrability conditions on its μ-divergence.

In the present paper, also taking a Gaussian measure μ as a reference measure, we prove uniqueness for (1) by a completely different method and improve the above results since we do not assume any exponential μ-integrability conditions on div F. The idea of proof is inspired by the uniqueness proof for Fokker–Planck equations in Hilbert spaces from V. Bogachev, G. Da Prato and M. Röckner (*Comm. Partial Diff. Equations*, 2011), proving a suitable rank condition for the Kolmogorov operator in (2).

7. Delius, Gustav (University of York, UK)
Coupling Size and Space in Stochastic Population Models
Abstract: Both the size of individuals and their relative location in space are important in describing competition between individuals. However there are few theoretical studies of the effects of this coupling of size effects and spatial effects in models of population dynamics. We introduce an individual-based stochastic model of fish populations which takes into account both size-dependent predation and fitness-optimizing spatial movement. We analyze the steady-state and its stability analytically. We find that the population undergoes a Hopf bifurcation in which the homogeneous steady state becomes unstable, leading to waves of population density travelling from smaller to larger sizes while simultaneously travelling across space. Advance warning of this pattern forming transition can be found in the correlations of stochastic fluctuations around the stable steady-state.

8. Derfel, Gregory (Ben-Gurion University, Beer Sheva, Israel)
Diffusion on Fractals and the Poincaré Equation
Abstract: I shall give a brief overview of applications of the Poincaré equation to the study of Laplace operators on the Sierpiński gasket and other self-similar fractals. Topics to be discussed include anomalous diffusion, relation to branching processes, decimation invariance and spectral decimation. Methods of complex analysis and the iteration theory are used to deal with the aforementioned problems. (Joint work with Peter Grabner and Fritz Vogl.)

9. Deuschel, Jean-Dominique (Technical University Berlin, Germany)
Quenched Invariance Principle for the Random Conductance Model in Ergodic Environment
Abstract: We consider a continuous-time random walk on the lattice $\mathbb{Z}^d$ in an environment of symmetric random conductances, $\mu_{x,y}$. The law of the environment is assumed to be ergodic with respect to space shifts with $\mathbb{P}(0 < \mu_{x,y} < \infty) = 1$. In this talk, we show how a quenched invariance principle can be established under suitable moment conditions. A key ingredient in the proof is to establish the sub-linearity of the corrector by means of Moser's iteration scheme. We also get parabolic Harnack inequalities and quenched local limit theorems. This is joint work with Sebastian Andres (Univ. Bonn) and Martin Slowik (TU Berlin).

10. Fattler, Torben (Technical University Kaiserslautern, Germany)
A Dynamical Wetting Model: Construction and Analysis via Dirichlet Forms
Abstract: We give a Dirichlet form approach for the construction of a distorted Brownian motion, where the behaviour on the boundary is determined by the competing effects of reflection from and pinning at the boundary. By providing a Skorokhod decomposition of the constructed process we are able to justify that the stochastic process solves the underlying stochastic differential equation weakly in the sense of N. Ikeda and S. Watanabe for quasi-every starting point with respect to the associated Dirichlet form. In particular, our considerations enable us to construct a dynamical wetting model (also known as Ginzburg–Landau dynamics) on a bounded set.

11. Finkelstein, Dmitri (Institute of Mathematics, Kiev, Ukraine)
Properties of Some Nonlocal Kinetic Equations Derived from Stochastic Dynamics of Complex Systems
Abstract: We consider a number of nonlocal nonlinear kinetic-type equations whose solutions approximate densities of complex systems in the course of proper stochastic evolutions. The approximation was obtained using a mesoscopic scaling in the corresponding microscopic (non-equilibrium) dynamics. All equations are rigorously derived from the mesoscopic evolutions. We are interested in the following properties of the equations and their solutions: existence and uniqueness, comparison principle, stationary solutions, stability, travelling waves, propagation of front. We present an overview of recent results in this area.

12. Gentz, Barbara (Bielefeld University, Germany)
Noise-Induced Passage Through an Unstable Periodic Orbit
Abstract: We consider a dynamical system given by a planar differential equation exhibiting an unstable periodic orbit. Assume the initial state lies inside the unstable periodic orbit. If the system is subject to noise, the first-passage location through the unstable periodic orbit typically displays the phenomenon of cycling: The distribution of first-exit locations is translated along the unstable periodic orbit proportionally to the logarithm of the noise intensity as the noise intensity goes to zero. We will show that for a large class of such systems, the cycling profile is given, up to a model-dependent change of coordinates, by a universal function. Our techniques combine large-deviation results with properties of random Poincaré maps described by continuous-space discrete-time Markov chains. Joint work with Nils Berglund (Orléans).

13. Goldsheid, Ilya (Queen Mary, University of London, UK)
Relations between Various Aspects of the Asymptotic Behaviour of Random Walks in Random Environments

Abstract: I shall explain the connection between different ways of describing the asymptotic behaviour of a RWRE on a strip. In particular, it turns out that the Local Limit Theorem (LLT) for hitting times implies the LLT for the position of the particle and allows one to control the invariant measure of the associated Markov chain on the set of environments (the so-called *environment viewed from the particle*).

14. Granovsky, Boris (Israel Institute of Technology – Technion, Haifa, Israel)
Principles of the Khinchine–Meinardus Method for Asymptotic Enumeration of Decomposable Combinatorial Structures

Abstract: The talk is based on joint work with Dudley Stark (*Commun. Math. Phys.* **314** (2012), 329–350). Our objective in this talk is derivation of the asymptotics of the number c_n ($n \to \infty$) of decomposable structures arising in statistical mechanics, combinatorics and quantum field theory. The method in the title is a combination of Khintchine's probabilistic representation (1950) for c_n and the Meinardus analytical approach (1954) for the asymptotics of the generating function for the sequence $\{c_n\}$. We extend Khintchine's representation of c_n to general multiplicative generating functions of $\{c_n\}$ and derive an asymptotic formula for $\{c_n\}$ for three basic types of decomposable models, when the Dirichlet generating function for the associated weights $\{b_n\}$ has multiple simple poles on the positive real axis. Our asymptotic formula for the number of weighted partitions disproves the accepted belief in the physics literature that the main term in the asymptotics of c_n is determined by the rightmost pole. We also demonstrate the failure of the Khintchine–Meinardus method for models for which the normal local limit theorem does not hold. This part of the talk is based on joint work in progress with Dudley Stark.

15. Grothaus, Martin (Technical University Kaiserslautern, Germany)
Scaling Limit of Interface Models

Abstract: A starting point is the dynamical wetting model (also known as Ginzburg–Landau dynamics with pinning and reflection competing on the boundary) on a bounded set. From the abstract point of view this is a distorted Brownian motion with sticky boundary condition. Scaling limits of the corresponding invariant measures have been studied by Deuschel, Giacomin and Zambotti. In this talk we consider the scaling limit of the dynamics in the critical regime.

16. Hryniv, Ostap (Durham University, UK)
Stability of the Bolker–Pacala Model

Abstract: We show that the Bolker–Pacala model in the space of locally finite configurations in $\mathbb{R}^d$ with dispersion kernel $a^+(z) \equiv a^+ \mathbb{1}_{\{|z| \le R\}}$, competition kernel $a^-(z) \equiv a^- \mathbb{1}_{\{|z| \le r\}}$ and mortality rate m, where $a^\pm \ge 0,\ m \ge 0$ and $R > 0,\ r > 0$, is stable as long as $a^- > 0$.

17. Kolokoltsov, Vassili (Warwick University, UK)
Stochastic Differential Equations with Coefficients Depending on VaR or other Quantiles

Abstract: The talk will be devoted to the well-posedness for nonlinear McKean–Vlasov type diffusions with coefficients depending on the median or Value-at-Risk (VaR) of the underlying distribution. The median is not a continuous function on the space of probability measures equipped with the weak convergence. This is one reason why well-posedness of the SDE considered in this talk does not follow by standard arguments. This work was initiated by a question of Tom Kurtz, addressed to the author in June 2012 at a previous stochastic conference in ZiF, Bielefeld.

18. Koralov, Leonid (University of Maryland at College Park, USA)
Diffusion in Periodic Channels

Abstract: I shall discuss analytical and probabilistic approaches to the study of the asymptotic properties of diffusions in periodic channels. Namely, the effective drift and the effective diffusivity may depend on small parameters describing the geometry of the channel as well as on the values of the molecular diffusion and drift. We explore the behaviour of the effective parameters in different asymptotic regimes. This is joint work with S. Molchanov and B. Vainberg.

19. Kozitsky, Yuri (Maria Curie-Sklodowska University, Lublin, Poland)
Birth-and-Death Dynamics with Aging

Abstract: A model for a mesoscopic evolution of a continuum particle system with dispersal and competition is proposed and discussed. The model takes into account also the age of the particles and is described by a system of integro-differential (kinetic) equations, which are nonlocal in space and time. Based on joint research with Haggai Katriel (ORT Braude College, Karmiel).

20. Kramer, Peter (Rensselaer Polytechnic Institute, Troy, USA)
Incorporation of Binding Dynamics into Molecular Motor Models

Abstract: In the second workshop of our program (June 2012), I presented some work on a model, consisting of a system of stochastic differential equations, for interacting molecular motors bound to a common cargo. An important next step was to incorporate the possibility for the motors to unbind and rebind to the microtubule. In collaboration with research group fellows Leonid Bogachev, Leonid Koralov, and Yuri Makhnovskii, we formulated a mathematical framework to extend our asymptotic stochastic analysis to certain nontrivial distinguished limits concerning the binding and unbinding rates of the motors. I will report on our progress on this new research direction.

21. Kurtz, Thomas (University of Wisconsin at Madison, USA)
Weak and Strong Solutions for General Stochastic Models

Abstract: Typically, a stochastic model relates stochastic "inputs" and, perhaps, controls to stochastic "outputs". A general version of the Yamada–Watanabe and Engelbert theorems relating existence and uniqueness of weak and strong solutions of stochastic equations will be given in this context. A notion of "compatibility" between inputs and outputs is critical in relating the general result to its classical forebears.

22. Lythe, Grant (University of Leeds, UK)
New Numerical Methods for Stochastic Differential Equations

Abstract: This talk will consist of three parts.

1. Numerical solutions of stochastic differential equations can be carried out using successive time increments that are independent random variables with a symmetric exponential distribution. Such "exponential" time-stepping algorithms are efficient for escape-time problems because a simple boundary test can be performed at the end of each step. (Joint work with Kalvis Jansons.)

2. We consider new numerical methods for second-order-in-time stochastic differential equations that accurately reproduce the stationary distribution for all values of damping. A complete analysis is possible for linear second-order equations. The "reverse leapfrog" method has remarkably good properties in the position variable. The analysis permits the construction of new family of explicit partitioned Runge–Kutta methods. (Joint work with Kevin Burrage.)

3. Kinks (localized coherent structures) are a striking feature of noisy, nonlinear, spatially-extended systems in one space dimension with local bistability. At late times, a steady-state density is dynamically maintained: kinks are nucleated in pairs, diffuse and annihilate on collision. Long-term averages can be calculated using the transfer-integral method, developed in the 1970s, giving exact results that can be compared with large-scale numerical solutions of the SPDE. (Joint work with Salman Habib.)

23. Lytvynov, Eugene (University of Wales at Swansea, UK)
Equilibrium Dynamics on the Cone of Discrete Radon Measures

Abstract: A discrete Radon measure is a measure on $\mathbb{R}^d$ which has the form $\eta = \sum_{i=1}^{\infty} s_i \delta_{x_i}$, where δ_{x_i} is the Dirac measure with unit mass at point x_i, $s_i > 0$, and for any bounded set $\Lambda \subset \mathbb{R}^d$, $\eta(\Lambda) = \sum_{i:\, x_i \in \Lambda} s_i < \infty$. We will deal with the set $\mathbb{K}(\mathbb{R}^d)$ of discrete Radon measures η for which the set of its atoms, $\{x_i\}_{i=1}^{\infty}$, is dense in $\mathbb{R}^d$. Elements $\eta \in \mathbb{K}(\mathbb{R}^d)$ may model, for example, biological systems, so that the points x_i represent location of some organisms and the values s_i are a certain attribute attached to these organisms, like their weight or height. A fundamental example of a probability measure on $\mathbb{K}(\mathbb{R}^d)$ is the gamma measure, which has many distinguished properties. We note that a study of countable dense random subsets $\{x_i\}$ of $\mathbb{R}^d$ leads to "situations in which probabilistic statements about such sets can be uninformative" (W. Kendall). It is the presence of the weights s_i in random discrete measures that makes a real difference.

The aim of this talk is the construction and study of certain stochastic dynamics on $\mathbb{K}(\mathbb{R}^d)$ which has the gamma measure as invariant measure. This Markov process can be thought of as a Brownian motion on the set of discrete Radon measures. To this end, we will introduce some elements of differential calculus on $\mathbb{K}(\mathbb{R}^d)$. Using an integration-by-parts formula with respect to the gamma measure, we will construct a Laplace operator $\Delta_{\mathbb{K}}$ defined on functions on $\mathbb{K}(\mathbb{R}^d)$. This will lead us to a Markov process on $\mathbb{K}(\mathbb{R}^d)$ which has the generator $\Delta_{\mathbb{K}}$. In these dynamics, one observes a random motion of both the atoms $x_i = x_i(t)$ and the corresponding weights $s_i = s_i(t)$. (Joint work with Dennis Hagedorn, Yuri Kondratiev and Anatoly Vershik.)

24. Molchanov, Stanislav (University of North Carolina at Charlotte, USA)
Intermittency of the Particle Fields for the Reaction-Diffusion Equations

Abstract: It is well known that in the classical FKKP model the front of the population propagates linearly in time. The analysis of the higher moments inside the front indicates the development of strong intermittency near the front (clusterization of the population). Similar intermittency effects also exist in the stationary (critical) model: the smaller is the initial density, the stronger is the intermittency. (Work in collaboration with Leonid Koralov.)

25. Oliveira, Maria Joao (University of Lisbon, Portugal)
Dynamical Widom–Rowlinson Model and its Mesoscopic Limit

Abstract: We construct the time evolution for states of the Widom–Rowlinson model for an infinite two-component particle system in terms of generating functionals. This is carried

out by an Ovsjannikov-type result in a scale of Banach spaces, which leads to a local (in time) solution. An application of this approach to a mesoscopic scaling, in the sense of Lebowitz–Penrose, in terms of generating functionals is considered as well.

26. Ovaskainen, Otso (University of Helsinki, Finland)
Mathematical Framework for the Use of Spatio-Temporal Point Processes in Theoretical Ecology
Abstract: Almost all ecological and evolutionary processes are in a way or another structured by space, and consequently spatial models are much used in theoretical ecology. In this talk I will focus on a specific class of spatial and stochastic models, called spatio-temporal point processes in the ecological and statistical literature, and Markov evolutions in locally finite configurations in the mathematical literature. In our joint work (with D. Finkelshtein, O. Kutovyi, S. Cornell, B. Bolker and Y. Kondratiev), we have translated concepts and results from the mathematical literature to provide a rigorous and a practical framework for theoretical ecology. Starting from the evolution of measures, describing assumptions at the individual level, we derive spatial moment equations and spatial cumulant equations, describing model behaviour at the population level. To close the infinite hierarchy of these sets of equations, we consider the limit of large-scale interactions, at which limit a perturbation expansion around the mean-field model results in a closed system of equations. I compare analytical results with simulation results to illustrate the asymptotically exact nature of the expansion. Finally, I discuss the applications of the framework in theoretical ecology.

27. Pastur, Leonid (Institute for Low Temperature Physics & Engineering, Kharkov, Ukraine)
Limits of Infinite Interaction Radius, Dimensionality and the Number of Components in Spectral Theory of Disordered Systems
Abstract: The limits of infinite interaction radius, dimensionality and the number of components of dynamical variables are well known in statistical mechanics. The first two limits coincide with the mean-field approximation and the third limit yields the spherical version of corresponding models. Thereby the limits provide simplified versions of important models, which nevertheless possess a number of relevant properties of the models. We study analogous limit for self-adjoint ergodic operators describing thermodynamics and kinetics of disordered systems. We prove that the Integrated Density of States of the operators in question converges weakly to a certain measure in the above limits. We also show that the limiting measure coincides with the infinite-size limit of the Normalized Counting Measure of eigenvalues of certain random matrices. We then give an informal discussion of these results as possible indications of the presence of the continuous spectrum of ergodic operators for sufficiently large interaction radius, dimensionality or the number of components, hence the existence of non-trivial transport in the corresponding disordered systems.

28. Pasurek, Tatjana (Bielefeld University, Germany)
Gibbs States of Amorphous Media
Abstract: We consider a multi-component continuum model of classical particles described by their positions $x \in \mathbb{R}^n$ and vector spins $s_x \in \mathbb{R}^m$. The interaction between the particles is given by the pair potential

$$W(x, y; s_x, s_y) := \phi\left(|x-y|_{\mathbb{R}^n}\right) + J\left(|x-y|_{\mathbb{R}^n}\right) \cdot |s_x - s_y|^2_{\mathbb{R}^m}, \qquad x, y \in \mathbb{R}^n.$$

The purely positional term $\phi\left(|x-y|_{\mathbb{R}^n}\right)$ is assumed to be superstable (e.g., of the Lennard-Jones type). The intensity $J\left(|x-y|_{\mathbb{R}^n}\right)$ of the harmonic spin-spin interactions $|s_x - s_y|^2_{\mathbb{R}^m}$

is bounded and of finite range, but not necessarily ferromagnetic. The reference (i.e., free) measure is the Poisson point process π_σ on the marked configuration space $\Gamma(\mathbb{R}^n, \mathbb{R}^m)$ with intensity measure $\sigma(dx, ds) = \exp\{-V(s)\}\, dx\, ds$, where $V(s)$ is an anharmonic single-spin potential. We construct the corresponding Gibbs distributions both in the annealed and quenched approaches and discuss their properties. (Joint work with Alex Daletski, Yuri Kondratiev and Yuri Kozitsky.)

29. Pitchford, Jon (University of York, UK)
Complexity, Stability and Reality in Ecological Networks

Abstract: For more than four decades ecologists and theoreticians have struggled to understand the relationships between stability and complexity. This battle has produced some elegant and inspirational theory, but the challenge of how to reconcile this with empirical data remains. I will discuss some recent attempts to bridge this gap, both by asking what hidden constraints may lurk within the theory, and also seeking methods to construct reliable mathematical descriptions of interactions using data from the field.

30. Presutti, Errico (Gran Sasso Science Institute, L'Aquila, Italy)
Particle Models for Free Boundary Problems

Abstract: I will report on some recent works on the hydrodynamic limit of stochastic particle systems. In particular I will discuss a system of independent random walks on the non-negative integers with a source at the origin and with a death rate for the rightmost particle: the rates are chosen so that in the average the number of particles is conserved. The hydrodynamic limit is described by the linear heat equation in the interval $(0, R_t)$ where R_t evolves with a law which depends on the solution of the equation (free boundary problem). The result has been proved in collaboration with G. Carinci, A. De Masi and C. Giardina and extends previous results on the symmetric simple exclusion process proved in a paper with A. De Masi and Pablo Ferrari.

31. Röckner, Michael (Bielefeld University, Germany)
Stochastic Nonlinear Schrödinger Equations with Linear Multiplicative Noise: The Rescaling Approach

Abstract: We present well-posedness results for stochastic nonlinear Schrödinger equations with linear multiplicative Wiener noise including the non-conservative case. Our approach is different from the standard literature on stochastic nonlinear Schrödinger equations. By a rescaling transformation we reduce the stochastic equation to a random nonlinear Schrödinger equation with lower order terms and treat the resulting equation by a fixed point argument, based on generalizations of Strichartz estimates proved by J. Marzuola, J. Metcalfe and D. Tataru in 2008. This approach allows to improve earlier well-posedness results obtained in the conservative case by a direct approach to the stochastic Schrödinger equation. In contrast to the latter, we obtain well-posedness in the full range $(1, 1 + 4/d)$ of admissible exponents in the nonlinear part (where d is the dimension of the underlying Euclidean space), i.e. in exactly the same range as in the deterministic case. Joint work with Viorel Barbu (Romanian Academy) and Deng Zhang (Bielefeld University).

32. Rudelson, Mark (University of Michigan at Ann Arbor, USA)
Permanent Estimators via Random Matrices

Abstract: The permanent of a square matrix is defined similarly to the determinant. It is the sum of products of entries over all "generalized diagonals", only without signs in front of the products. The evaluation of the determinant is computationally efficient, while the evaluation of the permanent is an NP-hard problem. Since the deterministic methods are not available, permanents are estimated probabilistically. One of such estimators constructed by Barvinok evaluates the permanent of a deterministic matrix via the determinant of a random matrix associated to it. Barvinok proved that the multiplicative error of this estimator is at most exponential, and this result cannot be improved for general matrices. We provide conditions on the matrix, under which the Barvinok estimator yields a subexponential error. Joint work with Ofer Zeitouni.

33. Scalas, Enrico (Università del Piemonte Orientale, Alessandria, Italy)
Finitary Probabilistic Methods in Economics and Finance

Abstract: Starting from the contents of [1], I will present a survey of some results on the role of statistical equilibrium in economics and finance. In this framework, there are some striking analogies between physics and economics whose consequences are not yet fully explored.

[1] Garibaldi, U. and Scalas. E. *Finitary Probabilistic Methods in Econophysics*. Cambridge Univ. Press, Cambridge, 2010.

34. Shevchenko, Georgiy (Taras Shevchenko National University of Kiev, Ukraine)
Mixed Stochastic Differential Equations

Abstract: The talk is devoted to the so-called mixed stochastic differential equation in $\mathbb{R}^d$:

$$X_t = X_0 + \int_0^t a(X_s)\, ds + \int_0^t b(X_s)\, dW_s + \int_0^t c(X_s)\, dB_s\,,$$

where $W = \{W_t,\, t \geq 0\}$ is an m-dimensional standard Wiener process, $B = \{B_t,\, t \geq 0\}$ is an ℓ-dimensional fractional Brownian motion; the coefficients $a\colon \mathbb{R}^d \to \mathbb{R}^d$, $b\colon \mathbb{R}^d \to \mathbb{R}^{d\times m}$, $c\colon \mathbb{R}^d \to \mathbb{R}^{d\times \ell}$ are continuous, and $X_0 \in \mathbb{R}^d$ is non-random. Such equations gained a lot of attention recently thanks to their modelling properties. Specifically, mixed equations are able to reflect the nature of randomness in financial markets, which has both a white noise and long memory components. In my talk I will give a review of our recent results for these equations, including unique solvability, integrability, convergence of solutions, comparison theorems, Malliavin regularity, etc.

35. Soshnikov, Alexander (University of California at Davis, USA)
Gaussian Fluctuation in Large Random Matrices

Abstract: I plan to talk about Central Limit Theorem for linear (and partial linear) statistics of the eigenavlues in large random matrices. In the first part of the talk, I will discuss band real symmetric random matrices with independent entries [1]. In the second part, I will talk about partial linear statistics for Wigner and sample covariance random matrices [2]. If time permits, I will also mention our recent results for beta ensembles of random matrices [3].

[1] Li, L. and Soshnikov, A. Central limit theorem for linear statistics of eigenvalues of band random matrices. Available at arXiv:1304.6744 [math.PR].

[2] O'Rourke, S. and Soshnikov, A. Partial linear eigenvalue statistics for Wigner and sample covariance random matrices. To appear in *J. Theoret. Probab.*, available at arXiv:1301.0368 [math.PR].

[3] Bufetov, A., Mkrtchyan, S., Shcherbina, M. and Soshnikov, A. Entropy and the Shannon–McMillan–Breiman theorem for beta random matrix ensembles. To appear in *J. Stat. Phys.*, available at arXiv:1301.0342 [math.PR].

36. Streit, Ludwig (Bielefeld University, Germany)
Asymptotic Scaling of Self-Repelling Fractional Brownian Motion

Abstract: Mathematically, self-repulsion can be modelled using the self-intersection local time of Brownian motion (Varadhan, Westwater). Its effect on the scaling property of paths has been extensively studied (and is still not completely understood in three dimensions). Here we extend the model to fractional Brownian motion and propose an extension of the scaling law to general Hurst indices and dimensions.

37. Torbin, Grygoriy (National Pedagogical Dragomanov University, Kiev, Ukraine)
On Fractal Properties of Attractors of Dynamical Systems Generated by Infinite IFS

Abstract: Fractal properties of attractors of dynamical systems generated by a finite Iterated Function System (IFS) satisfying the open set condition are well studied. On the other hand, properties of dynamical systems generated even by linear infinite IFS are essentially less investigated. In the talk we shall discuss several new unexpected probabilistic, fractal and number-theoretic phenomena connected with infinite linear IFS.

38. Zeindler, Dirk (Bielefeld University, Germany)
The Limit Shape of Random Permutations with Polynomially Growing Cycle Weights

Abstract: We study the limit shape of random permutations endowed with the generalized Ewens measure with polynomially growing cycle weights. Furthermore, we consider also the fluctuations at different points of the limit shape and study their joint behaviour.

39. Zhizhina, Elena (Institute for Information Transmission Problems, Moscow, Russia)
Direct Aggregation in Birth-and-Death Stochastic Dynamics in Continuum

Abstract: We consider birth and death stochastic dynamics of particle systems with attractive interaction. The heuristic generator of the dynamics has a constant birth rate and density-dependent decreasing death rate that defines prolongation of life for elements of configuration provided that there are many other elements nearby. We construct the corresponding statistical dynamics; then using the Vlasov type scaling we derive the limiting mesoscopic evolution of correlation functions and prove that this evolution propagates chaos. We study a nonlinear nonlocal kinetic equation for the first correlation function (density of population) and find uniformly bounded solutions as well as solutions growing inside a bounded domain. These solutions describe two regimes in the initial microscopic system: regulation and aggregation. (Joint work with Yuri Kondratiev, Dmitri Finkelshtein and Oleksandr Kutoviy.)