21^{th} Marian Smoluchowski Symposium on Statistical Physics

ZAKOPANE, POLAND, SEPTEMBER 13–18, 2008

organized by

Jagellonian University

Marian Smoluchowski Institute of Physics

Mark Kac Complex System Research Center

in cooperation with

Institute of Mathematics and Computer Sciences
Hugo Steinhaus Center
Institute of Physics
Wrocław University of Technology
Wrocław

Department of Physical Chemistry
Silesian University of Technology
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Saturday, September 13
Arrival Day

20:00 *Get–together Party*

Pre-poster session

Prior to the poster session, a pre-poster session will be organized. Authors of posters can advertise their posters on a "three by three" basis: not more than three minutes of talking and not more than three slides. We all know that you are grateful for having an opportuninty to present your work during this wonderful Symposium, so don't waste your time to thank the Organizers. If you want to have a three-slides computer-based presentation, it must be pre-recorded on a designated computer.

Authors may choose not to advertise their posters and opt out of the pre-poster session, risking a reduced interest in their work.

Proceedings

As usual, proceedings of the Symposium are going to be published as a special issue of *Acta Physica Polonica B*. Everybody is welcome to contribute, but please note that all submissions will go through a full editorial process, including peer review.

Please, send your submissions to the address of the **Organizers**
`proceedings@th.if.uj.edu.pl`
Your submission should be in the LaTeX (or plain TeX) format, figures in Encapsulated PostScript. We are sorry but we will **not** be able to handle other formats, including Word. Please, visit the publishers' website `http://th-www.if.uj.edu.pl/acta/` for further instructions for authors.

The submission deadline is **January 4, 2009**.

Sunday, September 14

8:00	*Breakfast*	
10:30	*Coffee break*	
	Chairperson: Karina Weron	
11:00	**Ewa Gudowska-Nowak**	
	Aleksander Weron	Opening address
11:30	**Mark M. Meerschaert**	Particle tracking for anomalous diffusion
12:00	**Agnieszka Jurlewicz**	Limit theorems for randomly coarse grained continuous-time random walks and applications
13:00	*Lunch*	
	Chairperson: Katja Lindenberg	
15:00	**Igor M. Sokolov**	Can continuous-time random walks describe subdiffusion in single protein molecules?
15:30	**Ilya Pavlyukevich**	Simulated annealing with Lévy flights
16:00	**Krzysztof Podgorski**	On stochastic self-similarity and approximations of fractional Brownian and Laplace motions
16:30	*Coffee break*	
	Chairperson: Zdzislaw Suchanecki	
17:00	**Aleksei Chechkin**	Some recent results on free and confined Lévy flights
17:30	**Krzysztof Burnecki**	Statistical Modeling of Solar Flare Activity from Empirical Time Series of Soft X-ray Solar Emission
18:00	**Young Shin Kim**	Tempered stable and tempered infinitely divisible GARCH models
19:00	*Dinner*	

Monday, September 15

8:00	*Breakfast*	
	Chairperson: M. Howard Lee	
9:00	**Katja Lindenberg**	Synchronization of discrete phase-coupled oscillators
9:30	**J. Miguel Rubi**	Entropic Stochastic Resonance
10:00	**Ralf Metzler**	Stochasticity and gene control
10:30	*Coffee break*	
	Chairperson: J. Miguel Rubi	
11:00	**M. Howard Lee**	Low temperature chemical potential of an ideal Fermi gas: Anomalous behavior in low dimensions
11:30	**Danuta Kruk**	The Smoluchowski equation in application to dynamics investigations by electron and nuclear spin resonances
12:00	**Danuta Makowiec**	Multifractal analysis of time series: practical approach
13:00	*Lunch*	
	Chairperson: Mark M. Meerschaert	
15:00	**Diederik Sybolt Wiersma**	A Lévy flight of light
15:30	**Iddo Eliazar**	Lorenzian analysis of infinite Poissonian populations and the phenomena of Paretian ubiquity
16:00	**Marcin Magdziarz**	Equivalence of the fractional Fokker-Planck and subordinated Langevin equations
16:30	*Coffee break*	

Monday, September 15 (continued)

	Chairperson: Igor M. Sokolov	
17:00	**Zbigniew Michna**	Asymptotic behavior of anomalous diffusions driven by alpha-stable noise
17:20	**Joanna Janczura**	Subdiffusion modeling of electricity markets
17:40	**Daniela Froemberg**	Fronts in an A+B→2A Reaction under Subdiffusion
18:00	**Piotr Garbaczewski**	Modular Schroedinger equation and dual "time arrows"
19:00	*Dinner*	

21th **Marian Smoluchowski Symposium on Statistical Physics**
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Tuesday, September 16

8:00	*Breakfast*
	Free time (excursions)
	No lunch is served
20:00	*Dinner*

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Wednesday, September 17

8:00	*Breakfast*		
	Chairperson: Zbigniew J. Grzywna		
9:00	**Anna Ochab-Marcinek**	Noise-assisted signal propagation in neurons	
9:30	**Franco Ferrari**	Diffusion of Brownian particles and Liouville field theory	
10:00	**Jarosław Paturej**	Generalized non-linear sigma model applied to the description of the dynamics of a random chain with rigid constraints	
10:30	*Coffee break*		
11:00	**Krzysztof Małysiak**	Diffusional approach to modelling of a wound healing assay	
11:30	**Alessandro Fiasconaro**	Role of the asymmetry in Piecewise linear potential on Stochastic Resonance and Resonant Activation	
12:00	**Bartłomiej Dybiec**	Ratchet driven by Lévy noise	
13:00	*Lunch*		
	Chairperson: Paweł F. Góra		
15:00	Pre-poster session		
16:30	*Coffee break*		
17:00	Poster session		
19:00	*Dinner*		
20:00	Poster session (continued)		

21$^{\text{th}}$ **Marian Smoluchowski Symposium on Statistical Physics**
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Thursday, September 18
Departure Day

8:00	*Breakfast*
9:00	Departure – bus to Krakow

21^{th} **Marian Smoluchowski Symposium on Statistical Physics**
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Invited talks

Aleksei Chechkin, Kharkov Institute of Physics and Technology, Kharkov, Ukraine
Some recent results on free and confined Lévy flights
Abstract: Lévy flights, also referred to as Lévy motion, stand for a class of non-Gaussian Markovian random processes whose stationary increments are distributed according to a Lévy stable distribution originally studied by French mathematician Paul Pierre Lévy. Lévy stable laws are important for three fundamental properties: (i) similar to the Gaussian law, Lévy stable laws form the basin of attraction for sums of random variables. This follows from the theory of stable laws, according to which a generalized central limit theorem exists for random variables with diverging variance. The Gaussian distribution is located at the boundary of the basin of attraction of stable laws; (ii) the probability density functions of Lévy stable laws decay in asymptotic power-law form with diverging variance and thus appear naturally in the description of many fluctuation processes with largely scattering statistics characterized by bursts or large outliers; (iii) Lévy flights are statistically self-affine, a property used for the description of random fractal processes. Lévy stable laws appear as statistical description for a broad class of processes in physical, chemical, biological, geophysical, or financial contexts, among others. However, despite their popularity and numerous applications, Lévy flights are far from being well understood. We here review the fundamental properties of Lévy flights, with the particular emphasis on recent developments such as the first passage time and leapover properties of Lévy flights, and the Lévy ratchet. These properties are discussed on the basis of analytical and numerical solutions of fractional kinetic equations as well as numerical solution of the stochastic Langevin equation with white Lévy noise.

[1] A.V. Chechkin, O.Yu. Sliusarenko, R. Metzler, J. Klafter, Barrier crossing driven by Lévy noise: Universality and the role of noise intensity, Physical Review E, vol.75, 041101, 1-11 (2007).

[2] T. Koren, M.A. Lomholt, A.V. Chechkin, J. Klafter, R. Metzler, Leapover lengths and first passage time statistics for Lévy flights, Physical Review Letters, vol.99, 160602, 1-4 (2007).

[3] R. Metzler, A.V. Chechkin, J. Klafter, Lévy Statistics and Anomalous Transport: Lévy Flights and Subdiffusion. Encyclopedia of Complexity and System Science, edited by Henrik Jeldtoft Jensen, Springer-Verlag, submitted; E-print arXiv:0706.3553.

[4] Chechkin, R. Metzler, J. Klafter, V. Gonchar, Introduction to the Theory of Lévy Flights. In: R. Klages, G. Radons, I.M. Sokolov (Eds), Anomalous Transport: Foundations and Applications, Wiley-VCH, Weinheim (2008).

[5] D. del-Castillo-Negrete, V.Yu. Gonchar, A.V. Chechkin, Fluctuation-driven directed transport in the presence of Lévy flights, Physica A (2008), doi:10.1016/j.physa.2008.08.034.

Invited talks (continued)

Iddo Eliazar, Holon Institute of Technology, Tel-Aviv, Israel

Lorenzian analysis of infinite Poissonian populations and the phenomena of Paretian ubiquity

Abstract: The Lorenz curve is a universally-calibrated statistical tool measuring quantitatively the distribution of wealth within human populations. We consider infinite random populations modeled by inhomogeneous Poisson processes defined on the positive half-line - the randomly scattered process-points representing the wealth of the population-members (or any other positive-valued measure of interest such as size, mass, energy, etc.). For these populations the notion of "macroscopic Lorenz curve" is defined and analyzed, and the notion of "Lorenzian fractality" is defined and characterized. We show that the only non-degenerate macroscopically observable Lorenz curves are power-laws manifesting Paretian statistics – thus providing a universal "Lorenzian explanation" to the ubiquitous appearance of Paretian probability laws in nature.

[1] I. Eliazar, Physica A 386, 318-334 (2007).

M. Howard Lee, University of Georgia, Athens, GA, USA

Low temperature chemical potential of an ideal Fermi gas: Anomalous behavior in low dimensions

Abstract: The chemical potential of an ideal Fermi gas in 2d or 3d has its maximum value at T=0, which as is well known corresponds to the Fermi energy. As T increases, the chemical potential decreases more or less monotonically eventually attaining the classical limit. This is not true if d=1. The maximum is not at T=0 but at some other value before becoming classical. This strange behavior has been known but to my knowledge there has been no reasonable explanation.
Some years ago the author has unified the statistical thermodynamics of ideal quantum gases (Bose and Fermi) by means of a transcendental function known as the polylogs [1,2]. Using this unified theory, I show that what appears to be anomalous is foreshadowing of the Pauli exclusion principle in the coordinate space.

[1] M. H. Lee, J Math Phys 36, 1217 (1995).
[2] M. H. Lee, Phys Rev E 54, 946 (1996).

Invited talks (continued)

Katja Lindenberg, University of California, San Diego CA, USA
Synchronization of discrete phase-coupled oscillators
Abstract: We investigate both continuous (second-order) and discontinuous (first-order) transitions to macroscopic synchronization within a single class of discrete, stochastic (globally) phase-coupled oscillators. We provide analytical and numerical evidence that the continuity of the transition depends on the coupling coefficients and, in some nonuniform populations, on the degree of quenched disorder. Hence, in a relatively simple setting this class of models exhibits the qualitative behaviors characteristic of a variety of considerably more complicated models. In addition, we study the microscopic basis of synchronization above threshold and detail the counterintuitive subtleties relating measurements of time averaged frequencies and mean field oscillations. Most notably, we observe a state of suprathreshold partial synchronization in which time-averaged frequency measurements from individual oscillators do not correspond to the frequency of macroscopic oscillations observed in the population. We also show that even in the presence of transition state disorder numerical and analytical results point to a single phase transition to macroscopic synchrony at a critical value of the coupling strength.

Mark M. Meerschaert, Michigan State University, East Lansing, MI, USA
Particle tracking for anomalous diffusion
Abstract: Fractional diffusion models replace the integer order derivatives in the classical diffusion model by their fractional analogues. Stable stochastic processes can be used for particle tracking, like a Gaussian process is used for classical diffusion. Fractional derivatives in space relate to long particle jumps, in one or more dimensions. Fractional time derivatives relate to long waiting times between jumps. Particle tracking uses a non-Markovian inverse stable subordinator. If waiting times and subsequent particle jumps are correlated, the subordinator is no longer independent of the outer process. This talk reviews the essential theoretical ideas, particle tracking codes, and applications to biology, finance, geophysics, and medicine.

Invited talks (continued)

Ralf Metzler, Technical University of Munich, Germany

Stochasticity and gene control

Abstract: Genes are regulated through binding of so-called transcription factors to specific sites on the DNA. To find its specific binding site such a DNA binding protein needs to scan megabases of DNA inside the cell. According to the Berg-von Hippel model [1] this search comprises volume diffusion with one-dimensional diffusion along the DNA mediated through non-specific binding [2]. An additional mechanism are intersegmental jumps in which the binding protein can jump from one segment of the DNA to a chemically remote segment that is close by in the embedding space due to DNA looping (e.g., bacterial DNA is of the length of several mm and on larger scales corresponds to a flexible polymer [4]). The binding dynamics of proteins to DNA can be probed on the level of single molecules [5].
The influence of the DNA conformation on the search efficiency of the transcription factors will be analysed. It will be shown that for long DNA chains under typical in vitro conditions intersegmental jumps help improving the search efficiency and actually give rise to Lévy flights along the DNA backbone [5]. These claims are confirmed by recent single molecule experiments in which the protein binding rate was measured versus the degree to which the DNA was allowed to relax conformationally [6].
In vivo the high degree of molecular crowding appears to significantly change the relative dynamics of the various search mechanisms in the Berg-von Hippel model. Some aspects of these changes will be addressed, in particular the effected more local nature of gene regulation [7].
The talk will close with some remarks on the interpretation of single particle tracking data of diffusion processes in complex environments.

[1] P.H. von Hippel and O.G. Berg, J. Biol. Chem. 264, 675 (1989).
[2] See, for instance, A. Bakk and R. Metzler, FEBS Lett. 563, 66 (2004); J. Theor. Biol. 231, 525 (2004).
[3] R. Metzler, T. Ambjornsson, A. Hanke, and S. Levene, Single DNA conformations and biological function, J. Comp. Theor. Nanoscience 4, 1 (2007); E-print physics/0609139.
[4] I. M. Sokolov, R. Metzler, K. Pant, and M. C. Williams, Biophys. J. 89, 895 (2005); Y. M. Wang, R. H. Austin, and E. C. Cox, Phys. Rev. Lett. 97, 048302 (2006).
[5] M. A. Lomholt, T. Ambjornsson, and R. Metzler, Phys. Rev. Lett. 95, 260603 (2005).
[6] B. van den Broek, M. A. Lomholt, S.-M. J. Kalisch, R. Metzler, and G. J. L. Wuite, Proc Natl Acad Sci, at press.
[7] M. A. Lomholt, I. M. Zaid, and R. Metzler, Phys. Rev. Lett. 98, 200603 (2007).

Invited talks (continued)

Krzysztof Podgorski, Lund University, Sweden

On stochastic self-similarity and approximations of fractional Brownian and Laplace motions

Abstract: Fractional Laplace motion has been recently introduced and discussed in the relation to stochastic models in hydrogeology. Among many of its interesting properties there is a particularly intriguing one which is termed stochastic self-similarity. The property parallels the ordinary self-similarity through a stochastic time change. This time change is expressed by the negative binomial Lévy process (NBP) which thus plays a central role in this development. The relations and invariance properties that are shared by and between the NBP, Gamma process as well as bivariate Gamma-NB stochastic process are discussed. A brief account of several consequences for approximations of the NBP, Gamma process and fractional Brownian and Laplace motions will be given. The presentation is based on published results, work in progress, and open problems. It combines a joint effort among several collaborators: Tomasz J. Kozubowski, Mark Meerschaert, Anastassia Baxevani, Anna K. Panorska.

J. Miguel Rubi, Universitat de Barcelona, Spain

Entropic Stochastic Resonance

Abstract: We show a new mechanism leading to the appearance of stochastic resonance when a Brownian particle moves in a confined medium in the presence of a periodic driving. The constrained motion impedes the accessibility of the particle to certain regions of the space and can be described in terms of a bistable entropic potential. The activated dynamics of the particle in this potential results in a cooperative effect between noise and external modulation and thus in an entropic stochastic resonance. The effect found is genuine of small-scale systems in which confinement and fluctuations are unavoidable factors ruling their evolution. The great possibilities of ESR on what concerns optimization and control may implicate new perspectives in the understanding of systems at these scales and open new avenues in their manipulation and control.

Invited talks (continued)

Igor M. Sokolov, Humboldt Universitat, Berlin, Germany

Can continuous-time random walks describe subdiffusion in single protein molecules?

Abstract: The origin of 'anomalous' subdiffusion in internal motions in proteins has attracted considerable attention recently. Our molecular dynamics simulations of oligopeptide chains reveal that even molecules of about ten amino acids show configurational subdiffusion extending from 1ps to 10ns. The corresponding mean squared displacement as obtained via moving time average over the corresponding variable shows anomalous subdiffusion at short times and stagnates at long times which are still shorter than the overall temporal length T of the data set. Motivated by this finding we investigate whether they can be explained by usual picture of potential landscapes leading to continuous time random walks (CTRW) in the configurational space of the molecule as used e.g. in the theory of protein folding. We show that the predictions of such theories differ drastically from our numerical observations. To show this we investigate CTRW with an asymptotic power law distribution of waiting times lacking the characteristic mean under moving time average. We show, that contrary to what is expected, the temporal averaged mean squared displacement leads to a simple diffusive behavior at short times and does not stagnate on the times smaller than T. Therefore, trap models, involving a random walk with a distribution of waiting times, cannot account for the subdiffusion observed, which rather arises from the fractal-like structure of the accessible configuration space.

[1] T. Neusius, I. Daidone, I. M. Sokolov, and J. C. Smith, Phys. Rev. Lett. 100, 188103 (2008)

[2] A. Lubelski, I.M. Sokolov and J. Klafter, Phys. Rev. Lett. 100, 250602 (2008)

Diederik Sybolt Wiersma and Jacopo Bertolotti, University of Florence, Florence, Italy

A Lévy flight of light

Abstract: We will report in this contribution on the realization of optical materials in which light waves perform a Lévy flight. The material is realized by constructing an inhomogeneous opaque system, in which the density distribution of scattering elements can be controlled. Disordered optical materials that had been studied up to today show interesting transport effects, like Anderson localization and the optical Hall effect, but the disorder in these materials was always Gaussian. In the new material that we realized, the disorder can be controlled and one can tune the material parameters from regular diffusion to superdiffusion, thereby controlling effectively the alpha parameter of a Lévy walk. It is easy to perform transport studies on these materials since many observables, like the conductance, are easy to measure.

Talks

Krzysztof Burnecki, Wrocław University of Technology, Wrocław, Poland
A. A. Stanislavsky, Institute of Radio Astronomy, National Academy of Sciences of Ukraine, Kharkov, Ukraine

Statistical Modeling of Solar Flare Activity from Empirical Time Series of Soft X-ray Solar Emission

Abstract: A time series of soft X-ray emission observed on 1974-2007 years (GOES) is analyzed. We show that in the periods of high solar activity 1977-1981, 1988-1992, 1999-2003 the energy statistics of soft X-ray solar flares for class M and C is well described by a FARIMA time series with Pareto innovations. The model is characterized by two effects. One of them is a long-range dependence (long-term memory), and another corresponds to heavy-tailed distributions. Their parameters are statistically stable enough during the periods. However, when the solar activity tends to minimum, they change essentially. We discuss possible causes of this evolution and suggest a statistical model for predicting the flare energy statistics.

Bartłomiej Dybiec, Jagellonian University, Kraków, Poland

Ratchet driven by Lévy noise

Abstract: We consider the motion of an overdamped particle in a periodic potential lacking spatial symmetry under the influence of symmetric, white, Lévy noise, being a minimal setup for a "Lévy ratchet". Due to the non-thermal character of the Lévy noise, the particle exhibits a motion with a preferred direction even in the absence of whatever additional time-dependent forces. The examination of the Lévy ratchet is based on the characteristics of directionality which are different from typically used measures like mean current and the dispersion of particles' positions, since these get inappropriate when the moments of the noise diverge.

[1] P. Reimann, Phys. Rep. 361, 57 (2002).
[2] B. Dybiec, E. Gudowska-Nowak and I.M. Sokolov, Phys. Rev. E. 78 011117 (2008).

Franco Ferrari, University of Szczecin, Szczecin, Poland

Diffusion of Brownian particles and Liouville field theory

Talks (continued)

Alessandro Fiasconaro, Jagellonian Univeristy, Kraków, Poland

Role of the asymmetry in Piecewise linear potential on Stochastic Resonance and Resonant Activation

Abstract: Stochastic resonance (SR) is one of the family of phenomena manifesting a constructive role of noises in physical, chemical and biological systems. The presence of noise and external periodic perturbation lead to increase of the system efficiency as measured by signal to noise ratio, spectral amplification or number of transitions between states during one period of external driving. Various examples of the SR phenomenon have been widely studied both theoretically and experimentally, and its ubiquity and robustness have been confirmed in a vast number of systems. Here, we inspect in more details the influence of the potential asymmetry on the SR and we compare it with the resonant activation phenomenon, such as a minimum of the mean exit time as a function of the frequency of the external driving. The contemporary presence of SR and RA is seen in a large of the driving frequency investigated. As a simplified model system for our studies, we choose a paradigm of an overdamped Brownian particle moving in a piecewise linear potential to the external sinusoidal force and white Gaussian fluctuations and the asymmetry is given by a dispacement of the maximum of the static potential.

Daniela Froemberg, Humbold Universitat, Berlin, Germany

Fronts in an A+B→2A Reaction under Subdiffusion

Abstract: Using the continuous time random walks approach, we generalize the Fisher-Kolmogorov-Petrovskii-Pisunov reaction-diffusion model to subdiffusion. The corresponding equations have an integro-differential form. Here we confine ourselves to the classical interpretation of the FKPP-equation, i.e. the kinetic equation for the irreversible autocatalytic A+B→2A reaction with local conservation of the overall particle number, A+B=const. In contrast to normal diffusion, where a nonzero minimal velocity of the front is attained, we show that this minimal velocity is zero for subdiffusion. This propagation failure in subdiffusion is corroborated by numerical simulations. The numerical simulations unveil however several other regimes of the reaction which are not described by the continuous scheme of reaction-subdiffusion models.

Piotr Garbaczewski, University of Opole, Opole, Poland

Modular Schroedinger equation and dual "time arrows"

Abstract: We discuss quite surprising properties of the one-parameter family of modular (name due to Auberson and Sabatier (1994)) Schrödinger equations. We develop a unified theoretical framework for this family as a whole. Special attention is paid to the emergent *dual* time evolution scenarios which, albeit running in the *real time* in each considered case, may be mapped among each other by means of an "imaginary time"transformation (here, a nickname for more serious analytic continuation in time procedure). A number of illustrative examples is worked out in detail, with an emphasis on the time duality notion in the classically inspired (standard Hamilton-Jacobi equations) and dissipative (Smoluchowski diffusion processes) patterns of evolution

Talks (continued)

Joanna Janczura, Wrocław University of Technology, Wrocław, Poland
Agnieszka Wyłomańska, Wrocław University of Technology, Wrocław, Poland

Subdiffusion modeling of electricity markets

Abstract: In a competitive power market electricity can be bought and sold at market price like any other commodity, [1,2]. Extreme price volatility, which can be even two orders of magnitude higher then for other commodities or financial instruments, has forced producers and wholesale consumers to hedge not only against price movements but also volume risk. In exhibition of many power data we observe characteristic traps, [3]. Till now, such economic systems were analyzed in the following manner: before the further investigation the trapping-data were removed and then the conventional methods used. Unfortunately, for many observations this approach seems not to be reasonable. Therefore we propose an alternative approach based on the subdiffusion models that demonstrate such characteristic behavior of electrical products.

[1] D.W. Bunn (ed.), Modeling Prices in Competitive Electricity Markets, Wiley, Chichester, 2004.

[2] H. Geman, Commodities and Commodity Derivatives. Modeling and Pricing for Agriculturals, Metals and Energy, Wiley, Chichester, 2005.

[3] R. Weron, Modeling and Forecasting Electricity Loads and Prices: A Statistical Approach, Wiley, Chichester, 2006.

Agnieszka Jurlewicz, Wrocław University of Technology, Wrocław, Poland

Limit theorems for randomly coarse grained continuous-time random walks and applications

Talks (continued)

Young Shin Kim and Svetlozar T. Rachev, University of Karlsruhe, Karlsruhe, Germany
Michele Leonardo Bianchi, University of Bergamo, Italy
Frank J. Fabozzi, Yale School of Management, Yale, USA

Tempered stable and tempered infinitely divisible GARCH models

Abstract: In this talk, we introduce a new GARCH option pricing model with non-Gaussian innovation. The rapidly decreasing tempered stable (RDTS) distribution, which is a parametric example in the tempered infinitely divisible (TID) class, is selected as the distribution for the innovation process and applied to the GARCH model to price American style options. The model is compared with the classical tempered stable GARCH model a tempered stable GARCH model. These two models allow the description of some stylized empirical facts observed in financial markets, such as volatility clustering, skewness, and heavy tails of stock returns. However, the Laplace transform of the any tempered stable (TS) distributions is defined only on a bounded interval. Consequently, a GARCH model with TS innovation has a technical limitation in the definition of the variance processes. Differently, the Laplace transform of a RDTS distribution is defined on the entire real line. Thus the GARCH model with RDTS innovations can be defined without any limitation in the variance process.

Danuta Kruk, Jagellonian University, Kraków, Poland

The Smoluchowski equation in application to dynamics investigations by electron and nuclear spin resonances

Marcin Magdziarz, Wrocław University of Technology, Wrocław, Poland

Equivalence of the fractional Fokker-Planck and subordinated Langevin equations

Abstract: We introduce a Langevin-type approach to modeling of anomalous diffusion in time-dependent force fields. Using the subordination technique and the theory of Levy processes, we construct rigorously a stochastic process, which is equivalent to the fractional Fokker-Planck equation with time-dependent force. Our model provides good physical insight through the trajectories. Moreover, it allows to study different anomalous diffusion processe both analytically and numerically. Moreover, the model can be easily extended to the general case of space-time dependent forces.

Talks (continued)

Danuta Makowiec, University of Gdańsk, Gdańsk, Poland

Multifractal analysis of time series: practical approach

Abstract: Multifractality is a continuous property – empirical data has an inherent discrete nature. Thus any tool designed to validate the multifractal property of a signal faces difficulties elicited by finite size and discretization. Any technique used to validate the multifractality involves some interpolation scheme what can make it prone to some bias. Hence it is very convenient to know beforehand the range of validity, limitations and biases as well as the theoretical foundations Our aim is to calibrate the quality of two multifractality estimators: Wavelet Transform Modulus Maxima and Multifractal Detrended Fluctuation Analysis in identification of fractional Brownian motions. The calibrated tools will be applied to RR-series: intervals between subsequent heart's contractions, to separate multifractal from monofractal characters of the heart dynamics.

Krzysztof Małysiak, Monika Krasowska and Zbigniew J. Grzywna, Silesian University of Technology, Gliwice, Poland

Diffusional approach to modelling of a wound healing assay

Abstract: Cell migration is a complex phenomenon that requires the coordination of numerous cellular processes. Investigation of a cell migration is of common interest for biologists as well as for clinicians. The wound healing assay is simple and inexpensive method to study directional cell migration in vitro. The basic steps involve creating a ”wound“ in a cellular monolayer, capturing the images at the beginning and at regular intervals during cells migration to close the wound. Wound healing has been given a various theoretical descriptions, including the diffusional models with traveling waves. In this poster, we present how to express some phenomena accompanying wound healing by means of various diffusional operators.

Zbigniew Michna, Wrocław University of Economics, Wrocław, Poland

Asymptotic behavior of anomalous diffusions driven by alpha-stable noise

Abstract: In this work we discuss decomposition principle for alpha-stable Lévy processes. We investigate asymptotic properties of components and stochastic integrals driven by such processes providing an important class of anomalous diffusions. We consider two case studies with integrands being fractional Brownian motion and gamma process.

Talks (continued)

Anna Ochab-Marcinek, Jagellonian University, Kraków, Poland & Augsburg University, Augsburg, Germany
Noise-assisted signal propagation in neurons
Abstract: We consider the noise-assisted spike propagation in myelinated axons within a multi-compartament stochastic Hodgkin-Huxley model. The noise originates from a finite number of ion channels in each node of Ranvier. For the subthreshold internodal coupling, we show that (i) intrinsic noise removes the sharp threshold for spike transfer from node to node and (ii) there exists an optimum number of ion channels which allows for the most efficient signal propagation.

Jarosław Paturej, University of Szczecin, Szczecin, Poland
Generalized non-linear sigma model applied to the description of the dynamics of a random chain with rigid constraints

Ilya Pavlyukevich, Humboldt University, Berlin, Germany
Simulated annealing with Lévy flights

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Posters

1.

Przemysław Borys, Silesian University of Technology, Gliwice, Poland
On the relation between fractal dimension and lacunarity
Abstract: The lacunarity measure can be related to a fractal dimension. We propose a short derivation of this relation and a discussion on the proportionality coefficient between these measures.

2.

Teodor Buchner, Warsaw University of Technology, Warsaw, Poland
Dynamical properties of a model of the cardiovascular system

3.

Michał Cieśla, Jagellonian University, Kraków, Poland
Jakub Barbasz, Institute of Catalysis and Surface Chemistry, Polish Academy of Science, Kraków, Poland
Molecular dynamics simulation of polyelectorlytes (advanced model of Lennard-Jones polymers)
Abstract: Linear polymers consisting of segments (monomers) connected by flexible joints constitute a vary important class of polymers. We carried out simulations of chain model polymers. The configurations of polymer chain were simulated by using Langevin dynamics method. Polymer was a chain (three-dimensional) of segments. Our model include interaction between monemer with its closes neighbors by harmonic potentail and betwen all monomers through the Lennard-Jones (LJ) potential. Our model included electrostatic interaction too. Numerical simulation enabled one to determine chain conformation, end to end ratio and mass moment of inertia for various polymer length and electric charge distribution.

4.

Simon Fugmann and Igor M. Sokolov, Humboldt Universitat, Berlin, Germany
Scaling in rupture of polymer chains
bf Abstract: We consider the rupture dynamics of a homopolymer chain pulled at one end at a constant loading rate r. Compared to single bond breaking, the existence of the chain introduces two new aspects into rupture dynamics: the non-Markovian aspect in the barrier crossing and the slow-down of the force propagation to the breakable bond. The relative impact of both these processes is investigated, and the second one was found to be the most important at moderate loading rates. The most probable rupture force is found to decrease with the number of bonds as $f_{max} \propto \text{const} - (\ln(N/r))^{2/3}$ and finally to approach a saturation value independent on N. All our analytical findings are confirmed by extensive numerical simulations.

Posters (continued)

5.

Jakub Gac, Warsaw University of Technology, Warszawa, Poland

Influence of dichotomous Markov noise on crises of chaotic attractor in dynamical systems

Abstract: The crises of chaotic attractors [1] can be observed in such systems in which this attractors - depending on the kind of crisis - suddenly grow, vanish or merge with another chaotic attractor when the control parameter of the system is changed continuously. The first of these chaotic transitions is known as the interior crisis, the second - the boundary crisis and the last one - the attractor merging crisis. Crisis-induced intermittency is associated with the interior crisis. The mechanism of appearance of all the kinds of crises is in fact similar: the chaotic attractor collides with the stable manifold of unstable periodic orbit. However, in the case of boundary and merging crisis, this manifold is lying on the boarder of the basin of attraction of the attractor, when in the case of the interior crisis is embedded in the basin of attraction. This is the reason of different scenarios of these three phenomena. The statistical properties of these phenomena, like the mean residence time on pre crisis attractor, or the distribution of the residence time, has been analyzed for a long time for the stationary systems, and theirs dependence on the value of the parameters of the system is well-known. However, in real systems noise usually is present. Due to noise the above mentioned statistics measured in real systems differ from these found in simple models. There is some result of influence of Gaussian white noise on crises, but we should remember, that not only such a kind of noise is present in real systems. In our poster we present the influence of dichotomous Markov noise [2] on systems with crises. Dichotomous Markov noise is a very simple two-valued stochastic process, with constant transition rates between the two states. This kind of noise is very simple to simulate both in discrete and in continuous time problems. Also, many problems concerned with DMN can be easily solved analytically. On the other hand, DMN mimics the effect of finite correlation time of the noise. Those are the basic reasons, for which DMN gets more and more popular as a stochastic forcing in many theoretical models of various phenomena. We describe the influence of dichotomous Markov noise on the mean residence time on pre-crisis attractor and on the residence time distribution. The numerical results are obtain for simple, discrete-time maps, like e.g. logistic map, as well as for the continuous time physical model (dynamics of damped spin in the presence of periodic magnetic field). These results are explained theoretically by means of Markov chain model, but the situation when this method fails are always consider.

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Posters (continued)

6.

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Opinion formation in a social network: The role of human activity

Abstract: The model of opinion formation in human population based on social impact theory is investigated numerically. On the basis of a database received from the on-line game server, we examine the structure of social network and human dynamics. We calculate the activity of individuals, i.e. the relative time daily devoted to interactions with others in the artificial society. We study the influence of correlation between the activity of an individual and its connectivity on the process of opinion formation. We find that such correlations have significant influence on the temperature of the phase transition and the effect of the mass media, modeled as an external stimulation acting on the social network.

7.

Yasuhiro Igarashi, Polish Academy of Science, Warsaw, Poland

Switchig signal diode built with excitable chemical media

8.

Joanna Janczura, Agnieszka Wyłomańska, Wrocław University of Technology, Wrocław, Poland

Subdynamics of financial and power data from fractional Fokker-Planck equation

Abstract: In exhibition of many real market data we observe characteristic traps. This behavior is especially noticeable for processes corresponding to stock prices and power data. Till now, such economic systems were analyzed in the following manner: before the further investigation the trapping-data were removed and then the conventional methods used. Unfortunately, for many observations this approach seems not to be reasonable therefore we propose an alternative attitude based on the subdiffusion models that demonstrate such characteristic behavior and their corresponding p.d.f. is described by the fractional Fokker-Planck equation.
In this paper we model market data using subdiffusion with a constant as well as a special periodic force. We demonstrate properties of the considered systems and propose estimation methods.

9.

Tadeusz Kosztołowicz, University of Kielce, Kielce, Poland

Hyperbolic subdiffusion in a membrane system

10.

Andrzej Krawiecki, Warsaw University of Technology, Warsaw, Poland

Dynamical phase transitions in the Ising model on scale-free networks

Posters (continued)

11.

Katarzyna Lewandowska, Medical University of Gdańsk, Gdańsk, Poland

Subdiffusion in a spatially restricted membrane system

Abstract: We study the subdiffusion in a finite-size system with a thin membrane. The process is described by means of the subdiffusion equation with a fractional time derivative. The equation is solved analytically in the long time limit and, in particular, we show that the time evolution of the so-called near membrane layers (NML) is not given by a power function of time in this limit, as it happens in infinite systems. Since the time evolution of NML has been used to extract subdiffusion parameters from experimental data, our results will be helpful to precisely determine the parameters.

12.

Marek Litniewski, Polish Academy of Science, Warsaw, Poland

The influence of quencher concentration on the reaction rate for ionic systems by molecular dynamics simulations

bf Abstract: The influence of concentrations of reagents on the rate of reaction: A+B -¿ C+B for low density equimolar mixtures of spherically symmetric ions immersed in the Brownian medium is investigated by performing large scale molecular dynamics simulations. The Coulomb potential of ion-ion interactions is truncated at the cut-off distance large enough to make the kinetics of the reaction independent of its value. The simulations have been performed at conditions close to that for quenching reactions for fluophores. One of the simulation results is that the excess in the rate coefficient is always positive and converges to a constant value which is 2–3 orders in magnitude higher than that for the soft spheres immersed in the Brownian medium [M.Litniewski, J.Chem.Phys. 124, 114502 (2006)]. The excess is approximately proportional to the concentration of B however, if the concentration is high, positive deviations are noticeable. The simulation results are compared with simple model that bases on the superposition approximation. The model predicts most of the properties of the excess. The predicted values are about 30–40% lower than that from the simulations.

13.

Anna Mańka, University of Science and Technology (AGH), Kraków, Poland

Magnetism of frustrated regular networks

Posters (continued)

14.

Grzegorz Pająk, Lech Longa, Jagellonian University, Kraków, Poland

Unusual phases for bent-core lattice model: breaking of chiral symmetry

Abstract: Landau-deGennes description [1] of orientational ordering in the bent-core systems [2] requires first, second, and third-rank tensor order parameters. Stabilization due to mutual coupling between the order parameters for such systems can lead to phases with eleven nontrivial local symmetries [1], which are spatially homogeneous, but orientationally ordered. In this study we use a simple generalization of the dispersion lattice model [3] to account for some of these spontaneously broken phases. Interestingly, in addition to the standard uniaxial and biaxial nematic phases, the other nematic-like phases are observed. The most exotic of these are the liquids of global T_d, D_{2d}, and D_2 symmetry, or more conveniently tetrahedratic, distorted tetrahedral nematic, and spontaneously chiral (tetro-biaxial) liquids, respectively. Results are obtained in the mean-field approximation by means of a bifurcation analysis and in MC computer simulations. These lower-symmetry liquid crystalline phases can become stable e.g. in the systems composed of complexes of V-shaped molecules or, more generally, composed of particles possessing four rigid arms.

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[2] H. Takezoe, Y. Takanishi, Japanese Journal of Applied Physics, 45, 597 (2006).
[3] L. Longa, P. Grzybowski, S. Romano, E. Virga, Phys. Rev. E, 71, 051714 (2005).

15.

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Markov model of the selectivity filter

Posters (continued)

16.

Monika Petelczyc, Jan J. Żebrowski and R. Baranowski, Warsaw University of Technolgy, Warsaw, Poland & National institute of Cardiology, Warsaw, Poland

Higher order Kramers-Moyal expansion coefficients of heart rate variability

Abstract: The extraction of the first six Kramers-Moyal coefficients was performed for human heart rate variability. The method requires the determination of the Markov time and of the proper conditional probability densities. We analyzed heart rate data recorded in a group of ten young, healthy subjects. We obtained non-negligible higher order Kramers-Moyal (K-M) terms in 6h nighttime parts of the 24-h recordings. This indicates that the data is a non-Gaussian process and may indicate a correlated signal. In the night hours, the dominant oscillation in the heart rate is the so called respiratory sinus arrhythmia (RSA) - a physiological phenomenon in which respiration acts as a drive for the heart rate.
Certain kinds of pathology may disrupt RSA. We compared nighttime recordings of the healthy group with those recorded in five patients with hypertrophic cardiomyopathy (HCM). HCM is a pathological condition of the heart muscle which may also disrupt RSA. Using the higher order Kramers-Moyal coefficients, we analyzed skewness and kurtosis in the nighttime recordings of both groups. Significant differences were obtained indicating, on the one hand, possible diagnostic applications and yielding important insights into the character of the stochastic processes measured in the two cases.

17.

Aleksandra Rybak, Monika Krasowska, Anna Strzelewicz, Zbigniew J. Grzywna, Silesian University of Technology, Gliwice, Poland

"Smoluchowski type" equations for modelling a membrane air separation

Abstract: The problem of a membrane air separation in the presence of a magnetic field, is considered. Paramagnetism of oxygen and diamagnetic behaviour of nitrogen form the basis for air separation. A new concept of polymer membranes filled with neodymium powder and magnetized ("magnetic membranes"), was applied. Membranes with dispersed metal powder were casted in an external magnetic field of a specially designed coil The Smoluchowski equation for oxygen, and simple diffusion equation for nitrogen behaviour in the air have been discussed. The theoretical predictions and selected experimental data are compared.

18.

Oleksii Sliusarenko, Kharkov Institute of Physics and Technology, Kharkov, Ukraine

Kramers Problem for Fractional Brownian Motion

Abstract: We study fractional Brownian motion in a truncated harmonic potential well and consider the problem of a particle's escape (the Kramers problem). By means of numerical simulation we find the mean escape time dependence on the noise intensity and calculate the probability density function of the escape time for the whole range of the Hurst exponent of the fractional Brownian motion ($0 < H < 1$).

Posters (continued)

19.

Małgorzata Snarska, Jagellonian University, Kraków, Poland

Toy model for temporal cross - correlation matrix

Abstract: Non-symmetric rectangular correlation matrices occur in many problems in modern science. We test the method of extracting statistically meaningful correlations between input and output variables of large dimensionality and build a toy model for artificially included correlations in large random time series.The results are then applied to analysis of polish macroeconomic data and can be used as an alternative to classical cointegration approach.

20.

Ryszard Zygadło, Jagellonian University, Kraków, Poland

Bose-Einstein condensation of noninteracting free or trapped particles: a common treatment of the both theories

Abstract: The importance of the low-temperature behavior of the exact one-particle canonical partition function in BEC is addressed. The elementary proof of the phase-transition in the thermodynamical limit is presented.

21.

Michał Żabicki, Jagellonian University, Kraków, Poland

Proton transfer in CGC+ ensemble

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