22^{nd} Marian Smoluchowski Symposium on Statistical Physics

ZAKOPANE, POLAND, SEPTEMBER 12–17, 2009

organized by

Jagellonian University

Marian Smoluchowski
Institute of Physics

Mark Kac Complex
System Research Center

in cooperation with

Polish Academy of Sciences
Institute of Physical Chemistry
Warszawa, Poland

Hotel "Bankowiec" ul. Bulwary Słowackiego 14, 34–500 Zakopane, Poland, tel. +(48)(18) 201 40 71
Symposium Organizing Committee: M. Smoluchowski Institute of Physics, Jagellonian University, ul. Reymonta 4, 30–059 Kraków, Poland
e–mail zfs@th.if.uj.edu.pl WWW http://th-www.if.uj.edu.pl/zfs/smoluchowski/

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Saturday, September 12
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 opportunity 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**

`zfs@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, 2010**.

22^{nd} **Marian Smoluchowski Symposium on Statistical Physics**
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Sunday, September 13

8:00	*Breakfast*	
10:30	*Coffee break*	
	Chairperson: Lutz Schimansky-Geier	
11:00	**Ewa Gudowska-Nowak**	Opening address
11:15	**Karina Weron**	Over- and undershoot compound subordination. Anomalous diffusion - relaxation consequences
11:45	**Andrzej Fuliński**	First-passage times and related characteristics of anomalous diffusion
12:15	**Igor M. Sokolov**	Nonergodicity in continuous-time random walk models
13:00	*Lunch*	
	Chairperson: M. Howard Lee	
15:00	**Lutz Schimansky-Geier**	Increase of coherence in excitable systems by delayed feedback
15:30	**Bernardo Spagnolo**	Environmental noise and nonlinear relaxation in biological systems
16:00	**Hyunggyu Park**	Collective synchronization in a large population of random frequency oscillators
16:30	*Coffee break*	
19:00	*Dinner*	

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Monday, September 14

8:00	*Breakfast*	
	Chairperson: Hyunggyu Park	
9:00	**Gerhard Schmid**	Entropic particle transport
9:30	**Zdzisław Burda**	Maximal entropy random walk
10:00	**Ryszard Zygadło**	Thermodynamical quantities and relativity
10:30	*Coffee break*	
	Chairperson: Sighart F. Fischer	
11:00	**Robert Hołyst**	Viscosity in polymer solutions at nano and macroscale
11:30	**Francesc Sagués**	Dynamical regimes of individually actuated paramagnetic colloids
12:00	**Marcin Fiałkowski**	Polymer-induced phase separation and ordering in ionic surfactants
13:00	*Lunch*	
	Chairperson: Zbigniew J. Grzywna	
15:00	Pre-poster session	
17:00	*Coffee break*	
19:00	*Dinner*	

Tuesday, September 15

8:00	*Breakfast*
	Free time (excursions)
	No lunch is served
19:00	*Concert*
20:00	*Formal dinner*

Wednesday, September 16

8:00	*Breakfast*	
	Chairperson: Bernardo Spagnolo	
9:00	**Jörn Dunkel**	Nonlocal observables and lightcone-averaging in relativistic thermodynamics
9:30	**M. Howard Lee**	Ergometric theory of the ergodic hypothesis
10:00	**Dmitry Postnov**	Noise-controlled pattern formation in "fire-diffuse-fire" model of neural tissue
10:30	*Coffee break*	
	Chairperson: Robert Hołyst	
11:00	**Sighart F. Fischer**	Universal power-law model for the random fluctuations in the fluorescence of Cd Se/ZnS quantum dots
11:30	**Danuta Makowiec**	Multifractal estimators of short-time autonomic control of the heart rate
13:00	*Lunch*	
	Chairperson: Aleksander Weron	
15:00	**Karol Życzkowski**	On statistics of scientific citations and performance indices
15:30	**Piotr Garbaczewski**	Lévy flights in confining potentials
15:50	**Davide Valenti**	Moment equations in a system of three interacting species subject to colored noise
16:10	*Coffee break*	
16:30	Poster session	
19:00	*Dinner*	
20:00	Poster session (continued)	

Thursday, September 17
Departure Day

8:00 *Breakfast*

9:00 Departure – bus to Krakow

22^{nd} **Marian Smoluchowski Symposium on Statistical Physics**
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Invited talks

Zdzisław Burda, Jagellonian University, Kraków, Poland

Maximal entropy random walk

Abstract: We discuss a new class of random walk processes which maximize entropy. This maximal entropy random walk is equivalent to generic random walk if it takes place on a regular lattice, but it is not if the underlying lattice is irregular. In particular, we consider a lattice with weak dilution. We show that the stationary probability of finding a particle performing maximal entropy random walk localizes in the largest nearly spherical region of the lattice which is free of defects. This localization phenomenon, which is purely classical in nature, is explained in terms of the Lifshitz states of a certain random operator.

Jörn Dunkel, University of Oxford, Oxford, United Kingdom

Nonlocal observables and lightcone-averaging in relativistic thermodynamics

Abstract: The unification of relativity and thermodynamics has been a subject of considerable debate over the last 100 years. The reasons for this are twofold: (i) Thermodynamic variables are nonlocal quantities and, thus, single out a preferred class of hyperplanes in spacetime. (ii) There exist different, seemingly equally plausible ways of defining heat and work in relativistic systems. These ambiguities led, for example, to various proposals for the Lorentz transformation law of temperature. Traditional "isochronous" formulations of relativistic thermodynamics are neither theoretically satisfactory nor experimentally feasible. I will discuss how these deficiencies can be resolved by defining thermodynamic quantities with respect to the backward-lightcone of an observation event. This approach also allows for a straightforward-extension of thermodynamics to general relativity. Theoretical considerations are illustrated through three-dimensional relativistic many-body simulations.

Marcin Fiałkowski, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Polymer-induced phase separation and ordering in ionic surfactants

Abstract: I will present a new and simple method of inducing phase separation and further ordering in solutions of ionic surfactants. In this method the phase separation is obtained either by addition of polyelectrolytes or nonionic polymers along with inorganic salt. The system separates into surfactant-rich and polymer-rich phase. The resulting surfactant-rich phase exhibits the hexagonal ordering. The method of the induction of the phase separation is versatile and facilitates formation of surfactant-rich ordered phases in a broad range of surfactant mass fractions. The surfactant-rich phases can be employed as templates to fabricate structural functional materials.

Invited talks (continued)

Andrzej Fuliński, Jagellonian University, Kraków, Poland

First-passage times and related characteristics of anomalous diffusion

Abstract: Tools which enable the identification of anomalous diffusion and its exponent α in experimental or simulation series of data are discussed. Among others, the concept of bounded average first-passage-time $\langle\theta_L\rangle_T$ to the absorbing barrier L, averaged over finite time interval T is introduced, which corresponds to real data much better than standard MFPT, the more that the latter is divergent in many cases. $\langle\theta_L\rangle_T$ scales as $L^{2/\alpha}$. This scaling (and some other ones) is illustrated by simulations of anomalous Brownian motion driven by thermal noise, and by intermittent chaotic generator.

Robert Hołyst, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Viscosity in polymer solutions at nano and macroscale

Abstract: We measured a viscosity of poly(ethylene glycol) (PEG 6000, 12000, 20000) in water using capillary electrophoresis and fluorescence correlation spectroscopy with nanoscopic probes of different diameters (from 1.7 nm up to 114 nm). For a probe of diameter smaller than the radius of gyration of PEG (e.g. rhodamine B or lyzozyme) the measured nanoviscosity was orders of magnitude smaller than the macroviscosity. For sizes equal to (or larger than) the polymer radius of gyration, macroscopic value of viscosity was measured. Mathematical relation for macro and nanoviscosity was found as a function of PEG radius of gyration, R_g, correlation length in semidilute solution, x , and size of a probe, R. For $R < R_g$ the nanoviscosity (normalized by water viscosity) is given by $\exp(b(R/x)^a)$ and for $R > R_g$ both nano and macroviscosity follow the same curve $\exp(b(R_g/x)^a)$, where b and the exponent a are two constants close to unity. This mathematical relation was shown to describe equally well rhodamine (of size 1.7 nm) in PEG 20000 and macroviscosity of PEG 8 000 000 whose radius of gyration exceeds 200 nm. Additionally, for smallest probes (rhodamine B and lyzozyme) we have verified using capillary electrophoresis and fluorescence correlation spectroscopy that the Stokes-Einstein (SE) relation holds providing that we use size dependent viscosity in the formula. SE relation is correct even in PEG solution of very high viscosity (three orders of magnitude larger than that of water).

Invited talks (continued)

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

Ergometric theory of the ergodic hypothesis

Abstract: The ergometric theory of the ergodic hypothesis is a physical theory for Hermitian many body systems. It is applicable to both quantum and classical macroscopic ensembles. The basic elements of the theory which determine whether a dynamical variable (say A) of a system is ergodic are the existence of the thermodynamic limit and the delocalizability of perturbed energy coupled to dynamical variable A. In several recent papers the workings of the ergometric theory have been demonstrated.

The ergodic theory of the ergodic hypothesis is a mathematical theory developed over the years by Birkhoff, Khinchin and other mathematicians, primarily applicable to classical many body problems. The essential elements of the ergodic theory are invariant measures, transitivity and chaos. We show that these elements are also contained in the ergometric theory. It will be illustrated through several many body models.

Hyunggyu Park, Korea Institute for Advanced Study, Seoul, Korea

Collective synchronization in a large population of random frequency oscillators

Abstract: The synchronization transition of coupled random frequency oscillators is revisited. The Kuramoto model (global coupling) is shown to exhibit a mean-field-type continuous phase transition in both phase and frequency synchronization. On the other hand, locally coupled oscillators in d space dimensions reveal two types of synchronization transitions: mean-field behavior at $d > 4$, and aggregation of compact synchronized domains in three and four dimensions. In the latter case, there exists no ordering in phase synchronization, but only in frequency synchronization, which shows an abrupt change at the transition. We also discuss over sample-to-sample fluctuations as well as temporal fluctuations, which dominate the finite-size-scaling behavior near the transition.

Invited talks (continued)

Dmitry Postnov, Saratov State University, Saratov, Russia

Noise-controlled pattern formation in "fire-diffuse-fire" model of neural tissue

Abstract: Beside the well-known coupling between neurons via the chemical and electrical synapses, there are another communication pathways in the brain tissue, that can significantly alter the network dynamics. According to the conventional approach the extracellular environment has fixed ionic concentrations. However, in many cases the extracellular concentration of potassium ions can not be regarded as constant. That represents specific chemical pathway for neurons to influence each other and can influence strongly the behavior of a single neuron as well as large ensembles. The "potassium accumulation hypothesis" is still debating mechanism for the onset of epileptic seizures.

We address this problem by studying the dynamics of simplified model systems based on excitable units each being an extension of FitzHugh-Nagumo model. For a a single such unit embedded in the extracellular matter that leads to a number of noise-induced effects, like self-modulation of firing rate. In the spatially extended situation various patterns appear ranging from spirals and traveling waves to oscillons and inverted structures depending on the parameters of the medium.

Francesc Sagués, Universitat de Barcelona, Barcelona, Spain

Dynamical regimes of individually actuated paramagnetic colloids

Abstract: I will report on different dynamical regimes in a soft-matter system consisting of a dispersed solution of micron-size paramagnetic colloidal particles. The system is actuated from outside with an external magnetic field either precessing or simply rotating. Two situations will be considered, depending on whether the particles are floating on a free surface or over a ferromagnetic structured garnet film. The anisotropy in the shape of the particles will be also taken into account by reporting forcing conditions of either spherical or ellipsoidal particles. Different scenarios of transport will be unveiled from localized to superdiffusive and ballistic. Experiments will be presented, together with numerical simulations based on overdamped dynamic equations.

Lutz Schimansky-Geier, Humboldt Universitat, Berlin, Germany

Increase of coherence in excitable systems by delayed feedback

Abstract: The control of coherence and spectral properties of noise-induced oscillations by time-delayed feedback is studied in a FitzHugh-Nagumo system which serves as a paradigmatic model of excitable systems. A semianalytical approach based on a discrete model with waiting time densities is developed which allows one to predict quantitatively the increase of coherence measured by the correlation time, and the modulation of the main frequencies of the stochastic dynamics in dependence on the delay time. The analytical mean-field approximation is in good agreement with numerical results for the full nonlinear model.

[1] T. Prager, H.-P. Lerch, L. Schimansky-Geier and E. Schöoll, J. Phys. A: Math. Theor. **40**, 1 (2007).

Invited talks (continued)

Gerhard Schmid, Augsburg University, Augsburg, Germany

Entropic particle transport

Abstract: We demonstrate that transport in the presence of entropic barriers exhibits peculiar characteristics which makes it distinctly different from that occurring through energetic barriers. The constrained dynamics yields a scaling regime for the particle current and the diffusion coefficient in terms of the ratio between the work done to the particles and available thermal energy [1,2]. The problem is analyzed under the perspective of the Fick-Jacobs equation which accounts for the effect of the lateral confinement by introducing an entropic barrier in a one dimensional diffusion. The validity of this approximation, being based on the assumption of an instantaneous equilibration of the particle distribution in the cross-section of the structure, is analyzed by comparing the different time scales that characterize the problem. A validity criterion is established in terms of the shape of the structure and of the applied force [2,3].

Moreover, we investigate the role of entropic barriers for the phenomenon of "Stochastic Resonance" [4]. This Entropic Stochastic Resonance (ESR), characteristic of small-scale systems, constitutes a useful mechanism for manipulation and control of single molecules and nanodevices.

[1] D. Reguera, G. Schmid, P. S. Burada, J. M. Rubi, P. Reimann, and P. Hänggi, Phys. Rev. Lett. **96**, 130603 (2006).

[2] P. S. Burada, G. Schmid, P. Talkner, P. Hänggi, D. Reguera, and J. M. Rubi, Biosystems **93**, 16 (2008).

[3] P. S. Burada, P. Hänggi, F. Marchesoni, G. Schmid, and P. Talkner, ChemPhysChem **10**, 45 (2009).

[4] P. S. Burada, G. Schmid, D. Reguera, M. H. Vainstein, J. M. Rubi, and P. Hänggi, Phys. Rev. Lett. **101**, 130602 (2008).

Invited talks (continued)

Bernardo Spagnolo, University of Palermo, Palermo, Italy

Environmental noise and nonlinear relaxation in biological systems

Abstract: We investigate the role of the environmental noise in three biological systems: (i) an ecosystem described by a Verhulst model with a multiplicative Lévy noise; (ii) polymer translocation, and (ii) individuals of *Nezara viridula*. Specifically the transient dynamics of the Verhulst model perturbed by arbitrary non-Gaussian white noise is investigated as a first biological system. For Cauchy stable noise, exact results for the probability distribution of the population density and nonlinear relaxation are derived. We find a transition induced by the multiplicative Lévy noise, from a trimodal probability distribution to a bimodal probability distribution in asymptotics, and a nonmonotonic behavior of the nonlinear relaxation time as a function of the Cauchy stable noise intensity. (ii) The noise driven translocation of short polymers in crowded solutions is analyzed as a second biological system. The polymer dynamics is simulated in a two-dimensional domain by numerically solving the Langevin equations of motion with a Gaussian uncorrelated and correlated noise source, and an oscillating electric field. We find a nonmonotonic behaviour of the mean first passage time and the most probable translocation time, of the polymer centre of inertia, as a function of the polymer length at low noise intensity: Moreover the mean first translocation time of the polymer centre of inertia shows a resonant activation behavior. Finally we report on experiments on the response of *Nezara viridula* individuals to sub-threshold signals plus noise in their mating behavior. We analyzed the insect response by directionality tests and different noise intensity levels performed on a group of male individuals. The percentage of insects which react to the sub-threshold signal, shows a non-monotonic behavior, characterized by the presence of a maximum, for increasing levels of the noise intensity. This is the signature of the non-dynamical stochastic resonance phenomenon. By using a "soft" threshold model we find that the maximum of the output cross correlation occurs in the same range of noise intensity values for which the activating behavioral has a maximum.

Karina Weron, Wrocław University of Technology, Wrocław, Poland

Over- and undershoot compound subordination. Anomalous diffusion – relaxation consequences

Abstract: The subordination form of the diffusion front resulting from the clustering-jump continuous-time random walk is presented. The jump-waiting and waiting-jump schemes, leading to different two-power-law relaxation processes, are discussed and shown to be related to over- and undershoot compound subordination, respectively.

Invited talks (continued)

Ryszard Zygadło, Jagellonian University, Kraków, Poland

Thermodynamical quantities and relativity

Abstract: Selected problems concerning transformational properties of thermodynamical quantities and relativistic diffusion will be commented.

Karol Życzkowski, Jagellonian University, Kraków, Poland

On statistics of scientific citations and performance indices

Abstract: Some current attempts to define performance indices based on the number of scientific citations are reviewed. A scheme of evaluating an impact of a given scientific article based on importance of papers quoting it is investigated. Introducing a weight of a given citation dependent on the previous record of the author of the citing paper we define the weighting factor of a given scientist. These weighting factors, defined by the components of the normalized leading eigenvector of the matrix describing the citation graph, allow us to define weighted number of citations, weighted impact factor of a journal or weighted Hirsch index of an individual scientist or of an entire scientific institution.

[1] K. Zyczkowski, Citation graph, weighted impact factors and performance indices, arxiv:0904.2110.

Talks

Sighart F. Fischer, Technische Universität München, München, Germany

Universal power-law model for the random fluctuations in the fluorescence of Cd Se/ZnS quantum dots

Abstract: The fluorescence intermittency of quantum dots like Cd Se/ZnS is interpreted in terms of uncorrelated nonadiabatic charge separation and charge recombination events. It is shown that light induced randomness in the charge transfer couplings can lead to a power law behaviour of the fluorescing "on"-"off" waiting time distributions in a well defined long time limit.

The universal exponent of -1.5 is derived for a large class of coupling distributions, which do not approach zero for arbitrary small couplings. Deviations from this universal behaviour and the time window of its applicability are discussed in relation to other models (see for example the review [1]). The inclusion of multi channel charge separation events can give rise to larger or smaller exponents in the limit of sparce manifolds. Comparison with observed fluorescing time distributions, which show aging under continuous excitation conditions, is also discussed.

[1] F. Cichos et al., Curr. Opin. Colloid Interface Sci. **12**, 272 (2007).

Piotr Garbaczewski, University of Opole, Opole, Poland

Lévy flights in confining potentials

Abstract: We analyze confining mechanisms for Lévy flights. Two classes of stochastic jump-type processes are considered: those driven by Langevin equation with Lévy noise and those, named topological Lévy processes (occurring in systems with topological complexity like folded polymers or complex networks), whose Langevin representation is unknown. Both classes of processes stay in affinity and may share common stationary probability density, even if their detailed dynamical behavior look different.

Danuta Makowiec, University of Gdańsk, Gdańsk, Poland

Multifractal estimators of short-time autonomic control of the heart rate

Abstract: Understanding of real world phenomena needs to incorporate the fact that observations on different scales each carry essential information. Multifractal formalism is tested if it can work as a robust estimator of monofractal properties when scaling interval is consistent with low-frequency (LF) band of power spectral analysis used in estimates of heart rate variability. Tests with fractional Brownian motions are performed to validate two popular multifractal methods: Wavelet Transform Modulus Maxima (WTMM) and Multifractal Detrended Fluctuation Analysis. Only WTMM method passes the tests when scaling is limited to LF band. Then WTMM method is applied in analysis of short-time control processes driving the heart rate. The significant difference is found between multifractal spectra describing healthy hearts and hearts suffering from left ventricle systolic dysfunction.

Talks (continued)

Igor M. Sokolov, Humboldt Universitat, Berlin, Germany

Nonergodicity in continuous-time random walk models

Abstract: We discuss nonergodicity (i.e. difference in the ensemble and time averages) in continuous time random walks (CTRW) on different substrates: simple CTRW on a homogeneous infinite lattice, CTRW in a bounded domain and CTRW on a fractal structure, all corresponding to subordination of an ergodic process of normal or anomalous diffusion to a non-ergodic one. While in all these cases the ensemble averaging gives rise to the well defined, deterministic behavior, the time averaged quantities show universal fluctuations and do not lead to a deterministic limit even in the case of averaging over very long time intervals. Additional ensemble averaging of these time averages yields a deterministic behavior, which however differs from the ensemble-averaged result (in the absence of time-preaveraging). We discuss physical implication of the results, especially with respect to clear discrimination between subdiffusion caused by the presence of energetic or chemical traps and the one due to geometric disorder and crowding, as well as cases of subdiffusion of mixed origin.

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

[2] T. Neusius, I. M. Sokolov and J.C. Smith, Phys. Rev. E **80**, 011109 (2009).

[3] Y. Meroz, I. M. Sokolov and J. Klafter, Subdiffusion of mixed origins: When ergodicity and nonergodicity coexist (submitted).

Davide Valenti, University of Palermo, Palermo, Italy

Moment equations in a system of three interacting species subject to colored noise

Abstract: We study the effects of the colored noise on a Lotka-Volterra system of three interacting species, namely two preys and one predator, in a two-dimensional domain. The three species are affected by an external multiplicative time correlated noise, which accounts for environment fluctuations. Moreover, the interaction parameter between the two preys is a dichotomous stochastic process, which determines two dynamical regimes corresponding to different biological conditions. First, we study the noise effects on the three species dynamics in a single site. Afterwards, by a mean field approach we obtain, in Gaussian approximation, the moment equations for the species densities. Within this formalism we analyze the effect of the external colored noise on the spatially extended system. We find that the multiplicative noise does not affect the time behavior of the 1st order moments. Conversely, the 2^{nd} order moments are strongly dependent both on the intensity and correlation time of the multiplicative noise. Finally, we compare our results with those obtained by a discrete time approach based on a model of coupled map lattice.

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Posters

1.
Giuseppe Augello, Davide Valenti and Bernardo Spagnolo, University of Palermo, Palermo, Italy
Transient dynamics of short Josephson junctions under the influence of non-Gaussian noise
Abstract: We investigate the effects of non-Gaussian white noise source on the transient dynamics of short Josephson junctions. The noise signal is simulated generating standard stable random variables with characteristic function described by Lévy index α and asymmetry parameter β. We study the lifetime of the superconductive state as a function both of the frequency of the external driving bias current and the noise intensity for different values of index α. We compare our results with those obtained in the presence of Gaussian white noise. We find the presence of noise induced effects such as resonant activation and noise enhanced stability.

2.
Przemysław Borys, Silesian University of Technology, Gliwice, Poland
Stochastic model of a newborn's physical development
Abstract: According to Vojta principles, newborn's physical development is genetically determined. The development must go through well defined subsequent stages to achieve the final walk and sit abilities. A frequent question of parents is how long will the development take if the baby has some deficiencies, i.e. achievement of a certain state is delayed. Doctors usually don't give the answer being aware of large uncertainty margins and having poor skills in statistics to describe their predictions. In this work I try to present a model that predicts this time based upon the development data in Vojta results and Munich Functional Development Diagnostics. I also take into account the plasticity of the neural system that decreases with age.

3.
Teodor Buchner, Warsaw University of Technology, Warszawa, Poland
Dynamics of coupled rotators kicked with delay
Abstract: We analyze a simple nonlinear system – a pair of mutually kicking rotators theoretically and numerically. Classification of synchronization states is supplied by theoretical analysis and verified by numerical experiment. As such a system is a toy model for cardiorespiratory synchronization, it is discussed how well can it mimic the original physiological phenomenon.

Posters (continued)

4.

Pasquale Caldara, Alessandro Fiasconaro and Bernardo Spagnolo, University of Palermo, Palermo, Italy

Role of the multiplicative noise in a system with a metestable state

Abstract: The interaction of a system with environment can be modelized with a stochastic variable that affects the evolution of the system. This noisy interaction can be described by additive and/or multiplicative noise sources. This kind of situation is ubiquitous in both natural [1, 2] and human-made complex systems [3], which are open systems. In population dynamics, for example, the noise can break the symmetry of the dynamical behaviour of two interacting species system [4]. Metastability is quite general problem in physics and we can find examples in condensed matter and in the study of the decaying of false vacuum states in quantum field theory [5, 6, 7]. Here we study a model system characterized by an asymmetric bistable potential with a metastable state in the presence of both additive and multiplicative noise sources. The role of both noise sources on the lifetime of the metastable state will be analyzed. The effective potential of our model system allows us to analyze how the noise-enhanced stability phenomenon [8, 9] is affected by both additive and multiplicative noise sources. This model is also suitable to describe the essential physics of a non-equilibrium Ising lattice. We find a non monotonic behaviour of the mean escape time that arises in the presence of both additive and multiplicative noise for certain ranges of the parameters that can be seen as "islands of metastability".

[1] P. Sura et al., Jour. Atm. Sci. **62**, 1391 (2005).

[2] L. Schimansky-Geier, D. Abbott, A. Neiman, C. Van Den Broeck, Proc. SPIE **5114**, (2003).

[3] R. N. Mantegna and H. E. Stanley, An Introduction to Econophysics Correlations and Complexity in Finance, Cambridge University Press, 2000.

[4] B. Spagnolo, D. Valenti, A. Fiasconaro, Math. Biosc. and Eng. **1**, 185 (2004).

[5] P. G. Debenedetti, F. H. Stillinger, Nature **410**, 267 (2001).

[6] M. Gleiser, R. C. Howell, Phys. Rev. Lett. **94**, 151601 (2005).

[7] P. I. Hurtado, J. Marro, P. L. Garrido J. Stat. Phys. **133**, 29 (2008).

[8] N. Agudov and B. Spagnolo, Phys. Rev. E **64**, 035102(R) (2001).

[9] A. A. Dubkov, N. V. Agudov and B. Spagnolo, Phys. Rev. E **69**, 061103-1 (2004).

Posters (continued)

5.

Joanna Deperas-Standyło, Jagellonian University, Kraków, Poland

Effect of LET and track structure on cell-cycle delay and statistical distribution of chromosome aberrations.

Abstract: Investigations of the genetic effects of particle exposure are of particular interest in relevance for application of particle beams in therapy and prediction of radiation risk in space. The key issue in understanding biophysical effects of radiation is the difference in energy deposition following irradiation with photons and heavy charged particles [2-5,7]. Following microdosimetric concepts, distribution of imparted energy can be estimated from the knowledge of range and stopping powers of penetrating charged particles in an irradiated object. For particles, the energy is inhomogeneously deposited along the trajectory of an ion penetrating the matter with a local dose distribution within a particle track following the $1/r^2$ dependence. In contrast, in the case of X-rays, the energy deposition is spatially uniform. Due to the high local energy deposition within the particle track, a traversal of a single ion through a cell nucleus can result in multiple chromatin breaks. This lesion "clustering" determines non-Poisson distribution of aberrations among cells. Additionally, contributions to damage coming from independent individual tracks give rise to a compound distribution well approximated by a mixed statistics [1,6,8]. We have analyzed chromosome aberration data obtained for human lymphocytes exposed to X-rays and C (LET = 175 $keV/\mu m$ and 29$keV/\mu m$) and Fe-ions (LET = 155 $keV/\mu m$). For cytogenetic analysis lymphocytes were collected in metaphase at 48,60,72 and 84 post-irradiation. For the time-course analysis a modified mathematical approach proposed by Scholz [9] has been used. To account for the different kinetics of high and low-LET induced damage, the total amount of aberrations induced within the entire population has been determined. For each subgroup of aberrant cells the flux through mitosis was analyzed revealing correlation between delay in mitosis and number of aberrations carried by a cell. This observation is of particular importance for the proper estimation the biological efficiency of C ions and health risks associated with radiation exposure.

[1] E. Gudowska-Nowak, A. Kleczkowski, E. Nasanova, M. Scholz, S. Ritter, Int. J. Radiat. Biol. **81**, 23 (2005).

[2] E. Nasanova, E. Gudowska-Nowak, S. Ritter, G. Kraft, Int. J. Radiat. Biol. **77**, 59 (2001).

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Posters (continued)

6.

Bartłomiej Dybiec, Jagellonian University, Kraków, Poland

Anomalous diffusion: temporal non-Markovianity and weak ergodicity breaking

Abstract: Traditionally, discrimination between Markovian and non-Markovian process is based on the definition. If the process is Markovian, its transition probability does not depend on the history of the process and it fulfills the Smoluchowski-Chapman-Kolmogorov equation. A practical verification of these two criteria can be not always possible or fully conclusive. Therefore, we present an additional method which can be used to confirm the simplest version of Markovianity. This method is based on properties of sums of independent random variables. We apply the presented method to prove the increment dependent character of an anomalous process combining long waiting times with long jumps. Such a process, despite being non-Markovian in nature, due to a competition between long waiting times and long jumps can reveal "normal" behavior. We also demonstrate that this anomalous process breaks the ergodicity in the weak sense. Finally, we apply the suggested method to some experimental time series proving their Markovian nature for small time scales.

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7.

Daniela Froemberg and Igor M. Sokolov, Humboldt Universitat, Berlin, Germany

Boundary value problems under subdiffusion

Abstract: We investigate boundary value problems for subdiffusion which can be solved within the Green functions approach, including the case when the particles degrade at a certain rate, which corresponds to the simplest possible chemical reaction. Here we use the reaction-subdiffusion equations with non-decoupling reaction- and transport terms derived earlier. Although these equations appear complicated at first glance, it turns out that the methods for the solution of the corresponding linear reaction-diffusion equations can easily be adopted to the anomalous case.

Posters (continued)

8.

Simon Fugmann and Igor M. Sokolov, Humboldt Universitat, Berlin, Germany

Rupture dynamics of a bond in a grafted chain

Abstract: We consider the equilibrium relaxation properties in a grafted homopolymer chain. We calculate mean first passage times of monomer distances (bonds) within the framework of the Wilemski Fixman approximation. We show that these times crucially depend on the length of the chain and the position of the bond in the chain. Close to the grafted end we observe an increase of the mean first passage time, which grows with the chain length and is the stronger the softer the bonds are. Close to the free terminal the typical passage times are lowered to a chain length independent value. Based on these results we discus the effect of spacer molecules in polymer rupture experiments performed at a constant loading rate.

9.

Tomasz Gradowski, Maciej Mrowiński and Robert Kosiński, Warsaw University of Technology, Warszawa, Poland

Cooperation in peer-to-peer networks

Abstract: The Internet has become one of the most important means of communication of our century. Every second it is being used worldwide to deliver an unimaginable amount of content. A substantial part of this traffic can be attributed to the so called peer-to-peer networks in which users can exchange data directly, without the assistance of any intermediate server (there may be some servers involved in establishing the connection). While used mostly for illegal file sharing, peer-to-peer networks are an effective way of distributing files to a large group of users at virtually no cost for the publisher. Unlike centralized server-based solutions, peer-to-peer networks are as reliable (in terms of file availability) as their users and cooperation between the file sharers plays a crucial role in spreading files over the network. In our work we use simple models to study the cooperative and dynamical phenomena in peer-to-peer networks. By extensive numerical simulations and analytical calculations based on the master equation we study the efficiency and stability of this file sharing mechanism. We look for critical parameters that determine the dynamics of such systems and discuss ways of preventing free-riding (users who download files without sharing them).

Posters (continued)

10.

Saverio Bivona, Giovanni Bonanno, Riccardo Burlon, Davide Gurrera and Claudio Leone, University of Palermo, Palermo, Italy

Forecasting by seasonal and long-memory stochastic models

Abstract: The idea of using a mathematical model to describe the behaviour of a physical phenomenon is well established, but in many problems we have to consider a time-dependent phenomenon in which there are many unknown factors and for which it is not possible to write a deterministic model. Nevertheless, it may be possible to derive a stochastic model. The models for time series that are needed for example to achieve optimal forecasting and control are in fact stochastic models, but the choice of the suitable kind of model is never straightforward. In the present work, we test the modelling and forecasting ability of two different kinds of stochastic models: seasonal autoregressive integrated moving average models and autoregressive fractionally integrated moving average models. As an example, we employ wind speed data, but a like analysis could be developed in other fields, like for example econophysics, social sciences, engineering, natural sciences (including biology).

11.

Robert Kosiński and Andrzej Grabowski, Central Institute for Labour Protection – National Research Institute, Warszawa, Poland & Warsaw University of Technology, Warszawa, Poland

Percolation in on-line networks

Abstract: We study bond and site percolation in four real social networks: two Internet society of friends consisting of over 10^6 and 10^7 people, over 10^6 users of music community website and over 5×10^6 users of gamers community server. We study the properties of those systems (e.g. the network components size distribution) in function of fraction p of nodes or links that retained in network. We have calculated critical fraction p_C at which the percolation transition takes place and giant component emerges.

12.

Robert Hołyst and Marek Litniewski, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Heat transfer at the nanoscale: evaporation of nanodroplets

Abstract: We demonstrate [1] using molecular dynamics simulations of the Lennard-Jones fluid that the evaporation process of nanodroplets is limited by the heat transfer. The temperature is continuous at the liquid-vapor interface if the vapor/liquid density ratio is higher than about 0.05 and discontinuous if it is lower. The temperature in the vapor has a scaling form $T(r,t) = T[r/R(t)]$, where $R(t)$ is the radius of evaporating droplet at time t and r is the distance from its center. Mechanical equilibrium establishes very quickly, and the pressure difference obeys the Laplace law during evaporation.

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Posters (continued)

13.

Agnieszka Jurlewicz, Justyna Trzmiel, Joanna Janczura and Marek Teuerle, Wrocław University of Technology, Wrocław, Poland

Two-power-law relaxation processes in gallium doped $Cd_1 - xM_xTe$

Abstract: We present the results concerning dielectric response of gallium doped $Cd_{0.99}M_{0.01}Te : Ga$, revealing stochastic origins of the observed non-Debye patterns of the corresponding relaxation processes. We detect the two-power-law behavior of the measured permittivity with m and n, the low- and high-frequency exponents, respectively, that satisfy $m < 1 - n$. To explain the empirical results we propose the stochastic diffusion scenario leading to the generalized Mittag-Leffler relaxation function.

14.

Ewelina Kalwarczyk, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Polymer-induced phase separation in solutions of ionic surfactants

Abstract: We present a new method to induce phase separation in solutions of ionic surfactants. In this method, the phase separation is obtained either by addition of polyelectrolytes or nonionic polymers along with inorganic salt. As a result, the system separates into polyelectrolyte-rich (or nonionic polymer rich) and surfactant-rich phase. Four types of the mixtures were investigated: (i) anionic surfactants and anionic polyelectrolytes, (ii) cationic surfactants and cationic polyelectrolytes, (iii) cationic surfactants and nonionic polymers, and (iv) anionic surfactants and nonionic polymers. We found that the addition of polyelectrolyte with the charge of the same sign as that of surfactant can induce the phase separation in a wide range of surfactant concentrations. The addition of nonionic polymers induces the phase separation only in solutions of cationic surfactants. Moreover, the addition of nonionic polymers induces the phase separation only for relatively high total content of polymer and surfactant in the mixture. We found however that the addition of inorganic salt to the mixture of cationic surfactant and nonionic polymer triggers the phase separation even for a small concentrations of surfactant. In our experiments, water as well as mixtures of water and polar solvents were employed as solvents. Based on the optical microscopy studies we found that the surfactant-rich phase represents hexagonal ordering.

Posters (continued)

15.

Tomasz Kalwarczyk, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Tracing of single nano objects as a tool for viscosity measurements in polymer solutions

Abstract: We measured [1] the viscosity of poly(ethylene glycol) (PEG 6000, 12 000, 20 000) in water using capillary electrophoresis and fluorescence correlation spectroscopy with nanoscopic probes of different diameters (from 1.7 to 114 nm). For a probe of diameter smaller than the radius of gyration of PEG (e.g. rhodamine B or lyzozyme) the measured nanoviscosity was orders of magnitude smaller than the macroviscosity. For sizes equal to (or larger than) the polymer radius of gyration, macroscopic value of viscosity was measured. A mathematical relation for macro and nanoviscosity was found as a function of PEG radius of gyration, R_g, correlation length in semi-dilute solution, ξ, and probe size, R. For $R<R_g$, the nanoviscosity (normalized by water viscosity) is given by $\exp(b(R/\xi)^a)$, and for $R>R_g$, both nano and macroviscosity follow the same curve, $\exp(b(R/\xi)^a)$, where a and b are two constants close to unity. This mathematical relation was shown to equally well describe rhodamine (of size 1.7 nm) in PEG 20 000 and the macroviscosity of PEG 8 000 000, whose radius of gyration exceeds 200 nm. Additionally, for the smallest probes (rhodamine B and lysozyme) we have verified, using capillary electrophoresis and fluorescence correlation spectroscopy, that the Stokes-Einstein (SE) relation holds, providing that we use a size-dependent viscosity in the formula. The SE relation is correct even in PEG solutions of very high viscosity (three orders of magnitude larger than that of water).

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16.

Tadeusz Kosztołowicz and Katarzyna D. Lewandowska, Jan Kochanowski University, Kielce, Poland & Medical University of Gdańsk, Gdańsk, Poland

Subdiffusion in a composite medium

Abstract: We study a system with two infinitely thin partially permeable walls divided this system into three homogenous parts. In each part there are different values of subdiffusion coefficients and subdiffusion parameters. The system is described by the linear differential equations with fractional time derivative. We derive the Greens functions for this system which have an universal character and allow one to calculate the concentration profiles for any initial conditions. We also discuss the properties of the concentrations found for the system where initially concentration was nonzero only in the one part.

Posters (continued)

17.

Andrzej Krawiecki, Warsaw University of Technology, Warszawa, Poland

Stochastic resonance in systems on hierarchical and modular networks

Abstract: Stochastic resonance in two exemplary complex systems in which the structure of interactions between coupled units is that of modular or hierarchical networks is investigated. The first system consists of threshold elements coupled to form a hierarchical Ravasz-Barabasi network. The second one is the Ising model on two weakly coupled scale-free networks. In both cases, under certain conditions, structural stochastic multiresonance occurs, i.e., signal-to-noise ratio or spectral power amplification exhibit multiple maxima as functions of the input noise intensity or temperature, respectively. The appearance of multiresonance is directly related to the complex structure of interactions.

18.

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

Thermodynamical aspects of generalzed fractal dimension case of cancer cell lines metastasis

Abstract: The generalized fractal dimension (D_q) and its Legendre transform ($f(\alpha)$, partitioned iterated function system- semifractals (PIFS-SF) and lacunarity, were used to analyze quantitative differences in secretory membrane activities. Two rat prostate cancer cell lines (Mat-LyLu and AT-2) as well as two human breast cancer cell lines (MDA-MB-231 and MCF-7) were analyzed. Mat-LyLu and MDA-MB-231 showed the strong metastatic membrane potential whereas AT-2 and MSF-7 showed the weak metastatic membrane potential. Based on the previous [1, 2] we can conclude, that the vesicle patterns differ depending on the metastatic potential of cancer cells and can be characterized using generalized fractal dimension particularly D_0, D_1, D_{-1}, and ΔD. Generally this tools can be potentially useful in cancer diagnostics. In this presentation we have shown thermodynamical aspects of generalized fractal dimension in case of cancer cell lines metastasis.

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Posters (continued)

19.

Angelo La Cognata, Davide Valenti, Alexander A. Dubkov and Bernardo Spagnolo, University of Palermo, Palermo, Italy & State University of Nizhni Novgorod, Nizhni Novgorod, Russia

Dynamics of a Lotka-Volterra system in the presence of non-Gaussian noise sources

Abstract: We consider a Lotka-Volterra system of two competing species subject to multiplicative α-stable Lévy noise. The interaction parameter between the species is a random process which obeys a stochastic differential equation with a generalized bistable potential in the presence both of a periodic driving term and an additive α-stable Lévy noise. We study the species dynamics, which is characterized by two different dynamical regimes, exclusion of one species and coexistence of both ones, analyzing the role of the Lévy noise sources.

20.

Katarzyna D. Lewandowska and Tadeusz Kosztołowicz, Medical University of Gdańsk, Gdańsk, Poland & Jan Kochanowski University, Kielce, Poland

The scaling method to study the subdiffusion and subdiffusion-reaction equations

Abstract: We consider a (sub)diffusion-reaction system of two initially separated substances A and B reacting according to the formula $\lambda_A A + \lambda_B B \to P(inert)$. To study the normal diffusion equation one usually uses the scaling method. However, this method cannot be applicable to the subdiffusion-reaction system due to the specific properties of fractional derivative. We propose modified scaling method and use it to study the subdiffusion-reaction system.

21.

Adam Lipowski, Adam Mickiewicz University, Poznań, Poland

Prisoner's dilemma on reinforcing weighted networks

Abstract: We examine a directed weighted network of agents playing the prisoner's dilemma game. Network weights (that determines probabilities of who plays with whom) depends on the accumulated payoff obtained from playing the game between a pair of agents. Simulations show that such a network evolves towards a random-graph-like structure. In a version of the model where weights depends also on the total payoff accumulated by a given agent, the network evolves towards scale-free-like structure. Wealth distribution and kinetics of these two versions of the model are also much different.

Posters (continued)

22.

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

Ionic strength influence on the potassium ion channel rate of N-inactivation

Abstract: N-inactivation is the process in which one of the four, charged N-endings of the potassium ion channel protein binds to its allosteric centre, plugs the channel's pore and stops the ion transport. Apart from this scenario, it has been experimentally shown that N-inactivation can be recovered for the channels with its N-endings removed, by delivering them into the bathing solution. We develop the Langevin-type model for the random walk of inactivating N-endings in electrostatic field, at different ionic strengths of the bathing solution. Model's output is directly compared with the measurement of an ensemble averaged trans-channel current. In conclusions we point and discuss important differences between two mentioned modes of N-inactivation that cannot be easily distinguished in experiment.

23.

Patrycja Nitoń, Andrzej Zywocinski, Robert Hołyst, Robert Kieffer and Carsten Tschierske, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland & Cardinal Stefan Wyszyński University, Warszawa, Poland & Martin-Luther-University Halle-Wittenberg, Halle, Germany

Reversible aggregation of bolaamphiphiles with partially fluorinated lateral chains at the air/water interface

Abstract: We present the results for four new compounds from the group of partially fluorinated X-shaped bolaamphiphiles. Three of them are partially fluorinated and the forth one is left in hydrogenated form for comparison. The compounds of this type have broad medical applications (e.g. gene delivery) because of their liquid-crystalline properties, strong interaction with air/water interface and tendency to self-organization. The fluorinated bolaamphiphiles exhibit an unusual reversibility of Langmuir isotherms even though compressed at maximum rate of compression up to a total collapse of the film. The subsequent compression-decompression cycles follow perfectly the first isotherm proving also a very good reproducibility of the isotherms. Fluorination of the lateral chains is the key property here, since the hydrogenated compound does not exhibit such perfect reversibility of the isotherm.

Posters (continued)

24.

Anna Ochab-Marcinek, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Extrinsic noise passing through a Michaelis-Menten reaction: universal response of a genetic switch

Abstract: The study of biochemical pathways usually focuses on a small section of the protein interaction network. Fluctuations in such a system are not only generated intrinsically by molecular dynamics, but also extrinsically, by interactions of the system with the rest of the network and its environment. Concentration fluctuations of a substance outside the studied system can enter it through a nonlinear uptake reaction which acts as a nonlinear filter. Varying the intensity of the input noise varies the mean of the output noise after the passage through the filter, which causes a change of stability properties of the system. Using an analytical method of small noise expansion, I prove that when weak and rapid noise enters the system through a reaction of Michaelis-Menten type (reaction rate function monotonically increasing and concave), then the steady states of the system always shift to the right as noise intensity increases. I demonstrate this by an example of two different models of lac operon. The bistable switch responds to fluctuations in extracellular TMG/lactose concentration in an asymmetric manner because of the displacement of its bistability region to the right: As noise intensity increases, uninduction becomes easier and induction becomes more difficult. The steady-state displacement due to weak and rapid extrinsic noise passing through a nonlinear filter is a universal phenomenon: It is independent of the kinetics of the system but it only depends on the filtering function. The calculation method presented enables even qualitative predictions of this effect, only by inspection of the experimental data.

25.

Krzysztof Pawełek, John J. Kozak and Zbigniew J. Grzywna, Silesian University of Technology, Gliwice, Poland & University of Chicago, Chicago, USA

Synchronous vs. asynchronous motion of K+ in the KcsA selectivity filter

Abstract: The difference of synchronous vs. asynchronous motion of the K+ ions and water molecules in the selectivity filter of the KcsA bacterial channel is studied by recently proposed Markovian model. Five different cases are taken into account: the simplest system without any interactions, the system with only repulsive interactions between K+ ions or only attractive interactions between K+ ions and the carbonyl groups lining the channel, the system with electrostatic potential added to the membrane and in the last case, the system, in which all interactions are turned on. The degree of asynchronicity in K+ ions and water molecules motion is taken quantitatively by "an asynchronicity factor". Considering the simplest system with excluded volume effects only, the difference in mean passage time through the channel is in the range 50%-75%. In the other cases the difference is also important and can not be neglected.

Posters (continued)

26.

Dominique Persano Adorno, Nicola Pizzolato, Davide Valenti and Bernardo Spagnolo, University of Palermo, Palermo, Italy

Complex dynamics of leukemic cells under intermittent therapy

Abstract: The evolutionary dynamics of cancerous cell populations in a model of Chronic Myeloid Leukemia (CML) is investigated. A Monte Carlo approach is applied to model the cancer development and progression by simulating the stochastic evolution of initially healthy cells which can experience genetic mutations and modify their reproductive behavior, becoming leukemic clones. Front line therapy for the treatment of this kind of tumor is achieved by tyrosine kinase inhibitors, namely imatinib (Gleevec) or, more recently, dasatinib or nilotinib. Despite they represent the first example of a successful molecular targeted therapy, the development of resistance to these drugs is observed in a proportion of patients, especially those with advanced-stage CML. In the present work, we simulate an imatinib-like treatment of CML by modifying the fitness and the death rate of cancerous cells and describe the several scenarios in the evolutionary dynamics of blood cells as a consequence of the efficacy of the different modeled therapies. In our model, resistant cancerous cells, which are insensitive to the therapy, are generated from leukemic cells by a stochastic process of genetic mutation. We study how the patient response to the therapy changes when the drug is assumed with an intermittent time scheduling. Of course the best results, in terms of a permanent disappearance of the leukemic phenotype and containment of resistance, are achieved with a continuous therapy. However, our findings demonstrate that an intermittent therapy could also represent a valid choice in patients with high risk of toxicity, despite the retard on the complete restoring of healthy cells. The description of this biological system in terms of a complex system of evolving cells contributes to an overall understanding of the cancer dynamics.

Posters (continued)

27.

Monika Pyzalska, Piotr Korczyk and Piotr Garstecki, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Up-scaling microfluidics

Abstract: The idea to conduct reactions within droplets in microfluidic channels has been intensively exploited in the recent years due to the following, attractive characteristics: i) fast (millisecond) mixing that is either difficult or impossible to achieve in single-phase microfluidics, ii) lack of dispersion of time of residence that is inherent to single phase flow-through reactors iii) ease of controlling the kinetics of reactions via the simple correspondence between the time of residence and the position in the channel, and iv) efficient convection from the bulk of the droplets to their (extended in ratio to volume) surface that provides for efficient phase transfer. The intrinsically small throughput of these systems is preferable for analytical purposes, yet for applications in synthesis it constitutes a significant drawback.

A potential solution lies in up scaling of the channels of millimetric cross-sections. We have investigated experimentally the answers to the question of how much can the microfluidic systems be enlarged while preserving the attractive features of flow at the microscale. In our poster we will present results from characterization the formation of droplets, the rate of mixing in droplets and the rate of phase transfer in systems with increasing cross-sections of the channels (up to 2 mm, and in particular cases even larger).

28.

Pawel Romanczuk, Humboldt Universitat, Berlin, Germany

Effective diffusion and quasi-deterministic transport of Brownian particles in a spatio-temporally oscillating potential

Abstract: We consider overdamped Brownian dynamics in an temporally oscillating and spatially periodic potential. We analyze the nondirected diffusive transport which shows oscillation induced enhancement of the effective diffusion and present an approximate formula for the effective diffusion coefficient. Furthermore we analyze the effect of the oscillating potential on directed transport due to the application of a constant force. We show via numerical simulations the existence of an optimal force at which the deterministic dynamics is in resonance with the potential oscillations giving rise to directed transport with extremely low dispersion and discuss a simplified theoretical description of the observed effect.

Posters (continued)

29.

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

Structure morphology problems in the air separation by magnetic membranes

Abstract: Study of transport processes through membranes is a difficult problem, especially, if structure-morphology aspects have to be taken into account. In this work we are analyzing the complex behavior of non-classical membrane systems. Considered system is being studied basing on the phenomenological (ideal Fickian or non-ideal), and molecular (random walk on a fractal lattice) approach. Comparison with experimental data for the case of oxygen and nitrogen diffusing through magnetic membranes is also presented.

30.

Marta Siek, Agnieszka Kamińska and Piotr Garstecki, Cardinal Stefan Wyszyński University, Warszawa, Poland & Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Generation of polymer-encapsulated microbubbles in a microfluidic flow-focusing system

Abstract: Microfluidics is a technique for precise handling of small quantities of fluids. In recent years microfluidics has been demonstrated to provide useful tools for preparation of emulsions and foams. For example, it is possible to form highly monodisperse droplets, bubbles, or structured (multiple) droplets.

Bare bubbles, even if prepared almost ideally monodisperse, are unstable – they undergo coalescence, Ostwald ripening and dissolution of the gas into the surrounding liquid – until saturation. There are different ways to increase the stability of bubbles, by e.g. creation of a shell typically composed of either a protein (e.g., denatured albumins) or a surfactant such as phospholipids or a polymer like a poly (acrylic acid), present at the surface of the bubble.

Gas microbubbles, stabilized by a surfactant or polymer coating, have become well established over the past 20-30 years as the most effective type of contrast agent available for ultrasound radiography. More recently, their potential for use in therapeutic applications including targeted drug delivery, gene therapy and focused ultrasound surgery has also been investigated. Providing a high degree of control over microbubble size, composition, stability and uniformity is needed.

We demonstrate formation of monodisperse bubbles in a microfluidic flow-focusing device, and stabilization of these bubbles by building a polymer (poly (acrylic acid)) coating around them, all *in situ* in the same device and process.

Posters (continued)

31.

Susane E. L. Silva, Mendeli H. Vainstein and Fernando A. Oliveira, University of Brasília, Brasília, Brazil

Breaking in polymeric chains

Abstract: Extensive simulations call atention to the anomalous dynamics of breaking of anharmonic chains and its connection with basic principles of statistical mechanics[1, 2]. The dynamics of a set of rectilinear chains was followed solving simultaneously a set of coupled Langevin equations. The problem addressed here is that of calculating the breaking strength of a polymer fibril immersed in a fluid. This problem has technological interest due the use of petrol additive [3]. Long chains are better for drag reduction; however they are weak and have a small lifetime, which is the reason one needs to change the motor oil frequently, since successive breaking reduces the chain to small ineffective parts. Many essential biological processes for life depend on the reaction of various bonds to an applied force. One such example is how leukocytes recognize invading pathogenic organisms in blood vessels [4]. Atomic force microscope (AFM) [5, 6] and biomembrane force probe (BFP) [7-9] are now being used to determine the energy landscape of those complex molecules, as well as scaling laws [10, 11]. We present here a short review of those ideas and their implications, and we also discuss the state of art of the theory.

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Posters (continued)

32.

Stefano Spezia, Dominique Persano Adorno, Nicola Pizzolato and Bernardo Spagnolo, University of Palermo, Palermo, Italy

Nonlinear temperature and field dependence of electron spin depolarization in GaAs semiconductors

Abstract: In this work we investigate the influence of temperature and transport conditions on the electron spin relaxation in n-type GaAs bulk semiconductors. The electron transport, including the evolution of the spin polarization vector, is simulated by a Monte Carlo procedure which keeps into account all the possible scattering phenomena of the hot electrons in the medium. Electron-spin states in semiconductor structures relax by scattering with imperfections, other carriers and phonons. Spin relaxation lengths and times are computed through the D'yakonov-Perel process since this is the more relevant spin relaxation mechanism in the regime of interest ($10 < T < 300$ K). The decay of the initial spin polarization of the conduction electrons is calculated as a function of the distance under the presence of a static electric field varying in the range 0.01-3 kV/cm. We find that the electron spin relaxation distance and time have a nonmonotonic dependence on both the lattice temperature and the electric field amplitude. We discuss the behaviour of the electron spin relaxation lengths and times, showing the best conditions to achieve extended functionality in spin-based devices, to be exploited on future information processing systems.

33.

Anna Strzelewicz and Zbigniew J. Grzywna, Silesian University of Technology, Gliwice, Poland

On the measures of coupling in isothermal mass transport through magnetic membranes

Abstract: It is known from the theory of linear nonequilibrium thermodynamics, that when several species are simultaneously diffusing, the flow of one species influences the flow of another, i.e. there are cross effects between diffusing species. In the paper we consider the diffusional system consisted of two components gas, permeating through a planar membrane of thickness l, where external (magnetic) field affects one component transport. An operational activity of magnetic field is covered by drift term in the transport equation. An influence of the two components on each other transport (coupling) could be measured by the "influence factor IF". We have introduced a couple of different quantitative measures of IF. It turned out however, that in our case IF is small (weak coupling) and, as a first approximation, we can use two independent PDEs for N_2 and O_2, respectively i.e. $D_{12} = D_{21} = 0$ in the set.

Posters (continued)

34.

Marcin Tabaka, Institute of Physical Chemistry, Polish Academy of Sciences, Warszawa, Poland

Accurate genetic switch in escherichia coli: novel mechanism of regulation by co-repressor

Abstract: Understanding a biological module involves recognition of its structure and the dynamics of its principal components. In this report we present an analysis of the dynamics of the repression module within the regulation of the trp operon in Escherichia coli. We combine biochemical data for reaction rate constants for the trp repressor binding to trp operator and in vivo data of a number of tryptophan repressors (TrpRs) that bind to the operator. The model of repression presented in this report greatly differs from previous mathematical models. One, two or three TrpRs can bind to the operator and repress the transcription. Moreover, reaction rates for detachment of TrpRs from the operator strongly depend on tryptophan (Trp) concentration, since Trp can also bind to the repressor–operator complex and stabilize it. From the mathematical modeling and analysis of reaction rates and equilibrium constants emerges a high-quality, accurate and effective module of trp repression. This genetic switch responds accurately to fast consumption of Trp from the interior of a cell. It switches with minimal dispersion when the concentration of Trp drops below a thousand molecules per cell.

35.

Natalia Ziębacz, Stefan A. Wieczorek, Tomasz Szymborski, Piotr Garstecki and Robert Hołyst, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland & Cardinal Stefan Wyszyński University, Warszawa, Poland

Thousand-fold acceleration of phase decomposition in polymer/liquid crystal blends

Abstract: Small-angle light scattering measurements were carried out on 5CB/PS (4-cyano-4'-n-pentyl-biphenyl/polystyrene) and 8CB/PS (4-cyano-4'-n-octyl-biphenyl/polystyrene) mixtures during phase separation in the AC electric field. The size of polymer domains in LC matrix was determined as a function of time, film composition, amplitude and frequency of applied external electric field. For 5CB/PS and 8CB/PS, in the absence of electric field or in a high frequency (> 30 Hz) electric field, we found diffusion growth of domains, $L(t) \sim t^{\alpha}$, in time t with exponent $\alpha = 0.3 \pm 0.04$. In the low frequency electric field (< 30 Hz) the phase separation process in the isotropic phase was accelerated more than one order of magnitude for moderate fields of amplitude 3 $V/\mu m$. For 5CB/PS and 8CB/PS mixtures in the AC field of frequency 2 Hz and amplitude $3.3V/\mu m$ we found exponential growth of the domain's size $L(t) \sim \exp(bt)$. We gave a set of experimental evidence that ion impurities in liquid crystals are responsible for the acceleration of the phase separation process in liquid crystal/polymer mixtures.

Posters (continued)

36.

Xia Xin, Institute of Physical Chemistry Polish Academy of Sciences, Warszawa, Poland

Incorporation of carbon nanotubes into lyotropic liquid crystal induced by phase separation

Abstract: We incorporated carbon nanotubes (CNTs) including single-walled carbon nanotubes (SWNTs) and multi-walled carbon nanotubes (MWNTs) into nonionic surfactant n-dodecyl octaoxyethene monoether (C12E6) lyotropic liquid crystal (LLC) phase formed spontaneously by phase separation in the presence of nonionic hydrophilic polymer poly (ethylene glycol) PEG 20000. The properties of LLC/CNTs composites were investigated by polarized optical microscopy, Raman spectra and small-angle X-ray scattering measurements. The results obtained clearly indicated that SWNTs have been successfully incorporated into the lytropic hexagonal upper phase formed by C12E6 without destroying the LLC matrix and MWNTs are more difficult to be incorporated into LLC matrix compared with SWNTs due to their larger tube diameter. Moreover, the incorporation of CNTs can also induce interesting changes of the host LLC phase, which is also of great fundamental interest. So, the effects of temperature, concentrations of CNTs, C12E6 and PEG 20000 on the properties of LLC/CNTs composites were also observed. The results showed that all of these factors can significantly influence the properties of LLC/CNTs composites.

22^{nd} **Marian Smoluchowski Symposium on Statistical Physics**
ZAKOPANE, POLAND, SEPTEMBER 12–17, 2009

List of participants

Giuseppe Augello	Palermo, Italy	augello@gip.dft.unipa.it
Marcello Borromeo	Perugia, Italy	marcello.borromeo@pg.infn.it
Przemysław Borys	Gliwice, Poland	przemyslaw.borys@polsl.pl
Teodor Buchner	Warszawa, Poland	buchner@if.pw.edu.pl
Zdzisław Burda	Kraków, Poland	burda@th.if.uj.edu.pl
Pasquale Caldara	Palermo, Italy	pcaldara@gip.dft.unipa.it
Michał Cieśla	Kraków, Poland	ciesla@th.if.uj.edu.pl
Joanna Deperas-Standyło	Kraków, Poland	joannadeperas@wp.pl
Jörn Dunkel	Oxford, United Kingdom	jorn.dunkel@physics.ox.ac.uk
Bartłomiej Dybiec	Kraków, Poland	bartek@th.if.uj.edu.pl
Marcin Fiałkowski	Warszawa, Poland	fialkows@ichf.edu.pl
Sighart Fischer	München, Germany	sighart.fischer@ph.tum.de
Daniela Froemberg	Berlin, Germany	daniela.froemberg@web.de
Andrzej Fuliński	Kraków, Poland	fulinski@if.uj.edu.pl
Simon Fugmann	Berlin, Germany	simon.fugmann@physik.hu-berlin.de
Piotr Garbaczewski	Opole, Poland	pgar@uni.opole.pl
Paweł F. Góra	Kraków, Poland	gora@if.uj.edu.pl
Tomasz Gradowski	Warszawa, Poland	tomgrad@if.pw.edu.pl
Zbigniew J. Grzywna	Gliwice, Poland	zbigniew.grzywna@polsl.pl
Ewa Gudowska-Nowak	Kraków, Poland	gudowska@th.if.uj.edu.pl
Davide Gurrera	Palermo, Italy	davide.gurrera@difter.unipa.it
Robert Hołyst	Warszawa, Poland	holyst@ptys.ichf.edu.pl
Agnieszka Jurlewicz	Wrocław, Poland	agnieszka.jurlewicz@pwr.wroc.pl
Tadeusz Kosztołowicz	Kielce, Poland	tadeusz.kosztolowicz@ujk.kielce.pl
Ewelina Kalwarczyk	Warszawa, Poland	ewelina.ewa@gmail.com
Tomasz Kalwarczyk	Warszawa, Poland	t.kalwarczyk@gmail.com
Robert Kosinski	Warszawa, Poland	kosinski@if.pw.edu.pl
Monika Krasowska	Gliwice, Poland	monika.krasowska@polsl.pl
Andrzej Krawiecki	Warszawa, Poland	akraw@if.pw.edu.pl
Angelo La Cognata	Palermo, Italy	angelolc@gip.dft.unipa.it
M. Howard Lee	Athens, USA	mhlee@uga.edu
Katarzyna Lewandowska	Gdańsk, Poland	kale@amg.gda.pl
Adam Lipowski	Poznań, Poland	lipowski@amu.edu.pl
Marek Litniewski	Warszawa, Poland	mark@ichf.edu.pl

List of participants (continued)

Krzysztof Małysiak	Gliwice, Poland	krzysztof.malysiak@polsl.pl
Danuta Makowiec	Gdańsk, Poland	fizdm@univ.gda.pl
Maciej Mrowiński	Warszawa, Poland	mrow@if.pw.edu.pl
Patrycja Nitoń	Warszawa, Poland	pati8319@wp.pl
Anna Ochab-Marcinek	Warszawa, Poland	ochab@ifka.ichf.edu.pl
Jeremi Ochab	Kraków, Poland	jeremi.ochab@uj.edu.pl
Fernando A. Oliveira	Brasilia, Brasil	fao@fis.unb.br
Hyunggyu Park	Seoul, Korea	hgpark@kias.re.kr
Krzysztof Pawełek	Gliwice, Poland	krzysztof.pawelek@polsl.pl
Dmitry Postnov	Saratov, Rusia	postnov@chaos.ssu.runnet.ru
Monika Pyzalska	Warszawa, Poland	mpyzalska@gmail.com
Pawel Romanczuk	Berlin, Germany	romanczuk@physik.hu-berlin.de
Aleksandra Rybak	Gliwice, Poland	aleksandra.rybak@polsl.pl
Francesc Sagués	Barcelona, Spain	f.sagues@ub.edu
Adam Samborski	Warszawa, Poland	asam@ichf.edu.pl
Gerhard Schmid	Augsburg, Germany	gerhard.schmid@physik.uni-augsburg.de
Lutz Schimansky-Geier	Berlin, Germany	alsg@physik.hu-berlin.de
Marta Siek	Warszawa, Poland	marta.siek@o2.pl
Susane E. L. Silva	Brasilia, Brasil	susane.eterna@gmail.com
Igor M. Sokolov	Berlin, Germany	igor.sokolov@physik.hu-berlin.de
Bernardo Spagnolo	Palermo, Italy	spagnolo@unipa.it
Stefano Spezia	Palermo, Italy	spezias@gip.dft.unipa.it
Anna Strzelewicz	Gliwice, Poland	anna.strzelewicz@polsl.pl
Marcin Tabaka	Warszawa, Poland	marcin@leon.ichf.edu.pl
Justyna Trzmiel	Wrocław, Poland	justyna.trzmiel@pwr.wroc.pl
Aleksander Weron	Wrocław, Poland	aleksander.weron@pwr.wroc.pl
Karina Weron	Wrocław, Poland	karina.weron@pwr.wroc.pl
Stefan Wieczorek	Warszawa, Poland	wieczor@ichf.edu.pl
Davide Valenti	Palermo, Italy	valentid@gip.dft.unipa.it
Xia Xin	Warszawa, Poland	xinxiasdu@hotmail.com
Natalia Zięba cz	Warszawa, Poland	nziebacz@ichf.edu.pl
Ryszard Zygadło	Kraków, Poland	zygadlo@if.uj.edu.pl
Andrzej Zywocinski	Warszawa, Poland	zywot@ichf.edu.pl
Michał Żabicki	Kraków, Poland	zabicki@th.if.uj.edu.pl
Karol Życzkowski	Kraków, Poland	karol@tatry.if.uj.edu.pl

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Hotel "Bankowiec" ul. Bulwary Słowackiego 14, 34–500 Zakopane, Poland, tel. +(48)(18) 201 40 71
Symposium Organizing Committee: M. Smoluchowski Institute of Physics, Jagellonian University, ul. Reymonta 4, 30–059 Kraków, Poland
e–mail zfs@th.if.uj.edu.pl WWW http://th-www.if.uj.edu.pl/zfs/smoluchowski