PLENARY TALKS

Absence of Energy Diffusion in Nonlinear Random Systems with linear Anderson Localization

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We study the spreading of an initially localized wavepacket in two nonlinear random 1D systems (random DNLS and quartic random KG models) [1]. We observe numerically similar behaviors in both models. The second moment seems to diverge as a function of time but the participation number of the energy (or norm) distribution of any initially localized wavepacket remains bounded at all time. We provide a straitghtforward rigorous proof that the participation number remains bounded for the random DNLS model and initial wave packets with large enough amplitude. Then a limit profile for the energy (or norm) distribution should exist in all cases (whatever is the second moment behavior diverging or non diverging) which forbids the possibility of slow energy diffusion (subdiffusion) where the amplitude of the wavepacket vanishes at infinite time. Numerical indications suggest that this limit profile could be an almost periodic solution (corresponding to infinite dimension KAM torus) though numerical convergence is extremely slow likely due to Arnol'd diffusion effect (note that recently a rigororous proof for the existence of quasiperiodic solutions (finite dimension invariant tori) in random DNLS models has been provided by Bourgain and Wang [2]). We shall present new empirical arguments supporting the above conjectures.

[1] G. Kopidakis, S. Komineas,S. Flach and S. Aubry *Phys. Rev. Lett.* **100** 084103 (2008).

[2] J. Bourgain and W.-M. Wang *J. Eur. Math. Soc.* **10** 1 (2008).

Generalized statistical mechanics methods for superstatistical systems

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A review of the superstatistics concept is given. Many complex driven nonequilibrium systems are effectively described by a superposition of several statistics on different time scales, in short a "superstatistics". Superstatistical systems typically have marginal distributions that exhibit fat tails, for example power law tails or stretched exponentials. In most appliactions one finds three relevant universaliy classes: Lognormal superstatistics, chi-square superstatistics and inverse chi-square superstatistics. Superstatistical tech- niques can be applied to a variety of complex systems, for example turbulence (Lagrangian, Eulerian, environmental), hydroclimatic fluctuations, pattern formation, mathematical finance, traffic delay statistics, random matrix the- ory, networks, as well as medical and biological applications. In this talk I will deal with a generalized maximum entropy principle for superstatistical systems [1] and describe some applications in hydrodynamics [2], traffic dynamics [3], and medicine [4].

[1] S. Abe, C. Beck, E.G.D. Cohen, *Phys. Rev. E* **76** 031102 (2007).

[2] C. Beck, *Phys. Rev.Lett.* **98** 064502 (2007).

[3] K. Briggs and C. Beck,*Physica A* **378** 498 (2007).

[4] L. Leon Chen and C. Beck,*Physica A* **387** 3162 (2008).

Open systems entanglement: What we do know, and what we would like to know

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Quantum entanglement is considered as the precious "fuel" on which quantum computers will run. However, except for the very simplest case of the entanglement between two two-level systems, this fragile quantum feature is very hard to quantify already on the theoretical level, let alone to measure in the lab. In this lecture, I will recall the basic elements of entanglement theory, spell out the central obstacles for an efficient quantification, describe the dynamics of entanglement in noisy environments, and discuss strategies for its direct experimental measurement.

Combinatorics of linear codes as a realisation of constraint satisfaction in biological networks

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Complex biological structures incorporate self-organization at all levels, from the combinatorics of linear codes to three dimensional chemical scaffolds. It is of interest to try to compare them with the emergent structures predicted by ab initio null models. A special case is the so called content-based network [1, 2], where the rules for the formation of bonds derive from a string-matching condition, and the network can be regarded as a superposition of classical random networks with hidden variables [3]. Given biological input regarding the distribution of the information content of the connections (binding sites), this model has been shown to predict, with a high degree of fidelity, the statistics of the transcriptional gene regulatory network of yeast [4] and, more recently, of *E. coli* [5]. I will discuss the implications and shortcomings of this approach to modeling biological networks. Finally, I will discuss this model as a particular realization of a constraint-satisfaction network [6, 7, 8], with a variable information content or specificity.

[1] D. Balcan and A. Erzan, *Eur. Phys. Jour. B* **38**, 253 (2004).

[2] M. Mungan, A. Kabakçıoğlu, D. Balcan and A. Erzan, *J. Phys. A* **38**, 9599 (2005).

[3] D. Balcan and A. Erzan, *Chaos* **17**, 026108 (2007).

[4] D. Balcan, A. Kabakçıoğlu, M. Mungan, and A. Erzan, *PLoS ONE* **2**, e501 (2007).

[5] B. Malkoç, M. Sevgi, D. Balcan, A. Erzan, in preparation.

[6] R.Monasson and R. Zecchina, *Phys. Rev. E* **56**, 1357 (1997).

[7] G. Parisi, *Physica A* **365**, 1 (2006).

[8] D. Achlioptas, A.Naor, Y. Peres, *Nature* **435**, 759 (2005).

New Approaches to the Modelling and Forecast of Epidemics in a World without Frontiers

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The efficiency of epidemic modelling and forecasts has suffered in the past from a poor description of the spatial dynamics. Accurate models are needed e.g. to test potential strategies to control the spread of an epidemic. While the local infection dynamics is well understood for many diseases, little was known about the statistical laws by which humans and their germs disperse. We have simulated the dispersal of pathogens by international air traffic in a comprehensive network model and used it to forcast the spreading of SARS; it can be used to test the efficiency of various control strategies.
To obtain a better spatiotemporal resolution we need the statistical laws governing human travel on all scales, i.e. by all means of transportation. As accurate data were previously not available, we have studied this problem empirically and theoretically using the dispersal of dollar bills as a proxy. The time dependent probability density obtained in this way exhibits pronounced spatiotemporal scaling and su-

perdiffusive spreading, which we model by an ambivalent Lvy random walk. The empirical data can be described very accurately in terms of a bifractional diffusion equation with few parameters.

[1] D. Brockmann, L. Hufnagel, and T. Geisel, *Nature* **439**, 462 (2006).

[2] Hufnagel, D. Brockmann, and T. Geisel, *PNAS*, **101**, 15124 (2004).

Synchronization in Oscillatory Networks

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The formation of collective behaviour in large ensembles or networks of coupled oscillatory elements is one of the most fundamental aspects of dynamical systems theory. Applications range from physics and chemistry via neuroscience to engineering and social sciences. Here some basic properties, potentials but also open problems will be discussed.

Recent research has revealed a rich and complicated network topology in the cortical connectivity of mammalian brains. A challenging task is to understand the implications of such network structures on the functional organization of the brain activities. This is studied here basing on dynamical complex networks. We investigate synchronization dynamics on the cortico-cortical network of the cat by modelling each node (cortical area) of the network with a subnetwork of interacting excitable neurons. We find that the network displays clustered synchronization behaviour and the dynamical clusters coincide with the topological community structures observed in the anatomical network. Our results provide insights into the relationship between the global organization and the functional specialization of the brain cortex.

This approach of a network of networks seems to be of general importance, especially for spreading of diseases or opinion formation in human societies or socio-economic dynamics.

[1] Osipov, G.V., J. Kurths, and C. Zhou, Synchronization in Oscillatory Networks, Springer Complexity, Berlin 2007.

[2] Motter, A., C. Zhou, and J. Kurths, Europhys. Lett. 2005, 69, 334.

[3] Motter, A., C. Zhou, and J. Kurths, Phys. Rev. E 2005, 71, 016116.

[4] Zhou, C., A. Motter, and J. Kurths, Phys. Rev. Lett. 2006, 96, 034101.

[5] Zhou, C., L. Zemanova, G. Zamora, C. Hilgetag, and J. Kurths, Phys. Rev. Lett. 2006, 97, 238103.

New condensates of matter and light

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Macroscopic phase coherence is one of the most remarkable manifestations of quantum mechanics, yet it seems to be the inevitable ground state of interacting many-body systems. In the last two decades, the familiar examples of superfluid He and conventional superconductors have been joined by exotic and high temperature superconductors, ultra-cold atomic gases, both bosonic and fermionic, and recently systems of excitons, magnons, and exciton-photon superpositions called polaritons, the subject of this talk.

An exciton is the solid-state analogue of positronium, made up of an electron and a hole in a semiconductor, bound together by the Coulomb interaction. The idea that a dense system of electrons and holes would be unstable toward an excitonic (electrical) insulator is one of the key ideas underlying metal-insulator transition physics. The further possibility that an exciton fluid would be a Bose-Einstein condensate was raised over 40 years ago, and has been the subject of an extensive experimental search in a variety of condensed matter systems. Such a condensate would naturally exhibit phase coherence.

Lately, some novel experiments with planar optical microcavities make use of the mixing of excitons with photons to create a composite boson called a polari-

tons that has a very light mass, and is thus a good candidate for a high-temperature Bose condensate. Good evidence for spontaneous coherence has now been obtained1, though there are special issues to resolve2 considering the effects of low dimensionality, disorder, strong interactions, and especially strong decoherence associated with decay of the condensate into environmental photons3 — since the condensate is a special kind of laser.

[1] J. Kasprzak, et al. *Nature* **443** 409-415 (2006).

[2] J. Keeling, F. M. Marchetti, M. H. Szymanska, P. B. Littlewood, *Semiconductor Science and Technology*,**22** R1-26 (2007).

[3] M. H. Szymanska, J. Keeling, P. B. Littlewood, *Phys. Rev. B* **75** 195331 (2007).

Characterization of heat transport in one-dimensional systems

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Heat transport in classical one-dimensional systems is reviewed with the goal of identifying the various universality classes. Particular emphasis is given to the anomalous behaviour that is typical of translationally invariant systems. A simple stochastic model is also discussed, which allows clarifying the structure of the (non-equilibrium) invariant measure in a contenxt of anomalous (i.e. diverging) heat conductivity.

Statistical Mechanics and Error-correcting Codes

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I will first show that there is a mathematical correspondance between error-correcting codes and certain mathematical models of disordered spin systems.

I will then show how the recently discovered (or rediscovered) codes which approach Shannon's Chanel Capacity (turbo codes and low density parity check codes) can be analysed using statistical mechanics. It is possible to show, using statistical mechanics, that these codes allow error-free communication for signal to noise ratio above a certain threshold. This threshold, which corresponds to a phase transition in the spin model, depends on the particular code, and can be computed analytically in many cases.

Finally I will discuss some recent progress and some open problems.

Renormalization of Random Multiplicative Processes

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We consider a random multiplicative process as a minimal model of complex system's growth phenomena. It is known that a single random multiplicative process produces a power law steady distribution in general, so that, this simple model can be used as a first step model for phenomena in which variables follow power law distributions. Starting with this simple model of independent variables, we consider sum of many variables. It can be shown that the sum satisfies the same form of random multiplicative stochastic process with modified random variables for multiplication. Namely, by this grouping we can define a renormalization of random multiplicative variables. By numerical simulation and theoretical analysis we can show that starting by repeating renormalization processes we have a universal limit distribution of random multiplier. The distribution is given by Lorentz distribution having power law tails. This result implies that even in the case that microscopic growth rate distribution has no long tail, renormal-

ized macroscopic growth rate distribution has power law tails in general, so that a macroscopic system generally has a risk of extraordinarily large fluctuations. We apply this model to company's financial data such as sales or income with the multiplier representing annual growth rate. This model gives a consistent view to the power law distribution of sales and long-tailed distribution of growth rate observed in real company data.

[1] Misako Takayasu, Takayuki Mizuno, Takaaki Ohnishi, and Hideki Takayasu, in Practical Fruits of Econophysics (edited by H.Takayasu, Tokyo, Springer), 29 (2005).

[2] M.Takayasu, T.Mizuno and H.Takayasu, *Physica A* **370**, 91-97 (2006).

[3] Misako Takayasu, Takayuki Mizuno and Hideki Takayasu, *Physica A* **383**, 115-119 (2007).

Physical View of Market Prices: Random Walks in Complex Potential Functions

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Market prices sometimes show quite dynamical behaviors such as bubbles or crashes, while in most of ordinary situations they are well approximated by random walks. These two types of behaviors are now described by a unified physical model called PUCK model [1, 2]. We consider a random walk in a deforming potential function which moves with its center given by the moving average of the market price. The model's parameters can be determined from market price data and basic empirical statistics can be reproduced in this frame work. Typical conventional models in financial technology such as the Nobel prize laurelled ARCH model can be derived as a special limit case of our potential model [3], namely, our formulation is more general. Not only stochastic properties our model can properly describe dynamical behaviors of markets such as bubbles and crashes, while conventional models can only describe stochastic behaviors. Further, our formulation can be extended to macro-economic behaviors such as inflation or even hyper-inflations. In this talk I will review our formulation from derivation to frontier applications. The most advanced version of PUCK model is now used in a major bank's foreign exchange divisions in Tokyo and London.

On the foundations of statistical mechanics: Extensivity of the nonadditive entropy Sq, and generalized central limit theorems

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The (additive) Boltzmann-Gibbs-von Neumann-Shannon (BG) entropy is extensive in the thermodynamical sense for say classical short-range-interacting and other relatively standard systems. The situation is more subtle for complex systems such as quantum entangled ones, long-standing quasi stationary states in classical long-range-interacting Hamiltonian systems, optical latices, plasma, among others. The nonadditive entropy Sq (S1 being the BG entropy) appears to be extensive for a special value of the index q which differs from unity. This class of systems is discussed,. as well as their connections to the Central Limit Theorem, which mathematically grounds BG statistical mechanics.

[1] M. Gell-Mann and C. Tsallis, Nonextensive Entropy - Interdisciplinary Applications (Oxford University Press, New York, 2004).

[2] J.P. Boon and C. Tsallis, Nonextensive Statistical Mechanics - New Trends, New Perspectives, Europhysics News 36 (6) (European Physical Society, 2005).

[3] C. Tsallis, Entropy, Springer Encyclopedia of Complexity and Systems Science (2008), in press;

[4] S. Umarov, C. Tsallis and S. Steinberg, On a q-central limit theorem consistent with nonextensive statistical mechanics, Milan J. Math. (2008)

[DOI 10.1007/s00032-008-0087-y].

[5] P. Douglas, S. Bergamini and F. Renzoni, Tunable Tsallis distributions in dissipative optical lattices, *Phys. Rev. Lett.* **96**, 110601 (2006).

[6] Bin Liu and J. Goree, Superdiffusion and non-Gaussian statistics in a driven-dissipative 2D dusty plasma, *Phys. Rev. Lett.* **100**, 055003 (2008)

[7] http://tsallis.cat.cbpf.br/biblio.htm

INVITED TALKS

Charged bosons in 2D harmonic trap: localization-delocalization

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In this work the localization and delocalization of strongly coupled ultra-cold bosonic atoms with a logaritmic repulsion confined to a two-dimensional (2D) harmonic trap is investigated numerically. Recent calculations on the structure and spectrum of classical 2D clusters with a logarithmic interaction potential on ordered structures formed in rotating ultracold Bose gases are regarded as introductory to a broader view of this research field. The work will be relevant to the experimental study of vortices in atomic Bose-Einstein condensates and will provide another method to understand the Abrikosov lattice formation of small numbers of vortices in the inhomogeneous systems.

In a system of N bosonic atoms (Rubidium), with N in the range from 2 to 10, the density profiles and energies can be obtained without any unnatural boundary conditions using the 'Unrestricted Bose-Hartree-Fock' method. The ground state properties of the systems are analyzed by changing the strength of the interactions and also the geometry of the traps from isotropic to nonistropic. Starting from a symmetric Bose-Einstein Condensate, (BEC) the calculations show that symmetry broken states are observed under the effects of strong correlations between the bosonic atoms. The localization and delocalization

of bosons (Wigner and Super -molecules) will be discussed with the comparison of their properties. The numerical calculations for BEC and Fermion-like states in a 2D geometry will be reported for a logaritmic potential in comparison with the results of 1/r type potential.

Probing the Landscape of Proteins via Linear Response Theory

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Functional proteins have highly complex structures, remaining mainly unmodified as a result of a multitude of mutations, yet their energy surface going through significant changes upon perturbing specific regions. How the various accessible states are populated may be manipulated by short and long-range modifications in the structure; alternatively, the dynamical control may differ without any significant structural variation. In this study, we analyze the h. influenzae Ferric binding protein (FBP), using computational perturbation/response techniques [1, 2, 3]. We consider the folded protein as a network of its amino acids with links between residues in close proximity. Using linear response theory, we reproduce residue-by-residue structural changes [3] as determined from the X-ray structures of the ligand-free and ligand-bound forms. We perturb the protein in three different initial conformations: (i) the apo form; (ii) the holo form with only the protein (Fe+3 stripped from the data); (iii) the holo form where the Fe is treated as an additional node of the network. By sequentially inserting directed forces on single-residues along the chain [1] and recording the resulting relative changes in the atomic coordinates, we find that for the predominant number of the cases the residue-by-residue structural changes as determined from the X-ray structures are faithfully reproduced (correlation coefficient larger than 0.9). Moreover, these changes are reversible, unless a ligand that introduces a few new interactions is also present in the model. The latter observations are explained by the incessant sampling of several conformational states - including that of the bound form - in the presence of fluctuating forces provided by the environment. Shifts in the energy landscapes are only induced once a ligand that stabilizes certain conformations is integrated to the system. To provide further understanding of how the protein operates structurally, we concentrate on the few residues that give high correlations in the presence of the ligand. These include residues that are either (i) in the fixed domain that support the ferric binding region, or, (ii) residues that are located in the moving domain loops that display the largest amount of displacement upon binding. Thus, it is possible to manipulate the bound form of the protein towards the unbound form only by either directly perturbing Fe binding residues, or by controlling the distant loops that show large displacements upon binding. The latter are particularly interesting in that they are positively charged residues, providing chloride ion binding locations - chloride has been proposed as a possible controlling agent for the release of Fe+3 . We find that, by perturbing any one of these residues in a collection of directions spherically symmetric around it, the residues around the Fe+3 that are located at the tip of the cap that opens the exit of Fe+3 are made to operate in a coherent fashion. On the other hand, directly perturbing Fe+3 , as well as many of the other residues destroys this coherence. The techniques developed are generalizable to study of the thermodynamic response expected of many protein molecules including the analysis of very large proteins as well as domain motions.

[1] C. Baysal and A.R. Atilgan, *Proteins* **45** 62-70 (2001).

[2] M. Ikeguchi et al *Proteins* **45** 62-70 (2001).

[3] L.S. Yilmaz and A.R. Atilgan,*J. Chem. Phys.* **113** 4454-4464 (2000).

Q - RINGS (Phys.Rev.Lett.86:4459-4462,2001)

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We discuss evidence for the existence of new type of semitopological ring-like localized field configurations whose stability is due to both topological and non-topological charges. They are local minima of the energy in scalar field theories with an unbroken U(1) global symmetry. We obtain numerical solutions of the filed configuration corresponding to to large rings and derive virial theorems demonstrating their stability.

Water Droplets on Superhydrophobic Surfaces: Tunable Optical Microcavities

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Surface hydrophobicity is enhanced by roughness. While the static contact angle of a water droplet can be maximum 120o on a smooth hydrophobic surface, it can be increased above 150o by surface roughness. Applications of superhydrophobic surfaces require control of the surface roughness from micrometer to nanometer length scales. Nano-rough surfaces are transparent to visible light and have potential to be used in optical applications. In the first part of the talk, the control of the surface hydrophobicity of polymer-nanoparticle nanocomposites will be discussed. The addition of hydrophobically coated nanoparticles in a polymer increases the contact angle θ of a water drop with respect to that on polymer surface due to change of surface composition and/or surface roughness. When the nanoparticles disperse well in the polymer, $Cos(\theta)$ decreases linearly with increasing amount of nanoparticles indicating a composite surface consisting of smooth polystyrene regions and nanoparticle regions. In case of formation of nanoparticle aggregates in the polymer, $Cos(\theta)$ decreases sharply at a critical concentration of nanoparticles. The observed behaviour was modeled in terms of a transition from Wenzel regime to Cassie-Baxter regime at a critical roughness length scale below which the Laplace pressure prevented the penetration of the water drop into the surface undulations. We argue that multiple length scales are needed below the critical roughness length scale to increase the contact angle further by decreasing the fraction of surface area of solid material (increasing the fraction of surface area of air) underlying the water drop. The second part of the talk will be on the use of water microdroplets on nano-rough superhydrophobic surfaces as tunable optical microcavities. Water microdroplets act as optical microsphere microcavities due to their nearly spherical shapes. Transparency of the surfaces to visible light allows the optical characterization of the microcavities. In a humidity chamber, we have demonstrated the tunability of these microcavities over large spectral ranges by controlled evaporation and condensation. The importance of optical resonances for the characterization of the superhydrophobic surfaces will be discussed.

Quantization of Nambu flow equations in three dimensional phase space

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We present a toroidal dicretization of Nambu dynamics for three dimensional phase space and we construct the quantum mechanical evolution matrix for any linear Nambu flow.When the discretization number is N=prime integer our quantization is a unitary matrix representation of the discrete group SL[3,Z[N]],the group of 3x3 matrices with integer elements modN and determinant one.The motivation of this work is to present a framework for the quantization of dynamics of perfect fluids in three dimensions.

Information Geometry and Quantum Dynamical Systems: Conceptual Problems and Potential Applications

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Information Geometry is a Riemannian geometry of manifolds of distributions. For classical distributions, the Fisher metric is effectively unique and the geometric set up offers useful tools for parameter estimation problems, neural networks and other classical applications. For Quantum Mechanics, and the corresponding manifolds of quantum states, i.e. spaces of density operators, there is a host of non equivalent Riemannian metrics with information content. Tools for the quantum estimation problem have been developed, the concept of quantum dual connections has been analyzed, but the potential of the geometric structure is still not fully explored. Here we present some results related to problems which concern quantum dynamical systems and can be formulated and studied with techniques of quantum information manifolds. We first make a short introduction to the main concepts of Information Geometry. Then we introduce an approach to the geometric structure using the phase-space formulation of Quantum Mechanics and discuss the possibilities it offers for the semi-classical analysis. Next we present some results on symmetries of information manifolds and their relation to evolution problems. General quantum processes and specifically decoherence are formulated in the information geometric language. Finally we present some ideas about the development of techniques related to control theory and other potential applications.

Stretched exponential humidity diffusion for nonlinear trending

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In studying the relative humidity dependence of the transient current in polymer thin films, if one allows the humidity in the chamber to increase and samples the current through a thin film as a time series, the time dependence of the relative humidity in the chamber becomes significant, since any chaotic behavior in the transient current could, in principle, be attributed to chaotic behavior in the time dependence of relative humidity.
The stretched exponential function is an empirical function that describes relaxation rates of many physical properties of complex systems such as polymers and glasses, dielectric relaxation, discharge of capacitors. Such relaxation phenomena have also been observed in diffusion phenomena with noise. Hence, it can serve as a good model for the absorption of relative humidity into the PEG polymer sample. A simple exponential relaxation with the functional form given below fails to give a satisfactory fit and shows systematic departures both during the build up and saturation

$$RH = a_1(1 - a_2 \exp(-\frac{t}{t_0})) \tag{1}$$

A stretched exponential function of the form below, where the residual relative humidity in the chamber is modeled by the product of an absorption coefficient and the stretched exponential function, gave a very good fit with a residual chi square per degree of freedom of 0.134048.

$$RH = a_1(1 - a_2 \exp(-(\frac{t}{t_0})^{\alpha}) \tag{2}$$

The fitted parameter values are $a_1 = 90.3199 \pm 0.001973$, $a_2 = 0.640363 \pm 0.0001099$, $t_0 = 43933.27 \pm 2.393$, $\alpha = 0.661957 \pm 0.0001763$. Similar results have been obtained for the time dependence of the relative humidity for PAF and hydrogenated PEG samples, showing that the stretched exponential form has some degree of universality and the diffusion process of humidity into the polymer sample departs from Fick's Law. The value of the stretching exponent is compatible to that observed in the literature for short range forces.
This functional form can also enable repeating the detrended fluctuation analysis for the transient current using nonlinear detrending with the functional form given above and this is expected to eliminate systematic errors that can be hidden because of linear detrending.

Spectrally breathing pulses in a mode-locked

fiber laser: self-similar and soliton-like propagation in alternate parts of the resonator

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We report a mode-locked fiber laser incorporating dispersion-managed fiber sections and a narrow-bandpass filter. Modelocked operation corresponds to Kruglov- type self-similar pulse propagation in the normal-dispersion section (with amplification) and soliton-like pulse propagation in the anomalous-dispersion section (without amplification) of the resonator. Pulses circulating in the laser resonator exhibit periodic spectral broadening and reduction by 7 times, as a result of the optical Kerr nonlinearity. This is to our knowledge by far the highest of any laser reported. Given that spectral broadening is strictly a nonlinear process, the laser can be considered to be the "most nonlinear laser" demonstrated. The observed stability of the pulse formation in the presence of such strong nonlinear effects has profound implications on the pulse shaping mechanisms in a mode-locked laser. Although a wide range of pulse shaping schemes have been reported for ultrafast lasers, including soliton, stretched-pulse, similariton and all-normal dispersion regimes, in all of these cases spectral modification of the pulse remain minor. Here, we report a laser containing a narrowband optical filter, with the spectral width of the pulse changing by as much as 7-8 times within a single roundtrip. Remarkably, the laser operation is very stable. Experimentally, the cavity consists of 3.5m of single-mode fiber (SMF) with negative dispersion and 1 m of highly doped Er-doped fiber with positive dispersion. The net dispersion of the laser cavity is 0.01ps. We measured bandwidths of 12 nm and 85 nm for the optical spectra at different points within the cavity. The laser generates chirped pulses, which are compressed externally to 110 fs. We seek maximal understanding of this mode of operation using numerical simulations. The model is based on a nonlinearch Schrodinger equation, generalized to include higher-order dispersion, Raman scattering, gain with saturation and band-width filtering, saturable absorption and the bandpass filter. Experimentally observed behavior is reproduced well with the simulations. A simple picture of how the pulse evolves emerges: upon filtering, the pulses enter the SMF, where they are of too low power to regenerate the lost spectral width. The broadening takes place predominantly within the normal-GVD Er-fiber, exhibiting an extreme case of similariton propagation maintained without pulse break-up owing to beginning the evolution with a particularly narrow spectrum. The pulse shape evolves into the parabolic shape, which is characteristic of similaritons. Note that, all previous observations of similaritons in a laser cavity exhibited mild changes in the spectral width. In conclusion, we report a novel mode of operation of an ultrafast fiber laser, corresponding to extremely strong nonlinear shaping of the pulse, with spectral width breathing by a factor of 7. In analogy to the stretched-pulse laser, this laser could be regarded as a 'stretched-spectrum' laser.

Denaturation of circular DNA through supercoil formation

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We generalize the Poland-Scheraga (PS) model to the case of a circular DNA, taking into account the twisting of the two strains around each other. The proposed construction preserves the total linking number of the system which is a topologi- cal invariant. Guided by the observations in recent single molecule experiments on DNA strands, we assume that the torsional stress induced by denaturation enforces formation of supercoils whose writhe absorb the linking number expelled by the loops. We find that the first-order melting transition observed in the PS model survives under certain conditions, whereas the second-order transition in the PS model for 1 ¡ c ¡ 2 vanishes upon the introduction of linking number conser- vation. These results are in contrast with other treatments of DNA melting with twist where denaturation is accompanied by an increase in twist rather than writhe.

[1] A. Kabakcioglu, D. Mukamel, E. Orlandini, in preparation.

Statistical and dynamical properties of nonlinear base-pair openings in DNA

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Statistical and dynamical properties of base-pair openings (bubbles) in double stranded DNA will be discussed using the Peyrard-Bishop-Dauxois (PBD) nonlinear dynamical model [1]. A number of successful comparisons with experiments related to base-pair openings will be presented [1, 2, 3, 4].

Theoretical predictions for the position of large thermal openings are compared with experimental results in gene promoter DNA sequences and the most favorable openings occur at transcriptionally relevant sites [5, 6].

Several physical properties of the model will be discussed, like temperature dependent signatures of big bubbles identified in the dynamic structure factor [7], non-exponential decay of base-pair opening fluctuations [8], and the probability distribution of bubble lengths [9].

Finally the structural PBD model will be coupled with a charge propagating along the DNA double helix [10]. Static polaronic solutions and their normal modes related to AC response [11], as well as dynamical charge trapping affecting macroscopic transport parameters [12] will be presented.

[1] T. Dauxois, M. Peyrard, and A.R. Bishop, *Phys. Rev. E* **47**, 44 (1993).

[2] D. Cule and T. Hwa, *Phys. Rev. Lett.* **79**, 2375 (1997).

[3] A. Campa and A. Giansanti, *Phys. Rev. E* **58**, 3585 (1998).

[4] S. Ares, N.K. Voulgarakis, K.Ø. Rasmussen, and A.R. Bishop, *Phys. Rev. Lett.* **94**, 035504 (2005).

[5] C.H. Choi, et al.,*Nucleic Acids Res.* **32**, 1584 (2004).

[6] G. Kalosakas, et al., *Europhys. Lett.* **68**, 127 (2004).

[7] N.K. Voulgarakis, G. Kalosakas, K.Ø. Rasmussen, and A.R. Bishop, *Nano Lett.* **4**, 629 (2004).

[8] G. Kalosakas, K.Ø. Rasmussen, and A.R. Bishop, *Chem. Phys. Lett.* **432**, 291 (2006).

[9] S. Ares and G. Kalosakas, *Nano Lett.* **7**, 307 (2007); S. Ares and G. Kalosakas, preprint.

[10] S. Komineas, G. Kalosakas, and A.R. Bishop, *Phys. Rev. E* **65**, 061905 (2002); G. Kalosakas, K.Ø. Rasmussen, and A.R. Bishop, *J. Chem. Phys.* **118**, 3731 (2003).

[11] P. Maniadis, G. Kalosakas, K.Ø. Rasmussen, and A.R. Bishop, *Phys. Rev. E* **72**, 021912 (2005).

[12] G. Kalosakas, K.L. Ngai, and S. Flach, *Phys. Rev. E* **71**, 061901 (2005).

Kinetics of a mixed spin-1 and spin-3/2 Ising system under a time-dependent oscillating magnetic field

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We present a study, within a mean-field approach, of the kinetics of the mixed spin-1 and spin-3/2 Ising model Hamiltonian with bilinear and biquadratic nearest-neighbor exchange interactions and a single-ion potential or crystal-field interaction in the presence of a time-dependent oscillating external magnetic field [1]. We employ the Glauber transitions rates to construct the mean-field dynamical equations. We investigate the time dependence of average magnetizations and the quadrupole moments, and the thermal behavior of the dynamic order parameters. From these studies, we obtain the dynamic phase transition (DPT) points and construct the phase diagrams in three different planes. Phase

diagrams contain disordered (d), ferrimagnetic (i), the antiquadrupolar or staggered (a) phases, and four coexistence or mixed phase regions, namely the i+d, i+a, i+a+d and a+d, that strongly depend on interaction parameters. The system also exhibits the dynamic tricritical behavior in most cases, the reentrant behavior in few cases. The results are compared with the single counterparts, namely kinetic spin-1 [2] and spin-3/2 [3] Ising systems, and as well as two sublattice kinetic spin-1 [4] and spin-3/2 Ising systems [5].

[1] See, e. g., E. C. Fireman, R. J. V. dos Santos, *J. Appl. Phys.* **81**, 4198 (1997); W. Jiang, G. Z. Wei, Z. D. Zhang, *Phys. Rev. B* **68**, 134432 (2003).

[2] M. Keskin, O. Canko, Ü. Temizer, *Phys. Rev. E* **72**, 036125 (2005); O. Canko, Ü Temizer, M. Keskin, *Int. J. Mod. Phys. C* **17**, 1717 (2006).

[3] M. Keskin, O. Canko, B. Deviren, *Phys. Rev. E* **74**, 011110 (2006); O. Canko, B. Deviren, M. Keskin, *J. Phys.: Condens. Matter* **18**, 6635 (2006).

[4] Ü. Temizer, E. Kantar, M. Keskin, O. Canko, *J. Magn. Magn. Mater.* **320**, 1787 (2008).

[5] B. Deviren, M. Keskin, O. Canko, *Comp. Phys. Commun.* **178**, 420 (2008).

A nonlinear dynamical model for electron transfer

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A theory for electron transfer (ET), particularly relevant to ultrafast processes, is presented [1]. Our model explicitly includes interactions of electronic states with vibrational degrees of freedom. When the energy barrier for ET is small, at the inversion point, electronic frequencies are of the order of vibrational frequencies and electron tunelling is nonadiabatic. The effective electron dynamics becomes nonlinear and energy is dissipated through the phonon bath. While recovering standard theories far from the inversion point, our formalism also captures the main features of fast ETs, when such processes cannot be simply described as thermally activated. ETs in well studied biosystems are discussed, such as photosynthetic reaction centers, where experimental observations can be explained by our approach [2]. As a result of fine tuning between a donor and an extra molecule that acts as a catalyst (coherent electron-phonon oscillator), fast and efficient long distance ET to an acceptor (which is separated from the donor by a large energy barrier) becomes possible.

[1] S. Aubry and G. Kopidakis, "A Nonlinear Dynamical Model for Ultrafast Catalytic Transfer of Electrons at Zero Temperature", *Int. J. Mod. Phys. B*, **17**, 3908 (2003).

[2] S. Aubry and G. Kopidakis, "A Nonadiabatic Theory for Ultrafast Catalytic Electron Transfer, A Model for the Photosynthetic Reaction Center", *Journal of Biological Physics*, **31**, 375 (2005).

Nonlinear excitations in dusty (complex) plasmas and Debye crystals: a survey of theoretical results

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Dusty Plasmas (DP) (or *Complex Plasmas*), i.e. large ensembles of interacting particles consisting of electrons, ions and massive, strongly charged, mesoscopic-sized defects (*dust* particulates), occur widely in Space and in the laboratory [1]. Due to the presence of the dust component, new charged matter configurations (plasma 'states') are possible, including strongly-coupled configurations in the form of quasi-*crystalline* lattice structures. Dust crystals (DCs) occur in a plasma discharge, where the dust

grains remain suspended under the combined action of gravity and electric forces. Dust lattices offer an efficient model for microscopic Debye crystals, e.g. occurring in Penning traps and ultra-cold plasmas, and also mimic the generic structure of atomic chains, yet on a different, easily accessible scale.

The general characteristics of dusty plasmas are presented. The nonlinear aspects of dust grain motion in one- (1D) and two-dimensional (2D) (hexagonal, generally) dust lattices are reviewed, from first principles. Electrostatic inter-grain interactions, along with the plasma sheath electric substrate potential and the intrinsic lattice discreteness, provide the necessary ingredients for the formation of localized excitations in Debye lattices.

Horizontal (longitudinal, acoustic) as well as vertical (transverse, optic-like) dust grain motion in a 1D dust monolayer has been studied thoroughly [1]. Excitations in 1D include kink-shaped supersonic solitary excitations (density solitons), related to longitudinal (in-plane) dust grain displacement, and modulated envelope localized modes associated with either longitudinal (in-plane, acoustic) or transverse (off-plane, inverse-optic, backward wave) oscillations. Highly localized excitations (Discrete Breathers), associated with transverse (off-plane) dust-grain motion may also exist, as recently shown from first principles, both in 1D and 2D crystals [2]. Hexagonal (2D) dust lattices sustain modulated envelope structures, formed via modulational instability of in-plane vibrations [3]. A discrete analysis of hexagonal crystals also suggests the occurrence of ultra-localized modes multipole, vortex and soliton type modes [4]. Explicit predictions have been obtained for the stability of such structures, in terms of experimental parameters, via a critical comparison among Klein-Gordon [2] and Discrete Nonlinear Schrodinger [4] theories. Dusty plasma crystals provide a challenge for experimental investigations, which would confirm the predictions of nonlinear theories. New directions are thus opened, thanks to this novel interface among nonlinear lattice dynamics and plasma physics.

[1] P. K. Shukla and A. A. Mamun, *Introduction to Dusty Plasmas Physics* (Institute of Physics, Bristol, 2001).

[2] I Kourakis and P. K. Shukla, Int. J. Bif. Chaos **16**, 1711 (2006).

[3] V. Koukouloyannis and I. Kourakis, Phys. Rev. E **76**, 016402 (2007); also, in preparation.

[4] B. Farokhi, I. Kourakis and P. K. Shukla, Physics of Plasmas **13**, 122304 (2006).

[5] K.J.H. Law, P.G. Kevrekidis, V. Koukouloyannis, I. Kourakis, D.J. Frantzeskakis and A.R. Bishop, *Discrete solitons and vortices in hexagonal and honeycomb lattices*, submitted to Phys. Rev. E (2008).

Dissipative Discrete Breathers in rf SQUID Metamaterials

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The developement of artificially structured, composite materials (metamaterials) have substantially extended the range of possible electromagnetic response that can be obtained by naturally occuring materials. For example, some magnetic metamaterials (MMs) exhibit significant magnetic properties at Terahertz and optical frequencies, as well as negative magnetic response at far-infrared frequencies. It has been recently suggested that rf SQUID (i.e., superconducting quantum interference device) arrays in an alternating magnetic field can operate as nonlinear MMs in microwaves [1], leading to negative magnetic response above the resonance frequency of its constituent elements. The nonlinearity, which is intrinsic to each rf SQUID due to the presence of the Josephson junction, provides the possibility of tuning the magnetic permeability of the MM by varying the applied flux.

Moreover, the combined effects of nonlinearity and discreteness may lead in the generation of nonlinear excitations of the form of dissipative discrete breathers (DDBs), i.e., spatially localized, time-periodic, and stable excitations, whose dynamics is

governed by power balance between losses and external driving field. The existence and stability of DDBs in rf SQUID arrays is investigated numerically. We analyze several DDB excitations, both in one and two dimensions, which are linearly stable up to relatively large coupling parameters. We find that DDBs may locally alter the magnetic response of the array from paramagnetic to diamagnetic (or vice versa), and that they are not destroyed by increasing the dimensionality [2].

Those DDB excitation exhibit some similarities with those appearing in other systems whose elements are coupled magnetically, which are usually referred to as magneto-inductive systems. For instance, DDBs may appear in MMs comprised of nonlinear split-ring resonators [3, 4]. However, there are distinct differences between DDB excitations in those systems, due to the different form of the nonlinear on-site potential. Given that both nonlinear systems have been constructed in the laboratory [5, 6], our theoretical predictions are experimentally testable.

[1] N. Lazarides and G. P. Tsironis, *Appl. Phys. Lett.* **90**, 163501 (2007).

[2] N. Lazarides, G. P. Tsironis, and M. Eleftheriou, to appear in *Nonlinear Phenomena in Complex Systems* (2008), arXiv:0712.0719.

[3] N. Lazarides, M. Eleftheriou, and G. P. Tsironis, *Phys. Rev. Lett.* **97**, 157406 (2006).

[4] M. Eleftheriou, N. Lazarides, and G. P. Tsironis, *Phys. Rev. E* **77**, 036608 (2008).

[5] I. V. Shadrivov, A. B. Kozyrev, D. W. van der Weide, and Yu. S. Kivshar, arXiv:0805.0028v1 (2008).

[6] J. R. Kirtley, C. C. Tsuei, Ariando, H. J. H. Smilde, and H. Hilgenkamp, *Phys. Rev. B* **72**, 214521 (2005).

Frenkel Kontorova Models, Free Energy Recursions and Burgers Shocks

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The Frenkel Kontorova Model is a classical infinite chain of atoms linked by elastic springs with equilibrium spacing a that is subject to an external periodic potential of period b [1]. The model is characterized by the competition of two different length scales, a and b. The lowest energy configurations of the chain have a very complex depedence on a/b and the relative strength of the external potential, giving rise to commensurate or incommensurate configurations, and transitions between these, as the parameters of the model are varied [2]. The ground state configurations are also closely related to the unstable (hyperbolic) orbits of 2 dimensional hamiltonian maps such as the standard map.

It is possible to approach this problem from a statistical mechanical point of view, constructing a transfer matrix that captures the evolution of the free-energy. The recursion equations for the evolution of the free-energy were derived by Griffiths and Chou for the zero-temperature case [3] and for the general case by Feigelman [4]. One of the major advantages of the transfer matrix description is that besides the inclusion of non-zero temperature, this approach readily accomodates the case of random as opposed to periodic external potentials.

It has been recently realized that a continuum hydrodynamic type evolution underlies the discrete free energy recursions. For the case of an elastic chain of particles embedded in an external potential, this evolution turns out to be governed by an iterated Burgers Equation [5, 6] and the emerging shock discontinuities have a natural interpretation in terms of meta-stable states.

In this talk, I will present the connections of FK type models and the Burgers-type evolution and illustrate this by means of an exactly solvable (non-trivial) model that we worked out recently [7].

[1] Y. Frenkel and T. Kontorova, *Phys. Z. Sowietunion*, **13** 1 (1938).

[2] S. Aubry, *Solitons and Condensed Matter Physics,* ed by A.R. Bishop, T. Schneider, *Solid State Sciences*, **8** 264 (Springer Berlin 1978); S.

Aubry and P.Y. De Laeron, *Physica D*, **8** 381 (1983); S. Aubry, *Physica D*, **7** 240 (1983); S. Aubry, *J. Phys. C:Solid State Phys.*, **16** 2497 (1983).

[3] R.B. Griffiths and W. Chou, *Phys. Rev. Lett*, **56** 1929 (1986); Chou W. and R.B. Griffiths, *Phys. Rev. B*, **34** 6219 (1986).

[4] M.V. Feigel'man, *Sov. Phys. JETP*, **52** 555 (1980).

[5] H.R. Jausslin, H.O. Kreiss and J. Moser, *Proc. Symp. Pure Math.*, **65** 133 (1999).

[6] W. E, K. Khanin, A. Mazel and Ya. Sinai, *Ann. Math.*, **151** 877 (2000).

[7] C. Yolcu and M. Mungan *in preparation.*

Photonics with Atomic Bose-Einstein Condensates

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Materialization of Bose-Einstein condensation in trapped ultracold alkali atom clouds has led to experimental demonstrations of various coherent atomic phenomena which resembles coherent optical effects. Present experimental techniques allow for unprecedented ability of control over mutual interaction of coherent matter and optical waves. Novel observations such as matter wave amplification, atomic four-wave mixing, ultraslow light propagation and coherent optical information storage, as well as intriguing proposals such as photonic band gaps, and multimode waveguiding have already been reported. Integrated atom-optical systems at smaller scales, in particular atom-chips or atomtronics are already under development to bring such exciting effects closer to practical applications. In this talk we shall review some of the key developments related to photonics applications with atomic Bose-Einstein condensates. We shall also discuss how some of these developments can assist quantum information science and technology.

Ultra-cold atoms in rotating optical lattices

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Experiments on ultracold atoms in optical lattices opened up a new avenue to study correlated quantum states. The versatility of cold atom experiments hold promise for the experimental realization of many models that were first introduced for solid-state systems. One such model is the study of particles moving in a tight binding lattice under a magnetic field. When the magnetic flux per plaquette of the lattice becomes of the order of a flux quantum hc/e, the single particle energy spectrum forms a complicated self-similar structure, known as the Hofstadter butterfly. It has not been possible to reach this regime in ordinary condensed matter experiments due to the required high magnetic fields. However, the ultracold atom experiments are extremely flexible and it should be possible to create required effective magnetic fields in optical lattice experiments. A conceptually simple way of creating an effective magnetic field is to rotate the optical lattice, as demonstrated in a recent experiments. We study a number problems within the context of this model: 1) Superfluid-Insulator (Mott) transition of Bosons in a rotating optical lattice. 2) Realization and detection of Topological Hofstadter Insulator with fermions in an optical lattice. 3) Effective Hamiltonians for the excited (p-band) atoms in a rotating optical lattice. We find that the effective magnetic field created by rotation has non-trivial effects on many body properties. For bosons, the Mott transition boundary is scaled by the bandwidth of the Hofstadter butterfly, and new Fractional Quantum Hall phases appear. For non-interacting fermions, the quantized Hall conductance is related to the change of density with rotation. Rotation also creates a non-zero critical attraction strength for BCS instability by opening up gaps. For the excited bands we find a systematic way of applying Peierls substitution to obtain effective Hamiltonian for the system.

Existence and Stability of Solitons in DNLS

with Saturable Nonlinearity

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In the first part, we investigate the existence of periodic and decaying solutions in DNLS with saturable nonlinearity. Using the method of calculus of variations and Nehari manifolds we prove the existence of these two type solutions. Next, we consider the discrete solitons bifurcating from the anti-continuum limit of the discrete nonlinear Schrodinger (NLS) lattice with saturable nonlinearity. The discrete soliton in the anti-continuum limit represents an arbitrary finite superposition of in-phase or anti-phase excited nodes, separated by an arbitrary sequence of empty nodes. By using stability analysis, we prove that the discrete solitons are all unstable near the anti-continuum limit, except for the solitons, which consist of alternating anti-phase excited nodes. Also, we study effects of nonlinearity saturation on existence and stability of discrete cavity solitons. Unlike in the previously studied case of Kerr nonlinearity some of the solitons exist in the regime where the linear cavity detuning is not compensated by the nonlinearity detuning. Surprisingly enough these solutions even persist into the conservative 'zero-dissipation' limit.

Stability analysis of Yang-Mills equations in four and six dimensions

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We present a complete stability analysis of the gauge field fluctuations in the neighborhood of the rotating ellipsoidal solution of Yang-Mills equations. This solution also describe the D2-D0-branes. Initially only perturbations that do not modify the original $SU(2)$ solution was analyzed. Now this analysis is extended to the case when perturbations are in the full $SU(N)$ algebra directions. The results indicate that in the case of $SU(2)$ most of the modes display the enhanced symmetry of the original solution, *i.e.* the additional degrees of freedom are zero-modes. This means that the rotating ellipsoidal solution is in fact the most general solution that can be constructed out of an $SU(2)$, independently of the dimension of space. In the full $SU(N)$ case there are exactly $N^2 + 12$ zero-modes, of which $N^2 - 1$ are the consequence of the global color rotation symmetry of the solution, and 6 are associated with global space rotations. All the other modes, for the totality of all possible gauge field perturbations in $SU(N)$, are completely stable and execute harmonic oscillations around the original trajectories.

Chaotic behavior in polymers

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Polymers are large and relatively complicated molecules that involve a multitude of bonds ranging from covalent to ionic as well as hydrogen and Van der Waals. Moreover, they may contain impurities and defects. It is only natural that such complicated structures will display instabilities and metastable states, which delay the attainment of a steady state for hours, days, and even years at times. Instabilities cause many measurable properties of polymers to vary in an apparently random fashion over time. Despite of this irreproducibility, reproducible chaotic behavior is often seen under close scrutiny. Our measurements of the time variation of the current through thin films of PMMA and PEG under high relative humidity conditions demonstrate a positive Lyapunov exponent and agree with a classical one-dimensional randomly pinned charge density wave model in the former, while they confirm a phase change from semi-crystalline to gel state for the latter. The phase change is further supported by the presence of two distinct regimes in a detrended fluctuation analysis of the time series of the PEG conductivity data.

Statistical physics of DNA breathing, melting

and unzipping

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The cooperative behavior of double-stranded DNA macromolecules can be described in terms of mesoscopic models which identify a single, "relevant' degree of freedom per base pair (Peyrard-Bishop-Dauxois Hamiltonians). This type of modeling has been successful in capturing the essential nonlinear lattice dynamics which underlies thermal and mechanical denaturation phenomena (DNA "melting" and "unzipping", respectively).
I will present the general theoretical framework and report some more recent results obtained by applying the theory to other features of DNA secondary structure, such as hairpin formation and the properties of local openings ("denaturation bubbles') which are known to be instrumental in the process of transcription.

Charge transfer mechanism along the DNA double helix

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Experimental results and contradictory theoretical interpretations have spurred intense debate over the charge transfer mechanism along the DNA double helix. The enlightenment of this issue is of fundamental importance in the long range chemistry of oxidative DNA damage and repair processes [1], monitoring protein-DNA interactions, while novel research areas of the dynamics, response and function of nanostructures and biosensors are emerging [2, 4]. ultiphonon-assisted small polaron hopping between neighbouring base pairs is proposed as a possible charge transfer mechanism for the interpretation of the strong temperature dependence of the electrical conductivity measured at high temperatures along the DNA double helix [5, 6]. The proposed model takes into account the one-dimensional character of the system and the presence disorder resulting from the random base sequences and the randomly positioned positively charged counterions along the backbone of the DNA helix. he importance of correlations between successive hops is also discussed. The analytical expressions for the temperature dependence of the electrical conductivity and the maximum hopping distance obtained, based on percolation-theoretical considerations, are successfully applied to experimental data reported for the λ-DNA and the poly(dA)-poly(dT) DNA [7, 9]

[1] S. O. Kelly and J. K. Barton, *S*cience, **283**, 1375, (1999).

[2] H. Fink and C. Schonenberger, *N*ature, **398**, 404, (1999).

[3] D. Porath et al, *N*ature, **403**, 635, (2000).

[4] A. Y. Kasunov et al , *S*cience, **291**, 280, (2001).

[5] G. P. Triberis, C. Simserides and V. C. Karavolas, . Phys.: Cond. Matt., **17**, 2681, (2005).

[6] G. P. Triberis, The Physics of Low-Dimensional Structures, From Quantum Wells to DNA and Artificial Atoms (Nova Science Publishers, N. Y., 2007) Chap. 2, p. 94

[7] P. Tran, B. Alavi, and G. Gruner, *P*hys. Rev. Lett., **85**, 1564, (2000).

[8] A. Inomata et al, *J.* Phys. Soc Japan, **75**, 074803-1, (2006).

[9] K. H. Yoo et al, *P*hys. Rev. Lett., **87**, 198102, (2001).

Open issues on the transport of 1D quantum systems

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I will discuss recent theoretical developments on the dynamics of one dimensional quantum systems[1]. In particular, I will focus on open issues and controversial results related to the finite temperature transport of integrable models[2]. These singular systems are commonly used in the description of quasi-one dimensional materials. They are recently attracting interest in connection to experiments, following the discovery of unusual thermal conductivity in quasi-1D magnetic materials[3].

[1] X. Zotos, *J. Phys. Soc. Jpn.* **74**, 173 (2005).

[2] X. Zotos, F. Naef and P. Prelovšek, *Phys. Rev.* **B55**, 11029 (1997).

[3] C. Hess, *Eur. Phys. J. Special Topics* **151**, 73 (2007).

CONTRIBUTED PRESENTATIONS

Bifurcation in a Bloch-Maxwell Model for the He-Ne Laser

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This paper studies chaotic behavior in He-Neon laser models. Transition to chaos is based on considering the resonance between the laser cavity frequency and atomic cavity TEM modes. It is reflected by the Maxwell-Bloch equations as given by Arrechi [1] and Haken [2]. The coupling of the fundamental cavity mode, E with the collective variables P and Δ, that represent the atomic polarization and the population inversion, gives the following equations.

$$\dot{E} = -kE + gP$$

$$\dot{P} = -\gamma_{\perp} P + gE\Delta$$

$$\dot{\Delta} = -\gamma_{\parallel}(\Delta - \Delta_o) - 4gPE$$

For the parameter values $k = \sigma$, $\gamma_{\perp} = g^2/k = 1$, $g^2\Delta_o/k = r$, $\gamma_{\parallel} = b$, the system can be transformed into the Lorenz system about the equilibrium point $\Delta = \Delta_o$ by setting $x = E$, $y = gP/k$,$z = \Delta_o - \Delta$. The meaning of the parameters in the original equations are given by Arrechi, while σ, r, b are the Lorenz parameters.

The Maxwell-Bloch equations have more parameters than the Lorenz system; this justifies a more detailed parameter study. Chaotic behavior has been experimentally observed in laser systems[1, 2] and controlling chaos is important in obtaining laser based standards in metrology. A parameter study that would reveal the range of parameters for which chaotic behavior characterized by the well known invariant, a positive maximal Liapunov exponent would thus be of interest. Results of such a study using the Wolf algorithm.[3] will be reported. Where possible, the bifurcation mechanism that characterizes the transition to chaos is also studied by the MATCONT[3] package and Hopf bifurcation is identified in several instances.

An example is $k = 11.75$, $\gamma_{\perp} = 2.66$, $\gamma_{\parallel} = 2.75$, $\Delta_o = 28$, $g = 6.06$. These parameters correspond to far infrared lasers where Lorenz like chaos has been observed.

[1] F. T. Arecchi, "Chaos and Generalized Multistability in Quantum Optics", *Physica Scripta* **T9**, 85-92 (1985).

[2] H. Haken "Light, Volume 2", North Holland (1985).

[3] A. Wolf, J. B. Swift, H. L. Swinney and J. A. Vastano "Determining Lyapunov exponents from a time series", *Physica D* **16**, 285-317 (1985).

[4] A. Dhooge, W. Govaerts, Yu.A. Kuznetsov, W. Mestrom, A.M. Riet and B. Sautois, "MATCONT and CL_MATCONT: Continuation toolboxes in matlab", Ghent and Utrecht Universities Preprint, (2006).

Three-dimensional lattice-based network models portray the properties of folded proteins

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We have previously shown that residue networks that model folded proteins have Ssmall-world T properties (i) with average path lengths that are similar to random nets, but (ii) still retaining local structure [1, 2]. The latter is measured by the clustering coefficient (C), which is a three-point correlation of the neighbors of a given node. While for the distributions of some of the measured properties, such as the path length (L) and connectivity (k) the residue networks resemble the Watts-Strogatz (WS) model (ring lattices randomly rewired with probability $0.01 < \beta < 0.1$), that of C is considerably more peakish. There is also a marked difference between the spectral properties of the normalized Laplacian for the residue networks and the WS model. Moreover, we have found that nearest neighbor degree of a node, (k_{nn}) defined as the average connectivity of nodes with a given connectivity, k, display a striking linear dependence on k, in contrast to the WS model, where there is no correlation. Motivated by these findings, we have investigated the properties of networks obtained from rewired three-dimensional regular lattices. The systems studied are the simple cubic (SC), body-centered-cubic (BCC), face-centered-cubic (FCC) and the hexagonal-close-packed (HCP) lattices. Each of these lattices display small-world properties in the same rewiring probability range of $0.01 < \beta < 0.1$. Their C values are distributed in a more restricted region than WS model, and are similar to that of proteins, BCC being the most peakish. Their k distributions are also different from the WS model, mainly featuring the presence of nodes located at the outermost regions of the three-dimensional lattices. Most strikingly, each has a linear dependence of k_{nn} on k, for a wide range of $\beta = 0$ - 0.5, extending into the region where the small-world properties have been lost. We have further derived a relationship between k_{nn} as a function of C and k under the assumption of constant C for a Poisson distributed network, given by the expression:

$$k_{nn} = Ck + (1 - C)(1 + z) \quad (3)$$

The relationship faithfully approximates the linear dependence observed in the rewired three-dimensional lattice models as well as the residue networks, which all display peakish C distributions. Each of the networks studied has a unique normalized Laplacian spectrum, whose properties with respect to the network structure are discussed.

[1] A.R. Atilgan, P. Akan, and C. Baysal, Small-world communication of residues and significance for protein dynamics. Biophysical Journal, 2004. 86(1): p. 85-91.

[2] A.R. Atilgan, D. Turgut, and C. Atilgan, Screened nonbonded interactions in native proteins manipulate optimal paths for robust residue communication. Biophysical Journal, 2007. 92(9): p. 3052-3062.

Analysis of the Humidity Dependence in the Current Through PEG-Si Thin Films by Time Series Methods

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The irregular current characteristic of the polymer Polyethylene Glycol (PEG-Si) under varying humidity is studied in this work. When water molecules penetrate into a polymer sample, the macromolecular chemical chains arrange themselves to form new phases. In previous studies it has been suggested that, after reaching a certain humidity level, a phase transition occurs from a semi crystalline state to a gel state, causing sudden decreases and increases in the current [1]. Water molecules penetrating the PEG samples increase conductivity by binding hydrogen bonds to polar groups. After crosslinking with

Gamma-isocyanatopropyltriethoxysilane and mixing the sample with various percentages of Perfluoroalkylethyalcohol (PAF) to obtain pure hydrophobically modified PEG-Si thin Films, we analyzed the current through a thin film of the sample for chaoticity. Different regimes of conductivity result from different types of contributions of water molecules to the hosting PEG or PAF samples. The characteristic and seemingly unstable behavior of the current as a function of increasing humidity, suggested the possibility of chaotic behavior probably by the intermittency route and inspired us to apply non-linear time series analysis on the current measurements[2]. The Lyapunov exponent increases with increasing relative humidity until the relative humidity reaches the constant value at 72% for samples of different hydrogen and alcohol percentages. This value is consistent with the reported value for the phase transition from the semi crystalline state to the gel state. [1, 3]. In order to confirm our suggestion of changing regimes due to the different binding modes of the water molecules, we used detrended fluctuation analysis and observed different slopes for pure PEG-Si[4, 5]. Hydrogenated and Hydrophobically modified PEG samples show different behavior in the Lyapunov exponents for all data sets [6]. Pure PEG samples lose current stability after 72 % but Hydrogenated and Hydrophobically modified PEG samples retain the stability of Lyapunov exponents and detrended fluctuation analysis produces no change in slope, confirming that correlation properties do not change [3].

[1] O. Erdamar, Y. Skarlatos, G. Aktas, M.N. İnci, *Applied Physics A*, **83**, 159-162 (2006)

[2] A. Hacınlıyan, Y. Skarlatos, G. Sahin, G. Akın, *Chaos, Solitons and Fractals* **17** 575-585 (2003).

[3] J. Crank, G.S. Park (editors), "Diffusion in Polymers", Academic Press, London, (1968).

[4] C. K. Peng, S. V. Buldyrev, S. Havlin, M. Simons, H. E. Stanley and A. L. Goldberger, *Phys Rev E*, **49**, 1685 (1994).

[5] C.K Peng, S. Havlin, H.E Stanley, A.L. Goldberger, *Chaos* **5**, 82 (1995).

[6] R. Hegger, H.G. Kantz, T. Schreiber, "Nonlinear Time Series Analysis", Cambridge University Press, (1997).

Klimontovich's S-theorem for Nonadditive Open Systems and Constraints

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Klimontovich's S theorem [1, 2] serves as a measure of order relative to a reference state for open systems, thereby providing the correct ordering of entropy values with respect to their distance from equilibrium state. Therefore, this theorem has been used as a measure of complexity for the logistic map [3], heart rate variability [4, 5] and the analysis of electroencephalograms of epilepsy patients [6]. The S-theorem can also be considered as a generalization of Gibbs' theorem if one of the distributions is associated with the equilibrium state.

Here, a nonadditive generalization of the S theorem is presented by the employment of Tsallis entropy [7]. This generalized form is then illustrated by applying it to the modified Van der Pol oscillator [8]. Interestingly, this generalization procedure favors the use of ordinary probability distribution instead of escort distribution [9].

[1] Yu. L. Klimontovich, Physica A 142, 390 (1987).

[2] Yu. L. Klimontovich, Chaos, Solitons and Fractals 5, 1985 (1994).

[3] P. Saparin, A. Witt, J. Kurths, and V. Anischenko, Chaos, Solitons and Fractals 4, 1907 (1994).

[4] J. Kurths et al., Chaos 5, 88 (1995).

[5] A. Voss et al., Cardiovasc. Res. 31, 419 (1996).

[6] K. Kopitzki, P. C. Warnke, and J. Timmer, Phys. Rev. E 58, 4859 (1998).

[7] C. Tsallis, J Stat Phys 52, 479 (1988).

[8] H. Engel-Herbert and W. Ebeling, Physica A 104, 378 (1980).

[9] C. Tsallis, R. S. Mendes, and A. R. Plastino, Physica A 261, 534 (1998).

Extension of Recommendation Model to Dynamic Population

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Recommendation Model [1]
is a model that is used to investigate the effects of memory size with respect to the population size where an agent learns a new agent by recommendation.
In recommendation model, there are n agents where each of them has the same memory size, m. The memory M_i of an agent a_i is a subset of the agents in the population. An agent a_i knows a_j if a_j is an element of M_i. The knownness k_i of an agent a_i is the number of agents that know a_i. If $k_i = 0$, then the agent a_i is called completely forgotten. The fame f_i of an agent a_i is k_i/n.
The memory ratio ρ is m/n.
Initially, an agent knows its m-neighbors. At each simulation cycle, a giver agent a_G selects the recommended agent a_R from its memory and recommends a_R to a taker agent a_T. If a_T already knows a_R, it does not do anything. Otherwise, a_T learns a_R by forgetting an agent a_F from its memory (learning an agent means getting it into the memory and forgetting an agent means removing it from the memory). The a_G, a_T, a_R and a_F are selected randomly. The simulation ends when the average recommendation per agent is 10^6.
Minimum fame in the population, maximum fame in the population, cumulative (average) fame of the top 5 percent of the agents from the population that are selected by ordering the agents according to their fame values in decreasing order and percentage of forgotten agents in the population vs. ρ graphs are investigated at the end of simulations for
different combinations of n and ρ.
Why not try to extend the Recommendation Model to simulate the fame in a world where agents born and die, agents can communicate with a limited number of agents, memory size of agents is not static and agents don't forget an agent that they know randomly.
The features of Recommendation Model that will be extended are dynamic population size, dynamic memory size, dynamic selection of a_F and dynamic selection of a_T. Simulation result of each possible combination of these features is going to be investigated one by one to see the effect of each feature.

[1] H. Bingol, *Phys. Rev. E* **77**,036118 (2008).

Nonlinear Fokker-Planck equations related to normal and anomalous diffusion

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In order to prove the H-theorem for a system in the presence of an external potential, a relation involving terms of the Fokker-Planck equation and the entropy of the system was recently proposed. In principle, one may have classes of Fokker-Planck equations related to a single entropic form. In the case of the standard Boltzmann-Gibbs entropy, apart from the simplest, linear Fokker-Planck equation, one may have a whole class of nonlinear Fokker-Planck equations, whose time-dependent probability distributions may be distinct from simple exponential distributions, presenting anomalous diffusion in the approach to equilibrium, but all of them related to the Boltzmann-Gibbs entropic form. All of these nonlinear Fokker-Planck equations, in the presence of a harmonic potential, yield Gaussian distributions as stationary states [1, 2]. The numerical integration of a subset of the class associated to the Boltzmann–Gibbs entropy is carried out and the dynamics of such systems is analyzed. For a particular subset of this class, presenting the same anomalous diffusion term as the one obtained for the porous media equation with suitable exponents, the nonlinearity induces temporarily stable long–tailed, or short–tailed distributions. The same qualitative scenario, presenting normal and anomalous diffusion, can be obtained if one uses a different entropic form, like the Tsallis en-

tropy.

[1] V. Schwämmle, E. M. F. Curado and F. D. Nobre, Eur. Phys. J. B 58 (2007) 159;

[2] V. Schwämmle, F. D. Nobre and E. M. F. Curado, Phys. Rev. E 76 (2007) 041123.

Discrete Breathers in 2d SRR systems

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We consider SRR (split ring resonators) arrays positioned in the 2D plane, with axial or planar geometry. Using these topologies we construct Discrete Breathers of various types such as Hamiltonian, dissipative, single site and multibreathers as well as surface DB modes, located in the corner or in the edges of the lattice. We show that the presence of these modes induce negative magnetic response in the system.

[1] N. Lazarides, M. Eleftheriou, and G. P. Tsironis, *Phys. Rev. Lett.* **97**, 157406 (2006).

[2] M. Eleftheriou, N. Lazarides and G. P. Tsironis, *Phys. Rev. E* **77**, 036608 (2008).

[3] N. Lazarides, G. P. Tsironis, Y. Kivshar, *Phys. Rev. E* **77**, 065601 (2008).

Simulation of Conflicting Traffic Flows a Crossroads

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Modelling the dynamics of vehicular traffic flow has constituted the subject of intensive research by statistical physics and applied mathematics communities during the past years [1, 2]. Recently, physicists have paid notable attention to controlling traffic flow at intersections and other traffic designations such as roundabouts [3, 4, 4, 6]. In this respect, our objective is to study some generic features of vehicular traffic flows at a single intersection. Our study includes some aspects of conflicting traffic flows at an intersection without a traffic light. In this case, approaching cars to the intersection yield to traffic at the perpendicular direction by adjusting its velocity to a safe value to avoid collision. The yielding dynamics in the vicinity of the intersection is implemented by introducing a safety distance D_s. The approaching cars (nearest cars to the crossing point) should yield to each other if their distances to the crossing point are both less than the safety distance D_s. In this case, the movement priority is given to the car which is closer to the crossing point. This car adjust its velocity as usual with its leading car. On the contrary, the further car, which is the one that should yield, brakes irrespective of its direct gap. Closed boundary condition is applied to the streets. Extensive Monte Carlo simulations is taken into account to find the model characteristics. Our results suggest that yielding mechanism gives rise to a high total flow throughout the intersection especially in the low density regime. Intersection of two chains makes the intersection point appear as a site-wise dynamical defective site. It is a well-known fact that a local defect can affect the low dimensional non-equilibrium systems on a global scale [5]. This has been confirmed not only for simple exclusion process but also for

cellular automata models describing vehicular traffic flow. Next, we consider a signalised intersection which is controlled under a fixed time scheme. There is cycle time T which is divided into two parts: T_g and $T-T_g$. The light remains green for road A for T_g seconds (red for the perpendicular road B). Then the light turns into red for road A (green for road B) for the remaining time of the cycle i.e.; $T - T_g$ seconds. We show the simulation results for this signalised intersection and will compare them to the results of the unsignalised scheme. By this comparison, we will able to quantify the conditions at which the signalised scheme operates in a more efficient manner.

[1] D. Chowdhury, L. Santen and A. Schadschneider, *Physics Reports*, **329**, 199 (2000).

[2] D. Helbing, *Rev. Mod. Phys.*, **73**, 1067 (2001).

[3] O. Biham, A. Middleton and D. Levine, *Phys. Rev. A*, **46**, R6124 (1992).

[4] T. Nagatani, *J. Phys. Soc. Japan*, **63**, 1228 (1994).

[5] M. E. Fouladvand, Z. Sadjadi and M. R. Shaebani *Phys. Rev. E*, **70**, 046132 (2004).

[6] B. Ray and S.N. Bhattacharyya, *Phys. Rev. E*, **73**, 036101 (2006).

[7] S. Janowsky and J. Lebowitz *Phys. Rev. A*, **45**, 618 (1992).

Correlations in Disordered Asymmetric Exclusion Process

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Transport processes in disordered media constitute an important class of problems especially in the light of their relevance to the modelling of a vast variety of phenomena in physics and many interdisciplinary areas. It is a well-established fact the disorder can strongly affect the transport characteristics of equilibrium as well as out of equilibrium systems. Among various non equilibrium systems, low dimensional driven lattice gases have played an important role in describing the transport in many physical and biological processes [1, 2]. A model which has played a paradigmatic role in out of equilibrium statistical physics is the *Asymmetric Simple Exclusion Process* (ASEP) [3]. Recently new strides have been opened in the challenge between disorder, interaction and drive in the processes belonging to ASEP family [4]. The exploration of disordered ASEP began with a single defective site in a periodic chain by Janowsky and Lebowitz [5]. They showed that even one defective site can remarkably lead to global effects on the system current and its density profile. Subsequently, Tripathy and Barma [6] considered the ASEP on a ring with many defective sites. Their investigation revealed the existence of phase segregation in a wide range of global density in the chain. In conjunction with the results of ASEP on ring, investigation on disordered ASEP in an open chain, was introduced by Kolomeisky [7]. He showed that in some ranges of input and output rates, a single defect in the bulk could affect the systems properties on a global scale. Our goal in this talk is to deal in some depth with the problem of interaction of defects in ASEP. Particularly, we focus on the case of two defective sites both having equal hoping rates q. In contrast to normal ASEP, our simulation results reveal the existence of notable correlations in the vicinity of defects. We have developed a theoretical framework which is capable of evaluating the current via combination of mean-field approach and exact solution of finite ASEP chain. Furthermore, we have investigated the short range correlations near defects via a numerical scheme for solving the steady state equations governing the site densities and two points correlation functions. We compare our analytical findings to those recently discussed in [8]. It is shown that the distance between two defects plays a crucial role in the transport characteristics.

[1] B. Schmittmann and R.K.P. Zia in: *Phase transitions and Crtitical Phenomena, vol 17*, ed. C. Domb and L. Lebowitz (London: Academic) 1995.

[2] G. Schütz in: *Phase transitions and Crtitical Phenomena*, *vol 19*, ed. C. Domb and L. Lebowitz, Academic Press, 2001.

[3] B. Derrida, M.R. Evans, V. Hakim and V. Pasquir *J. Phys. A*, **26**, 1493 (1993).

[4] M.E. Foulaadvand, S. Chaaboki and M. Saalehi *Phys. Rev. E*, **75**, 011127 (2007).

[5] S. Janowsky and J. Lebowitz *Phys. Rev. A*, **45**, 618 (1992).

[6] G. Tripathy and M. Barma, *Phys. Rev. E*, **58**, 1911, 1998.

[7] A. B. Kolomeisky, *J. Phys. A: Math, Gen.*, **31**, 1153, 1998.

[8] P. Grulich and A. Schadschneider, *Physica A*, **387**, 1972, 2008.

The occurrence of Bose-Einstein condensation in a low-dimensional confinement

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The possibility of Bose-Einstein Condensation (BEC) of an ideal Bose gas confined in a low-dimensional trap is investigated. The standard semi-classical approximation predicts the absence of BEC at finite temperature in such a system due to the use of the thermodynamic limit which assumes an infinite system with an infinite number of particles. However, the situation realized in atom traps is quite different where a finite number of atoms exist. Thus a quantum mechanical treatment has been adopted here to study the finite number effect on a low-dimensional system. The results obtained from this approach reveal clearly the macroscopic occupation of the ground state which can be regarded as an evidence for BEC.

Non linear analysis of oligonucleotide distribution of evolutionary recent organisms

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Computational DNA sequence analysis enhances our comprehension of complex biological systems and improves our knowledge on how biological information is stored and retrieved in the DNA [1, 2]. Following this approach we have focused on the statistical analysis of small DNA sequences (oligonucleotides) in evolutionary recent organisms. We have used chromosomes of most sequenced multi-celled organisms, and especially *Homo sapiens*, *Pan troglodytes*, *Mus musculus*, *Rattus norvegicus*, *Gallus gallus*, *Danio rerio*, *Drosophila melanogaster*, *Caenorhabditis elegans* and *Arabidopsis thaliana*.

Our approach is based on calculations of various scaling statistical parameters for all oligonucleotides of the same length [3]. Sequences of 5 and 6 nucleotides are used, depending on the size of the original chromosome. The distance distribution of consequent appearances of the same oligonucleotide is computed, for all possible nucleotides of a given length. Two parameters are used to model this size distribution, in order to find if long or short range tendency was present [4].

We have found that oligonucleotides bearing consensus promoter signatures follow power law distributions, while all others follow exponential distributions, or in general short range distributions. In a two dimensional plot of the two parameters, we have seen that oligonucleotides tend to cluster, depending on whether they contain the "CG" subsequence (a common consensus sequence of the promoter). In more resent organisms this phenomenon is more evident.

[1] W. T. Li and D. Holste, Universal 1/f noise, crossovers of scaling exponents, and chromosome-specific patterns of guanine-cytosine content in DNA sequences of the human genome, *Phys. Rev. E*, **71**, 041910 (2005).

[2] P. Bernaola-Galvan, P. Carpena, R. Oman-

Roldan, J.L. Oliver, Study of statistical correlations in DNA sequences, *Gene*, **200**, p.105 (2002).

[3] P. Katsaloulis, T. Theoharis, A. Provata, Statistical algorithms for long DNA sequences: oligonucleotide distributions and homogeneity maps, *Scientific Programming*, **13(3)**, p.177, (2005).

[4] P. Katsaloulis, T. Theoharis, W.M. Zheng, B.L. Hao, A. Bountis, Y. Almirantis, A. Provata, Long range correlations of RNA polymerase II promoter sequences across organisms, *Physica A*, **366**, p.308 (2006)

Empirical and simulational analysis of the jam formation for a problematic highway in Turkey

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We are stuck in a jam on traffic everyday and it is one of the most significant problems faced in modern cities today. In Istanbul, people generally work on the European side and live on the Asian side. The traffic therefore flows at the direction of the western side in the morning, and at the direction of the eastern side in the evening along the two bridges. Due to the fact that when 25 lanes come from the western side after the toll booths and the number of lanes is decreased to 4, traffic jams become a huge problem. Traffic research still cannot fully predict under which conditions a traffic jam may suddenly occur. The aim of our project is to define what causes such traffic jams from a physicist point of view. The possible reasons for the jam formation can be the frequent lane changing or less headway, high density or sudden braking. These parameters and their effect to the traffic flow should be investigated individually. In this simulation, the local vehicle density and flow values, and position of each vehicle for each time step are measured. The respective dependencies among these quantities, so-called fundamental diagrams, are plotted. Traffic modeling is distinguished as microscopic and macroscopic. Macroscopic approach maps traffic flow as a continuous unity of fluidized vehicles. No vehicle in the traffic flow is identifiable. Microscopic modeling maps traffic flow as a set of individual vehicles. We propose microscopic cellular automata rules for modeling highway consisting of four lanes, an onramp, an off-ramp, and an auxiliary lane in Istanbul. Cellular Automata have the advantage of modeling the traffic flow on the microscopic scale of individual vehicles and allow the study of large systems due to a simple type of dynamics. We use the Nagel-Schreckenberg (NaSch) microscopic model to simulate the traffic flowing from the European side to Asian side over the Bosphorus on the Fatih Sultan Mehmet Bridge. We also investigate phase transition and its order with real traffic data from government traffic control center. The transportation authority makes an arrangement in order to decrease the traffic jam, by taking one lane from the direction from eastern side to western side and adds this lane to the crowded side as an auxiliary lane at the rush hours. The effectiveness of the auxiliary lane at this portion of the road is investigated. To test the psychological aspects of the driver behavior and cultural side of the traffic flow problem, two scientists from different ethnic background approach this problem using different parameters related to their traffic cultures and perception of rules. The results are given as a comparative study of these two simulations. This project has been supported by Bogazici University BAP 07B303D project.

A Statistical Analysis of the Robustness of Alternate Genetic Coding Tables

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The rules that specify how the information contained in DNA is translated into amino acid language during protein synthesis are called the genetic code, com-

monly called the Standard or Universal Genetic Code Table. As a matter of fact, this coding table is not at all universal: in addition to different genetic code tables used by different organisms, even within the same organism the nuclear and mitochondrial genes may be subject to two different coding tables. Results In an attempt to understand the advantages and disadvantages these coding tables may bring to an organism, we have decided to analyze various coding tables on genes subject to mutations, and have estimated how these genes survive over generations. We have used this as indicative of the evolutionary success of that particular coding table. We find that the standard genetic code is not actually the most robust of all coding tables, and interestingly, Flatworm Mitochondrial Code (FMC) appears to be the highest ranking coding table given our assumptions. Conclusions It is commonly hypothesized that the more robust a genetic code, the better suited it is for maintenance of the genome. Our study shows that, given the assumptions in our model, Standard Genetic Code is quite poor when compared to other alternate code tables in terms of robustness. This brings about the question of why Standard Code has been so widely accepted by a wider variety of organisms instead of FMC, which needs to be addressed for a thorough understanding of genetic code evolution.

Clustering Results of Housing Prices in Different Countries

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We analyzed the effects of economic indicators on house prices in eighteen countries. The economic indicators, which we used, are Gross Domestic Product (GDP) and population. By using the Support Vector Machine algorithm, we identified clusters which show similar distributions of house prices under the effect of GDP and population. Sweden and New Zealand are always in same cluster which means that their house price changes according to their GDP changes and population changes behave similarly. Moreover, Belgium, UK, Ireland, Spain and France are the other countries which show similar distributions. Surprisingly, these five countries are in the first five in ranking in the Hallifax house price change report which shows the percentage changes of house price values of countries in last five years.

Stability and Bifurcation in Predator Prey Systems with Cubic Interaction

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The predator prey problem involves a class of models that predict the interaction between populations of different species in the same environment where some of the species (predators) prey on the others. The prey exhibits linear growth given by a positive parameter. Predators consume preys with a nonlinear interaction involving another set of parameters that specify the competition between predators. The natural death rate of the predator is assumed to be linear and given by a negative parameter. One of the earliest implementations, the Lotka-Volterra model that serves as a starting point for more advanced population dynamics models used today. Stability problems in the Lotka-Volterra model and its generalizations constitute a field that has recently gained much attention. To understand the behavior of a nonlinear system one has to also analyze the existence and stability of equilibrium points which change as parameters vary. Changes in the number and stability of equilibrium points in these models leading to qualitative changes in the behavior of the system have been studied by bifurcation analysis in this work. Both numerical methods [1] and the semi-perturbative analytic approach provided by the normal form method are useful tools in this context.
Nutku [2] has proposed a generalization where an additional cubic rather than a quadratic interaction is

involved. The numerical analysis of bifurcation and stability for this generalized system is studied with the help of the MatLab package MATCONT[3]. Then the normal form structure for a nontrivial equilibrium is achieved by linearizing the system and analyzing the existence of Hopf bifurcation using the method of Kuznetsov[4].

Results of a study involving the bifurcation properties shown by generalized Lotka-Volterra models[5] including the Nutku generalization with a cubic interaction term that is shown to introduce additional changes of the stability properties in a simple way will be presented.

[1] D. Ghosh and A. R. Chowdhury "On the Bifurcation Pattern and Normal Form in a Modified Predator; Prey Nonlinear System", *Journal of Computational and Nonlinear Dynamics* **2**, 267-273 (2007).

[2] Y. Nutku, "Hamiltonian structure of the Lotka-Volterra equations", *Phys. Lett A* **145** 27-28 (1990).

[3] A. Dhooge, W. Govaerts, Yu.A. Kuznetsov, W. Mestrom, A.M. Riet and B. Sautois, "MATCONT and CL_MATCONT: Continuation toolboxes in matlab", Ghent and Utrecht Universities Preprint, (2006).

[4] Yu. A. Kuznetsov, "Elements of Applied Bifurcation Theory", Springer New York (1995).

[5] H. Zhu, S. A. Campbell and G. S. K. Wolkowicz "Bifurcation Analysis of A Predator-Prey System With Nonmonotonic Functional Response", *SIAM J. APPL. MATH. V.63* **2**, 636-682 (2002).

Cylindrical Sandpile Formation on Angularly Accelerated Horizontal Plane

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Here we report a formation of a cylindrical sand pile. A steady stream of dry sand is poured into a horizontally revolving cylindrical shell which is full up to a certain level with water. The water first forms a parabola which leaves the bottom of the cylindrical shell dry. The sand is poured of axis. The steady steam sand forms a cylinder with a parabolic cavity in the middle. For bigger granular sand particles this new developed cylinder is more stable than for smaller granular sand particles. The essential features of the system that produce the phenomenon are discussed and the robustness of the phenomena is demonstrated with experiments using different boundary conditions and sands.With the help of this experiment we observed the effect of capillary force on granule-fluid mixtures.

As a result of the centrifugal force fluids are thrown outwards if they are revolved in a rotating shell. The fluid which is forced outwards in a radial direction is replaced by a fluid stream in the axial direction so the fluid rotates over the wall. The sand particles which rotate with water at a distance from the wall are at equilibrium under the influence of centrifugal force, which is balanced by a radial pressure gradient. As the tangential velocity of the particles near the cylindrical wall is reduced, the radial pressure remains the same because of the decreasing centrifugal force. All of these circumstances cause the particle near the wall to flow radially inwards and because of continuity reasons to compensate these motion particles rises up and this motion forces the particles construct a cylindrical pile. The external flow occurring in the water is called secondary flow and plays a major role here by the development of our cylindrical sandpile . This secondary flows forces the downward flowing sand take a shape of a cylinder.

As the sand flows downwards and constructs the pile the capillary force from the base affects the pile and climbs up in the sandpile. This capillary movement causes to a negative pore pressure which makes the sand particles attract each other but as the capillary movement improves the negative pore pressure turns to neutral (or positive) and this causes the sand particles repel each other this time. So we observe that the cylindrical sand pile actually has wet side walls, wet inner volume but a dry parabolic surface over the pile. As the pore pressure turns into neutral or positive the pile formation becomes unstable from a

metastable condition. It disperses as soon as the pore pressure forces it at maximum. The dispersion is not formed uniformly but occurs step wisely.

The Role of Impurities in the Transport Properties of Heisenberg Chains

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Thermal management is a major problem in novel electronic devices, where the overheating of such a device, can reduce its expectation time of life and its reliability. Due to the necessity for efficient heat removal, novel materials which exhibit high values of thermal conductivity are under investigation. These materials exhibit magnetic modes of transport, which are responsible for the dissipation-less heat transport. Moreover these materials are electric insulators and highly anisotropic, characteristics, that make them of high technological interest. Transport properties along the axis in which ballistic transport occurs, can be well described by one dimensional spin Heisenberg models.
We consider the case of one dimensional Heisenberg Hamiltonian (XXZ model)

$$H_0 = J \sum_l S_l^x S_{l+1}^x + S_l^y S_{l+1}^y + \Delta S_l^z S_{l+1}^z \ , \qquad (4)$$

under various perturbations. The unperturbed Heisenberg model exhibits infinite d.c. spin (for the special case $\Delta = 0$ (XY model)) and thermal conductivity for any value of the anisotropy Δ at all temperatures. Using numerical diagonalization we explore two types of impurities, local magnetic fields and extra spins out of chain within memory function formalism [1] . In the former case, comparison with results for spin and thermal conductivity obtained from the full Hamiltonian diagonalization [2], shows a good agreement in the range of validity of memory function.

[1] W. Gotze and P. Wolfe, Phys. Rev. B **6**, 1226 (1972)
[2] P. Prelovšek, X. Zotos et al. cond-mat/0803.1379 (2008)

Which are the most important skills and knowledge for today's science jobs? A network analysis of the O*NET occupation database

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In this paper, we identify the most central knowledge and skills competencies for the science jobs by analyzing the characteristics of the jobs-knowledge and jobs-skills bipartite weighted networks for the 48 jobs (and the 33 knowledge domains and 35 skills categories) comprising the "Life, Physical and Social Sciences" job family of the O*NET (Occupational Information Network) database. O*NET is USA's primary source of occupational information (continually updated by surveying a broad range of workers from each occupation.) Our results can be interpreted as the identification of the knowledge and skills "superhighways" of the science jobs, that is, their infinite incipient percolation cluster, for which nodes with high betwenness centrality dominate (Wu et al, 2006.) Such an approach can serve to systematically monitor the "coupling" between education systems and the evolution in the workplace, that is, whether workers' skills and education are, or are not, adequate for the demands of jobs in the current economy, a problem which many believe will become even more serious because the pace of change is accelerating and the workplace is becoming increasingly high tech, service-oriented, and reorganized to involve greater employee participation.)

Diffusive mixing versus reactive mixing in non-linear dynamical systems

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Non-linear, interacting particle systems are studied using both the Mean-Filed approach and Kinetic Monte Carlo simulations on lattice substrates.
First, the behavior of lattice compatible, non-linear dynamical systems will be explored, which at the mean-field level present conservative, **center-type** dynamics. It will be shown that the reduction of these systems on low dimensional lattice supports causes clustering and drives the systems away from their mean-field behavior. In particular, the conservative systems organize in a number of local oscillators of finite sizes. These spatially extended, local oscillators have random phases, are nonsynchronous and as a result global oscillations are suppressed.
If in addition, *reactive long range mixing* is introduced, the spatially extended system regains its mean-field behavior, i.e. the conservative global oscillations, when the reactivity range becomes comparable to the system size.
If instead of reactive mixing *diffusive long range mixing* is introduced, the behavior changes drastically. For small diffusion rates p the system retains its original form, i.e. clusters into local asynchronous oscillators. After the diffusion rate p crosses a critical point p_c all local oscillators synchronize into a stable, dissipative attractor of **limit-cycle** type. Thus, oscillations in these spatially extended systems emerge as the **Hopf-like** bifurcation in dynamical systems.
This conclusion is important in physics, chemistry and population dynamics because it points out that a long range diffusive mechanism can stabilize oscillatory systems. In particular, in systems described by conservative, center-type mean field equations which are sensitive to stochastic noise, the long range diffusion mechanism can drive them to global, stable oscillations.

[1] A. Provata and G. A. Tsekouras, *P*hys. Rev. E, **67**, Art. No. 056602, (2003).

[2] K. Wood, C. Van den Broeck, R. Kawai, K. Lindenberg, *P*hys. Rev. Lett., **96**, 145701, (2006).

[3] A. Efimov, A. Shabunin and A. Provata, *submitted*.

Diffusion Entropy Analysis of Long-range Correlation In The Turkish Language Using Non-corpus Parametrization

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The existence of long-range correlation in (twelve) natural languages by means of detrended fluctuation analysis had been reported by Hacinliyan [1] et al where each language shows two distinct scaling regimes. This work extends this line of research to demonstrate that the historical development of a language such as Turkish can easily be traced out using the proposed corpus independent parametrization.

The first issue that one faces in an attempt to analyze a natural language as a time series is the mapping of texts onto a time series. The usual choice in is using a time series derived form a corpus (see [2, 3, 4]). Our proposed variable in this work is inspired by DNA random walks and is derived by assigning values to the letters constituting a given word. The resultant time series for texts in the Turkish language from different time periods are analyzed via Diffusion Entropy analysis (DEA) ([5]).

The texts analyzed in this work show two different regimes under DEA, the short range regime is virtually parallel within errors in all cases, while the long range correlations for the texts belonging to the time period are markedly different from the other texts of different time period. These results imply that the time evolution in a language can be detected by means of DEA based on the proposed parametrization.

[1] Sahin , G , M. Erentürk and A. Hacinliyan, "Detrended fluctuation analysis in natural languages

using non-corpus parametrization", *Chaos, Solitons and Fractals*, Article in Press.

[2] Montemurro MA, Pury PA. "Long-range fractal correlations in literary corpora." (2002). Available from cond-mat/0201139.

[3] Bhan,J, S. Kim, J. Kim, Y. Kwon, "Long-range correlations in Korean literary corpora", *Chaos, Solitons and Fractals*, **29**, 69- 81, (2006).

[4] P. Allegrini, P. Grigolinib and L. Palatella, "Intermittency and scale-free networks: a dynamical model for human language complexity", *Chaos, Solitons and Fractals*, **20**, 95-105, (2004).

[5] N. Scafetta, V. Latora and P. Grigolini, "Lévy scaling: The diffusion entropy analysis applied to DNA sequences", *Phys. Rev. E*, **66**, 031906, 2002.

Is there a barrier separating large and small polarons in one dimension?

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We discuss dimensionality effects of the Holstein polaron from the fully quantum regime, where the crossover between large and small polaron solutions is known to be continuous in all dimensions, into the limit described by the semiclassical Discrete Nonlinear Schrödinger (DNLS) Equation, where the crossover is continuous in 1D but discontinuous in higher dimensions. We use exact numerics on one hand and a two variable parametrization of the Toyozawa ansatz on the other in order to probe the crossover region in all parameter regimes. We show that a barrier appears also in 1D separating the two types of solutions, seemingly in contradiction to the common paradigm for the DNLS according to which the crossover is barrier-free. We quantify the polaron behavior in the crossover region as a function of the exciton overlap and find that the barrier remains small in 1D and tunnelling through it is not rate-limiting. We discuss ramifications of these findings in materials such as acetanilide.

[1] P. Hamm and G. P. Tsironis, *Barrier crossing to the small Holstein polaron regime*, to be published in Phys. Rev. B.

[2] P. Hamm and G. P. Tsironis, Eur. Phys. J. Sp. Topics, **147**, 303, (2007).

[3] Y. Zhao, D. W. Brown and K. Lindenberg, J. Chem. Phys. **107**, 3159 (1997).

[4] G. Kalosakas, S. Aubry and G. P. Tsironis, Phys. Rev. B **58**, 3094 (1988)

[5] J.Bonča, S. A. Trugman and I. Batistić, Phys. Rev. B **60**,1633 (1999).

Some properties of a complex network memory model for neurosis

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We have described the mental pathology known as neurosis, in terms of its relation to memory function and proposed neural network mechanisms, whereby neurotic behavior is described as a brain associative memory process. Modules corresponding to sensorial and symbolic memories interact, representing unconscious and conscious mental processes. Memory was first modeled by a Boltzmann machine (BM), represented by a complete graph. Since it is known that brain neural topology is selectively structured, we have further developed the memory model, including known microscopic mechanisms that control synaptic properties and self-organize the complex network to a hierarchical, clustered structure.

The resulting power-law and q-exponential behavior for the node degree distribution of the network's

topology suggest that memory dynamics and associativity may not be well described by Boltzmann-Gibbs (BG) statistical mechanics. We thus model memory access dynamics by a generalization of the BM called Generalized Simulated Annealing (GSA), derived from the nonextensive formalism. We illustrate the neurocomputational substrate model with simulations, showing some properties of these complex networks' topological structures and behavior.

[1] G.M. Edelman, "Wider than the Sky, a Revolutionary View of Consciousness", Penguin Books, London (2005).

[2] S. Freud, "Introductory Lectures on Psycho-Analysis", Standard Edition, W. W. Norton & Company, New York - London (1966), First German ed. 1917.

[3] J.A. Hertz, A. Krogh and R.G. Palmer, Eds., "Introduction to the Theory of Neural Computation", Lecture Notes, Vol. I, Santa Fe Institute, Studies in the Science of Complexity, Perseus Books, Cambridge, MA (1991).

[4] E.R. Kandel, J.H. Schwartz, and T.M. Jessel, eds., "Principles of Neural Science", MacGraw Hill, USA (2000).

[5] M.E.J. Newman, "Random Graphs as Models of Networks", in: S. Bornholdt, et al., eds., Handbook of Graphs and Networks, from the Genome to the Internet, Wiley-VCH, USA, 35–68 (2003).

[6] C. Tsallis and D. A. Stariolo, *Physica A*, **233**, 395–406 (1996).

[7] R. S. Wedemann, L. A. V. Carvalho and R. Donangelo, *Lecture Notes in Computer Science*, **4131**, 543–552 (2006).

A numerical approach for solving the epidemic model

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In this study, the problem of spread of a non-fatal disease in a population which is assumed to have constant size over the period of the epidemic model is considered. Variational iteration method (VIM) is employed to compute an approximation to the solution of the system of nonlinear ordinary differential equations governing on the problem. The results show applicability, accuracy and efficiency of VIM in solving the epidemic model.

Application of variational iteration method to nonlinear population dynamics models

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In this study, the variational iteration method (VIM) is employed to derive approximate series solutions of nonlinear population dynamics models. The nonlinear models considered are the multispecies Lotka-Volterra equations. The accuracy of this method is examined by comparison with the available exact solution and other methods.

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