



מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

STATISTICAL MECHANICS DAY VI

Wednesday June 5, 2013

Weizmann Institute of Science

Physics Building, Weissman Auditorium

ABSTRACTS :

Joel L. Lebowitz, Rutgers University

Title : Existence and Entropy of measures/density matrices with prescribed correlations

G Falkovich – Weizmann Institute

Title : What a single snapshot reveals about the future and the past of turbulent flow

We develop an analytic formalism and derive new exact relations that express the short-time dispersion of fluid particles via the single-time velocity correlation functions in homogeneous isotropic and incompressible turbulence. The formalism establishes a bridge between single-time Eulerian and long-time Lagrangian pictures of turbulent flows. In particular, we derive an exact formula for a short-term counterpart of the long-time Richardson law, and we identify a conservation law of turbulent dispersion which is true even in non-stationary turbulence.

David Kessler – Bar Ilan University

Title: Delbruck-Luria revisited

We explain the structure of the Delbruck-Luria distribution for the number of mutants in an exponentially growing population. We show that for the stochastic model the fixed-population size ensemble behaves completely different than the fixed-time ensemble. Also, in the limit of large population, the distribution becomes the universal alpha-stable distribution. We show how this is true even for different growth rates of mutant and wild-type and in the presence of death.

Eran Bouchbinder – Weizmann Institute

Title: A simple nonlinear equation for structural relaxation in glasses

A wide range of glassy and disordered materials exhibit complex, non-exponential, structural relaxation (aging). We propose a simple, analytically solvable, two-parameter nonlinear rate equation to describe glassy relaxation. Analysis of extensive experimental data shows that this equation quantitatively captures structural

relaxation in response to both positive (heating) and negative (cooling) temperature jumps, where the two parameters exhibit systematic variation with the initial and target temperatures. The analysis explicitly demonstrates that structural relaxation carries long-time memory of its thermal history and hence that it cannot be accurately described by a single non-equilibrium variable. A rationalization of the proposed equation in terms of a two-state model is offered, allowing to estimate the activation energies and volumes scales associated with structural relaxation.

Yacov Kantor, Tel Aviv University

Forces between polymers and scale-free surfaces

The number of configurations of a polymer is reduced in the presence of an obstacle/object. The resulting loss of entropy leads to repulsion between the polymer and the object. When the obstacles have scale-free shapes, exact expressions for the forces can be found. These expressions depend on the (geometry-related) critical exponents but are independent of polymer details.

Haye Hinrichsen – University of Wuerzburg

Title: Detailed fluctuation theorem for non-stationary nonequilibrium systems (with D. Luposchinsky and A. C. Barato)

We introduce a finite-time detailed fluctuation theorem for an appropriately weighted probability density of the external entropy production in the environment. The fluctuation theorem is valid for nonequilibrium systems with constant rates starting with an arbitrary initial probability distribution. We discuss the implication of this new relation for the case of a temperature quench in classical equilibrium systems. See also: arxiv 1302.1013, Phys. Rev. E 87, 042108 (2013).

Saar Rahav – Technion

Title: The non-equilibrium thermodynamics of a coherent quantum heat engine

Quantum heat engines are quantum systems which exchange energy with reservoirs at different temperatures and do some useful work. An interesting model of a quantum heat engine was developed by Scully and coworkers [1]. This model exhibits noise induced coherence, and this coherence was shown to affect the thermodynamical properties of the engine. We investigate this model using approaches employed to describe classical microscopic machines. In particular, we study how the coherence affects properties such as the efficiency at maximum power and the fluctuations around steady state.

[1] M. O. Scully, K. R. Chapin, K. E. Dorfman, M. B. Kim and A. Svidzinsky, PNAS 108, 15097 (2011).

Sorin Solomon – Hebrew University

Title : Statistical Mechanics of Crises

Eric Akkerman- Technion

Title : Cumulants of the current and large deviations in the symmetric simple exclusion process on an arbitrary graph

The purpose of this talk is to show that the statistics of the current of the current of the symmetric simple exclusion process (SSEP) are the same on an arbitrary graph as in the one dimensional case. To prove this result, we shall use two different approaches. One is based on a direct calculation which bears some analogy with electrostatics. The second approach makes use of energy forms.

Doron Cohen – Ben Gurion University

Title : Thermalization of mesoscopic subsystems

We explore a minimal paradigm for thermalization, consisting of two weakly-coupled, low dimensional, non-integrable subsystems. As demonstrated for Bose-Hubbard trimers, chaotic ergodicity results in a diffusive response of each subsystem, insensitive to the details of the drive exerted on it by the other. This supports the hypothesis that thermalization can be described by a Fokker Plank equation. We also observe, however, that Levy-flight type anomalies may arise in mesoscopic systems, due to the wide range of time scales that characterize 'sticky' dynamics. I. Tikhonenkov, A. Vardi, J.R. Anglin, D. Cohen, Phys. Rev. Lett. 110, 050401 (2013)

Eli Barkai – Bar Ilan University

Title : Theory of fractional-L'evy kinetics for cold atoms diffusing in optical lattices

Recently, anomalous superdiffusion of ultra cold ^{87}Rb atoms in an optical lattice has been observed by Davidson's group, along with a fat-tailed, L'evy type, spatial distribution. The anomalous exponents were found to depend on the depth of the optical potential. We find, within the framework of the semiclassical theory of Sisyphus cooling, three distinct phases of the dynamics, as the optical potential depth is lowered: normal diffusion; L'evy diffusion; and $x \sim t^{3/2}$ scaling, the latter related to Obukhov's model (1959) of turbulence. The process can be formulated as a L'evy walk, with strong correlations between the length and duration of the excursions. These are described by the statistics of the area under the Bessel excursion. We derive a fractional diffusion equation describing the atomic cloud, and the corresponding anomalous diffusion coefficient.

Joint work with David Kessler.

Gad Kozma- Weizmann Institute

Title: On the Mermin-Wagner argument

We survey some recent progress on methods for rigorously applying the Mermin-Wagner argument. Joint work with Ron Peled.

Oleg Krichevsky – Ben Gurion University

Title : The efficiency of autocrine and paracrine communication between T cells.

Cells of the immune system secrete various small proteins – cytokines that can bind the receptors of the secreting cell itself (in an autocrine loop), or to other cells in the organ (paracrine signaling). The cytokine binding to the receptor causes a chain of signaling events that determine the fate of the receiving cell: its survival, differentiation and proliferation. Based on our measurements of interleukin-2 (IL-2) signaling, I will address two questions: 1) the efficiency of the autocrine loop, i.e. the probability of the cytokine molecule binding to the cell it has been secreted from, and, 2) the spatial extent of paracrine communication: how far from the secreting cell the cytokine field extends.

Yaron Silberberg, Weizmann Institute

Title : Discrete Systems in a New Light

Strong Light propagating in a discrete system of waveguides is modeled by the Discrete Nonlinear Schrodinger Equation, and can be used to demonstrate the unique thermodynamic of this system. The temperature of the system can be determined by controlling the initial distribution of the wave. Most interestingly, we have found experimentally and verified theoretically that when a field with random phases is launched into this system (no correlation between sites), it reaches an equilibrium state with a universal field correlation function and intensity distribution that do not depend on any system parameter.