Oleg Kogan

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EDUCATION

California Institute of Technology, Pasadena, CA
Ph.D., *Research Advisor*: Michael Cross. (expected) 2008
Thesis: *Stochastic and collective properties of nonlinear oscillators.*
M.S., 2003

Case Western Reserve University, Cleveland, OH
B.S. Physics, magna cum laude. 2001

RESEARCH INTERESTS

Nonequilibrium statistical mechanics and its applications to complex systems. Collective behavior away from equilibrium, interplay of nonlinearities and nonequilibrium, generic properties (such as scaling laws, distributions, correlations etc.) in systems lacking detailed balance, collective behavior in disordered systems. Other interests include the feasibility of observing quantum phenomena in various macroscopic and mesoscopic systems, mathematical physics, applications of physics methods in biological and interdisciplinary fields.

HONORS AND AWARDS

- Fulbright Postdoctoral Fellowship to Israel (declined) 2008
- Caltech Institute Fellowship 2001 - 2002
- Ohio Space Grant Consortium scholarship 2000 - 2001

PUBLICATIONS

- Oleg Kogan, Jeffrey L. Rogers, M. C. Cross, G. Refael, *Renormalization Group Approach to Oscillator Synchronization.* arXiv:0810.3075v1, submitted to Phys. Rev. E.
- Oleg Kogan, *Scaling crossovers in activated escape of nonequilibrium systems: a resonantly driven oscillator.* arXiv:0805.0972v2. A short version with M. Dykman to appear in Phys. Rev. E.
- Mihai Bonderescu, Oleg Kogan, Yanbei Chen, *Optimal light beams and mirror shapes for future LIGO interferometer.* Phys. Rev. D **78**, 082002 (2008).
- Henk Postma, Inna Kozinsky, Oleg Kogan, Ali Husain, Michael Cross, Michael Roukes, *Basins of Attraction of a Nonlinear Nanomechanical Resonator.* Phys. Rev. Lett. **99**, 207201 (2007).
- Oleg Kogan, *Controlling transitions in a Duffing Oscillator by sweeping parameters in time*. Phys. Rev. E **76**, 037203 (2007).

CONFERENCE PRESENTATIONS

- "Dynamics Days", 2008, "American Physical Society March Meeting", 2008, *Renormlization group method for predicting frequency clusters in a chain of nearest neighbor Kuramoto oscillators*.
- "American Physical Society March Meeting", 2007*, Scaling crossovers in activated escape of nonequilibrium systems: a resonantly driven oscillator.*
- "Dynamics Days", 2007, "American Physical Society March Meeting, 2006, *Controlling transitions in aDuffing Oscillator by sweeping* parameters *in time.*

RESEARCH EXPERIENCE

California Institute of Technology
Graduate Researcher 06/2002 - Present

Renormalization Group treatment of a chain of phase oscillators to understand the emergence of collective features.

- Developed a strong-randomness renormalization group (RG) method for the chain with nearest-neighbor coupling; used it to solve a long-standing frequency cluster problem posed 20 years ago.
- Extensively studied the numerical implementation of this RG method and compared the results to numerical simulations of the dynamics of the chain.
- Discovered the exponentially decaying distribution of frequency clusters sizes and calculated the scaling of characteristic cluster size with the control parameter that measures the degree of disorder.

Scaling crossovers in activated escape of non-equilibrum systems: a resonantly driven oscillator**.**

- Investigated the properties of crossovers between various scaling regimes of the activation barrier.
- Performed the calculation of escape barriers via most probable escape paths (instanton method).
- Mapped out the parameter space for regions of various scaling laws in the escape barrier versus deviation of a parameter from a saddle-node bifurcation.
- Discover that the exponent "3/2" holds over a much larger region of parameter space then where it would be expected to hold based on the theory of 1-dimensional over-damped soft mode.

Onset of singularities in the probability distribution of a non-linear oscillator as it is driven away from thermal equilibrium.

- Investigated the development of a steady-state nonequilibrium probability distribution with a *non-smooth* effective potential when detailed balance is broken.
- Discovered *fragility of detailed balance* by finding the absence of a threshold for the strength of driving needed for the appearance of non-smoothnesses.
- Utilized a combination of numerical and analytical methods (classical perturbation theory, WKB method, caustics).

Controlling transitions in a Duffing Oscillator by sweeping parameters in time.

- Investigated transitions in a Duffing oscillator induced by a rapid variation of parameters in time.
- Discovered unusually long transients and the scaling of the life-time of these transients with control parameters.
- Proposed a simple explanation of the phenomenon; used this to explain the scaling of the transient life-time.
- Suggested potential uses in experimental systems.

Basins of attraction of a nonlinear Pt nanowire mechanical resonator.

- Provided theoretical support for the experiment that mapped out basins of attraction of a non-linear NEMS resonator.
- Participated in the two-way interaction between myself (theory) and experimentalists to analyze and interpret experimental data.

Optimal Light Beams and Mirror Shapes for Future LIGO Interferometer

- Studied the minimization of noise in the next generation LIGO (gravitational wave detector) by optimizing the intensity profile and the corresponding mirror shape.
- Developed the minimization algorithm and implemented it numerically.

Jet Propulsion Laboratory 05/2001 – 09/2001
Investigation of the feasibility of using the Sun as a gravitational lens for telescoping purposes.

NASA Glenn Research Center 06/1999 – 09/1999
Jamming in granular beds via electrical conductivity measurements.

TEACHING EXPERIENCE

California Institute of Technology,
Teaching Assistant
Course: "Methods of Complex analysis" Fall 2007, Fall 2008
Course: "Ordinary Differential Equations" Winter, 2008
Course: "Partial Differential Equations" Spring, 2008
- Lectured in weekly recitation sessions.
- Held office hours to answer students' questions.
- Graded homework and exams.

Teaching Assistant Spring, 2007
Course: **"**Kinetic Processes in Materials"
- Provided solutions, and graded homework and exams.
- Held office hours/discussion sections.
- Gave a lecture when the professor was on leave.

Teaching Assistant Spring, 2003
Course: "Introductory Physics"
- Graded homework, quizzes and final exams.

Teaching Assistant Winter, 2003
Course: **"**Statistical Mechanics"
- Wrote problems and solutions, graded homework and exams.
- Conducted recitation and discussion sections, held office hours.

Private Tutoring 1997 - Present
Subjects: Mathematics and Physics (High School and College)
- Tutor students in Algebra, Calculus, and Physics in a wide range of grade and skill levels.

OTHER SKILLS AND PROFICIENCIES

- Foreign languages*:* fluent in Russian.
- 1+ years experience in independent project management while research advisor was on sabbatical.
- 4+ years experience in independently developing and maintaining research collaborations from a variety of institutions and fields.

REFERENCES

Michael Cross, *Caltech*, Pasadena, CA
Mark Dykman, *Michigan State University*, East Lansing, MI
Ron Lifshitz, *Tel Aviv University*, Tel Aviv, Israel
Igor Aranson, *Argonne National Laboratory*, Chicago, IL
Gil Refael, *Caltech*, Pasadena, CA