Yale Institute for Nanoscience and Quantum Engineering

Friday- February 8, 2013

12:00 to 1:00 p.m.

Becton Seminar Room

Light lunch will be served at 11:45 a.m.

Donghun Lee

Department of Physics, Yale University

"Optomechanics at Cryogenic Temperature"

One key challenge to observing quantum phenomena in a macroscopic mechanical oscillator is reaching its ground state. To achieve the low temperatures required for this, we utilize resolved sideband laser cooling of a few hundred kHz mechanical oscillator with high mechanical Q (a Si_3N_4 membrane) inside a high finesse optical cavity, in addition to cryogenically reducing the bath temperature. Realizing high Q and high finesse cavity optomechanical devices in a cryogenic environment requires overcoming a number of challenges. In this talk, we describe the design and construction of such a device working at a bath temperature of 300 mK (in a ^3He refrigerator) and suited for operation at lower temperatures (in a dilution refrigerator). The design incorporates in-situ commercial piezo actuators to couple externally prepared laser light into the cold optical cavity. The design also incorporates filtering cavities to suppress classical laser noise, and acoustic and seismic isolation of the experiment.

Stefanos Papanikolaou

School of Engineering and Applied Science, Yale University

"From dislocations to earthquakes: The emergence of oscillations in driven systems"

When a physical system, under slowly increasing external stress, responds through impulsive events, there is commonly a regime where avalanches cluster in time and oscillatory "stick-slip" response is observed. The traditional explanation for such phenomena has to do with a microscopic stick-slip effect due to increasing friction at material contacts. However, earthquakes deep in the Earth's crust, jammed granular matter near jamming onset, plastically deformed microcrystals, bulk metallic glasses, as well as the brain during sleep, all develop oscillatory response as collective stress relaxation channels proliferate but with no apparent connection to friction --if can be defined-- or other microscopic, "friction"-inspired effects. In this talk, I will present a novel universal mechanism for the emergence of oscillatory response in such systems, the self-organized avalanche oscillator. This is a novel critical state exhibiting oscillatory approaches toward an interface depinning critical point. While the theory is general enough to be applicable to all aforementioned phenomena, I will demonstrate how its predictions are faithfully exhibited in a thorough experimental investigation of slowly compressed Ni microcrystals, where unconventional quasi-periodic plastic bursts and higher critical exponents are observed while the nominal strain rate is decreased.

HOST: Mark Reed