



Wednesday July 16, 2014

**Seminar 3:30 PM - Refreshments prior to seminar
BRK, ROOM 1001**

Mark Rudner

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at Niels Bohr International Academy in Copenhagen*

“Coupling of Electron Spin Dynamics and Nanomechanical Motion in Carbon Nanotubes”

Due to their low masses and high stiffnesses, nanostructures made out of atomically-thin carbon-based materials such as graphene and carbon nanotubes (CNTs) feature high mechanical oscillation frequencies and large zero-point vibration amplitudes. These properties open many avenues for exploring both fundamental phenomena and potential applications based on the coupling of nanomechanical and electronic degrees of freedom. The recently discovered strong spin-orbit coupling in CNTs provides an intrinsic coupling between electron spins and flexural motion of the nanotube. For a long nanotube with a quasi-continuous phonon spectrum, we show that this coupling gives rise to a dramatic enhancement of the electron spin relaxation rate near a level crossing in the Zeeman spectrum of a few-electron nanotube quantum dot spin qubit, as observed in recent experiments. For a short suspended nanotube with well-separated discrete phonon modes, this system can provide a natural solid state realization of the Jaynes-Cummings model of quantum optics. Our estimates indicate that, with currently achievable experimental parameters, the strong coupling regime of coherent spin-phonon exchange is within reach. Detection schemes and potential applications will be discussed.

Brief Bio: After earning his PhD in Physics at the Massachusetts Institute of Technology (2008), he spent 3 years as a postdoctoral fellow at Harvard University. In 2011 he joined the faculty of Ohio State University as an Assistant Professor, before moving to NBIA in the fall of 2012. Mark has worked on a wide range of topics, including electron-nuclear spin dynamics in semiconductor quantum dots, electron transport and photothermal effects in graphene, spin-orbit coupling in carbon nanotubes, and topological phenomena in dissipative and periodically-driven systems.