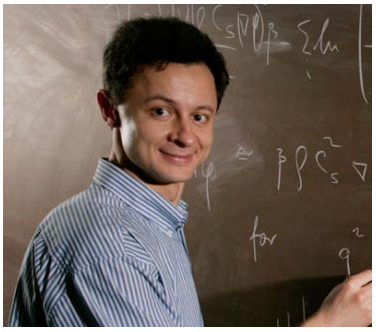
TcSUH Bi-Weekly Seminar

Temperature-driven narrowing of the insulating gap as a precursor of the insulator-to-metal transition: Implications for the electronic structure of solids



Prof. Vassiliy Lubchenko

Professor, Department of Chemistry; TcSUH PI

Friday, October 25, 2019

Room 102, Houston Science Center
12:00 p.m. – 1:00 p.m.

ABSTRACT: We present a microscopic picture rationalizing the surprisingly steep decrease in the bandgap with temperature in insulators, crystalline or otherwise. The gap narrowing largely results from fluctuations of long-wavelength optical phonons—when the latter are present—or their disordered analogs if the material is amorphous. We elaborate on this notion to show that possibly with the exception of weakly bound solids made of closed-shell electronic configurations, the existence of an insulating gap or pseudogap in a periodic solid implies that optical phonons must be present, too. This means that in an insulating solid, the primitive cell must have at least two atoms and/or that a charge density wave is present, with the possible exception of weakly bonded solids such as rare-gas or ferromagnetic Wigner crystals. As a corollary, a (periodic) elemental solid held together by nonclosed shell interactions and whose primitive unit contains only one atom will ordinarily be a metal, consistent with observation. Consequences of the present picture for Wigner solids are discussed. A simple field theory of the metal-insulator transition is constructed that directly ties long-wavelength optical vibrations with fluctuations of an order parameter for the metal-insulator transition. The order parameter is shown to have at least two components, yet no Goldstone mode arises as a result of the transition. If time permits, I will touch on our recent work that views distinct types of bonding in the solids states as distinct phases of the electronic fluid.

BIO: Vassiliy Lubchenko is professor of Chemistry and Physics at UH. His research interests include the structural glass transition, inorganic solid states chemistry, and anomalous aggregation behaviors in liquid solutions. Lubchenko is a recipient of the Beckman Young Investigator Award, the Sloan Research Fellowship, and the NSF CAREER Award.

RSVP by Thursday at Noon to bdherndo@central.uh.edu for Vietnamese sandwiches.

Persons with disabilities who require special accommodations to attend this lecture should call (713) 743-8213.