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Baton Rouge, Louisiana 70803-4001

WEEKLY CALENDAR

November 5-9, 2012

DEPARTMENTAL COLLOQUIUM

"Observation of Zitterbewegung in a degenerate quantum gas"

3:30 PM, November 8, 2012
109 Nicholson Hall

Ian Spielman
National Institute of Standards and Technology (NIST)

Host: Daniel Sheehy

• Refreshments served at 3:10 PM in 232 (Library) Nicholson Hall •

Here I present our experimental work on Bose-Einstein condensates, systems of ultra-cold charge neutral atoms at a temperature of about 100 nano-Kelvin: one billion times colder than room temperature. These condensates - quantum gases - are nearly perfect quantum mechanical systems, and here we demonstrate a technique by which these charge neutral particles have articial spin-orbit coupling, of a form more well known in material systems.

In one limit, this spin-orbit coupled system is described by the 1D relativistic Dirac equation. Among the earliest predictions of relativistic quantum mechanics is Schrödinger's suggestion that a relativistic quantum particle, such as an electron, should undergo a microscopic trembling - Zitterbewegung - is it moves. For the electron, the $f = mc^2/h \approx 1 \times 10^{20}$ Hz frequency and $\delta x = h/mc \approx 2$ pm amplitude of this motion is below any foreseeable threshold for detection. This desperate situation can be happily resolved by working with articial relativistic systems such as graphene, or as here with ultracold atoms where c can be vastly decreased and where the mass m is tunable. In our experiment, where $c \approx 6$ mm/s, $f \sim 1$ kHz and $\delta x \sim 0.5$ μm, Zitterbewegung is easily observed.

In our engineered system, we observed Zitterbewegung and directly measured the frequency and amplitude of this microscopic motion, and nd it to be in agreement with our relativistic model.

Louisiana Alliance for Simulation-Guided Materials Applications

Fall Seminar Series

3:30pm - 4:30pm, Wednesday, November 7, 2012

Johnston Hall, Room 338

Transport in Thermoelectric Materials

by

David J. Singh

Oak Ridge National Laboratory, Oak Ridge, TN

Abstract: There is increasing interest in thermoelectric materials motivated in part by recent progress and in part by the potential of these materials in various energy technologies. Thermoelectric performance is a multiply contra-indicated property of matter. For example, it requires (1) high thermopower and high electrical conductivity, (2) high electrical conductivity and low thermal conductivity and (3) low thermal conductivity and high melting point. The keys to progress are finding an optimal balance and finding ways of using complex electronic and phononic structures to avoid the counter-indications mentioned above. In this talk, I discuss some of the issues involved in the context of recent results. These include the surprising doping dependence of the thermopower in PbTe and PbSe, and the interplay between acoustic and optical phonons in PbTe. The potential of some new materials is discussed.

This work was done in collaboration with David Parker, Olivier Delaire and Mao-Hua Du and was supported by the Department of Energy through the S3TEC Energy Frontier Research Center.

Biography: David Singh is a Corporate Fellow at Oak Ridge National Laboratory where he is group leader for the Advanced Materials Group. He specializes in first principles calculations applied to functional materials including thermoelectrics, superconductors, ferroelectrics and radiation detection materials. He is a fellow of the American Physical Society. He obtained his Ph.D. Degree in Physics from the University of Ottawa, did postdoctoral work at the College of William and Mary and the Naval Research Laboratory, where he became a staff member serving until 2004. He has published a book on the LAPW method and more than 400 scientific papers.