A GENERAL THEORY OF SPIN-RELAXATION IN TWO-DIMENSIONAL SEMICONDUCTORS"

V. Galitski

Center for Nanophysics and Advanced Materials and Joint Quantum Institute, University of Maryland, College Park, MD 20742-4111

In this talk, I will review our recent work on microscopic theory of spin relaxation in two-dimensional semiconductors, which was recently verified in an experiment by Orenstein and Koralek (Nature, 2009). Our theory [1] involves a compete microscopic derivation and analysis of spin-charge coupled diffusion equations in the presence of all relevant spin-orbit coupling terms: The linear Rashba, Dresselhaus, and cubic Dresselhaus terms. Spin dynamics is shown to depend on just two independent parameters (constraint to be within a circle in a two-dimensional "dynamic phase diagram") and exhibits qualitatively different dynamic regimes, which include oscillating-in-time behavior, persistent helix behavior in the vicinity of Bernevig-Zhang SU(2) symmetry point, real-space oscillations, etc. The theory fits the experiment extremely well with no adjustable parameters (apart from the couplings, whose values allow an independent experimental verification). In addition, we derive a similar set of spin-charge coupled diffusion equations in the presence of an electric field and analyze a new setup for the observation of a bulk version of (direct and inverse) spin Hall effect [2]. Usually, a manifestation of the effect is a spin or charge accumulation at sample boundaries, but it is shown that in the presence of a periodic perturbation in the form spin/charge-density wave and an electric field, a charge/spin-density wave can be induced in the bulk of the sample, originating form the same spin-Hall physics.

References

[1] T. D. Stanescu and V. M. Galitski, Phys. Rev. B 75 , 125307 (2007)
[2] B. Anderson, T. D. Stanescu, and V. M. Galitski, to appear as Phys. Rev., Rapid Comms. (2010) [http://arxiv.org/abs/0905.2771]