MAR09-2008-000561

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Optical Control of Topological Quantum Transport in Semiconductors

WANG YAO, The University of Hong Kong

Spin-orbit coupling enables electrical manipulations of spins, e.g. through the spin Hall effect, but it also causes spin relaxation and thus a rapid loss of information stored in spins. We propose a solution to this dilemma by exploiting light-matter interactions in the reactive regime: light is used as a control knob to switch on/off spin-orbit coupling readily without exciting real carriers. In electron-doped semiconductors, when an off-resonant optical field virtually excites interband transitions, the large spin-orbit coupling in the valence bands can be partially transferred to the photon-dressed conduction band. The adiabatic electronic ground state can thus be reactively controlled by optical pulses, exhibiting anomalous Hall conductivity. By the control of linearly polarized light, a pure spin Hall current of electrons can be driven by an in-plane DC electric field, which results in net spin accumulations at the edges of the optical excitation area. Effectively, one has created a spin battery powered by optical pulses together with DC electric field, which allows the spatial and temporal control of spin generations. The resultant electron spin accumulations can have long lifetime when spin-orbit coupling vanishes with the adiabatic switch off of the control light. Circularly polarized light breaks the time reversal symmetry and can result in spin polarized charge Hall conductance.