Dynamical Self-Quenching of Spin Pumping into Double Quantum Dots
Arne Brataas and Emmanuel I. Rashba
Phys. Rev. Lett. 109, 236803 (2012)
Nuclear spin polarization can be pumped into spin-blockaded quantum dots by multiple Landau-Zener passages through singlet-triplet anticrossings. By numerical simulations of realistic systems with 107 nuclear spins during 105 sweeps, we uncover a mechanism of dynamical self-quenching which results in a fast saturation of the nuclear polarization under stationary pumping. This is caused by screening the random field of the nuclear spins. For moderate spin-orbit coupling, self-quenching persists but its patterns are modified. Our finding explains low polarization levels achieved experimentally and calls for developing new protocols that break the self-quenching limitations.

Nanomechanical read-out of a single spin
P. R. Struck, Heng Wang, Guido Burkard
arXiv:1212.1569
The spin of a single electron in a suspended carbon nanotube can be read out by using its coupling to the nano-mechanical motion of the nanotube. To show this, we consider a single electron confined within a quantum dot formed by the suspended carbon nanotube. The spin- orbit interaction induces a coupling between the spin and one of the bending modes of the suspended part of the nanotube. We calculate the response of the system to pulsed external driving of the mechanical motion using a Jaynes-Cummings model. To account for resonator damping, we solve a quantum master equation, with parameters comparable to those used in recent experiments, and show how information of the spin state of the system can be acquired by measuring its mechanical motion. The latter can be detected by observing the current through a nearby charge detector.

Coulomb drag between ballistic quantum wires
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Phys. Rev. B 86, 245402 (2012)
We develop a kinetic equation description of Coulomb drag between ballistic one-dimensional electron systems, which enables us to demonstrate that equilibration processes between right- and left-moving electrons are crucially important for establishing dc drag. In one-dimensional geometry, this type of equilibration requires either backscattering near the Fermi level or scattering with small-momentum transfer near the bottom of the electron spectrum. Importantly, pairwise forward scattering in the vicinity of the Fermi surface alone is not sufficient to produce a nonzero dc drag resistivity ?D, in contrast to a number of works that have studied Coulomb drag due to this mechanism of scattering before. We show that slow equilibration between two subsystems of electrons of opposite chirality, [U+FFFD]bottlenecked[U+FFFD] by inelastic collisions involving cold electrons near the bottom of the conduction band, leads to a strong suppression of Coulomb drag, which results in an activation dependence of ?D on temperature, instead of the conventional power law. We demonstrate the emergence of a drag regime in which ?D does not depend on the strength of interwire interactions, while depending strongly on the strength of interactions inside the wires.

Even-odd effects in NSN scattering problems: Application to graphene nanoribbons
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arXiv:1212.0659
We study crossed Andreev reflection (CAR) of electrons or holes in normal metal-superconductor-normal metal junctions and highlight some very strong effects of the underlying lattice. In particular, we demonstrate that for sharp interfaces and under certain, albeit generic, symmetry conditions, the CAR probability exactly vanishes for an even number of atoms in the superconducting region. This even-odd effect applies notably to NSN junctions made of graphene nano-ribbons with armchair edges and for zigzag edges with somewhat more restrictive conditions. We analyze its robustness towards smoothing of the boundaries or doping of the sample.

Non-Fermi liquid and topological states with strong spin-orbit coupling
Eun-Gook Moon, Cenke Xu, Yong Baek Kim, Leon Balents
arXiv:1212.1168
We argue that a class of strongly spin-orbit coupled materials, including some pyrochlore iridates and the inverted band gap semiconductor HgTe, may be described by a minimal model consisting of the Luttinger Hamiltonian supplemented by Coulomb interactions, a problem studied by Abrikosov and collaborators. It contains two-fold degenerate conduction and valence bands touching quadratically at the zone center. Using modern renormalization group methods, we update and extend Abrikosov's classic work and show that interactions induce a quantum critical non-Fermi liquid phase, stable provided time-reversal and cubic symmetries are maintained. We determine the universal power-law exponents describing various observables in this "Luttinger Abrikosov Beneslavskii" state, which include conductivity, specific heat,non-linear susceptibility and magnetic Gruneisen number. Furthermore, we determine the phase diagram in the presence of cubic and/or time-reversal symmetry breaking perturbations, which includes topological insulator and Weyl semi-metal phases. Many of these phases possess an extraordinarily large anomalous Hall effect, with the Hall conductivity scaling sub-linearly with magnetization.

Contact-induced spin relaxation in Hanle spin precession measurements
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Phys. Rev. B 86, 235408 (2012)
In the field of spintronics the "conductivity mismatch" problem remains an important issue. Here the difference between the resistance of ferromagnetic electrodes and a (high resistive) transport channel causes injected spins to be backscattered into the leads and to lose their spin information. We study the effect of the resulting contact-induced spin relaxation on spin transport, in particular on nonlocal Hanle precession measurements. As the Hanle line shape is modified by the contact-induced effects, the fits to Hanle curves can result in incorrectly determined spin transport properties of the transport channel. We quantify this effect that mimics a decrease of the spin relaxation time of the channel reaching more than four orders of magnitude and a minor increase of the diffusion coefficient by less than a factor of two. Then we compare the results to spin transport measurements on graphene from the literature. We further point out guidelines for a Hanle precession fitting procedure that allows the reliable extraction of spin transport properties from measurements.

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