arXiv:1408.1100 : Non-Local Transport Mediated by Spin-Supercurrents

Hua Chen, Andrew D. Kent, Allan H. MacDonald, Inti Sodemann

In thin film ferromagnets with perfect easy-plane anisotropy, the component of total spin perpendicular to the easy plane is a good quantum number and the corresponding spin supercurrent can flow without dissipation. In this Letter we explain how spin supercurrents couple spatially remote spin-mixing vertical transport channels, even when easy-plane anisotropy is imperfect, and discuss the possibility that this effect can be used to fabricate new types of electronic devices.

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arXiv:1408.0194 : Critical current oscillation by magnetic field in semiconductor nanowire Josephson junction

Tomohiro Yokoyama, Mikio Eto, Yuli V. Nazarov

We study theoretically the critical current in semiconductor nanowire Josephson junction with strong spin-orbit interaction. The critical current oscillates by an external magnetic field. We reveal that the oscillation of critical current depends on the orientation of magnetic field in the presence of spin-orbit interaction. We perform a numerical simulation for the nanowire by using a tight-binding model. The Andreev levels are calculated as a function of phase difference φ between two superconductors. The DC Josephson current is evaluated from the Andreev levels in the case of short junctions. The spin-orbit interaction induces the effective magnetic field. When the external field is parallel with the effective one, the critical current oscillates accompanying the 0-π like transition. The period of oscillation is longer as the angle between the external and effective fields is larger.

arXiv:1408.0518 : Carrier Transport in 3D Dirac Semimetals

E. H. Hwang, Hongki Min, S. Das Sarma

A theory is developed for the density and temperature dependent carrier conductivity in doped three-dimensional (3D) Dirac materials focusing on resistive scattering from screened Coulomb disorder due to random charged impurities (e.g., dopant ions and unintentional background impurities). The theory applies both in the unroped intrinsic ("high-temperature", $T \gg T_F$) and the doped extrinsic ("low-temperature", $T \ll T_F$) limit with analytical scaling properties for the carrier conductivity obtained in both regimes. The scaling properties can be used to establish the Dirac nature of 3D systems through transport measurements.

arXiv:1408.0746 : The effect of spin-orbit interactions on the 0.7-anomaly in quantum point contacts

Olga Goulko, Florian Bauer, Jan Heyder, Jan von Delft

We study how the conductance of a quantum point contact is affected by spin-orbit interactions, for systems at zero temperature both with and without electron-electron interactions. In the presence of spin-orbit coupling, tuning the strength and direction of an external magnetic field can change the dispersion relation and hence the local density of states in the point contact region. This modifies the effect of electron-electron interactions, implying striking changes in the shape of the 0.7-anomaly and introducing additional distinctive features in the first conductance step.

arXiv:1408.1590 : Effects of disorder on electron tunneling through helical edge states

Pietro Sternativo, Fabrizio Dolcini

A tunnel junction between helical edge states, realized via a constriction in a Quantum Spin Hall system, can be exploited to steer both charge and spin current into various terminals. We investigate the effects of disorder on the transmission coefficient T_p of the junction, by modeling disorder with a randomly varying (complex) tunneling amplitude $\Gamma_p=|\Gamma_p| \exp[i \phi_p]$. We show that, while for a clean junction T_p is only determined by the absolute value $|\Gamma_p|$ and is independent of the phase ϕ_p, the situation can be quite different in the presence of disorder: phase fluctuations may dramatically affect the energy dependence of T_p of any single sample. Furthermore, analyzing three different models for phase disorder (including correlated ones), we

show that not only the amount but also the way the phase ϕ_p fluctuates determines the localization length ξ_{loc} and the sample-averaged transmission. Finally, we discuss the physical conditions in which these three models suitably apply to realistic cases.

arXiv:1408.4937: Tunneling spectroscopy of Majorana-Kondo devices

Erik Eriksson, Andrea Nava, Christophe Mora, Reinhold Egger

We study the local density of states (LDOS) in systems of Luttinger-liquid nanowires connected to a common mesoscopic superconducting island, in which Majorana bound states give rise to different types of topological Kondo effects. We show that electron interactions enhance the low-energy LDOS in the leads close to the island, with unusual exponents due to Kondo physics that can be probed in tunneling experiments.

arXiv:1408.2012 : Long-range Cooper pair splitting Enhanced by Supercurrent
Wei Chen, D. N. Shi, D. Y. Xing

We investigate crossed Andreev reflection (CAR) in a long-range normal metal-superconductor-normal metal junction, with the superconductor carrying a supercurrent along the junction. The energy splitting of quasiparticles in the superconductor induced by the supercurrent opens an energy window, in which CAR can occur over a distance between two normal leads much larger than the superconducting coherence length, with another nonlocal process of elastic cotunneling being completely quenched. As a result, CAR is significantly enhanced within the energy window, and dominates the nonlocal transport, which can be directly measured by the nonlocal differential conductance. The nonlocal entangled electron pairs generated via inverse CAR may belong to opposite or equal energy levels beyond the tunneling limit, and the total entanglement production rate within a unit bias voltage is solely determined by the CAR probability as P=2(1−A2)A2/h. Our work indicates that a long-range Cooper pair splitter with high efficiency of nonlocal entanglement production can be implemented by simply driving a supercurrent.

arXiv:1408.3804 : Detecting a quantum critical point in topological SN junctions

Yashar Komijani, Ian Affleck
A spin-orbit coupled quantum wire, with one end proximate to an s-wave superconductor, can become a topological superconductor, with a Majorana mode localized at each end of the superconducting region. It was recently shown that coupling one end of such a topological superconductor to \emph{two} normal channels of interacting electrons leads to a novel type of frustration and a quantum critical point when both channels couple with equal strength. We propose an experimental method to access this critical point in a \emph{single} quantum wire and show its resilience to disorder.

arXiv:1408.3953 : Spin Orbit coupling and Anomalous Josephson effect in Nanowires
G. Campagnano, P. Lucignano, D. Giuliano, A. Tagliacozzo
A superconductor-semiconducting nanowire-superconductor heterostructure in the presence of spin orbit coupling and magnetic field can support a supercurrent even in the absence of phase difference between the superconducting electrodes. We investigate this phenomenon, the anomalous Josephson effect, employing a model capable of describing many bands in the normal region. We discuss geometrical and symmetry conditions required to have finite anomalous supercurrent and in particular we show that this phenomenon is enhanced when the Fermi level is located close to a band opening in the normal region.

arXiv:1408.3910 : Rényi entropy flows from quantum heat engines
Mohammad H. Ansari, Yuli V. Nazarov

arXiv:1408.4484 **: Coulomb blockade with neutral modes**
Alex Kamenev, Yuval Gefen