Gapped Excitations of unconventional FQHE states in the Second Landau Level

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We report the observation of low-lying collective charge and spin excitations in the second Landau level at $\nu = 2 + 1/3$ and also for the very fragile states at $\nu = 2 + 2/5, 2 + 3/8$ in inelastic light scattering experiments. These modes exhibit a clear dependence on filling factor and temperature suggesting incompressible quantum states. A detailed mode analysis reveals low energy modes at around $70\mu eV$ and a rather sharp mode slightly below the Zeeman energy interpreted as gap and spin wave excitation, respectively. The striking polarization dependence in light scattering is discussed in the framework of stabilization of nematic FQHE states in the second Landau level.

Coincidence of Superparamagnetism and perfect quantization in the Quantum Anomalous Hall state

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Topological insulators doped with transition metals have recently been found to host a strong ferromagnetic state with perpendicular to plane anisotropy as well as support a quantum Hall state with edge channel transport, even in the absence of an external magnetic field. It remains unclear however why a robust magnetic state should emerge in materials of relatively low crystalline quality and dilute magnetic doping. Indeed, recent experiments suggest that the ferromagnetism exhibits at least some superparamagnetic character. We report on transport measurements in a sample that shows perfect quantum anomalous Hall quantization, while at the same time exhibits traits in its transport data which suggest instabilities in the magnetic state. We speculate that this may be evidence that the percolation path interpretation used to explain the transport during the magnetic reversal may actually have relevance over the entire field range.

Supercurrent Reversal in Two-Dimensional Topological Insulators

Alexander Zyuzin, Mohammad Alidoust, Jelena Klinovaja, Daniel Loss, arXiv:1507.05089

We theoretically demonstrate that a supercurrent across a two-dimensional topological insulator subjected to an external magnetic field unambiguously reveals the existence of edge-mode superconductivity. When the edge states of a narrow two-dimensional topological insulator are hybridized, an external magnetic field can close the hybridization gap, thus driving a quantum phase transition from insulator to semimetal states of the topological insulator. Importantly, we find a sign reversal of the supercurrent at the quantum phase transition which offers a simple and experimentally feasible way to observe intrinsic properties of topological insulators including edge-mode superconductivity.

Addressing the Challenges of Using Ferromagnetic Electrodes in the Molecular Spintronics Devices

Pawan Tyagi, Edward Friebe, Collin Baker, arXiv:1507.05146

Ferromagnetic electrodes chemically bonded with thiol functionalized molecules can produce novel molecular spintronics devices. However, major challenges lie in developing Ferromagnetic electrodes based commercially viable device fabrication scheme that consider the susceptibility of ferromagnetic electrodes to oxidation, chemical etching, and stress induced deformations during fabrication and usage. This paper studies NiFe, an alloy used in the present day memory devices and high-temperature engineering applications, as a candidate FM electrode for the fabrication of MSDs. Our spectroscopic reflectance studies show that NiFe start oxidizing aggressively beyond 90 C. The NiFe surfaces, aged for several months or heated for several minutes below 90 C, exhibited remarkable electrochemical activity and were suitable for chemical bonding with the thiol functionalized molecular device elements. NiFe also demonstrated excellent etching resistance and minimized the mechanical stress induced deformities. This paper demonstrates the successful utilization of NiFe electrodes in the tunnel junction based molecular device fabrication approach. This paper is expected to fill the knowledge gap impeding the experimental development of ferromagnetic electrode based molecular spintronics devices for realizing novel logic and memory devices and observing a numerous theoretically predicted phenomenon.

Majorana zero modes in the hopping-modulated one-dimensional p-wave superconducting model

Yi Gao, Tao Zhou, Huaixiang Huang, Ran Huang, arXiv:1507.05380

We investigate the one-dimensional p-wave superconducting model with periodically modulated hopping and show that under time-reversal symmetry, the number of the Majorana zero modes (MZMs) strongly depends on the modulation period. If the modulation period is odd, there can be at most one MZM. However if the period is even, the number of the MZMs can be zero, one and two. In addition, the MZMs will disappear as the chemical potential varies. We derive the condition for the existence of the MZMs and show that the topological properties in this model are dramatically different from the one with periodically modulated potential.

Edge states and local electronic structure around an adsorbed impurity in a topological superconductor

Yuan-Yen Tai, Hongchul Choi, Towfiq Ahmed, C. S. Ting, Jian-Xin Zhu, arXiv:1507.05904

Recently topological superconducting states has attracted a lot of interest. In this work, we consider a topo- logical superconductor with Z2 topological mirror order [1] and $s_{\pm}$-wave superconducting pairing symmetry, within a two-orbital model originally designed for iron-based superconductivity [2]. We predict the existence of gapless edge states. We also study the local electronic structure around an adsorbed interstitial magnetic impurity in the system, and find the existence of low-energy in-gap bound states even with a weak spin polar- ization on the impurity. We also discuss the relevance of our results to the recent STM experiment on Fe(Te,Se) compound with adsorbed Fe impurity [3], for which our density functional calculations show the Fe impurity is spin polarized.

Induced p-wave superconductivity without spin-orbit interactions

Fernanda Deus, Mucio A. Continentino, Heron Caldas, arXiv:1507.05906

The study of Majorana fermions is of great importance for the implementation of a quantum computer. These modes are topologically protected and very stable. It is now well known that a p-wave superconducting wire can sustain, in its topological non-trivial phase, Majorana quasi-particles at its ends. Since this type of superconductor is not found in nature, many methods have been devised to implement it. Most of them rely on the spin-orbit interaction. In this paper we study the superconducting properties of a two-band system in the presence of antisymmetric hybridization. We consider inter-band attractive interactions and also an attractive interaction in one of the bands. We show that superconducting fluctuations with p-wave character are induced in the non-interacting band due to the combined effects of inter-band coupling and hybridization. In the case of a wire, this type of induced superconductivity gives rise to four Majorana modes at its ends. The long range correlation between the different charge states of these modes offers new possibilities for the implementation of protected q-bits.

Stretched exponential decay of Majorana edge modes in many-body localized Kitaev chains under dissipation

Alexander Carmele, Markus Heyl, Christina Kraus, Marcello Dalmonte, arXiv:1507.06117

We investigate the resilience of symmetry-protected topological edge states at the boundaries of Kitaev chains in the presence of a bath which explicitly introduces symmetry-breaking terms. Specifically, we focus on single-particle losses and gains, violating the protecting parity symmetry, which could generically occur in realistic scenarios. In homogeneous systems, we show that the Majorana mode decays exponentially fast. However, we find that it is possible to substantially increase its life-time by eliminating the dissipative dynamics close to the edges. Most importantly, we demonstrate that the Majorana mode can be further stabilized by the inclusion of disorder where the decay of the Majorana converts into a stretched exponential form implying an exponential gain in stability compared to the homogeneous case. In particular, for pure loss dynamics we find a universal exponent $\alpha \approx 2/3$. We show that this holds both in the Anderson and many-body localized regimes. Our results thus provide a concrete recipe to stabilize edge states even in the presence of symmetry-breaking environments.

Superconductivity Induced Topological Phase Transition at the Edge of Even Denominator Fractional Quantum Hall States

Maissam Barkeshli, Chetan Nayak, arXiv:1507.06305

We show that every even-denominator fractional quantum Hall (FQH) state possesses at least two robust, topologically distinct gapless edge phases if charge conservation is broken at the boundary by coupling to a superconductor. The new edge phase allows for the possibility of a direct coupling between electrons and emergent neutral fermions of the FQH state. This can potentially be experimentally probed through geometric resonances in the tunneling density of states at the edge, providing a probe of fractionalized, yet electrically neutral, bulk quasiparticles. Other measurable consequences include a charge e fractional Josephson effect, a charge e/4q quasiparticle blocking effect in filling fraction p/2q FQH states, and modified edge electron tunneling exponents.