
H. Peng, D. De, B. Lv, F. Wei, C.-W. Chu,
Absence of zero-energy surface bound states in $Cu_xBi_2Se_3$ via a study of Andreev reflection spectroscopy,
arXiv:1301.1030
$Cu_xBi_2Se_3$ has been proposed as a potential topological superconductor characterized by an odd-parity full bulk superconducting gap and zero-energy surface Andreev bound states (Majorana fermions). A consequence of such Majorana fermions is a peak in the zero-energy density of states which should lead to a persistent zero-bias-conductance-peak (ZBCP) in Andreev reflection (AR) or tunneling experiments. Here we employ a newly developed nanoscale AR spectroscopy method to study normal metal/superconductor (N-S) devices featuring $Cu_xBi_2Se_3$. The results show that a ZBCP can be tuned in or out from $Cu_xBi_2Se_3$ samples depending on the N-S barrier strength. While the appearance of ZBCP may be traced to different origins, its absence under finite barrier strength represents the absence of zero-energy Majorana fermions. The present observations thus call for a reexamination of the nature of the superconducting state in $Cu_xBi_2Se_3$.

T. R. Kirkpatrick and D. Belitz,
Quantum Phase Transition in a Clean Two-Dimensional Electron System,
Phys. Rev. Lett. **110**, 035702 (2013)
A quantum phase transition that was recently observed in a high-mobility silicon metal-oxide-semiconductor field-effect transistor is analyzed in terms of a scaling theory. The most striking characteristic of the transition is a divergence of the thermopower, according to an inverse linear law, as a critical value of the electron density is approached. A scaling description of this transition yields predictions about the critical behavior of other observables, e.g., the specific heat. We also explore the possibility that this transition realizes a recently predicted transition from a Fermi liquid to a non-Fermi-liquid state.

Nicoletta Gnan, Claudio Maggi, Giorgio Parisi, and Francesco Sciortino,
Generalized Fluctuation-Dissipation Relation and Effective Temperature Upon Heating a Deeply Supercooled Liquid,
Phys. Rev. Lett. **110**, 035701 (2013)
We show that a generalized fluctuation-dissipation relation applies upon instantaneously increasing the temperature of a deeply supercooled liquid. This has the same two-step shape of the relation found upon cooling the liquid, but with opposite violation, indicating an effective temperature that is lower than bath temperature. We show that the effective temperature exhibits some sensible time dependence and that it retains its connection with the partitioned phase space visited in aging. We underline the potential relevance of our numerical results for experimental studies of the fluctuation-dissipation relation in glassy systems.

Yi-feng Yang,
Anomalous Hall effect in heavy electron materials,
Phys. Rev. B **87**, 045102 (2013)
We propose an empirical formula for the anomalous Hall effect in heavy electron materials based on a phenomenological two-fluid description of the f-electron states. This formula incorporates two previous theories, proposed by Fert and Levy in 1987 and Kontani et al. in the early 1990s, and takes into account both incoherent and coherent skew scatterings from local and itinerant f electrons. We perform experimental analysis in several heavy electron compounds and show that the formula provides a consistent description of the evolution of the Hall coefficient in the whole temperature range down to only a few Kelvin.

Y. Yang, H. Li, L. Sheng, R. Shen, D. N. Sheng, and D. Y. Xing,
Topological phase transitions with and without energy gap closing,
arXiv:1301.1618
Topological phase transitions in a three-dimensional (3D) topological insulator (TI) with an exchange field of strength g are studied by calculating spin Chern numbers $C^{\pm}(k_z)$ with momentum k_z as a parameter. When $|g|$ exceeds a critical value g_c, a transition of the 3D TI into a Weyl semimetal occurs, where two Weyl points appear as critical points separating k_z regions with different first Chern numbers. For $|g| < g_c$, $C^{\pm}(kz)$ undergo a transition from ± 1 to 0 with increasing $|k_z|$ to a critical value k_z^{C}. Correspondingly, surface states exist for $|k_z| < k_z^{\mathrm{C}}$, and vanish for $|k_z| \geq k_z^{\mathrm{C}}$. The transition at $|k_z| = k_z^{\mathrm{C}}$ is accompanied by closing of spin spectrum gap rather than energy gap.

Hong-Hao Tu,
Projected BCS states and spin Hamiltonians for the $SO(n)_1$ Wess-Zumino-Witten model,
Phys. Rev. B **87**, 041103(R) (2013)
We propose a class of projected BCS wave functions and derive their parent spin Hamiltonians. These wave functions can be formulated as infinite matrix product states constructed by chiral correlators of Majorana fermions. In one dimension, the spin Hamiltonians can be viewed as SO(n) generalizations of Haldane-Shastry models. We numerically compute the spin-spin

correlation functions and Rényi entropies for n=5 and 6. Together with the results for $n = 3$ and 4, we conclude that these states are critical and their low-energy effective theory is the $SO(n)_1$ Wess-Zumino-Witten model. In two dimensions, we show that the projected BCS states are chiral spin liquids, which support non-Abelian anyons for odd n and Abelian anyons for even n.

Marcus Huber, and Julio I. de Vicente,
Structure of Multidimensional Entanglement in Multipartite Systems,
Phys. Rev. Lett. **110**, 030501 (2013)
We explore the structure of multipartite quantum systems which are entangled in multiple degrees of freedom. We find necessary and sufficient conditions for the characterization of tripartite systems and necessary conditions for any number of parties. Furthermore we develop a framework of multilevel witnesses for efficient discrimination and quantification of multidimensional entanglement that is applicable for an arbitrary number of systems and dimensions.

Jewook Park, Sung Won Jung, Min-Cherl Jung, Hiroyuki Yamane, Nobuhiro Kosugi, and Han Woong Yeom,
Self-Assembled Nanowires with Giant Rashba Split Bands,
Phys. Rev. Lett. **110**, 036801 (2013)
We investigated Pt-induced nanowires on the Si(110) surface using scanning tunneling microscopy (STM) and angle-resolved photoemission. High resolution STM images show a well-ordered nanowire array of 1.6 nm width and 2.7 nm separation. Angle-resolved photoemission reveals fully occupied one-dimensional (1D) bands with a Rashba-type split dispersion. Local dI/dV spectra further indicate well-confined 1D electron channels on the nanowires, whose density of states characteristics are consistent with the Rashba-type band splitting. The observed energy and momentum splitting of the bands are among the largest ever reported for Rashba systems, suggesting the Pt-Si nanowire as a unique 1D giant Rashba system. This self-assembled nanowire can be exploited for silicon-based spintronics devices as well as the quest for Majorana fermions.

Yi-Zhuang You, Chao-Ming Jian, and Xiao-Gang Wen,
Synthetic non-Abelian statistics by Abelian anyon condensation,
Phys. Rev. B **87**, 045106 (2013)
Topological degeneracy is the degeneracy of the ground states in a many-body system in the large-system-size limit. Topological degeneracy cannot be lifted by any local perturbation of the Hamiltonian. The topological degeneracies on closed manifolds have been used to discover/define topological order in many-body systems, which contain excitations with fractional statistics. In this paper, we study a new type of topological degeneracy induced by condensing anyons along a line in two-dimensional topological ordered states. Such topological degeneracy can be viewed as carried by each end of the line defect, which is a generalization of Majorana zero modes. The topological degeneracy can be used as a quantum memory. The ends of line defects carry projective non-Abelian statistics even though they are produced by the condensation of Abelian anyons, and braiding them allows us to perform fault tolerant quantum computations.

Chenjie Wang and D. E. Feldman,
Chirality, Causality, and Fluctuation-Dissipation Theorems in Nonequilibrium Steady States,
Phys. Rev. Lett. **110**, 030602 (2013)
Edges of some quantum Hall liquids and a number of other systems exhibit chiral transport: excitations can propagate in one direction only, e.g., clockwise. We derive a family of fluctuation-dissipation relations in nonequilibrium steady states of such chiral systems. The theorems connect nonlinear response with fluctuations far from thermal equilibrium and hold only in case of chiral transport. They can be used to test the chiral or nonchiral character of the system.

Lei Zhang, Thomas Koschny, and C. M. Soukoulis,
Creating double negative index materials using the Babinet principle with one metasurface,
Phys. Rev. B **87**, 045101 (2013)
Metamaterials are patterned metallic structures which permit access to a novel electromagnetic response, negative index of refraction, impossible to achieve with naturally occurring materials. Using the Babinet principle, the complementary split ring resonator (SRR) is etched in a metallic plate to provide negative ϵ, with perpendicular direction. Here we propose a new design, etched in a metallic plate to provide negative magnetic permeability ?, with perpendicular direction. The combined electromagnetic response of this planar metamaterial, where the negative μ comes from the aperture and the negative ϵ from the remainder of the continuous metallic plate, allows achievement of a double negative index metamaterial (NIM) with only one metasurface and strong transmission. These designs can be used to fabricate NIMs at microwave and optical wavelengths and three-dimensional metamaterials.