Phys. Rev. Lett. **111**, 060802 (2013)

Adiabatic Quantum Motors

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When parameters are varied periodically, charge can be pumped through a mesoscopic conductor without applied bias. Here, we consider the inverse effect in which a transport current drives a periodic variation of an adiabatic degree of freedom. This provides a general operating principle for adiabatic quantum motors which we discuss here in general terms. We relate the work performed per cycle on the motor degree of freedom to characteristics of the underlying quantum pump and discuss the motors' efficiency. Quantum motors based on chaotic quantum dots operate solely due to quantum interference, and motors based on Thouless pumps have ideal efficiency.

Phys. Rev. Lett. **111**, 066602 (2013)

Inverse Spin Hall Effect in a Ferromagnetic Metal

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The inverse spin Hall effect (ISHE) has been observed only in nonmagnetic metals, such as Pt and Au, with a strong spin-orbit coupling. We report the observation of ISHE in a ferromagnetic permalloy (Py) on ferromagnetic insulator yttrium iron garnet (YIG). Through controlling the spin current injection by altering the Py-YIG interface, we have isolated the spin current contribution and demonstrated the ISHE in a ferromagnetic metal, the reciprocal phenomenon of the anomalous Hall effect. A large spin Hall angle in Py, determined from Py thin films of different thicknesses, indicates many other ferromagnetic metals may be exploited as superior pure spin current detectors and for applications in spin current.

Phys. Rev. Lett. **111**, 053003 (2013)

Quantum Quench in an Atomic One-Dimensional Ising Chain

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We study nonequilibrium dynamics for an ensemble of tilted one-dimensional atomic Bose-Hubbard chains after a sudden quench to the vicinity of the transition point of the Ising paramagnetic to antiferromagnetic quantum phase transition. The quench results in coherent oscillations for the orientation of effective Ising spins, detected via oscillations in the number of doubly occupied lattice sites. We characterize the quench by varying the system parameters. We report significant modification of the tunneling rate induced by interactions and show clear evidence for collective effects in the oscillatory response.

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Dynamics of an Insulating Skyrmion under a Temperature Gradient

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We study the Skyrmion dynamics in thin films under a temperature gradient. Our numerical simulations show that both single and multiple Skyrmions in a crystal move towards the high temperature region, which is contrary to particle diffusion. Noticing a similar effect in the domain wall motion, we employ a theory based on magnon dynamics to explain this counterintuitive phenomenon. Unlike the temperature driven domain wall motion, the Skyrmion's topological charge plays an important role, and a transverse Skyrmion motion is observed. Our theory turns out to be in agreement with numerical simulations, both qualitatively and quantitatively. Our calculation indicates that a very promising Skyrmion dynamic phenomenon can be observed in experiments.

Phys. Rev. B **88**, 035131 (2013)

Bosonic topological insulator in three dimensions and the statistical Witten effect

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It is well known that one signature of the three-dimensional electron topological insulator is the Witten effect: if the system is coupled to a compact electromagnetic gauge field, a monopole in the bulk acquires a half-odd-integer polarization charge. In the present work, we propose a corresponding phenomenon for the topological insulator of bosons in three dimensions protected by particle number conservation and time-reversal

symmetry. We claim that although a monopole inside a topological insulator of bosons can remain electrically neutral, its statistics are transmuted from bosonic to fermionic. We demonstrate that this "statistical Witten effect" directly implies that if the surface of the topological insulator is neither gapless, nor spontaneously breaks the symmetry, it necessarily supports an intrinsic two-dimensional topological order. Moreover, the surface properties can not be fully realized in a purely two-dimensional system. We also confirm that the surface phases of the bosonic topological insulator proposed by Vishwanath and Senthil [Phys. Rev. X 3 011016 (2013)] provide a consistent termination of a bulk exhibiting the statistical Witten effect. In a forthcoming paper, we will provide an explicit field-theoretic, lattice-regularized construction of the three-dimensional topological insulator of bosons, employing a parton decomposition and subsequent condensation of parton-monopole composites.

Nature Physics **9**, 499-504 (2013)

Mapping the orbital wavefunction of the surface states in three-dimensional topological insulators

Yue Cao,1 et ak.

Understanding the structure of the wavefunction is essential for depicting the surface states of a topological insulator. Owing to the inherent strong spin–orbit coupling, the conventional hand-waving picture of the Dirac surface state with a single chiral spin texture is incomplete, as this ignores the orbital components of the Dirac wavefunction and their coupling to the spin textures. Here, by combining orbital-selective angle-resolved photoemission experiments and first-principles calculations, we deconvolve the in-plane and out-of-plane p-orbital components of the Dirac wavefunction. The in-plane orbital wavefunction is asymmetric relative to the Dirac point. It is predominantly tangential (radial) to the k-space constant energy surfaces above (below) the Dirac point. This orbital texture switch occurs exactly at the Dirac point, and therefore should be intrinsic to the topological physics. Our results imply that the Dirac wavefunction has a spin–orbital texture—a superposition of orbital wavefunctions coupled with the corresponding spin textures.

Nature Physics **9**, 505-511(2013)

Domain wall trajectory determined by its fractional topological edge defects

Aakash Pushp, et al.

A domain wall (DW) in a ferromagnetic nanowire is composed of elementary topological bulk and edge defects with integer and fractional winding numbers, respectively, whose relative spatial arrangement determines the chirality of the DW. Here we show how we can understand and control the trajectory of DWs in magnetic branched networks, composed of connected nanowires, by considering their fractional elementary topological defects and how they interact with those innate to the network. We first develop a highly reliable mechanism for the injection of a DW of a given chirality into a nanowire and show that its chirality determines which branch the DW follows at a symmetric Y-shaped magnetic junction—the fundamental building block of the network. Using these concepts, we unravel the origin of the one-dimensional nature of magnetization reversal of connected artificial spin ice systems that have been observed in the form of Dirac strings.

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Majorana Fermions on Zigzag Edge of Monolayer Transition Metal Dichalcogenides

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Majorana fermions, quantum particles with non-Abelian exchange statistics, are not only of fundamental importance, but also building blocks for fault-tolerant quantum computation. Although certain experimental breakthroughs for observing Majorana fermions have been made recently, their conclusive dection is still challenging due to the lack of proper material properties of the underlined experimental systems. Here we propose a new platform for Majorana fermions based on edge states of certain non-topological two-dimensional semiconductors with strong spin-orbit coupling, such as monolayer group-VI transition metal dichalcogenides (TMD). Using first-principles calculations and tight-binding modeling, we show that zigzag edges of monolayer TMD can host well isolated single edge band with strong spin-orbit coupling energy. Combining with proximity induced s-wave superconductivity and in-plane magnetic fields, the zigzag edge supports robust topological Majorana bound states at the edge ends, although the two-dimensional bulk itself is non-topological. Our findings points to a controllable and integrable platform for searching and manipulating Majorana fermions.