[1] *Dolcetto G., Cavaliere F., Ferraro D., and Sassetti M.*
Generating and controlling spin-polarized currents induced by a quantum spin Hall antidot.
Physical Review B **87**, 085425 (February 2013).
We study an electrically controlled quantum spin Hall antidot embedded in a two-dimensional topological insulating bar. Helical edge states around the antidot and along the edges of the bar are tunnel coupled. The close connection between spin and chirality, typical of helical systems, allows to generate a spin-polarized current flowing across the bar. This current is studied as a function of the external voltages, by varying the asymmetry between the barriers. For asymmetric setups, a switching behavior of the spin current is observed as the bias is increased, both in the absence and in the presence of electron interactions. This device allows to generate and control the spin-polarized current by simple electrical means.

[2] *Hunter L., Gordon J., Peck S., Ang D., and Lin J.F.*
Using the Earth as a polarized electron source to search for long-range spin-spin interactions.
Science **339**, 928–932 (February 2013).
Many particle-physics models that extend the standard model predict the existence of long-range spin-spin interactions. We propose an approach that uses the Earth as a polarized spin source to investigate these interactions. Using recent deep-Earth geophysics and geochemistry results, we create a comprehensive map of electron polarization within the Earth induced by the geomagnetic field. We examine possible long-range interactions between these spin-polarized geoelectrons and the spin-polarized electrons and nucleons in three laboratory experiments. By combining our model and the results from these experiments, we establish bounds on torsion gravity and possible long-range spin-spin forces associated with the virtual exchange of either spin-one axial bosons or unparticles.

[3] *Lucignano P., Tafuri F., and Tagliacozzo A.*
Topological rf-SQUID with a frustrating pi-junction for probing the Majorana bound state.
arXiv:1302.5242 (February 2013).
Majorana Bound States are predicted to appear as boundary states of the Kitaev model. Here we show that a π-Josephson Junction, inserted in a topologically non trivial model ring, sustains a Majorana Bound State, which is robust with respect to local and non local perturbations. The realistic structure could be based on a High-T_c Superconductor tricrystal structure, similar to the one used to spot the d-wave order parameter. The presence of the Majorana Bound State changes the ground state of the topologically non trivial ring in a measurable way, with respect to that of a conventional one.

[4] *Ojanen T. and Kitagawa T.*
Anomalous electromagnetic response of superconducting Rashba systems in trivial and topological phases.
Physical Review B **87**, 014512 (January 2013).
Two-dimensional electron systems with spin-orbit coupling in the proximity of a superconductor and a magnetic insulator have recently been considered as promising candidates to realize topological superconducting phases. Here we discuss electromagnetic response properties of these systems. Breaking of time-reversal symmetry leads to an anomalous Hall effect with a characteristic nonmonotonic gate voltage dependence and a Hall conductivity that can change a sign as temperature is varied. The imaginary part of the Hall conductivity at finite frequency, which shows up for example in the Kerr rotation or photoabsorption, can distinguish different topological phases. In addition, we demonstrate the existence of magnetoelectric effects associated with the Hall effect; in-plane electric fields induce a parallel magnetization and in-plane time-dependent magnetic fields induce parallel electric current.

[5] *Voloch-Bloch N., Lereah Y., Lilach Y., Gover A., and Arie A.*
Generation of electron Airy beams.
Nature **494**, 331–335 (February 2013).
Within the framework of quantum mechanics, a unique particle wave packet exists in the form of the Airy function. Its counterintuitive properties are revealed as it propagates in time or space: the quantum probability wave packet preserves its shape despite dispersion or diffraction and propagates along a parabolic caustic trajectory, even though no force is applied. This does not contradict Newton's laws of motion, because the wave packet centroid propagates along a straight line. Nearly 30 years later, this wave packet, known as an accelerating Airy beam, was realized in the optical domain; later it was generalized to an orthogonal and complete family of beams that propagate along parabolic trajectories, as well as to beams that propagate along arbitrary convex trajectories. Here we report the experimental generation and observation of the Airy beams of free electrons. These electron Airy beams were generated by diffraction of electrons through a nanoscale hologram, which imprinted on the electrons' wavefunction a cubic phase modulation in the transverse plane. The highest-intensity lobes of the generated beams indeed followed parabolic trajectories. We directly observed a non-spreading electron wavefunction that self-heals, restoring its original shape after passing an obstacle. This holographic generation of electron Airy beams opens up new avenues for steering electronic wave packets like their photonic counterparts, because the wave packets can be imprinted with arbitrary shapes or trajectories.

[6] *Weithofer L. and Recher P.*
Chiral Majorana edge states in HgTe quantum wells.
arXiv:1302.5049 (February 2013).
HgTe-based quantum wells (QWs) recently attracted a lot of attention for the realization of a two-dimensional topological insulator with protected helical edge states. Another class of topological systems are topological superconductors (TSCs) with Majorana edge states. In this paper, we show how proximity induced s-wave superconductivity in the bulk of HgTe-QWs and in the presence of a Zeeman field can exhibit a TSC with chiral Majorana edge states. We calculate the topological invariants and the corresponding Majorana edge states explicitly within a four-band model accounting for inversion symmetry breaking terms due to Rashba spin-orbit coupling and bulk inversion asymmetry present in these QWs.

[7] *Maier F., Kloeffel C., and Loss D.*
Tunable g factor and phonon-mediated hole spin relaxation in Ge/Si nanowire quantum dots.
arXiv:1302.5027 (February 2013).
We theoretically consider g factor and spin lifetimes of holes in a longitudinal Ge/Si core/shell nanowire quantum dot that is exposed to external magnetic and electric fields. For the ground states, we find a large anisotropy of the g factor which is highly tunable by applying electric fields. This tunability depends strongly on the direction of the electric field with respect to the magnetic field. We calculate the single-phonon hole spin relaxation times T_1 for zero and small electric fields and propose an optimal setup in which very large T_1 of the order of tens of milliseconds can be reached. Increasing the relative shell thickness or the longitudinal confinement length prolongs T_1 further. In the absence of electric fields, the dephasing vanishes and the decoherence time T_2 is determined by $T_2 = 2T_1$.