Rahul Sawant, Joseph Samuel, Aninda Sinha, Supurna Sinha, and Urbasi Sinha
Nonclassical Paths in Quantum Interference Experiments
Phys. Rev. Lett. **113**, 120406 (2014)

In a double slit interference experiment, the wave function at the screen with both slits open is not exactly equal to the sum of the wave functions with the slits individually open one at a time. The three scenarios represent three different boundary conditions and as such, the superposition principle should not be applicable. However, most well-known text books in quantum mechanics implicitly and/or explicitly use this assumption that is only approximately true. In our present study, we have used the Feynman path integral formalism to quantify contributions from nonclassical paths in quantum interference experiments that provide a measurable deviation from a naive application of the superposition principle. A direct experimental demonstration for the existence of these nonclassical paths is difficult to present. We find that contributions from such paths can be significant and we propose simple three-slit interference experiments to directly confirm their existence.

G. A. H. Schober, K.-U. Giering, M. M. Scherer, C. Honerkamp, M. Salmhofer
Superconducting order in the Rashba model with attractive interaction: Functional renormalization and mean-field approach,
arXiv:1409.7087

We investigate the two-dimensional Rashba model with attractive local interaction using the functional renormalization group (functional RG) and mean-field theory. By means of the functional RG we successively integrate out the high-energy degrees of freedom to study the competing Fermi liquid instabilities and to derive the effective interaction for the electrons at the Fermi energy e_F. We parametrize the scale-dependent interaction vertex in a refined Fermi surface patching scheme and fully implement its spin dependence in an RG flow without SU(2) symmetry. For any value of e_F we find as the leading instability a superconducting phase with singlet-type interaction between electrons with opposite momenta. Using this result, we subsequently employ mean-field theory to predict both the superconducting gap function and the order parameter as a function of eF. While the gap function has a singlet-type spin structure and is independent of e_F, the order parameter indicates a mixture of singlet and triplet superconductivity. The ratio between singlet and triplet amplitudes of the order parameter depends on eF and on the energy band, being plus or minus one for the upper or lower branch of the Rashba dispersion, respectively.

Yuxi Tian, Pedro Navarro, and Michel Orrit
Single Molecule as a Local Acoustic Detector for Mechanical Oscillators,
Phys. Rev. Lett. **113**, 135505 (2014)

A single molecule can serve as a nanometer-sized detector of acoustic strain. Such a nanomicrophone has the great advantage that it can be placed very close to acoustic signal sources and high sensitivities can be achieved. We demonstrate this scheme by monitoring the fluorescence intensity of a single dibenzoterrylene molecule in an anthracene crystal attached to an oscillating tuning fork. The characterization of the vibration amplitude and of the detection sensitivity is a first step towards detection and control of nanomechanical oscillators through optical detection and feedback.

Jiansheng Wu, Jie Liu, and Xiong-Jun Liu
Topological Spin Texture in a Quantum Anomalous Hall Insulator,
Phys. Rev. Lett. **113**, 136403 (2014)

The quantum anomalous Hall (QAH) effect has been recently discovered in an experiment using a thin-film topological insulator with ferromagnetic ordering and strong spin-orbit coupling. Here we investigate the spin degree of freedom of a QAH insulator and uncover the fundamental phenomenon that the edge states exhibit a topologically stable spin texture in the boundary when a chiral-like symmetry is present. This result shows that edge states are chiral in both the orbital and spin degrees of freedom, and the chiral edge spin texture corresponds to the bulk topological states of the QAH insulator. We also study the potential applications of the edge spin texture in designing topological-state-based spin devices, which might be applicable to future spintronic technologies.

Yong Xu, Li Mao, Biao Wu, and Chuanwei Zhang
Dark Solitons with Majorana Fermions in Spin-Orbit-Coupled Fermi Gases,
Phys. Rev. Lett. **113**, 130404 (2014)

We show that a single dark soliton can exist in a spin-orbit-coupled Fermi gas with a high spin imbalance, where spin-orbit coupling favors uniform superfluids over nonuniform Fulde-Ferrell-Larkin-Ovchinnikov states, leading to dark soliton excitations in highly imbalanced gases. Above a critical spin imbalance, two topological Majorana fermions without interactions can coexist inside a dark soliton, paving a way for manipulating Majorana fermions through controlling solitons. At the topological transition point, the atom density contrast across the soliton suddenly vanishes, suggesting a signature for identifying topological solitons.

Peter C. Humphreys, W. Steven Kolthammer, Joshua Nunn, Marco Barbieri, Animesh Datta, and Ian A. Walmsley
Continuous-Variable Quantum Computing in Optical Time-Frequency Modes Using Quantum Memories,
Phys. Rev. Lett. **113**, 130502 (2014)

We develop a scheme for time-frequency encoded continuous-variable cluster-state quantum computing using quantum memories. In particular, we propose a method to produce, manipulate, and measure two-dimensional cluster states in a single spatial mode by exploiting the intrinsic time-frequency selectivity of Raman quantum memories. Time-frequency encoding enables the scheme to be extremely compact, requiring a number of memories that are a linear function of only the number of different frequencies in which the computational state is encoded, independent of its temporal duration. We therefore show that quantum memories can be a powerful component for scalable photonic quantum information processing architectures.

Stefan Müllegger, Stefano Tebi, Amal K. Das, Wolfgang Schöfberger, Felix Faschinger, and Reinhold Koch
Radio Frequency Scanning Tunneling Spectroscopy for Single-Molecule Spin Resonance
Phys. Rev. Lett. **113**, 133001 (2014)

We probe nuclear and electron spins in a single molecule even beyond the electromagnetic dipole selection rules, at readily accessible magnetic fields (few mT) and temperatures (5 K) by resonant radio-frequency current from a scanning tunneling microscope. We achieve subnanometer spatial resolution combined with single-spin sensitivity, representing a 10 orders of magnitude improvement compared to existing magnetic resonance techniques. We demonstrate the successful resonant spectroscopy of the complete manifold of nuclear and electronic magnetic transitions of up to $\Delta I_z=\pm3$ and $\Delta J_z=\pm12$ of single quantum spins in a single molecule. Our method of resonant radio-frequency scanning tunneling spectroscopy offers, atom-by-atom, unprecedented analytical power and spin control with an impact on diverse fields of nanoscience and nanotechnology.
