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Phys. Rev. Lett. 107, 146801 (2011)

**Two-Qubit Gate of Combined Single-Spin Rotation and Interdot Spin Exchange in a Double Quantum Dot**

R. Brunner et al.

A crucial requirement for quantum-information processing is the realization of multiple-qubit quantum gates. Here, we demonstrate an electron spin-based all-electrical two-qubit gate consisting of single-spin rotations and interdot spin exchange in a double quantum dot. A partially entangled output state is obtained by the application of the two-qubit gate to an initial, uncorrelated state. We find that the degree of entanglement is controllable by the exchange operation time. The approach represents a key step towards the realization of universal multiple-qubit gates.

# Nature Physics 7, 790 (2011)

# A quantum memory intrinsic to single nitrogen–vacancy centres in diamond

# G. D. Fuchs, G. Burkard, P. V. Klimov, and D. D. Awschalom

# A quantum memory, composed of a long-lived qubit coupled to each processing qubit, is important to building a scalable platform for quantum information science. These two qubits should be connected by a fast and high-fidelity operation to store and retrieve coherent quantum states. Here, we demonstrate a room-temperature quantum memory based on the spin of the nitrogen nucleus intrinsic to each nitrogen–vacancy (NV) centre in diamond. We perform coherent storage of a single NV centre electronic spin in a single nitrogen nuclear spin using Landau–Zener transitions across a hyperfine-mediated avoided level crossing. By working outside the asymptotic regime, we demonstrate coherent state transfer in as little as 120 ns with total storage fidelity of 88±6%. This work demonstrates the use of a quantum memory that is compatible with scaling as the nitrogen nucleus is deterministically present in each NV centre defect.

Phys. Rev. Lett. 107, 146602 (2011)

**Control of Spin Waves in a Thin Film Ferromagnetic Insulator through Interfacial Spin Scattering**

Z. Wang, Y. Sun, M. Wu, B. Tiberkevich, and A. Slavin

Control of spin waves in a ferrite thin film via interfacial spin scattering was demonstrated. The experiments used a 4.6  *μ*m-thick yttrium iron garnet (YIG) film strip with a 20-nm thick Pt capping layer. A dc current pulse was applied to the Pt layer and produced a spin current across the Pt thickness. As the spin current scatters off the YIG surface, it can either amplify or attenuate spin-wave pulses that travel in the YIG strip, depending on the current or field configuration. The spin scattering also affects the saturation behavior of high-power spin waves.

## Phys. Rev. Lett. 107, 150503 (2011)

## Electron-Mediated Nuclear-Spin Interactions between Distant Nitrogen-Vacancy Centers

# A.Bermudez, F. Jelezko, M. B. Plenio, and A. Retzker

# We propose a scheme enabling controlled quantum coherent interactions between separated nitrogen-vacancy centers in diamond in the presence of strong magnetic fluctuations. The proposed scheme couples nuclear qubits employing the magnetic dipole-dipole interaction between the electron spins and, crucially, benefits from the suppression of the effect of environmental magnetic field fluctuations thanks to a strong microwave driving. This scheme provides a basic building block for a full-scale quantum-information processor or quantum simulator based on solid-state technology.

## Phys. Rev. Lett. 107, 155702 (2011)

# Phase Diagram of Water under an Applied Electric Field

# J. L. Aragones, L. G. MacDowell, J. I. Siepmann, and C. Vega

# Simulations are used to investigate for the first time the anisotropy of the dielectric response and the effects of an applied electric field Eex on the phase diagram of water. In the presence of electric fields ice II disappears from the phase diagram. When Eex is applied in the direction perpendicular to the *ac* crystallographic plane the melting temperatures of ices III and V increase whereas that of ice I*h* is hardly affected. Ice III also disappears as a stable phase when Eex is applied in the direction perpendicular to the *ab* plane. Eex increases by a small amount the critical temperature and reduces slightly the temperature of the maximum density of liquid water. The presence Eex modifies all phase transitions of water but its effect on solid-solid and solid-fluid transitions seems to be more important and different depending on the direction of Eex.

## Phys. Rev. B 84, 125132 (2011)

# Bulk-boundary correspondence of topological insulators from their respective Green’s functions

# A,M. Essin and V. Gurarie

# Topological insulators are noninteracting, gapped fermionic systems which have gapless boundary excitations. They are characterized by topological invariants, which can be written in many different ways, including in terms of Green’s functions. Here we show that the existence of the edge states directly follows from the existence of the topological invariant written in terms of the Green’s functions, for all ten classes of topological insulators in all spatial dimensions. We also show that the resulting edge states are characterized by their own topological invariant, whose value is equal to the topological invariant of the bulk insulator. This can be used to test whether a given model Hamiltonian can describe an edge of a topological insulator. Finally, we observe that the results discussed here apply equally well to interacting topological insulators, with certain modifications.

## Phys. Rev. B 84, 140501(R) (2011)

# Scheme to measure Majorana fermion lifetimes using a quantum dot

# M. Leijnse and K. Flensberg

# We propose a setup to measure the lifetime of the parity of a pair of Majorana bound states. The proposed experiment has one edge Majorana state tunnel coupled to a quantum dot, which in turn is coupled to a metallic electrode. When the Majorana fermions overlap, even a small relaxation rate qualitatively changes the nonlinear transport spectrum, and for strong overlap the lifetime can be read off directly from the height of a current peak. This is important for the usage of Majorana fermions as a platform for topological quantum computing, where the parity relaxation is a limiting factor.

## Phys. Rev. B 84, 165101 (2011)

# Quantum phase transition and fractional excitations in a topological insulator thin film with Zeeman and excitonic masses

# G. Y. Cho and J. E. Moore

# We study the zero-temperature phase diagram and fractional excitations when a thin film of 3D topological insulator has two competing masses: *T*-symmetric exciton condensation and the *T*-breaking Zeeman effect. Two topologically distinct phases are identified: in one, the quasiparticles can be viewed as in a quantum spin Hall phase and in the other a quantum anomalous Hall phase. The vortices of the exciton order parameter can carry fractional charge and statistics of electrons in both phases. When the system undergoes the quantum phase transition between these two phases, the charges, statistics, and the number of fermionic zero mode of the excitonic vortices are also changed. We derive the effective field theory for vortices and external gauge field and present an explicit wave function for the fermionic zero mode localized at the excitonic vortices with or without orbital magnetic field. The quantum phase transition can be measured by optical Faraday or Kerr effect experiments, and, in closing, we discuss the conditions required to create the excitonic condensate.