Entropy-based Tuning of Musical Instruments

Haye Hinrichsen

arXiv:1203.5101v2 [physics.class-ph]; Rev. Bras. Ens. Fis. **34**, 2301 (2012)

The human sense of hearing perceives a combination of sounds 'in tune' if the corresponding harmonic spectra are correlated, meaning that the neuronal excitation pattern in the inner ear exhibits some kind of order. Based on this observation it is suggested that musical instruments such as pianos can be tuned by minimizing the Shannon entropy of suitably preprocessed Fourier spectra. This method reproduces not only the correct stretch curve but also similar pitch fluctuations as in the case of high-quality aural tuning.

Room-Temperature Quantum Bit Memory Exceeding One Second

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Science **336**, 1283 (2012)

Stable quantum bits, capable both of storing quantum information for macroscopic time scales and of integration inside small portable devices, are an essential building block for an array of potential applications. We demonstrate high-fidelity control of a solid-state qubit, which preserves its polarization for several minutes and features coherence lifetimes exceeding 1 second at room temperature. The qubit consists of a single ^{13}C nuclear spin in the vicinity of a nitrogen-vacancy color center within an isotopically purified diamond crystal. The long qubit memory time was achieved via a technique involving dissipative decoupling of the single nuclear spin from its local environment. The versatility, robustness, and potential scalability of this system may allow for new applications in quantum information science.

Exchange-based CNOT gates for singlet-triplet qubits with spin orbit interaction

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arXiv:1206.2579v1 [cond-mat.mes-hall]

We propose a scheme for implementing the CNOT gate over qubits encoded in a pair of electron spins in a double quantum dot. The scheme is based on exchange and spin orbit interactions and on local gradients in Zeeman fields. We find that the optimal device geometry for this implementation involves effective magnetic fields that are parallel to the symmetry axis of the spin orbit interaction. We show that the switching times for the CNOT gate can be as fast as a few nanoseconds for realistic parameter values in GaAs semiconductors. Guided by recent advances in surface codes, we also consider the perpendicular geometry. In this case, leakage errors due to spin orbit interaction occur but can be suppressed in strong magnetic fields.

Strong correlations at topological insulator surfaces and the breakdown of the bulk-boundary correspondence

Manuel J. Schmidt

arXiv:1206.2646v1 [cond-mat.str-el]

The criteria for strong correlations on surfaces of three-dimensional topological insulators are discussed. Usually, the Coulomb repulsion at such surfaces is too weak for driving a phase transition to a strongly correlated regime. I discuss a mechanism and possibilities of its experimental implementation by which the strength of the Coulomb interaction can be tuned over a wide range. In the strongly interacting regime, the surface states are gapped, even though the topological classification of the bulk band structure predicts gapless surface states.

Self-correcting quantum memory with a boundary
Adrian Hutter, James R. Wootton, and Daniel Loss
arXiv:1206.0991v1 [quant-ph]

We study the two-dimensional toric code Hamiltonian with effective long-range interactions between its anyonic excitations induced by coupling the toric code to external fields. It has been shown that such interactions allow to increase the lifetime of the stored quantum information arbitrarily by making L, the linear size of the memory, larger [Phys. Rev. A 82 022305 (2010)]. We show that for these systems the choice of boundary conditions (open boundaries as opposed to periodic boundary conditions) is not a mere technicality; the influence of anyons produced at the boundaries becomes in fact dominant for large enough L. This influence can be both beneficial or detrimental. In particular, we study an effective Hamiltonian proposed in [Phys. Rev. B 83 115415 (2011)] that describes repulsion between anyons and anyon holes. For this system, we find a lifetime of the stored quantum information that grows exponentially in L^2, even for an architecture with open boundaries. However, L is upper-bounded through the breakdown of the perturbative threatment of the underlying Hamiltonian.

Strong correlations at topological insulator surfaces and the breakdown of the bulk-boundary correspondence
Manuel J. Schmidt
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The criteria for strong correlations on surfaces of three-dimensional topological insulators are discussed. Usually, the Coulomb repulsion at such surfaces is too weak for driving a phase transition to a strongly correlated regime. I discuss a mechanism and possibilities of its experimental implementation by which the strength of the Coulomb interaction can be tuned over a wide range. In the strongly interacting regime, the surface states are gapped, even though the topological classification of the bulk band structure predicts gapless surface states.

Theory of Spin Relaxation in Two-Electron Lateral Coupled Quantum Dots
Martin Raith, Peter Stano, Fabio Baruffa, and Jaroslav Fabian
Phys. Rev. Lett. **108**, 246602 (2012)

A global quantitative picture of the phonon-induced two-electron spin relaxation in GaAs double quantum dots is presented using highly accurate numerics. Wide regimes of interdot coupling, magnetic field magnitude and orientation, and detuning are explored in the presence of a nuclear bath. Most important, the giant magnetic anisotropy of the singlet-triplet relaxation can be controlled by detuning switching the principal anisotropy axes: a protected state becomes unprotected upon detuning and vice versa. It is also established that nuclear spins can dominate spin relaxation for unpolarized triplets even at high magnetic fields, contrary to common belief.

Electronic Pumping of Quasiequilibrium Bose-Einstein-Condensed Magnons
Scott A. Bender, Rembert A. Duine, and Yaroslav Tserkovnyak
Phys. Rev. Lett. **108**, 246601 (2012)

We theoretically investigate spin transfer between a system of quasiequilibrated Bose-Einstein-condensed magnons in an insulator in direct contact with a conductor. While charge transfer is prohibited across the interface, spin transport arises from the exchange coupling between insulator and conductor spins. In a normal insulator phase, spin transport is governed solely by the presence of thermal and spin-diffusive gradients; the presence of Bose-Einstein condensation (BEC), meanwhile, gives rise to a temperature-independent condensate spin current. Depending on the thermodynamic bias of the system, spin may flow in either direction across the interface, engendering the possibility of a dynamical phase transition of magnons. We discuss the experimental feasibility of observing a BEC steady state (fomented by a spin Seebeck effect), which is contrasted to the more familiar spin-transfer-induced classical instabilities.