Ultra long spin decoherence times in graphene quantum dots with a small number of nuclear spins

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arXiv:1311.1979 [cond-mat.mes-hall]

We study the dynamics of an electron spin in a graphene quantum dot, which is interacting with a bath of less than ten nuclear spins via the anisotropic hyperfine interaction. Due to substantial progress in the fabrication of graphene quantum dots, the consideration of such a small number of nuclear spins is experimentally relevant. This choice allows us to use exact diagonalization to calculate the longtime average of the electron spin as well as its decoherence time. We investigate the dependence of spin observables on the initial states of nuclear spins and on the position of nuclear spins in the quantum dot. Moreover, we analyze the effects of the anisotropy of the hyperfine interaction for different orientations of the spin quantization axis with respect to the graphene plane. Interestingly, we then predict remarkable long decoherence times of more than 10ms in the limit of few nuclear spins.

On the foundation of statistical mechanics under experimentally realistic conditions: a comparison between the quantum and the classical case

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Focusing on isolated macroscopic systems, described either in terms of a quantum mechanical or a classical model, our two key questions are: In how far does an initial ensemble (usually far from equilibrium and largely unknown in detail) evolve towards a stationary long-time behavior ("equilibration")? In how far is this steady state in agreement with the microcanonical ensemble as predicted by Statistical Mechanics ("thermalization")? In the first part of the paper, a recently developed quantum mechanical treatment of the problem is briefly summarized, putting particular emphasis on the realistic modeling of experimental measurements and non-equilibrium initial conditions. Within this framework, equilibration can be proven under very weak assumptions about those measurements and initial conditions, while thermalization still requires quite strong additional hypotheses. In the second part, an analogous approach within the framework of classical mechanics is developed and compared with the quantum case. In particular, the assumptions to guarantee classical equilibration are now rather strong, while thermalization then follows under relatively weak additional conditions.

Frequency-Stabilized Source of Single Photons from a Solid-State Qubit

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Single quantum dots are solid-state emitters that mimic two-level atoms but with a highly enhanced spontaneous emission rate. A single quantum dot is the basis for a potentially excellent single-photon source. One outstanding problem is that there is considerable noise in the emission frequency, making it very difficult to couple the quantum dot to another quantum system. We solve this problem here with a dynamic feedback technique that locks the quantum-dot emission frequency to a reference. The incoherent scattering (resonance fluorescence) represents the single-photon output, whereas the coherent scattering (Rayleigh scattering) is used for the feedback control. The fluctuations in emission frequency are reduced to 20 MHz, just approximately 5% of the quantum-dot optical linewidth, even over several hours. By eliminating the $1/f$-like noise, the relative fluctuations in quantum-dot noise power are reduced to approximately 10^{-5} at low frequency. Under these conditions, the antibunching dip in the resonance fluorescence is described extremely well by the two-level atom result. The technique represents a way of removing charge noise from a quantum device.

Physicists plan to build a bigger LHC

Eugenie Samuel Reich

Nature **503**, 177 (2013)

Accelerator ring would be 100 kilometers around and run at seven times the energy of the Large Hadron Collider.

Teleportation-induced entanglement of two nanomechanical oscillators coupled to a topological superconductor

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arXiv:1311.2765 [cond-mat.mes-hall]

A one-dimensional topological superconductor features a single fermionic zero mode that is delocalized over two Majorana bound states located at the ends of the system. We study a pair of spatially separated nanomechanical oscillators tunnel-coupled to these Majorana modes. Most interestingly, we demonstrate that the combination of electron-phonon coupling and a finite charging energy on the mesoscopic topological superconductor can lead to an effective superexchange between the oscillators via the non-local fermionic zero mode. We further show that this teleportation mechanism leads to entanglement of the two oscillators over distances that can significantly exceed the coherence length of the superconductor.

Magnetic conveyor belt transport of ultracold atoms to a superconducting atomchip

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arXiv:1311.3155 [quant-ph]

We report the realization of a robust magnetic transport scheme to bring $3x10^8$ ultracold ^{87}Rb atoms into a cryostat. The sequence starts with standard laser cooling and trapping of ^{87}Rb atoms, transporting first horizontally and then vertically through the radiation shields into a cryostat by a series of normal- and superconducting magnetic coils. Loading the atoms in a superconducting microtrap paves the way for studying the interaction of ultracold atoms with superconducting surfaces and quantum devices requiring cryogenic temperatures.

Manipulation of the nuclear spin ensemble in a quantum dot with chirped magnetic resonance pulses

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arXiv:1311.4295 [cond-mat.mes-hall]

The nuclear spins limit many of the quantum properties of nano-scale semiconductors. Manipulating the collective nuclear spin state is key to future progress. We report nuclear magnetic resonance on the quantum dot nuclear spin ensemble (containing 100 000 spins) using highly chirped radio frequency pulses. The inversion of the nuclear polarization mimics that of a single nuclear spin despite the highly inhomogeneous distribution of spins.

Parafermions in interacting nanowire bundle

J. Klinovaja and D. Loss

arXiv:1311.3259 [cond-mat.mes-hall]

Phonon-mediated decay of singlet-triplet qubits in double quantum dots

V. Kornich, C. Kloeffel, and D. Loss

arXiv:1311.2197 [cond-mat.mes-hall]