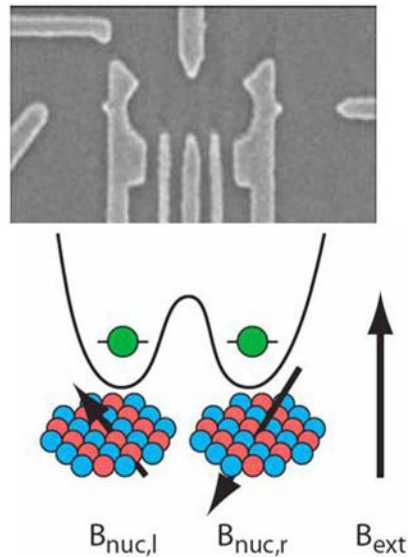


Controlling electron spins and nuclear spins in GaAs double quantum dots

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An attractive candidate for a solid-state quantum bit is based on semiconductor quantum dots, which allow controlled coupling of one or more electrons, using gigahertz frequency control of voltages applied to electrostatic gates. Due to tight confinement and the high degree of isolation from the environment, spin relaxation times in quantum dots can approach millisecond timescales [1]. In this talk I will describe how fast electrical control of the exchange interaction can be used to prepare, manipulate, and measure quantum states on a chip [2]. By separating a spin singlet state on a chip, we measure an ensemble averaged spin dephasing time T_2^* of 10 ns, limited by the contact hyperfine interaction with the GaAs host nuclei. Exchange driven spin rotations allow the implementation of a “singlet-triplet spin echo” pulse sequence, which leads to a spin coherence time, T_2 , exceeding 1 microsecond. Control of the double quantum dot near the singlet-triplet (S- T_+) degeneracy allows nuclear spins to be programmed. Spin can be transferred from the electronic to the nuclear spin system, resulting in nuclear spin polarizations on the order of 20 mT.

[1] A. C. Johnson et al., Nature **435**, 925 (2005).

[2] J. R. Petta et al., Science **309**, 2180 (2005).