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Coherent control and detection of spin qubits in semiconductor with magnetic field engineering[1]

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Electrical control and detection of the spin qubits in semiconductor quantum dots (QDs) are among the major rapidly progressing fields for possible implementation of scalable quantum information processing. Coherent control of one-[1-3] and two-[4,5] spin qubits by electrical means had been demonstrated with various approaches. We have used an engineered magnetic field structure realized with proximal micro-magnets to transduce the spin and charge degrees of freedom and to selectively address one of the two spins [3]. We have demonstrated an all-electrical two-qubit gate consisting of single-spin rotations and interdot spin exchange in double QDs. A partially entangled output state is obtained by the application of the two-qubit gate to an initial, uncorrelated state. Our calculations taking into account of the nuclear spin fluctuation show the degree of entanglement. Non-uniform magnetic field also enables spin selective photon-assisted tunneling in double QDs, which then constitutes non-demolition spin read-out system in combination with a near-by charge detector [6].

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