Jozef Stefan Institute, Department of Theoretical Physics

Solid State Group Seminars

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Single-qubit transformations of spin-charge states of electron on a ring in presence of Rashba coupling

Quantum dots in semiconductor heterojunctions are one of the most suitable candidates for realization of quantum computer. Their advantages are long spin coherence times of electrons in semiconductor, well developed technology of their production and simple scalability, to only name a few. Traditionally, magnetic field is used to manipulate spin, but since it is difficult to use it to address single quantum dot, we seek different ways to control it. In our work we theoretically study the possibility of using only electric field to manipulate spin-charge states in quantum dot. The system of interest is an electron in ring shaped quantum dot, entrapped with external gate potential, enabling a controlled movement of the electron around the ring. By considering the potential as parabolic, we can analytically solve the Schrdinger equation with time dependent position of potential and adiabatically changing Rashba coupling. Spin degenerate ground states of harmonic oscillator, interpreted as qubit states, are transformed with unitary transformation, which can be presented as a rotation of points on Bloch sphere. We show that the axis of rotation depends on strength of Rashba coupling while the angle of rotation is controlled by the shift in position of the electron. Proper selection of translations of electron with suitable Rashba coupling enables an arbitrary single-qubit transformation on the time scale of 10 ns, allowing a few thousand transformation before spin coherence is lost.

Tuesday, June 23th, 3:00pm

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