Spin control and transport in GaAs(111) quantum wells

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The control of the electron spin vector as well as of its coherence time are essential requirements for quantum information processing in semiconductors. Although electric fields can manipulate the spin vector in II-V semiconductors via the spin-orbit interaction, the spin-orbit coupling can also induce spin dephasing, thus reducing the spin lifetime of an electron ensemble. In this talk, we explore the symmetry of the spin-orbit interaction in GaAs quantum wells grown along non-conventional crystallographic directions in order to optimize the electron spin lifetime. We show that QWs grown along the [111] direction are particularly interesting for this purpose, since the spin-orbit interaction can be electrically suppressed for all in-plane wave vectors at low temperatures, thus leading to very long spin lifetimes in an electron ensemble. Studies of the electron spin dynamics combining spatially and time-resolved photoluminescence demonstrate electric-field-enhanced spin lifetimes exceeding 100 ns as well as the transport of out-of-plane polarized spins over several micrometers along the quantum well plane.

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