Spintronics and quantum computing in nanostructures

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If the states of electron spins in solids can be created, manipulated, and measured at the single-quantum level, an entirely new form of information processing, quantum computing and quantum communication, will be possible [1]. I will review a proposed spin-quantum dot architecture for a quantum computer, thereby indicating a variety of first generation nanostructures, as well as magnetic and electrical measurements which should be considered.

I will discuss a spin filter and spin detection mechanism [2] at the single-spin level which can be used for read-in and read-out in conventional as well as in quantum computer gates. Addressing the feasibility of quantum communication with entangled electrons [3, 4]. I discuss electronic Einstein-Podolsky-Rosen pairs produced by an "Andreev entangler" [5, 6] and show that the spin entanglement of two electrons (in a Fermi sea) can be detected in transport and noise measurements in mesoscopic systems [3, 4].

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