

Cooper pair splitting as a source of entangled electrons

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We study an entangled state of spin of spatially separated electrons, in a solid state electronic system. The ground state of conventional superconductors is a singlet state of electron Cooper pairs that can provide a natural source of entangled electrons. One of the proposals to obtain the nonlocal entanglement of electrons is to use the Cooper pairs split in the Double Quantum Dot (DQD) system using the Coulomb interaction between electrons. We have analyzed an efficiency of the separation of Cooper pairs in systems. Addressing the idea of quantum communication with entangled electrons in a solid state, where ferromagnetic detectors allow for spin correlation detection, we provide, using quantum information theory, a lower bound on the spin polarization of detectors. In ferromagnetic detectors the spin information is transformed into charge information, however, any real magnetic materials feature imperfect spin polarization. We find that lower bound for the spin polarization is $p > 58\%$ for detection of entanglement using an optimal entanglement witness. It provides the minimal spin polarization of ferromagnetic materials that can be useful in quantum communication.