Spin readout in exchange interaction quantum computers

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I discuss a method for performing a non-invasive quantum measurement of the spin degree of freedom of electrons in a semiconductor quantum computer. The proposed setup, shown in figure 1, consists of a two-site, two-electron system, which is capacitively coupled to a nearby quantum point contact (QPC) electrometer. The two site system may be formed from a pair of quantum dots, or from a pair of donor impurities. The QPC consists of an insulating potential barrier between two Fermi reservoirs. The tunnelling rate through the QPC is modified by the number of electrons on site '1', via the Coulomb interaction.

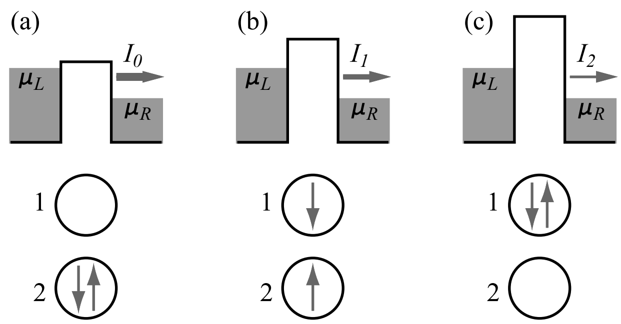

Figure 1: A schematic picture of a two electron, two site system, with a nearby low-transparency quantum point contact. The tunnelling rates through the QPC are modified by the number of electrons on site '1', via the Coulomb interaction.

The total spin of the two electron system can be inferred by observing *spin dependent fluctuations of charge* between the two sites. As a result of the coupling between the sites, it is possible for both electrons to tunnel from one site to the other. However, owing to the Fermionic symmetry of the two-electron wave function, the dynamics of the charge degrees of freedom is strongly affected by the total spin of the system. This spin-dependent charge motion can be detected by continuously observing the current through the electrometer. I show that for a two-electron system in a singlet state (total spin $S = 0$) one observes fluctuations in the output current, while for a triplet state ($S = 1$), these fluctuations are suppressed. Consequently, observing the detector output leads to a quantum measurement in the singlet-triplet basis.

I demonstrate that this scheme can lead to a single shot readout of the total spin of the two electron system. Furthermore, it ought to be possible to implement the measurement with existing detector technology.