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Electron-spin quantum computation: Three- and four-body interactions and other implementation challenges¹

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Several leading quantum computer proposals are based upon electron spins. While these designs do potentially satisfy the DiVincenzo criteria, subtle implementation challenges have been uncovered that need to be addressed if these designs are to be realized successfully. In this talk, we start by pointing out that, when several spins are engaged mutually in pairwise interactions, a change can arise in those interactions. In the case of three spins, the quantitative strengths of the interactions can change. For four or more spins, qualitatively new terms can arise in the Hamiltonian, including four-body interactions. Other implementation challenges are also considered, including the difficulty of performing strong projective measurements on solid state qubits (weak measurements are generally more natural to implement but their behavior is more subtle). These issues will need to be handled in quantum computer realizations, either as a source of error to be overcome or as new physics to be exploited.

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