

Abstract for an Invited Paper
for the MAR11 Meeting of
The American Physical Society

Quantum information in solid-state systems

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I review the theoretical concepts for spin qubits and scalable quantum computers in nanostructures and highlight the experimental progress in this fast moving field [1]. I describe the standard model of quantum computing and the basic criteria for its potential realization in solid state systems such as GaAs heterostructures, carbon nanotubes, InAs or SiGe nanowires, etc. Other alternative formulations such as measurement-based and adiabatic quantum computing are mentioned briefly. I then focus on qubits formed by individual electron spins in single and double GaAs quantum dots. Introducing the problem of decoherence arising from spin orbit and hyperfine interactions I discuss ways to overcome it, such as state narrowing and nuclear magnetism induced by strong correlations [2].

[1] R. Zak, B. Röhlisberger, S. Chesi, and D. Loss, *Rivista del Nuovo Cimento* 033, 345 (2010).

[2] B. Braunecker, P. Simon, and D. Loss, *Phys. Rev. B* 80, 165119 (2009).