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Taming spin decoherence in silicon[1]

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Electron spins in semiconductor hosts have been candidate qubits since the early days of experimental quantum computing research, but it was generally assumed that the solid state environment would limit coherence to times much shorter than that seen in isolated atoms or ions. The longest measured electron spin coherence, measured in isotopically enriched silicon, was of order 1 ms. However, over the last 8 or 10 years the measured electron spin coherence times have steadily increased as materials and experimental techniques have improved. Much of the decoherence observed in the early ensemble Electron Spin Resonance (ESR) experiments arose from interactions amongst the spins being measured. In the most highly enriched bulk silicon measured to date, the residual silicon isotopes with nuclear magnetic moments affect the coherence of electrons bound to phosphorus donors on about a 1 second time scale. The remaining decoherence is still dominated by interactions between the donor spins, even in very lightly doped Si. Other decoherence processes have been shown to be at least an order of magnitude weaker. Recent work suggested that longer spin coherence would be obtained in bismuth doped Si, where magnetic-field insensitive "clock transitions" occur in the GHz frequency range. Recent experiments are bearing out these suggestions.

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