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Electrical control of single spin dynamics[1]

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Over ten years ago, Daniel Loss and David DiVincenzo proposed using the spin of a single electron as a quantum bit. At the time of the proposal, it was not possible to trap a single electron in a device and measure its spin, let alone demonstrate control of quantum coherence. In this talk I will describe recent progress in the field, focusing on two new methods for single spin control that have been developed by my group at Princeton. The first method is based on quantum interference and implements spin-interferometry on a chip. The second method utilizes the strong spin-orbit coupling of InAs. By shifting the orbital position of the electronic wavefunction at gigahertz frequencies, we can control the orientation of a single electron spin and measure the full g-tensor, which exhibits a large anisotropy due to spin-orbit interactions. Both methods for single spin control are orders of magnitude faster than conventional electron spin resonance and allow investigations of single spin coherence in the presence of fluctuating nuclear and spin-orbit fields. I will also describe recent efforts to transfer these methods to silicon quantum dots, where the effects of fluctuating nuclear fields are much smaller.

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