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Electrically Driving Donor Spin Qubits in Silicon Using Photonic Bandgap Resonators A. J. SIGILLITO, A. M. TYRYSHKIN, S. A. LYON, Princeton University — In conventional experiments, donor nuclear spin qubits in silicon are driven using radiofrequency (RF) magnetic fields. However, magnetic fields are difficult to confine at the nanoscale, which poses major issues for individually addressable qubits and device scalability. Ideally one could drive spin qubits using RF electric fields, which are easy to confine, but spins do not naturally have electric dipole transitions. In this talk, we present a new method for electrically controlling nuclear spin qubits in silicon by modulating the hyperfine interaction between the nuclear spin qubit and the donor-bound electron. By fabricating planar superconducting photonic bandgap resonators, we are able to use pulsed electron-nuclear double resonance (ENDOR) techniques to selectively probe both electrically and magnetically driven transitions for ^{31}P and ^{75}As nuclear spin qubits. The electrically driven spin resonance mechanism allows qubits to be driven at either their transition frequency, or at one-half their transition frequency, thus reducing bandwidth requirements for future quantum devices. Moreover, this form of control allows for higher qubit densities and lower power requirements compared to magnetically driven schemes. In our proof-of-principle experiments we demonstrate electrically driven Rabi frequencies of approximately 50 kHz for widely spaced (10 μm) gates which should be extendable to MHz for nanoscale devices.

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