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Donor spin qubits with robust long-distance coupling VIVIEN SCHMITT, GUILHERME TOSI, FAHD MOHIYADDIN, STEFANIE TENBERG, ARNE LAUCHT, UNSW Sydney, RAJIB RAHMAN, GERHARD KLIMECK, Purdue University, ANDREA MORELLO, UNSW Sydney — Single-donor spin qubits in silicon have been shown to be among the most coherent in the solid state [1]. However, scaling up beyond one donor to build a scalable quantum computer architecture remains a great challenge. Here we propose to use the flip-flop states of electron and nucleus of an implanted phosphorus atom as a qubit. We induce an electric dipole by biasing the electron wavefunction between the donor and an interface state. This dipole couples the flip-flop states to a resonant oscillating electric field, which can drive fast transitions between the qubit states. The electric dipole-dipole interaction between two donors allows robust two-qubit logic gates at long-distance (200 nm). We present simulated single- and two-qubit gate fidelities exceeding 99% in the presence of realistic values of charge noise, and show that the ability to electrically drive and couple the qubits does not result in a deterioration of their coherence properties. Prototypical devices are currently being tested to demonstrate the predicted behavior. [1] J. T. Muhonen, et.al. Nature Nanotechnol. 9, 986 (2014). [2] G. Tosi, et.al. arXiv:1509.08538 (2015).

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