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A photonic link for donor spin qubits in silicon

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Atomically identical donor spin qubits in silicon offer excellent native quantum properties, which match or outperform many qubit rivals. To scale up such systems it would be advantageous to connect silicon donor spin qubits in a cavity-QED architecture. Many proposals in this direction introduce strong electric dipole interactions to the otherwise largely isolated spin qubit ground state in order to couple to superconducting cavities. Here I present an alternative approach, which uses the built-in strong electric dipole (optical) transitions of singly-ionized double donors in silicon. These donors, such as chalcogen donors S+, Se+ and Te+, have the same ground-state spin Hamiltonians as shallow donors yet offer mid-gap binding energies and mid-IR optical access to excited orbital states. This photonic link is spin-selective which could be harnessed to measure and couple donor qubits using photonic cavity-QED. This approach should be robust to device environments with variable strains and electric fields, and will allow for CMOS- compatible, bulk-like, spatially separated donor qubit placement, optical parity measurements, and 4.2K operation. I will present preliminary data in support of this approach, including 4.2K optical initialization/readout in Earth's magnetic field, where long T1 and T2 times have been measured.