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Telecom spin-photon interfaces in silicon

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To build a silicon-based global quantum network it would be advantageous to efficiently link silicons famously long-lived spin qubits directly to photons in the telecommunications bands. A class of light-emitting centres in group IV semiconductors called radiation damage centres are promising candidates towards this goal. A few notable radiation damage centres in diamond, silicon, and silicon carbide have been studied extensively. While some of the centres in silicon are known to emit light in the telecommunications bands, there has been little work to determine if any support long-lived spin qubits or potential spin/photon conversion possibilities. We have found the photoluminescence of many of these centres is much sharper in silicon-28 than natural silicon, often by over two orders of magnitude, and in some instances indicate near transform-limited luminescence in the bulk. [1] We will report on recent developments studying these centres for applications as spin qubits in isotopically purified silicon-28. We have identified long-lived spins, both electron and nuclear, connected with relatively efficient telecommunication band spin-dependent photon emission. We also report significantly sharper linewidths allowing us to resolve fine structure in several centres. Lastly, we will discuss the prospects and progress towards integrating these centres in silicon-on-insulator integrated photonic circuits.

[26] C. Chartrand, L. Bergeron, K.J. Morse, H. Riemann, N.V. Abrosimov, P. Becker, H.-J. Pohl, S. Simmons, and M.L.W. Thewalt. Highly enriched 28Si reveals remarkable optical linewidths and fine structure for well-known damage centers. PRB 98:195201 (2018).