

A fibre-coupled single-erbium-ion source in silicon nanophotonics

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Erbium in silicon combines telecommunications C-band transitions with long optical and electron-spin coherence [1], but its millisecond lifetime constrains photon generation. Here, we demonstrate a fibre-coupled single-photon source from individual Er ions in silicon photonic-crystal cavities. Each device integrates 40 cavities (mode volume approximately $0.04 \mu\text{m}^3$; quality factor near 100,000) on a common bus waveguide, with approximately 50% measured waveguide-to-tapered-fibre outcoupling. Magnetic-field tuning brings individual Er transitions into resonance with the cavity modes. For the most strongly coupled ion, the excited-state lifetime is reduced from 1.68 ms to $1.5 \mu\text{s}$, directly enhancing the total emission rate by more than a factor of 1000; correcting for the optical branching ratio implies a transition Purcell factor of approximately 5000. Pulsed Hanbury Brown and Twiss measurements give $g^2(0) = 0.001$, corresponding to a single-photon purity of approximately 0.999. A detected rate of approximately 3700 counts/s corresponds to an estimated in-fibre photon flux of approximately 60 kHz after accounting for excitation, spin shelving, optical transmission and detector efficiency. Similar lifetime reductions across cavities, and coupling of the same Er site in separate devices and fibre channels, demonstrate a reproducible fibre-addressed silicon architecture for telecom-band single-photon generation.

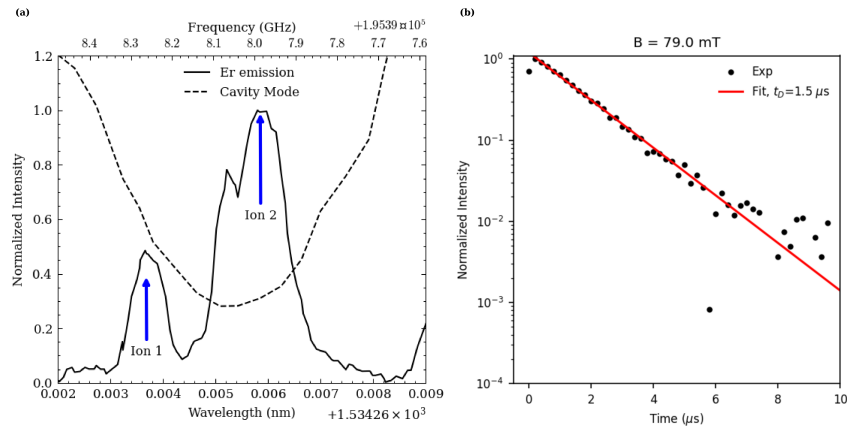


Figure 1. Cavity-enhanced emission from individual Er ions. (a) Magnetically tuned single-ion transitions near a cavity resonance. (b) The optical lifetime is reduced to $1.5 \mu\text{s}$ at zero detuning.

[1] I. R. Berkman et al., npj Quantum Information 11, 66 (2025).

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