Indistinguishable single photons from a single Er^{3+} ion

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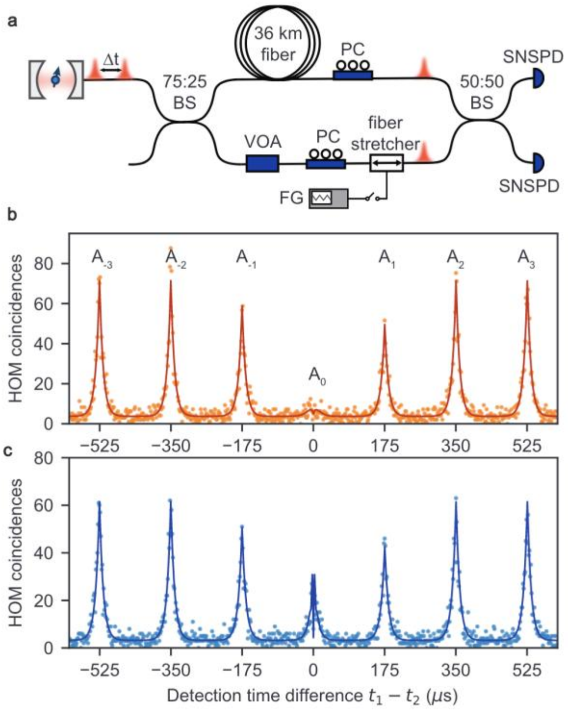
Atomic defects in solid-state crystals are widely explored as single-photon sources and quantum memories for quantum communications networks based on quantum repeaters. Rare earth ions, in particular Er^{3+}, have several unique features including a telecom-band optical transition facilitating long-distance entanglement distribution, and compatibility with a broad range of materials and device structures. I will give an overview of recent work from our lab including fast photon emission from single Er^{3+} ions using silicon nanophotonic cavities [1], single-shot spin readout [2], sub-wavelength addressing based on spectral multiplexing [3] and coherent control of nearby nuclear spins [4]. Through systematic materials exploration, we have significantly extended the spin and optical coherence times of Er^{3+} ions, enabling indistinguishable single-photon emission [5]. I will conclude by discussing ongoing efforts to probe spin-spin interactions, and how these advances may be combined into a practical quantum repeater architecture.



Indistinguishable single photons from a single Er^{3+} ion: (a) Schematic of Hong-Ou-Mandel (HOM) interferometer with 36 km delay line, (b) HOM interference with visibility V > 0.8, (c) the interference vanishes when adding phase noise to one arm.

References (10 pt, Times New Roman)

[1] A. M. Dibos, et al, PRL **120**, 243601 (2018).
[2] M. Raha, et al, Nat. Comm. **11**, 1605 (2020).
[3] S. Chen, et al, Science **370**, 592 (2020).
[4] M. T. Uysal, et al, arXiv:2209.05631.
[5] S. Ourari et al, arXiv: 2301.03564.