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Cavity assisted ion-photon entanglement

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Trapped ions are one of the leading platforms for quantum networks. They benefit from long coherence times, high-fidelity state preparation, readout and gate operations. However, the number of ions that can be well-controlled in any individual trap is very limited. To circumvent this limitation ions can be distributed among many smaller traps that are connected via photonic links [1]. In this way, entanglement can be shared across traps facilitating the scaling of ion-based quantum computers to large numbers of qubits. To demonstrate efficient photonic links between ion traps, we couple single calcium-40 ions trapped in a linear Paul trap to an optical cavity formed by two macroscopic mirrors to generate photons. By driving two separate Raman transitions simultaneously the ion state can be entangled with the polarisation state of the photon [2]. By using a cavity to perform this ion-photon entanglement we aim to improve the rate of entanglement production. This ion-photon entanglement can then be employed to generate ion-ion entanglement across a quantum network.

[1] T. Ward and M. Keller, New J. Phys. 24 123028 (2022)
[2] A. Stute et al., Nature 485, 482 (2012)

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