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Progress towards long-range entanglement of $^{40}Ca^{+}$ ions in a surface-electrode trap with an integrated fiber Fabry-Perot cavity.

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Remote entanglement using a quantum network has applications in distributed quantum computation, long-range quantum sensing, and secure quantum communication. Trapped ions present unique advantages as the quantum repeater node of a quantum network due to the ability to precisely prepare, control, and manipulate each qubit, perform high fidelity operations between qubits, and maintain superposition states for extended times. Here I present our new effort to create a long-range quantum network of $^{40}Ca^{+}$ ions. Ions will be trapped in a surface electrode trap, with an integrated fiber-based optical cavity that collects the flying qubits into an optical fiber. The system operates at cryogenic temperatures to reduce ion motional heating from the dielectrics in the cavity and for fast iteration of ion trap and cavity designs. The cavity uses micromirrors that are fabricated on a 2'' wafer, singulated, and attached to the tip of a single-mode optical fiber. These micromirrors have demonstrated scattering loss less than 1 ppm at telecom wavelengths, supporting a finesse above 1 million over a range of radius of curvatures from 100 μm to 1 m.

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