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Photon-mediated entanglement of co-trapped atomic barium ions

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Long chains of trapped ions are a leading platform for quantum information processing, but their control suffers from spectral crowding and excess motional heating when chains grow too long. One proposal to access larger Hilbert spaces and thus more computational power is to entangle ions in separate traps via photonic interconnects. Previous demonstrations have used 0.6 NA objectives to entangle ytterbium [1] and strontium [2] ions or optical cavities to entangle calcium ions [3]. Here, we make use of an RF Paul trap surrounded by two in-vacuo 0.8 NA aspheric lenses to entangle co-trapped barium ions. The higher NA increases the efficiency of our photonic interconnects and the presence of two high-NA imaging systems in a single vacuum chamber will allow this system to be integrated as the middle node in a three-node quantum network.

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[2] L. J. Stephenson, et al., PRL 124 110501 (2020)
[3] V. Krutyanisky, et al., arXiv:2208.14907 (2022)

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