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Coupling ions and photons via an optical cavity

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Trapped ions are a key experimental platform for quantum computing and simulation, while photons can transport quantum information over long distances. Optical cavities provide a coherent interface between these two quantum systems, an essential ingredient for future quantum networks. I will describe a cavity-mediated, bichromatic Raman transition using trapped calcium ions which allows us to connect the ions' electronic states with the polarization states of cavity photons. This transition is the basis for two protocols: the transfer of a quantum state from an ion onto a photon, and the generation of ion-photon entanglement. Furthermore, if two ions are coupled to the cavity mode, they can be entangled with one another, an event heralded by the detection of two orthogonally polarized cavity photons. Such entanglement could provide a robust link between remote ion-based quantum computers, and within a single cavity, enables enhanced quantum memories and the generation of photonic cluster states.