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Engineering Strong Interactions between mm-wave and Optical Photons using Rydberg Atoms AISHWARYA KUMAR, AZIZA SULEYMANZADE, MARK STONE, LAVANYA TANEJA, JASMINE KALIA, DAVID SCHUSTER, JONATHAN SIMON, University of Chicago — We describe progress towards an experimental system to couple single photons in the mm-wave and optical regimes. Such a system can enable realization of exotic photonic states, as well as open doors for new techniques in quantum information and communication. At the heart of our design is a high-Q, monolithic, superconducting cavity crossed with an optical resonator and with optical access to trap and cool atoms at the center. Quality factors of $\sim 10^7$ at 100 GHz and 1K temperature have recently been demonstrated in these cavities. Along with the strong electric dipole couplings between Rydberg states, exceptionally high single atom cooperativities are achievable. Here we show trapping and cooling of atoms, observation of Rydberg Electromagnetically Induced Transparency (EIT), and progress towards generating mm-wave induced optical non-linearity in such a cavity in a 3K cryostat.

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