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**Strongly Interacting mm-Wave and Optical Photons with Rydberg Atoms** MARK STONE, AZIZA SULEYMANZADE, JASMINE KALIA, LIN SU, JOSHUA WAKEFIELD, DAVID SCHUSTER, JONATHAN SIMON, University of Chicago — We describe progress towards a hybrid experimental system for engineering strong interactions between single optical and mm-wave photons using Rydberg atoms as an interface. Entanglement between photons with gigahertz and optical frequencies creates a new platform to access exotic photonic quantum states as well as powerful new techniques in quantum computing and simulation. We will present recent experimental developments including trapping and cooling atoms in a cryogenic MOT, measuring high-Q superconducting cavities at 100 GHz using a novel photonic crystal design, and coupling atoms to an optical cavity inside a cryostat at 3 Kelvin. Finally, we present a scheme to lock a single optical cavity at two independent resonant frequencies using a silicon nitride membrane, which allows cavity enhancement at both frequencies in an EIT process.

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