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3D Multimode Cavity QED RAVI NAIK, DAVID C. MCKAY, DAVID I. SCHUSTER, Physics Department and James Franck Institute, University of Chicago — Scalable quantum computing architectures require many long-lived and highly coherent, yet easily addressable quantum states. Photonic qubits in 3D superconducting microwave cavities are a promising approach because they are highly insensitive to decoherence and single photon lifetimes exceeding 10 ms have been demonstrated[1]. However, the plurality of current 3D cavity devices are engineered to address single photon modes. In this talk, we introduce our implementation of a multimode 3D cavity that can store greater than 20 distinct, long-lived photon modes. To perform single- and two-qubit gates between photons, each of the modes are coupled to a single flux-tunable superconducting transmon qubit. We will discuss our preliminary results towards a controlled phase gate between any pair of photons modes. This multimode circuit QED architecture may also be used as a many-body bosonic system for quantum simulation, to study multimode quantum optics, and for quantum memories as part of a larger quantum network.

[1]M. Reagor, Appl. Phys. Lett. **102**, 192604 (2013)

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