Quantum many-body physics with interacting photons: From Mott transitions to many-body localization

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The progress in quantum technologies involving manipulating light and matter at the microscopic level ranging from cold atoms coupled to nano-photonic structures, to superconducting quantum circuits, allow now to robustly observe nonlinear optical interactions at the quantum level. The latter has recently motivated the birth of a new area where strongly correlated states of light generated in such optical set ups are exploited for implementing quantum computation and for quantum simulation of a range of condensed matter and high energy physics effects. These include simulations of quantum phase transitions, topological effects, as well as gauge and relativistic field theories. I will briefly review the main theory results in this area along with our recent efforts for realizing models exhibiting strongly correlated phases and topological protected modes in out of equilibrium driven slow light and circuit QED set ups [1,2]. I will conclude by presenting a recent experiment done in collaboration with the John Martinis UCSB/Google group in probing many-body localization with interacting photons in superconducting circuits.

[1] C. Noh and D.G. Angelakis, Rep. Progr. Phys. **80**, 016401 (2016).

[2] D.G. Angelakis, *Quantum Simulators with Photons and Polaritons: Merging Quantum Optics with Condensed Matter Physics* Series on Quantum Science and Technology (2017).