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Many body physics with light[1]

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Systems of strongly interacting atoms and photons, which can be realized wiring up individual Cavity QED (CQED) systems into lattices, are perceived as a new platform for quantum simulation [1-3]. While sharing important properties with other systems of interacting quantum particles, the nature of light-matter interaction gives rise to unique features with no analogs in condensed matter or atomic physics setups. Such Lattice CQED systems operate on polaritonic quasi-particles that are hybrids of light and matter in a controllable proportion, combining long-range coherence of photons and strong interactions typically displayed by massive particles. In this talk, I will discuss our recent efforts [4-6] on the possibility of observing quantum many body physics and quantum phase transitions in Lattice CQED systems. Unavoidable photon loss coupled with the ease of feeding in additional photons through continuous external driving renders such lattices open quantum systems [5]. Another key aspect of many body physics with light that I will focus on is the particle number non-conserving nature of the fundamental light-matter interaction [6] and the question of what quantity, if not the chemical potential, can stabilize finite density quantum phases of correlated photons.

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