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Quantum phase transitions for light and XY spin models in coupled cavity arrays DIMITRIS ANGELAKIS, Centre for Quantum Computation, University of Cambridge, MARCELO FRANCA SANTOS, Universidade Federal de Minais Gerais, Brazil, SOUGATO BOSE, Department of Physics, University College London — The realization of insulator to superfluid transitions in optical lattices have opened great possibilities for simulating many body systems. It is thus interesting to explore which other systems permit such phases and simulations, especially if the problem of accessibility of the individual sites is not present. Particularly arresting will be to find such phases in a system of photons which, by being non-interacting, are unlikely candidates for the studies of many-body phenomena. Here we show that a Mott phase can arise in an array of coupled high Q electromagnetic cavities between which photons can hop, when each cavity is coupled to a *single* two level system (atom/quantum dot/superconducting qubit). In this phase each atom-cavity system has the same integral number of net (atomic plus photonic) excitations. It occurs for resonant photonic and atomic frequencies when the *photon blockade* effect provides an *effective repulsion* between the excitations in each atom-cavity system. Detuning the atomic and photonic frequencies suppresses this repulsion and induces a transition from the Mott phase to a photonic superfluid. We show that for zero detuning, the system can simulate the dynamics of an XY spin chain with arbitrary number of excitations.

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