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From Mott transitions to interacting relativistic theories with light: A brief history of photonic quantum simulators

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I will start by reviewing our early works for observing photon-blockade induced Mott transitions in coupled cavity QED systems [1]. After briefly touching on the idea of simulating spin-models and the Fractional Hall effect [2], I will analyze more recent developments in realizing continuous 1D models in nonlinear optical fibers exhibiting electromagnetically induced transparency nonlinearities. Here the concept of the "photonic Luttinger liquid" will be introduced, along with a proposal to observe spin-charge separation with polarized photons in a nonlinear slow light set up [3]. I will continue by presenting our recent efforts in simulating 1D lattice models in the non-relativistic regime, such as the sine-Gordon and Bose-Hubbard [4], and the efforts for simulations of out of equilibrium phenomena using driven systems [5,6]. I will conclude by presenting ongoing work on interacting relativistic models (Thirring)[7]. Possible experimental implementations in quantum optical systems such as photonic crystals, optical fibers coupled to cold atoms, and Circuit QED will be discussed.

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