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Quantum simulations of cooper pairing and driven nonlinear Schrödinger equation with stationary light PRIYAM DAS, MINGXIA HUO, CHANGSUK NOH, Center for Quantum Technologies, National University of Singapore, B. M. RODRIGUEZ-LARA, Instituto Nacional de Astrofisica, Optica y Electronica, Mexico, DIMITRIS G. ANGELAKIS, Center for Quantum Technologies, National University of Singapore and Science Department, Technical University of Crete — Strongly correlated states of photons generated in strongly coupled light-matter interfaces, such optical waveguides interacting with ensembles of cold atoms, have recently emerged as promising routes for a new kind of quantum simulators. In this work, we present two of our most recent results along this line, motivated by earlier proposals on strongly interacting stationary polaritons and a proposal to create an effective polaritonic lattice potential. In the first part, we show how to realize an optically tunable two-component Bose-Hubbard model and discuss the feasibility of generating an effective Fermi-Hubbard model of polaritons. This allows one to simulate and detect the 1D analog of the BEC-BCS crossover through correlation measurements. In the second part, we show how a similar setup allows one to study nonlinear transport properties. In the semi-classical regime, the system is formally analogous to a Bose-Einstein condensates in optical lattices or propagation of EM fields in photonic Kerr media, allowing for simulations of similar effects with distinct advantages due to the photonic nature of the proposed system. We conclude by proposing how one of the signature effects of nonlinear dynamics, bistablity, can be experimentally observed in our set up.

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