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Quantum transport in a nonlinear optical fiber: single-photon switching, photonic bound states and more MOHAMMAD HAFEZI, DARRICK E. CHANG, VLADIMIR GRITSEV, EUGENE DEMLER, MIKHAIL D. LUKIN, Harvard University — We examine the quantum transport properties of a few photons inside a one-dimensional nonlinear waveguide when the evolution is determined by the quantum nonlinear Schrodinger equation. The tight transverse confinement of the photonic modes enables a large atom-field coupling strength. Therefore, by coupling light to atoms loaded in a fiber, such a system is capable of acting as a single-photon switch, where the transmission of single photons occurs with high probability while that of multiple photons is strongly suppressed. This switching behavior also manifests itself in higher-order correlation functions of the transmitted field. In particular, when the interaction between photons is effectively repulsive, the suppression of multi-photon components results in anti-bunching of the transmitted field. In the attractive case, the switch can exhibit both anti-bunching and bunching behaviors. We show that the bunching is due to the resonant excitation of bound states of photons by the input field. Finally, an experimental implementation of such a system in hollow-core fibers loaded with cold atoms is discussed.

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