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Single Photon Transport through an Atomic Chain Coupled to a One-dimensional Nanophotonic Waveguide ZEYANG LIAO, XIAODONG ZENG, Institute for Quantum Science and Engineering (IQSE) and Department of Physics and Astronomy, Texas AM University, SHI-YAO ZHU, Beijing Computational Science Research Center, China, M. SUHAIL ZUBAIRY, Institute for Quantum Science and Engineering (IQSE) and Department of Physics and Astronomy, Texas AM University — We study the dynamics of a single photon pulse travels through a linear atomic chain coupled to a one-dimensional (1D) single mode photonic waveguide. We derive a time-dependent dynamical theory for this collective many-body system which allows us to study the real time evolution of the photon transport and the atomic excitations. Our analytical result is consistent with previous numerical calculations when there is only one atom. For an atomic chain, the collective interaction between the atoms mediated by the waveguide mode can significantly change the dynamics of the system. The reflectivity of a single photon pulse with finite bandwidth can even approach 100%. The spectrum of the reflected and transmitted photon can also be significantly different from the single atom case. Many interesting physical phenomena can occur in this system such as the photonic bandgap effects, quantum entanglement generation, Fano-like interference, and superradiant effects. For engineering, this system may serve as a single photon frequency filter, single photon modulation and may find important applications in quantum information.

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