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Single Photon Transport through an Atomic Chain Coupled to a One-dimensional Photonic Waveguide ZEYANG LIAO, XIAODONG ZENG, M. SUHAIL ZUBAIRY, Texas A&M 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 result is consistent with previous 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 can be tuned by changing the ratio of coupling strength and the photon linewidth or by changing the number of atoms in the chain. 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 physics can occur in this system such as the photonic bandgap effects, quantum entanglement generation, Fano-type interference, superradiant effects and nonlinear frequency conversion. For engineering, this system may be used as a single photon frequency filter, single photon modulation and photon storage.

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