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Single-photon nonlinear optics with nano-scale surface plasmons
DARRICK CHANG, Harvard University, ANDERS SORENSEN, Niels Bohr Institute, VLADIMIR GRITSEV, EUGENE DEMLER, MIKHAIL LUKIN, Harvard University — We explore nonlinear optical phenomena in systems that support a set of tightly-confined, one-dimensional electromagnetic modes. Among the physical systems of interest are guided surface plasmons propagating on conducting nanostructures and hollow-core photonic crystal fibers. The tight transverse confinement of the modes enables a large emitter-field coupling strength and the possibility of nonlinear optics down to a single-photon level. Several novel applications are presented. First, we demonstrate how the interaction between a single photon and either a single emitter or ensemble can be controlled to create a high-fidelity, state-dependent mirror. The state-dependent mirror can be used, for example, to implement a controlled-phase gate between photons or an all-optical, single-photon transistor. Connections to condensed-matter systems such as the Kondo Hamiltonian and Luttinger liquid are also discussed.

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