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Dynamical effects of Stark-shifted quantum dots strongly coupled to photonic crystal cavities KAUSHIK ROY CHOUDHURY, RANOJOY BOSE, EDO WAKS, Department of Electrical and Computer Engineering, IREAP, University of Maryland, College Park, Maryland 20742, USA — Single semiconductor quantum-dots (QDs) strongly coupled to photonic crystal cavities are a strong candidate for single photon generation, ultra-fast all optical switching and quantum information processing. Recent experiments on coupled-cavity quantum dot systems show possible manipulation of emission wavelength of the dot through optical Stark effect. Interesting dynamical features arise when the Stark pulse duration is comparable to QD-cavity interaction time. Here, we present a theoretical treatment of these dynamical effects and investigate dynamical emission spectrum, energy transfer and single photon generation. We study these effects through numerical solution of the full master equation. We demonstrate that dynamic Stark effects can be used to generate ultra-fast indistinguishable single photons using rapid Stark tuning of the quantum dot. The theoretical limit for the speed is shown to be faster than adiabatic rapid passage technique used for microwave photon generation in circuit QED. A systematic study of role of device parameters such as pulse-shape, dot-cavity coupling and incoherent losses on the efficiency and speed of single photon generation is also presented for possible experimental realization.

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