Dynamical Control of Optical Interactions on the Nanoscale: Ultrafast Excitation of Plasmon-Exciton Systems

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When a quantum dot and plasmonic system are resonantly coupled by an optical near field, the system can exhibit a Fano resonance, resulting in a transparency dip in the optical spectrum [1, 2]. I discuss the nonlinear optical response of such a system, using both cavity quantum electrodynamics and a semiclassical coupled-oscillator models [3].

For the experimentally relevant case of meV thermal broadening of the quantum-dot transition, ultrafast pulsed excitation of the system can lead to a reversal of the Fano resonance, with the induced transparency changing into a superscattering spike (Figure 1). This arises due to changes in the phase relationship between the plasmon and exciton dipoles and represents a new example of the ability to dynamically control coherent optical interactions on the nanoscale.

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