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Phonon-induced polarization rotation in coupled quantum dots

ANDREW JACOBS, JOSHUA CASARA, CAMERON JENNINGS, PARVEEN KUMAR, MICHAEL SCHEIBNER, University of California Merced — Coupled quantum dots have demonstrated the ability to promote coherent phonon behavior [1]. Such an effect is due to Fano-like quantum interference between continuum single-dot polaron and discrete spatially-indirect exciton states. This coherent phonon behavior manifests in the form of a nonlinear optical transparency [1], a phenomenon of interest for generating slow light [2] and other optical responses. Here, we consider spin—phonon correlation arising from optical selection rules and the optical nonlinearity of the Fano interference. The degree of polarization rotation is calculated using the difference in refractive index between Fano-like asymmetry and a conventional Lorentzian optical response. Under ideal conditions, we find that a single pair of coupled quantum dots, with spatial extent 10 nm, can lead to rotations of nearly 200 microradians. We also demonstrate the robustness of this rotation effect to lifetime of the indirect exciton, random charge fluctuations in the environment of the coupled quantum dots, and to the Fano asymmetry factor. We identify a "sweet spot" of spectral asymmetry that optimizes the amount of polarization rotation. Coherent phonon behavior is of interest for basic solid-state physics, and presents an opportunity to investigate its use for future phononic devices. [1] M. L. Kerfoot et al., Nat. Commun. **5**, 3299 (2014). [2] A. R. Jacobs et al., "Optical response of coupled quantum dots to phonon coherence" (in preparation).

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