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Exciton-plasmon interactions and energy transfer in nanoparticles[1]

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Energy transfer between optically-excited nanocrystals coupled by the Coulomb interaction can be very efficient. The interaction of excitons and plasmons in nanocrystals leads to several effects: energy transfer between nanoparticles (NPs), electromagnetic enhancement, reduced exciton diffusion in nanowires (NWs), exciton energy shifts, and interference and non-linear phenomena [1-3]. Using kinetic equations for excitons, we model exciton transport in a NW and explain the origin of the blue shift of exciton emission observed in the recent experiments on hybrid NW-NP assemblies [2]. We also model artificial light-harvesting complexes composed of chlorophylls, bacterial reaction centers, and NPs [3]. Using superior optical properties of metal and semiconductor NPs, one can strongly enhance the efficiency of light harvesting [3]. An interaction between a discrete state of exciton and a continuum of plasmonic states can give rise to interference effects (Fano-like asymmetric resonances). These interference effects greatly enhance visibility of relatively weak exciton signals and can be used for spectroscopy of single nanoparticle and molecules. In the nonlinear regime, the Fano effect becomes strongly amplified [4]. In conclusion, our theory explains present experimental results and also provides motivation for future experiments and applications. Potential applications of dynamical exciton-plasmon systems include sensors and light-harvesting. The above theoretical studies were performed in collaboration with several groups [1-4].

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