Mechanisms of Energy Redistribution in Laser-Driven Dynamics in Interconnected Quantum Dot - Metal Nanoparticle Systems

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The ultrafast energy redistribution mechanisms in interconnected quantum dot-metal nanoparticle systems upon laser pulse excitation are studied using a quantum dynamical approach based on the time-dependent version of the Fermi Golden Rule. The quantum dot is modeled as a single-particle system, within the effective mass theory and using model confining potentials. In the case of the metal nanoparticles, the equation of motion for the electronic wavefunction is derived using time-dependent density functional theory. This model is combined with quantum wave packet propagation to account for the main dynamical features of the interconnected system. The approach allows to compute the lifetime of the excited resonances, the time-evolution of the electronic wavepacket, and the detailed analysis of the ultrafast mechanism of the energy transfer between the two subsystems. The present analysis paves the way to investigate the possibility to achieve the coherent control of the electron relaxation pathway via the manipulation of macroscopic excitations such as the plasmon resonance in metal nanoparticles.