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Transient nonlinear optical properties of nanostructures made of quantum dots and metallic nanoparticles

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Recently, transient nonlinear optical properties of quantum dots have attracted much attention in photonic and plasmonic studies. We have investigated the effect of the decay rate, surface plasmon polariton (SPP) coupling strength, and dipole-dipole interaction (DDI) strength on the time-dependent behavior of the power emitted from a three-level lambda-type quantum dot in plasmonic nanohybrids composed of metallic nanoparticles and quantum dots. We introduced the quantum density matrix elements that are directly related to power emission in order to present the results. By controlling the SPP and DDI coupling constant as well as the decay rate, we plotted the time evolution of density matrix elements and found that the strength of SPP coupling and decay rate do not affect the time that the system takes to reach the steady state, whereas the DDI couping strength does. The transient behavior also exhibits giant oscillations and significant enhancement in power emission. The present findings can be used in the development of nanotechnology and the fabrication of nanodevices such as nanosensors and nanoswitches.

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