Weak and strong coupling light-matter dynamics considering non-local effects

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The relaxation process of a quantum emitter (QE) can be controlled by manipulating its environment. Metallic nanostructures support surface plasmon modes, that confine the light in nanometer dimensions, increase the interaction strength and time with nearby placed QEs. Nowadays, the characteristic lengths of the metallic structures approach the atomic scale [1], where nonclassical and nonlocal material effects become crucial. Including quantum material effects, the Purcell factor of the QE is modified compared to the customary Drude type response [2]. For the first time, the relaxation process of a two-level QE is studied in the strong coupling regime for Na layered nanostructures including quantum corrections in the material response. The quantum corrections are included in the EM calculations by modifying the boundary conditions through the Feibelman parameters [3]. In Fig.1(a) we observe that the emission spectrum of the QE presents a Rabi emission splitting and in Fig.1(b) we observe Rabi oscillations in the population of the excited state of the QE [4]. The inclusion of quantum effects in the material response is known that reduce the QE/nanostructure coupling strength, nevertheless our analysis shows that this interaction is still within the strong coupling regime, a conclusion that is corroborated by experimental results [1].

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FIGURES

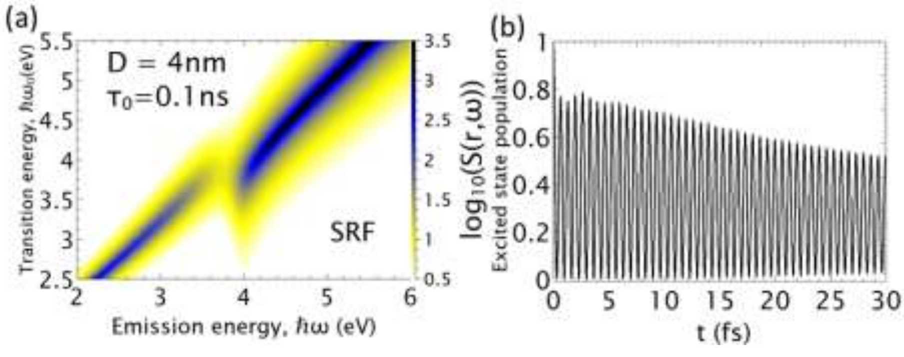

Figure 1: Quantum emitter is placed in the middle of a metal-insulator-metal cavity of 4nm thickness. (a) Emission spectrum of the QE/cavity system. (b) Population dynamics of the excited state of the QE.