Non-Markovian effects on quantum superpositions in a nanostructure

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We consider a laser driven nanostructure like a quantum dot (QD) of any shape, which is coupled to photon and phonon baths. These baths provide the basic source of pure dephasing and relaxation of quantum states in a single QD. At very short time scale (ultrafast regime), the interaction between nanostructure and environment must be properly taken into account. In the femto- to picosecond regime, the usual Markovian approximation overestimates the decay and dephasing effects. We present results which demonstrate that at times shorter than the typical decoherence time, the second order correlation function $g^{(2)}$ of the emitted photons, is strongly enhanced showing antibunching features[1]. This effect occurs in a time scale where non-Markovian signatures are important. Currently used ultrafast spectroscopy techniques should be able to detect this new effect. In particular, we demonstrate that for a QD nanostructure, prepared in a quantum superposition state, a new photon correlation signature occurs. By contrast, this effect is absent for a QD prepared in a statistical mixture of states. Finally, we propose an unambiguous signature for detecting quantum superposition states in a QD nanostructure.

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