Quantum Dynamics of the Hubbard-Holstein Model in Equilibrium and Nonequilibrium: Application to Pump-Probe Phenomena

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The paper shows that the calculated optical absorption of the 2D Hubbard-Holstein model at low doping reveals a three peak structure in agreement with experimental observations in many cuprates. We also address a very crucial problem in complex systems, as the high Tc superconductors are, where strongly interacting different degrees of freedom contribute to the system properties on very similar scale energies: Can ultrafast time dependent spectroscopy (pump and probe experiments) disantangle the different interactions by exploiting the fact that different interaction act on differet time scales? We show that this is possible and prove that, after an ultrashort pulse, phonon subsystem oscillate with a phonon period Tph=80 fs. The decay time of the phonon oscillations is about 150–200 fs. We propose a criterion for observing these oscillations in high Tc compounds: the time span of the pump light pulse has to be shorter than the phonon oscillation period Tph. On the other hand we find that the time scale of magnetic excitations are much shorter (few fs).