Photoexcitations in a 1D manganite model: From quasiclassical light absorption to quasiparticle relaxations

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We investigate 1D correlated systems following a photoexcitation by combining ab-initio methods, time-dependent matrix product state (MPS) approaches, analytical insights from quantum Boltzmann equations, and molecular dynamics (MD) simulations to describe the dynamics on different time scales ranging from femtoseconds up to nanoseconds. This is done for manganite systems in the material class $Pr_{1-x}Ca_xMnO_3$. We derive one-dimensional ab-initio model Hamiltonians for which we compute the ground states at different values of the doping using MD simulations. At half doping, we obtain a magnetic microstructure of alternating dimers which we use as a starting point to formulate a one-dimensional Hubbard-type model. In this strongly correlated 1D system we address the formation of quasiparticles after photoexcitations. The dynamics is analyzed concerning the formation and lifetime of such quasi-particles via a linearized quantum Boltzmann equation. In this way, our work constitutes a first step to building a unifying theoretical framework for the description of photoexcitations in strongly correlated materials over a wide range of time scales, capable of making predictions for ongoing experiments investigating pump-probe situations and unconventional photovoltaics.