Nonequilibrium electron-boson systems

Yaroslav Pavlyukh

Electron-boson interactions play a fundamental role in condense matter physics, optics and particle physics [Y. Pavlyukh, Sci. Rep. 7, 504 (2017)]. Holstein and Fröhlich Hamiltonians describe paradigmatic models of the electron-phonon interaction. In some limiting cases it has been possible to numerically study (propagation of the coupled Kadanoff-Baym equations) the ultrafast dynamics in these systems triggered by external perturbations (N. Säkkinen, Y. Peng, H. Appel, and R. van Leeuwen, J. Chem. Phys. 143, 234102 (2015), M. Schüler, J. Berakdar, Y. Pavlyukh, Phys. Rev. B 93, 054303 (2016)). Linear electron-boson coupling is typically considered.

There are, however, cases where nonlinear coupling is comparable in strength or even dominates the first-order electron-boson interaction. Flexural phonons in graphene is a typical example. Generalisations of the functional Hedin's equations for an arbitrary form of the interaction have been obtained recently for equilibrium conditions [A. Marini and Y. Pavlyukh, Phys. Rev. B 98, 075105 (2018)]. A wave-function approach for the quadratic electron-phono coupling has been introduced recently by Sentef (Phys. Rev. B 95, 205111 (2017)). In this talk I will present some ideas how the Kadanoff-Baym equations can be propagated for the quadratic (in bosonic displacement) coupling. One of the interesting features of this model is the form of random-phase approximation, in which both the electron density-density response and the quadratic bosonic correlator fulfil a coupled set of equations.