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Influence of correlated hopping on the optical conductivity spectra

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Optical conductivity spectra are studied for the Falicov-Kimball model with correlated hopping on the Bethe lattice. An expression for the current-current correlation function is derived using dynamical mean field theory. Besides, the Nyquist plots were built and used to distinguish different contributions in the optical conductivity spectra.
In the metallic phase without correlated hopping, both the current-current correlation function $\chi(\Omega)$ and optical conductivity $\sigma(\Omega)$ display Drude peak at low frequencies. The shape of Drude peak is described by the Debye relaxation equation

$\chi_{\mathrm{D}}(\Omega) = \chi_\infty + \frac{\chi_0 - \chi_\infty}{1 - \Omega\tau_{\mathrm{D}}}$

On the other hand in the presence of small correlated hopping, the shape of Drude peak deviates from the Debye relaxation peak, and an additional wide peak is observed on the optical conductivity spectra and on Nyquist plot when Fermi level is in the vicinity of the two particle resonance [1]. At larger values of the correlated hopping parameter, the density of states contains three bands [1] and the corresponding optical spectra and Nyquist plots display a more complicated shape with additional peaks. For the case of strong local correlations, the overall picture strongly depends on the doping level. For a small doping, when the chemical potential is placed in the wide lower Hubbard band the obtained results are much closer to the case of the doped Mott insulator without correlated hopping, whereas for a large doping, when the chemical potential is placed in the narrow upper Hubbard band, the spectral weight of the Drude peak is strongly reduced and it is separated by a gap from the charge-transfer peak.

[1] D.A. Dobushovskyi, A.M. Shvaika, V. Zlatic, Phys. Rev. B. 95, 125133 (2017).

Primary author: Mr DOBUSHOVSKYI, Danylo (Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine)

Presenter: Mr DOBUSHOVSKYI, Danylo (Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine)

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