Photoinduced pairing states in pumped excitonic insulators

Satoshi Ejima, Florian Lange, and Holger Fehske

University of Greifswald, Institute of Physics, Felixhausdorff-Str. 6, Greifswald 17489, Germany

The study of systems driven out of equilibrium attracts tremendous attention because of the recent rapid developments of ultrafast pump lasers and various time-dependent spectroscopic measurements. In this talk, we numerically prove photoinduced pairing states in the extended Falicov-Kimball model (EFKM) at half filling [1] both with and without the internal SU(2) structure. In the time-dependent photoemission spectra simulated by the time-dependent density-matrix renormalization group technique [2,3], we demonstrate that the extra band appears above Fermi energy after pulse irradiation, indicating an insulator-to-metal transition. Even in the absence of the SU(2) structure, the pair correlations are enhanced during the pump, while they decrease over time. This implies the possible metallization of Ta_2NiSe_5, a strong candidate for an excitonic insulator material for which the EFKM is considered to be minimal theoretical model. Optimizing the pulse parameters and simulating the time-dependent photoemission, we demonstrate the photoinduced quantum phase transition [4], reflecting recent findings in time- and angle-resolved photoemission spectroscopy experiments on Ta_2NiSe_5.

[1] S. Ejima, T. Kaneko, Y. Ohta and H. Fehske, Phys. Rev. Lett. **112**, 026401 (2014).

[2] S. Ejima, F. Lange and H. Fehske, SciPost Phys. **10**, 077 (2021).

[3] S. Ejima, F. Lange and H. Fehske, Phys. Rev. Res. **4**, L012012 (2022).

[4] S. Ejima, F. Lange and H. Fehske, Phys. Rev. B **105**, 245126 (2022).