

**Electron-phonon interactions in the time domain:  
from non-equilibrium phonon dynamics to theoretical spectroscopy**

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The relentless progress of ultrafast science has created an urgent need to advance ab-initio theory and computational methods to predictively model complex non-equilibrium phenomena resulting from the electron-phonon interaction (EPI) in condensed matter. This talk will illustrate our recent progress in the description of the ultrafast dynamics of electrons and phonons [1], coherent phonons [2] and phonon decoherence [3], based on ab-initio simulations of the EPIs. These advancements play an important role to reproduce and understand the outcome of pump-probe experiments in their full complexity [4].

References:

- [1] Y. Pan, F. Caruso, Nano Lett. 23, 7463 (2023)
- [2] C. Emeis, S. Jauernik, S. Dahiya, Y. Pan, P. Hein, M. Bauer, F. Caruso, arXiv 2407.17118 (2024)
- [3] Y. Pan, C. Emeis, S. Jauernik, M. Bauer, F. Caruso. arXiv 2502.01529 (2025)
- [4] Y. Pan, P. N. Hildebrand, D. Zahn, M. Zacharias, Y. W. Windsor, R. Ernstorfer F. Caruso, H. Seiler, ACS Nano, in press (2025)