Experimentelle Physik 2

Seminar Festkörperphysik (CMP Seminar)

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Quantum beats of exciton-polarons in $CsPbI_3$ perovskite nanocrystals

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Exciton-phonon interactions govern the energy level spectrum and thus the optical response in semiconductors. In this respect, lead-halide perovskite nanocrystals represent a unique system, for which the interaction with optical phonons is particularly strong, giving rise to a ladder of multiple exciton states which can be optically excited with femtosecond pulses. We establish a fully coherent regime of exciton-polaron dynamics in an ensemble of $CsPbI_3$ nanocrystals embedded in a glass matrix [1]. Using transient two-pulse photon echo at 2 K temperature, we observe pronounced quantum beats between the exciton-polaron states. Within a four-level model, we directly quantify the exciton-phonon coupling strength through the Huang-Rhys factors of 0.05-0.1 and 0.02-0.04 for low-energy optical phonons with energies of 3.2 and 5.1 meV, respectively. The pronounced size dependence of both coupling strengths and phonon lifetimes offers a path to tune the optical transitions between polaron states and to tailor the coherent optical dynamics in perovskite semiconductors.

[1] A. V. Trifonov et al., Quantum beats of exciton-polarons in $CsPbI_3$ perovskite nanocrystals. https://arxiv.org/pdf/2510.14695