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Seminar über Ultrafast Science and Technology

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Titel: Time-resolved spectroscopy of molecular exciton-polaritons

During the past decades molecular cavity QED (cQED) has evolved from a fundamental concept to an extensive framework that allows to manipulate chemistry, create exotic states of matter, and develop novel applications, combining the properties of light and matter.[1,2] However, despite these remarkable achievements, some of the underlying physical processes remain insufficiently understood. One example is the energy relaxation cascade that is initiated on the upper polaritonic branch (UPB) and leads to population of the exciton manifold of states, as well as the lower polaritonic branch (LPB). Establishing a microscopic understanding thereof will complement cavity-design rules and prove beneficial for applications that rely on efficient relaxation towards the LPB, e.g. when modifying chemical reactivity or creating non-equilibrium Bose-Einstein condensates.[3]

I will introduce the principles behind molecular exciton-polaritons, as well as those of the visible two-dimensional Fourier transform spectroscopy technique,[4] in order to provide a more thorough understanding and appreciation of the available experimental data.[5] Further, I would like to show that our knowledge of the microscopic processes happening within these system will benefit greatly from experimental studies with varying system parameters. This is achieved in a straight-forward (yet, not trivial) fashion, since fabrication of the microcavities used to confine the electromagnetic field involves a high degree of engineering. Finally, in order to test existing theoretical models against the prospective parameter-dependent experimental datasets, will require simulation of the experimental data from quantum mechanics, a challenge that relies on expertise from theory and experiment and that will be addressed by the proposal.

[1] Ebbesen, Acc. Chem. Res. 49 (2016) 2403-2412
[2] Hertzog et al, Chem. Soc. Rev. 48 (2019) 937-961
[3] Coles et al, Phys. Rev. B 88 (2013) 121303(R)
[4] Gelzinis et al. Biochim. Biophys. Acta, Bioenerg. (2019), 1860, 271–285
[5] Mewes et al. Commun Phys (2020), 3, 157

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