Theory of hybrid structures
- From Quantum-Nanoplasmonics to excitation transfer processes on semiconductor surfaces

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Hybrid nanostructures play a key role for future devices realized on the nanoscale. The basic idea is to combine two types of different nanostructures in order to exploit the advantages and to minimize the disadvantages of both materials.

In this talk, theoretical results for two classes of hybrid structures are presented: (i) plasmonic metal nanoparticles coupled to quantum emitters (quantum dots or organic dye molecules) and (ii) organic molecules coupled to a semiconductor substrate.

(I) For an externally pumped metal nanoparticle coupled to quantum emitters the excitation transfer processes between the different constituents are analyzed. The used theoretical methods give full access to the exciton and plasmon distribution function, i.e. the quantum statistical properties and its impact on experimental observables. We discuss the influence of Förster interaction between two quantum dots on the plasmon statistics and also the spaser transition in the intensity and in the intensity-intensity correlation for few to many quantum emitters.

(ii) For molecules on a semiconductor substrate, the case of a periodic arrangement of molecules on the substrate is investigated. In particular, the Coulomb (dipole-dipole) coupling element describing the excitation energy transfer between both constituents is analyzed in detail. This allows to optimize the coupling as function of coverage and geometric constraints.

The coupling strength between the molecular exciton and the electron-hole continuum of the semiconductor is reflected in the absorption spectra by a shift and increase of broadening of the molecular exciton.

At the end of the talk perspectives for future research in the framework of the HIOS SFB are given.