CNAM Condensed Matter Colloquium

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Exciton-Plasmon Interactions in Hybrid Nanostructures

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Coulomb interaction between optically-excited nanocrystals and molecules provides a very efficient mechanism of energy transfer. This transfer of optical energy from one component to another can be utilized in many applications, including sensing [1-2] and light-harvesting [3]. One particular type of nanostructures exhibiting efficient energy transfer incorporates metal and semiconductor nanocrystals [1-2,4]. The interaction of excitons and plasmons in such structures leads to several effects: Energy transfer between nanoparticles (NPs), electromagnetic enhancement, reduced exciton diffusion in nanowires (NWs), exciton energy shifts, and interference [1-2,4,5]. Recent experiments with NW-NP complexes [1] showed that the exciton - plasmon interaction can lead to a blue shift of excitonic emission. This blue shift can be used for bio-chemical sensing and comes from the combination of two effects - exciton diffusion along a NW and energy transfer. Exciton-plasmon interactions in metal-semiconductor structures have potential for detection of small amounts of molecules or semiconductor NPs. According to theoretical studies [5], the exciton-plasmon interaction can give rise to the interference effects (Fano-like asymmetric resonances and anti-resonances). This interference effect greatly enhances a visibility of weak exciton signals coming from single molecules and NPs. Another type of hybrid structures studied by us involves NPs and photosynthetic molecules (reaction centers). Reaction centers have an important functionality – charge separation. Modeling of the artificial light-harvesting complexes suggests an interesting opportunity of enhanced photosynthetic activity [3]. Optical enhancement in hybrid photosynthetic complexes comes from plasmon resonances, strong optical absorption by semiconductor NPs, and energy transfer from NPs to reaction centers.

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