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Optical nanoantennas for light - matter coupling through parallel multipolar mechanisms

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Optical nanoantennas are nanoscopic devices which dimensions are comparable to the visible light wavelengths. They are usually made of noble metals, dielectrics or even more exotic materials such as graphene. In analogy to their macroscopic counterparts, they are able to mediate between electromagnetic radiation and localized regions of space. Quantum systems positioned at such regions are then subject to interaction with largely enhanced (even a few orders of magnitude) and spatially confined electromagnetic fields.

It is higly valuable to examine behaviour of quantum systems in these 'hot spots'. Increased modes density in such positions causes faster spontaneous emisson, higher frequency of Rabi oscillations or enlarge importance of multipole expansion terms beyond electric dipole. That means interaction is not only stronger than in a free space, but its character is also changed by admitting previously inavailable channels, e.g. magnetic dipolar or electric quadrupolar coupling.

I will present applications of nanoantennas neighbouring molecules or quantum dots, as efficient devices to control light-matter interaction through multiple mechanisms. These mechanisms are related to several electric and magnetic multipolar terms of the coupling Hamiltonian. In particular, the magnetic dipolar and electric quadrupolar terms become significant due to strong electromagnetic field enhancement and confinement near the nanoantenna.

I will discuss nanoantennas tailored to selectively enhance individual interaction mechanisms, or to capitalize on their interference. Interference may cause an even stronger enhancement, but also it can strongly suppress a given transition. The suppression is achieved through tailoring the electromagnetic environment, usually discussed in terms of density of states, such that the spontaneous emission rate is decreased.

Studenckie Koło Nanotechnologii Nanorurki

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