Quantum aspects of light-matter interaction affected by plasmonic nano-structures

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Manipulation of optical near fields in vicinity of quantum emitters can significantly improve various tasks, relying on efficiency, polarization and directionality of extracted light. So called optical antennas, employing the phenomenon of localized plasmon resonances [1], were shown to provide some of the desired functionalities [2] and serve as very promising components for quantum information devises [3], where operation on few photons level is required.

Plasmonic nanostructures are also perfect candidates for the realization of various concepts for the improvement of nonlinear effects, since, generally, nonlinear optical phenomena are proportional to higher powers of the driving field, motivating the quest for the local electromagnetic field enhancement. For example, novel and very promising phenomena of spontaneous two-photon emission from semiconductors [4] was enhanced by three orders of magnitude, using array of plasmonic nano-antennas [5].

In this contribution we will discuss resent progress in light emission devices, enhanced or rely on subwavelength plasmonic resonators. The general concept of such configurations is depicted on Fig. 1:

Fig. 1 General concept - active media in conjugation to plasmonic resonator

The emphasis will be on rigorous quantum description of various linear [6] and nonlinear [7] processes on the nano-scale, involving the presence of active/absorbing and dispersive material components [8].

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