

Synthetic Approach for the Experimental Investigation of Plasmonic Dicke Effect in Au-Fluorophore Nanohybrids

Axe: Matériaux photoniques

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It has been postulated that for an ensemble of dipoles situated at the surface of a plasmonic nanoparticle (NP) the interaction between emitters is of plasmonic character, rather than radiative, leading to the formation of collective states known as “superradiant modes”.ⁱ These results are an extension of the previous work by Dicke, in which he postulated the existence of such states for an ensemble of dipoles confined in a volume smaller than the radiation wavelength.ⁱⁱ To the best of our knowledge, there has been no experimental demonstration of the plasmon-mediated superradiance near metal nanoparticles, this being a consequence of the difficulty to create a system in which the number of dipoles per plasmonic core and the distance between them are precisely controlled.

In our work, Au NPs functionalized with fluorophores (organic molecules or quantum dots) have been used as model systems. In both cases a homogeneous silica shell has been used as spacer between the plasmonic core and the fluorophores as a way to control the physical interaction between them. Time-resolved fluorescence spectroscopy has been used to study the light-matter interactions within the system, both in solution and in single particle measurements. This allows us to determine the collective emission rates as a function of wavelength, concentration of fluorophores and distance to finally compare the experimental data with the theoretical predictions.

ⁱ V. N. Pustovit, T. V. Shahbazyan Phys. Rev. Lett., 102 (2009), 077401.

ⁱⁱ R. H. Dicke, Phys. Rev., 93 (1954), 99.