Overall scaling behavior of individual metallic nanoparticles

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Abstract:

Today the optical response of metallic nanoparticles of arbitrary shape (geometry and size) is analyzed by using numerical methods such as FEM, MMP or FDTD in order to approximate the solution of the wave equation. Despite their undisputed potential for calculating the dependence of the optical response of NPs on a variety of parameters (shape, material, particle excitation, etc.), they are not well suited to deliver a more general picture of the dependence of plasmon resonance position on shape. The reason is the difficulty of integrating parameters which describe shape variations and the resulting need to perform a sequence of simulations in which the geometry is adapted.

In this talk we will introduce a non-numerical method that reveals some basic dependencies on shape of the dipolar modes of individual metallic nanoparticles. The model is based on a simple resonance condition generated by expansion of the first TM mode of Mie's formulation and incorporation of depolarization factors. We show that the sensitivity of the resonance position on changes in shape depends strongly on the overall length configuration of the NP. In consequence, the dipolar plasmon resonance positions of a NP can either scale exclusively with the associated principle axis linearly, or depend strongly on the absolute and relative lengths of all these principle axes. Experimental data on NPs in the size range of 10 to 300 nm and aspect ratios between 1 and 10 agree closely with the model's predictions.