MAR10-2009-003175

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Quantum description of plasmons in strongly coupled metallic nanostructures

PETER NORDLANDER, Rice University

The plasmonic couplings between closely positioned metallic nanoparticles can induce extraordinary large electric field enhancements in the junctions between the particles of relevance for surface enhanced spectroscopies such as SERS.[1] Such plasmonic couplings can also lead to plasmonic interference and coherence effects that manifest themselves as narrow Fano resonances in the optical spectra with extraordinary sensitivities to their dielectric environment.[2] Until very recently, the modeling of the plasmonic response of closely coupled metallic nanoparticles has been made using classical approaches neglecting quantum mechanical effects such as electron tunneling between the particles and screening due to the finite electron density in the junction. In this talk we will present a fully quantum mechanical investigation of the plasmonic response of two coupled metallic nanoparticles as a function of interparticle separation.[3] We identify three distinct regimes of interaction. In the classical regime for separations larger than 1 nm, the nanoparticles remain neutral and the plasmonic response is well described using classical theory. In the cross-over regime for separations between 0.5 and 1nm, electrons begin to tunnel between the nanoparticles and a reduction of the plasmonic couplings and field enhancements result. In the conductive regime for separations smaller than 0.5nm, a large conductive overlap is established between the two particles and a blue-shifted Charge Transfer Plasmon (CTP) emerges.[4] The CTP is a collective plasmon mode which both includes a polarization of the electron distribution of each individual nanoparticle and a significant electron current between the two particles. [1] F. Le et al., ACS Nano 2(2008)707-718 [3] N.A. Mirin, K. Bao, and P. Nordlander, J. Phys. Chem. A 113 (2009)4028-4034 [3] J. Zuloaga, E. Prodan, and P. Nordlander, Nano Lett. 9(2009) 887-891 [4] J.B. Lassiter et al., Nano Lett. 8(2008)1812-1816