Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Cooperative plasmon-mediated fluorescence of molecules near a metal nanoparticle[1] V. N. PUSTOVIT, T. V. SHAHBAZYAN, Jackson State University — We study radiative and nonradiative decays of an ensemble of molecules attached to a metal nanoparticle. We show that when the system size is smaller than the radiation wavelength, the excited molecular dipoles are hybridized with each other via the nanoparticle surface plasmon, leading to cooperative plasmon-mediated emission similar to Dicke superradiance. In particular, an ensemble of N molecules located at random positions but at the same distance from nanoparticle surface has only 3 bright (superradiant) eigenstates each characterized by the single-molecule plasmon-enhanced radiative decay rate multiplied by approximately N/3, while the remaining N-3 states are optically dark (subradiant). The fluorescence quenching by the nanoparticle exhibits a similar behavior, with bright states having single-molecule nonradiative decay rate multiplied by the same factor and dark states having much longer but still finite non-radiative lifetime due to contribution of higher angular momenta. As a result, the radiation power of an ensemble is thrice that of a single molecule near a nanoparticle irrespective to total number of molecules. Calculations were performed for both perpendicular and parallel dipole orientations with respect to the nanoparticle surface.

[1]Supported by NSF

Tigran Shahbazyan
Jackson State University

Date submitted: 27 Nov 2007 Electronic form version 1.4