# Enhanced Spontaneous Emission in Plasmonic Nanostructures

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## Abstract

Spontaneous emission -- an electron in an excited state of an emitter spontaneously decays to another state with lower energy -- plays an important role in determining the performance of light-emitting diodes, fluorescent dyes, colorants, solar cells, etc. The efficiency of spontaneous emission is determined by the interaction between the emitter and its local electromagnetic environment(1, 2), which gives us an opportunity to rational design nanostructures for enhancing the local electromagnetic interactions between the emitter and the nanostructures. Recently, large spontaneous emission enhancements exceeding 1000 had been reported in plasmonic patch antennas coupled quantum emitters, which provides a promising approach for the ultrafast optoelectronic devices(3, 4).

In this work, we used COMSOL Multiphysics® software to simulate the spontaneous emission process of an emitter coupled with plasmonic nanostructures. An electric point dipole source in Wave Optics Module of COMSOL® software was applied to model the radiative behavior of emitters. The spontaneous emission rate, as well as local density of states was derived via evaluating the system's Dyadic Green's function, which was realized in COMSOL® software by probing the field on the point dipole. We applied the model to study an emitter located above a metal sphere with dipole moment along x or z direction, the total and radiative and nonradiative decay rates (γ_sp,γ_r,γ_nr, respectively) for different dipole transition energies were calculated. The comparison between numerical results obtained from COMSOL® software and analytical results from Mie theory show a very good agreement (see Fig. 1).

## Reference

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## Figures used in the abstract

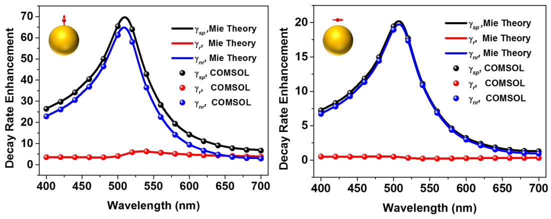


Figure 1: Comparison between numerical results and analytical results.