1 Optical Interactions in the Context of Nano Optics

- Discuss the modification of the decay rate when an oscillating dipole is in close proximity with a perfect metal conductor. Consider a dipole parallel and perpendicular to the metal surface and plot the normalized decay rate as a function of distance. Hint: use image charges to solve the problem.

- The Local Density of States (LDOS) of an electric dipole with average orientation is given by Equation (1).

$$\rho(r_0, \omega_0) = \frac{2\omega_0}{\pi c^2} \operatorname{Im}\left\{ \operatorname{Tr}[\overset{\leftrightarrow}{G}(r_0, r_0; \omega_0)] \right\}. \tag{1}$$

  In free-space, the partial local density of states ρ_μ is identical to the LDOS. To show this, prove that

$$\left[n_\mu . \operatorname{Im}\left\{ \overset{\leftrightarrow}{G}_0 \right\} . n_\mu \right] = \frac{1}{3} \operatorname{Im}\left\{ \operatorname{Tr}\left[\overset{\leftrightarrow}{G}_0 \right] \right\}, \tag{2}$$

  where $\overset{\leftrightarrow}{G}_0$ is the free-space dyadic Green function.

- Two molecules, fluorescein (donor) and alexa green 532 (acceptor), are located in a plane centered between two perfectly conducting surfaces separated by the distance d. The emission spectrum of the donor (f_D) and the absorption spectrum of the acceptor (σ_A) are approximated by a superposition of two Gaussian distribution functions. Use the fit parameters from Section 8.6.2 in the text book Principles of Nano-Optics (Second edition) by Lukas Novotny .

  1. Determine the Green's function for this configuration.
  2. Calculate the decay rate γ_0 of the donor in the absence of the acceptor.
  3. Determine the transfer rate $\gamma_{D\to A}$ as a function of the separation R between donor and acceptor. Assume random dipole orientations.
  4. Plot the Förster radius R_0 as a function of the separation d.

2 References

1. Principles of Nano-Optics (Second edition) by Lukas Novotny