DIPOLE-DIPOLE INTERACTIONS BETWEEN QUANTUM EMITTERS IN PLASMONIC NANOSYSTEMS

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The electromagnetic field confined to sub-wavelength volumes in plasmonic nanoparticle arrays is known to be able to strongly couple to quantum emitters (QEs; typically dye molecules or quantum dots) surrounding the nanoparticles. The character of the resulting spectra can be affected by the direct dipole-dipole interactions between the QEs [1][2].

We simulate the system of a nanoparticle and many QEs using two methods. One is based on the multiple-scattering model used in [2]. In the other method, we use exact diagonalization of a Hamiltonian with single-mode approximation for plasmonic excitations and where the emitters are treated as two-level systems—this approach allows inclusion of only a smaller count of QEs, but respects the limited number of excitations they can carry (which might be important when the total excitation number is high).

We apply both methods to explore the parameter space (including emitter density, dipole moment, configuration randomness, resonance frequencies etc.) in order to identify the regions with potentially observable effects of the dipole-dipole interactions between the QEs.

[1] A. Salomon, R. J. Grdon, Y. Prior, T. Seidelman, and M. Sukharev, Physical Review Letters **109**, 073002 (2012).
[2] A. Delga, J. Feist, J. Bravo-Abad and F. J. García-Vidal, Journal of Optics **16**, 114018 (2014).