Near-field mapping of the electric and magnetic local density of states

R. Carminati[1,*], D. Cao[1], A. Cazé[2], V. Krachmalnicoff[1], R. Pierrat[1] and Y. De Wilde[1]

L. Aigouy[3], P. Gredin[4] and M. Mortier[4]

[1] Institut Langevin, ESPCI ParisTech, CNRS, Paris, France
[2] Department of Mathematics, University of Michigan, Ann Arbor, MI, USA
[3] Laboratoire de Physique et d'Etude des Matériaux, ESPCI ParisTech, CNRS, Paris, France
[4] Institut de Recherche de Chimie Paris, Chimie Paristech, CNRS, Paris, France

*remi.carminati@espci.fr

In the first part of the talk, we will present a novel method for mapping the radiative and non-radiative decay rate of a fluorescent emitter in the near-field of a nanostructured sample. The approach is based on the simultaneous mapping of the fluorescence intensity and decay rate of fluorophores with electric dipole transitions [1], and on the rigorous application of the reciprocity theorem of electromagnetism. Experimental data are compared with exact numerical simulations. A quantitative agreement between theory and experiment is demonstrated, proving the validity and the relevance of the method [2].

In the second part, we will report on a similar experimental technique to quantify the relative importance of electric and magnetic dipole luminescence from a single nanosource. By attaching a Eu-doped nanocrystal to a near-field scanning optical microscope tip, we map the branching ratios associated to two electric dipole and one magnetic dipole transitions in three dimensions in the near field. The relative weights of the electric and magnetic radiative local density of states can be recovered quantitatively, based on a multilevel model. This studies paves the way towards the full electric and magnetic characterization of nanostructures for the control of single emitter luminescence.

References

[1] V. Krachmalnicoff, D. Cao, A. Cazé, E. Castanié, R. Pierrat, N. Bardou, S. Collin, R. Carminati and Y. De Wilde, Opt. Express **21**, 11536 (2013).

[2] D. Cao, A. Cazé, M. Calabrese, R. Pierrat, N. Bardou, S. Collin, R. Carminati, V. Krachmalnicoff and Y. De Wilde, *Mapping the radiative and non-radiative local density of states in the near field of a gold nanoantenna*, submitted (2014). arXiv:1401.2858

[3] L. Aigouy, A. Cazé, P. Gredin, M. Mortier and R. Carminati, *Mapping and quantifying electric and magnetic dipole luminescence at the nanoscale*, submitted (2014). arXiv:1404.1369