Master thesis proposal

Institut des Nanosciences de Paris
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Title: Spectral broadening of single colloidal nano-emitter under high excitation

Keywords: fluorescence, nanocrystal, plasmonics, Bayesian analysis

Scientific description:

CdSe/CdS core/shell nanocrystal are excellent bright nano-emitters. At room temperature, they behave as high quantum efficiency single photon source thanks to the electronic confinement and efficient Auger processes. Single photon emission can be described by the recombination of a single exciton within a simple two-level system. Under low excitation power at room temperature, the emission linewidth is approximately $\Delta\lambda \approx 20$ nm. However, by increasing the excitation power, emission spectrum broadens dramatically up to $\Delta\lambda \approx 150$ nm (Fig1a). Moreover, the emission intensity grows non-linearly with increasing excitation power [1][2]. The two- levels system paradigm fails for interpreting those features. We have recently developed a model based on the radiative recombination of multiple excitonic levels within a single nanocrystal , relying on statistical description[3] of electron and hole populations in a quasi-equilibrium and on their recombination.

During the internship the student will consider different types of nano-emitter, quantum dots or quantum wells, and will study their emission under high excitation. He/She will then analyse the experimental datas using among others Bayesian methods, and extent our theoretical model.

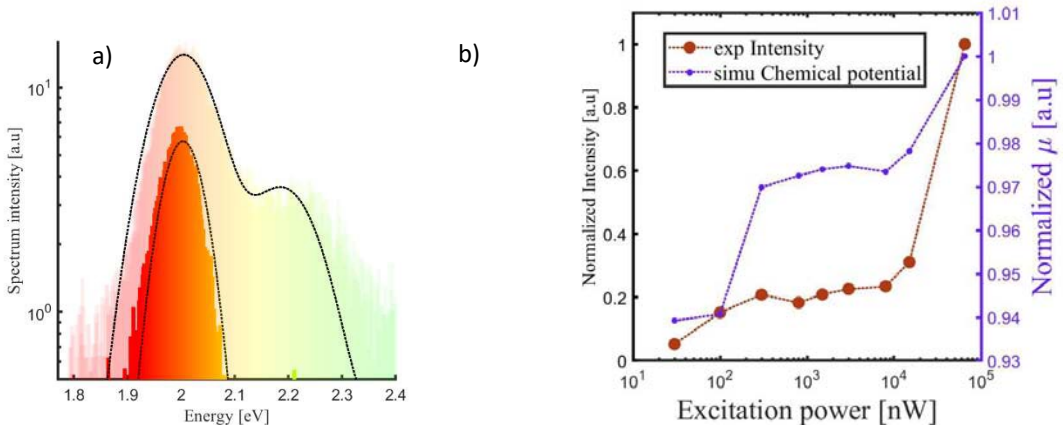

Fig. 1 a) Experimental spectra of a single core/shell CdSe/CdS quantum dot under low and high excitation power. Dashed lines represent the most probable fit. b) Evolutions of the normalized experimental intensity, numerical radiation chemical potential in function of the excitation power.

References

[1] A.R Dhawan, et al. (2020) Light: Science & Applications, 9(1), 1-9.
[2] A. R Dhawanet al (2022), Advanced Materials, 34(11), 2108120.
[3] P. Wurfel. (1982) 15(18), 3967.

Techniques/methods in use: optical microscopy, spectroscopy, data analysis, modelling
Internship supervisors: Agnès Maître, agnes.maitre@insp.upmc.fr
Internship location: INSP, campus Jussieu, Tour 32-22, 5ème
Possibility for a Doctoral thesis: Y (ANR CoLiMe)