M2 Internship offer

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Cooperative effects in a spherical quantum well supercrystal

The optical properties of single quantum emitters have been extensively studied in atomic physics and condensed matter physics. However, when several of these emitters share a volume on the order of the emission wavelength, various collective effects can modify the fluorescence of the ensemble, such as superradiance (*1*) or superfluorescence. These aspects have mainly been studied in atomic physics, but the development of supercrystals (*2*), which enable the construction of a very dense and organized array of quantum emitters, has opened the door to the study of these cooperative effects among solid emitters.

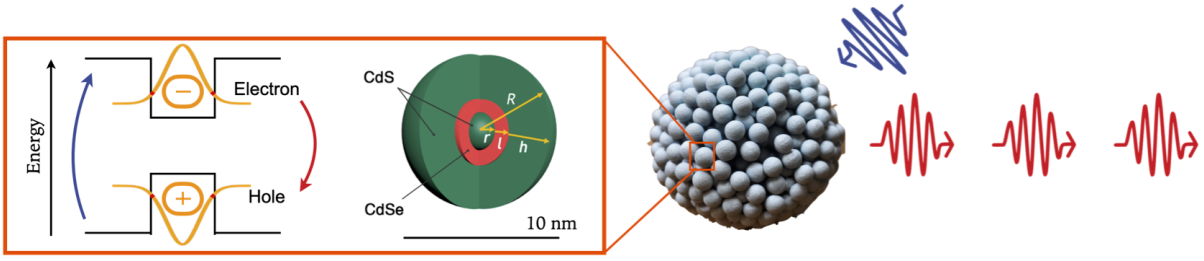

Figure 1: The fluorescence of a single quantum emitter (red box) is beginning to be well understood in condensed matter; but what happens when a large number of quantum emitters share a small volume, as in a supercrystal?

The aim of the internship is to measure and analyze the properties of the light emitted by quantum dot supercrystals. To measure the photoluminescence, we will use two experimental setups at room and low (4K) temperatures with various quantum optics tools which will give us access to the spectrum of emitted light, the lifetime of quantum emitters (time resolution $\sim$ 20 ps), and the photon emission statistics. The analysis of these experimental data (preferably in Python) and their comparison with theoretical models will enable us to understand the collective phenomena at work in these superstructures.

This internship can be followed by a PhD thesis with a secure funding by the *Agence Nationale de la Recherche (ANR)*.

1. R. H. Dicke, en, *Physical Review* **93**, 99–110, ISSN: 0031-899X, (2023; https://link.aps.org/doi/10.1103/PhysRev.93.99) (Jan. 1954).
2. G. Rainò *et al.*, en, *Nature* **563**, 671–675, ISSN: 0028-0836, 1476-4687, (2023; https://www.nature.com/articles/s41586-018-0683-0) (Nov. 2018).