Stage de master de physique / Physics Master Internship

Proposition de stage/ Internship proposal

Date de la proposition : october 2022

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Coupling effects between self-assembled fluorescent nanoparticles

The **group *Nanostructures and Optics* at INSP** studies light emission and propagation at the nanoscale : fluorescent nano-sources, emission control by photonic crystals or plasmonic nano-antennas, chirality of fluorophores and antennas etc. Among our interests, fluorescent semi-conductor nanoparticles are very bright, stable and versatile light sources with more and more applications in bio-imaging, lighting and TV displays. When a ***single* nanoparticle** is examined by **fluorescence microscopy**, its emission often displays purely quantum-optical properties such as single photon emission (photons are emitted one by one) which can be used for quantum information.

While fluorescence from isolated emitters is now well known, most opto-electronic applications (LEDs, solar cells…) involve nanoparticles packed in a dense layer, where they should behave very differently because of **short-range interactions, charge transport and exciton diffusion between neighboring particles.** By using adequate solvent and ligands, the group of B. Abécassis in ENS Lyon has managed to self-assemble chains of hundreds of semiconductor nanoplatelets (fig. 1(a-c)) which constitute a **good model system for nanoparticles interactions**. We have shown that, due to near-field dipole-dipole Förster-type interactions (FRET), excitons migrate extremely fast between platelets (fig. 1(d)) so that the **fluorescence behavior of assembled platelets is expected to show collective effects** instead of only being the sum of the luminescence of each platelet.

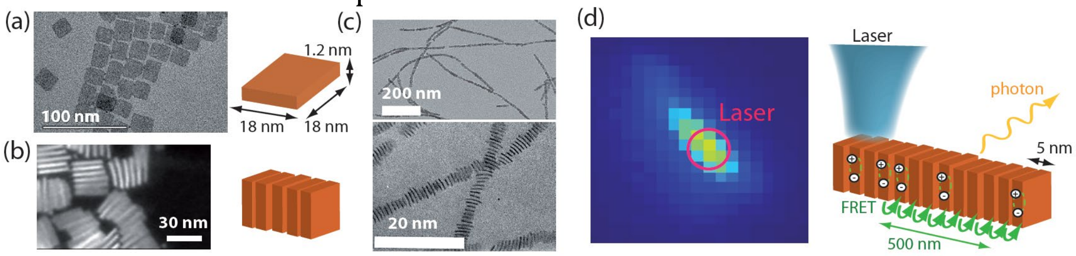

Figure 1 : TEM images of (a) CdSe nanoplatelets, (b) aggregated platelets and (c) self-assembled stacked nanoplatelets [S. Jana et al., Science Advances 2017]. (d) Previous result : a laser excites a spot on the chain and energy propagates by FRET between around 100 platelets so that a 1-μm portion radiates light [Jiawen Liu et al., Nano Lett. 20, 3465 (2020)].

The aim of the internship work is to **explore other coupling effects among the nanoplatelets**, in particular at higher excitation powers : when excitons are created simultaneously in different platelets, they may for instance migrate by FRET, meet and interact ; they may also experience the quantum-optical mechanism of **superradiance** leading them to interfere constructively. The work will be mostly experimental (fluorescence microscopy, single-photon counting) but may include some analytical or numerical modelling.

References (previous work in the group) :

Fu Feng et al., ACS Photonics 5, 1994 (2018) ; Jiawen Liu et al., Nano Lett. 20, 3465 (2020)
Jiawen Liu et al., ACS Photonics (2020)

Le stage pourra-t-il se poursuivre en thèse / *possibility of a PhD* ? YES
Financement envisagé / *financial support considered* : application to Ecole doctorale funding