INTERNSHIP PROPOSAL

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Internship location: Campus Pierre et Marie Curie, 4 place Jussieu ; 22-32-5e étage
Thesis possibility after internship: YES
Funding: Application to Ecole Doctorale

Cooperative light emission from self-assembled semiconductor nano-objects

Semi-conductor quantum dots 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. Because of quantum confinement, its energy levels make it similar to an "artificial atom".

By using adequate solvent and ligands, the group of B. Abécassis in ENS Lyon has managed to assemble chains of hundreds of semiconductor nanoplatelets (fig. 1(a-c)). They constitute a good model system to explore nanoparticles interactions as they offer strong interactions (large dipole moment, good spectral overlap between absorption and emission, well-known controlled order).

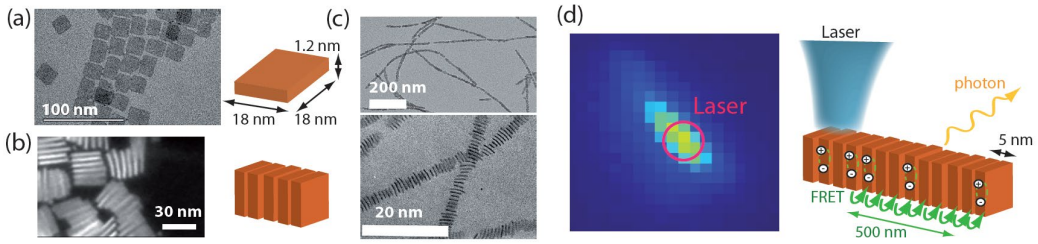

Figure 1 : TEM images of (a) CdSe nanoplatelets, (b) aggregated platelets and (c) self-assembled stacked nanoplatelets. (d) Previous result (Liu et al., 2020) : a laser excites a spot on the chain and energy propagates by FRET (dipole-dipole interaction) between around 100 platelets so that a 1-µm portion radiates light.

The aim of the internship is to examine whether this ensemble of light emitters can also exhibit superfluorescence, a mechanism by which incoherently excited dipoles, because of their coupling to the electromagnetic field, spontaneously develop a coherence and interfere constructively, leading to accelerated emission and original properties for emission correlations and directionality.

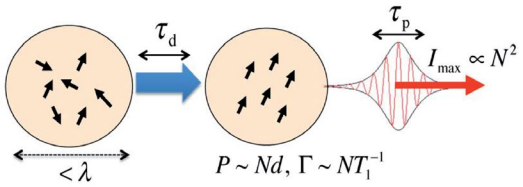

Figure 2 : Superfluorescence mechanism (Kankan Cong et al, 2016) : initially incoherent dipoles develop a coherence and a macroscopic dipole, then after this build-up time they all interfere constructively and radiate very intensity and, thus, very fast.

References (some previous work in the group) : Jiawen Liu et al., Nano Lett. 20, 3465 (2020) ; Jiawen Liu et al., ACS Photonics 7, 2825 (2020) ; Jiawen Liu et al., J. Phys. Chem A 125, 7582 (2021) ; Zakarya Ouzit et al., ACS Photonics 10, 421 (2023) ; Zakarya Ouzit et al., J. Phys. Chem. Lett. 14, 6209 (2023)

Condensed Matter Physics: YES	Soft Matter and Biological Physics: NO
Quantum Physics: YES	Theoretical Physics: NO