Single nano spherical quantum well optical characterization at low temperature

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Labs: Institute of Light and Matter (ILM)
Targeted level: M2
Duration: 4-6 Months
Keywords: nano-optics, quantum dots

The internship can be extended to a PhD *via* the ED PHAST.

The aim of the internship is to characterize the emission (intensity, exciton lifetime, spectral fluctuations and antibunching) of single nano spherical quantum wells (SQW) at low temperature (T=4 K).

Spherical quantum wells are luminescent nano-objects, with typical diameter ranging from 10 to 20 nm [1]. Characterization of these new nano-objects has been performed at room temperature and since their first discovery in 2016, SQW-based devices have been conceived (solar cell concentrators [2], LEDs [3]), highlighting the community interest in these objects.

Our research interests focus on developing an economic, easy-to-implement single photon source (SPS) in the visible. We want to test the optical properties of SQWs at low temperature to settle if they can be up to the SPS challenge.

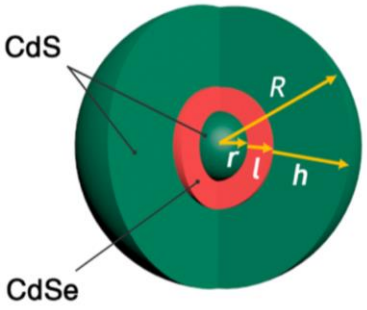

Figure 1 A CdS/CdSe/CdS spherical quantum well

The trainee will work on an existing low-temperature, home-build, confocal microscope operating at T=4 K. The internship will be divided in two main objectives, which can be realized independently:

Objective 1: Photon antibunching (3 months)
SQWs should exhibit a quantum-well-like confinement, and therefore should not emit single photons [4]. However, we found that at room temperature, SQWs emitting at 620 and 655 nm exhibit photon antibunching, the smoking gun of SPS emission; while no antibunching was observed for 675 nm emitting SQWs. We want to study this behavior at low-temperature as a function of the emission wavelength (i.e. the size of the active layer in the SQWs) and determine the transition size where single photon emission disappear.

Objective 2: Spectral fluctuations of a single SQW (3 months)
A SPS needs to achieve lifetime-limited emission linewidth to hope serving for hybrid quantum network applications. However, most of the nano-emitters exhibit spectral wandering of their emission wavelength as a function of time. Emission linewidth as a function of excitation intensity will be measured to gain information on the nature/localization of the local environment traps.

[1] B.G. Jeong *et al.*, ACSNano **10,** 9297 (2016)
[2] H-J Song *et al.*, Nano Lett. **18**, 395 (2018)
[3] X. Jin *et al.*, Optical Materials Express **7,** 4395 (2017)
[4] N. Razgoniaeva *et al.*, J. Am. Chem. Soc. **139**, 7815 (2017)