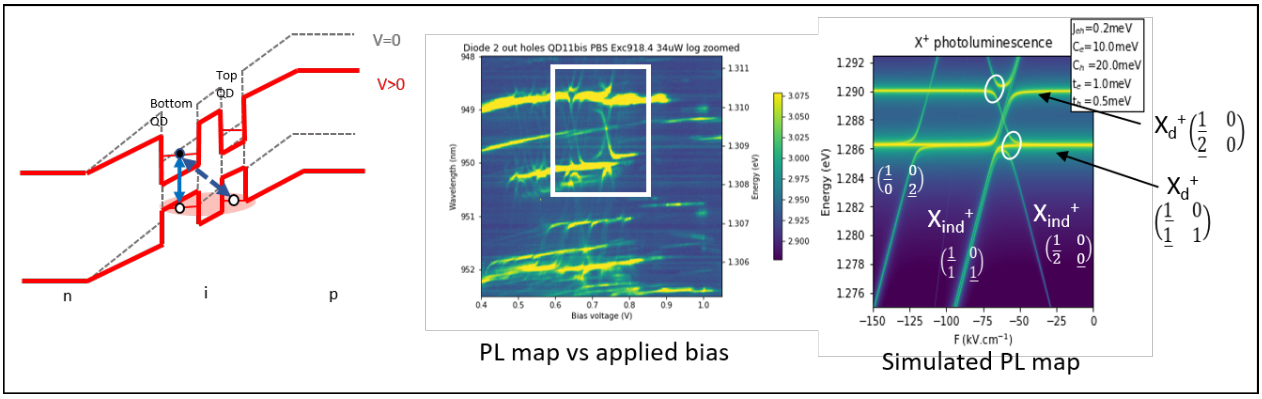
**M2 Internship Proposal: Coupled quantum dots for integrated quantum photonics**

Self-assembled quantum dots (QD) – clusters of hundreds of atoms that form spontaneously under certain thin film growth conditions – are ideal for quantum information applications due to their discrete, atom-like density of states and ease of integration into conventional semiconductor devices.

We propose to explore coupled quantum dots, or so-called quantum dot molecules, where two dots are close enough that carriers can tunnel coherently between them. This system has great potential as the quantum gate needed for quantum computation. By controlling the number of charge carriers in the molecule, a spin qubit with a large coherence time can be created, about two orders of magnitude longer than the coherence time of a single spin in a QD[1].

We propose to investigate such structures and realize a device for an efficient spin-photon interface. This challenging project combines advanced epitaxial growth, nanofabrication and quantum optics experiments. Molecules will be embedded in a diode structure to permit an electric field to be applied across the dots, in order to bring the energy levels of the two dots into resonance, creating new electron states which are delocalised across the two dots[2]. The spin states will be addressed and controlled with optical pulses under magnetic field. Original experiments can then be setup, for instance tuning a sequence of radio-frequency magnetic field pulses to the singlet-triplet spin resonance allowing driving the optically initialized qubit. The coupled QD will also be inserted in specifically designed photonic structures to enhance light-matter interaction and achieve Purcell enhanced spontaneous rate and improve the photon extraction efficiency.




The student will have the opportunity to participate in all the stages of development of a new quantum device: from device design and fabrication, to the final low temperature photoluminescence measurements of quantum confinement effects and quantum optics experiments.

**Techniques/methods used**: clean-room device fabrication, micro-photoluminescence at low temperature; FDTD modelling of semiconductor nanophotonic structures.

**Applicant skills**: Background knowledge in solid state physics and quantum mechanics; interest in experimental physics; experience in device fabrication and optical measurements will be appreciated.

**Supervisor(s) at INSP**: Valia VOLIOTIS and Benoit Eble

Possibility to continue with a PhD (funding Ecole Doctorale ED 564 or Sorbonne University)

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[1] Tran et al, Phys. Rev. Lett. 129,027403 (2022)

[2] Raymond et al, Phys. Rev. B 112, 125302 (2025)