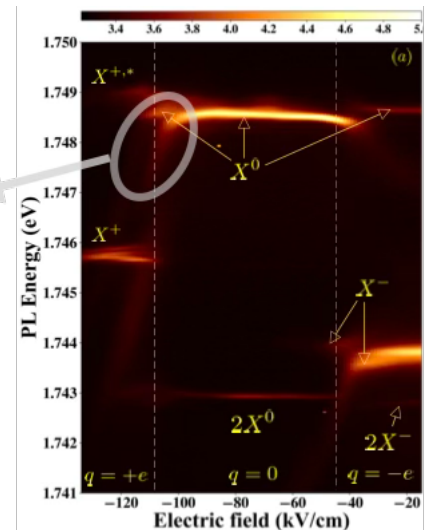
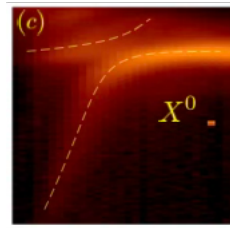


Magnetic Control of Inter-Valley Coupling in a single Type-II GaAs/AlAs Quantum Dot

Laboratory name: INSP ([Institut des NanoSciences de Paris](#))
CNRS identification code: UMR 7588
Internship director's surname: Benoit EBLE
e-mail: benoit.eble@insp.jussieu.fr
Web page: [Click here !](#)
Internship location: Sorbonne University Site Jussieu (tour 22-32)
Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: ED

In this Master's internship, we investigate the optical and electronic properties of GaAs/AlAs semiconductor quantum dots (QDs) grown by nanohole infilling at the Institut des NanoSciences de Paris. **These highly distinctive QDs have the ability to host two types of optical excitations whose hybridization can be tuned via a gate voltage:** (i) A direct exciton, formed by an electron-hole pair both localized within the GaAs quantum dot, and (ii) An indirect exciton, which is indirect in both real space and momentum space. In this case, the electron is confined in the X-valley of the surrounding AlAs barrier, stabilized by the high aluminum content, while the hole remains in the GaAs dot [1].

The spatial separation between the electron and hole leads to a strong coupling with the electric field of the structure. This interaction is easily detectable through the Stark effect and enables precise control of the relative energy between the two exciton species (see figure). The observation of an anti-crossing between these states reveals an inter-valley coupling mechanism mediated by **the electron tunneling across the atomically sharp interface between GaAs and AlAs** (see inset).



To harness such interface-driven phenomena for quantum technology applications, it is desirable to gain control over the inter-valley coupling strength. While this coupling is intrinsically determined by the nature and quality of the interface (material composition, interface roughness), it also depends on the local electronic density. This density can be modified via a magnetic field applied in the Voigt configuration (perpendicular to the growth axis), which leads to **a contraction of the electronic wavefunction and consequently a change in its spatial density**[2].

Implementing this specific magnetic field configuration in a high-resolution, low-temperature micro-photoluminescence setup will not only allow for tunable inter-valley coupling, but may also enable **the observation of spectral oscillations associated with the Aharonov-Bohm effect**, for which this new system presents a promising platform[3].

Required skills:

- A solid background in quantum physics and condensed matter physics.
- Interest in experimental physics, including optical alignment, microcontroller programming, and cryogenic techniques.

Biblio :

- [1] Phys. Rev. B 112, 125302 (2025)
- [2] Phys. Rev. B 112, L060404 (2025)
- [3] Nano Lett. 2016, 16, 27–33