

INTERNSHIP PROPOSAL M2

Laboratory name: CRHEA CNRS identification code: UPR10 Internship director'surname: Francois Dubin e-mail: fd@crhea.cnrs.fr Web page: www.crhea.cnrs.fr Internship location: Valbonne (06)	
Thesis possibility after internship: YES Funding: YES partially	Phone number:+33664581279 If YES, which type of funding: ANR

Quantum Simulation of Anyons

Over the last decade, experiments scrutinizing quantum particles strongly interacting in lattice potentials have concretized Feynman's seminal idea of quantum simulations. By relying on highly controlled platforms, neutral atoms or solid-state nanostructures, complex many-body problems have been accurately simulated, for example the quantum phase transition from superfluid to quantum solid for bosons, while longer term goals notably include exploration of exotic quantum statistics or unconventional superconductivity.

Here, we propose an internship to implement quantum simulation scenarios with ultra-cold dipolar excitons confined in nanoscopic electrostatic lattices. This semiconductor platform has shown a high level of performance [1-4]. It relies on electron-hole pairs that are optically injected in a double quantum well, where Coulomb attraction yields dipolar excitons. These are constituted by a pair of fermions and then realize model boson-like quasi-particles in a semiconductor. In our studies, the double quantum well is integrated in a field-effect device with surface gate electrodes that imprint electrostatic lattices confining excitons. Hence, a wide range of strongly-correlated quantum matter phases have been observed, including Mott insulators, superfluids and even supersolid crystals [1-4].

For this internship we propose route to explore anyonic excitations. Anyons, which are strikingly marked by a fractional quantum statistics, are theoretically accessible to dynamically varying lattices of dipolar excitons. following so-called Floquet engineering.

Refs. from our group:

- [1] C.Lagoin et al., Nature Phys. 18, 149 (2022)
- [2] C. Lagoin et al., Nature 609, 485 (2022)
- [3] C. Lagoin et al., Nature Phys. 22, 566 (2026)
- [4] C. Morin et al., Nature Phys. (in press)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

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