

Master 2: International Centre for Fundamental Physics INTERNSHIP PROPOSAL

Laboratory name : Matériaux et Phénomènes Quantiques – MPQ UMR7162

Location : Université Paris Cité – 10 Rue A. Domon et L. Duquet – Bât. Condorcet – 75013 PARIS

Internship director : Prof. Cristiano Ciuti (THEORIE group)

@mail : cristiano.ciuti@u-paris.fr

Tel : +33 (01) 57 27 62 37

<https://mpq.u-paris.fr/en/annuaire/ciuti-cristiano-en/>

<https://scholar.google.it/citations?user=rzc1ND0AAAAJ&hl=en>

Controlling Fractional Quantum Hall Systems through Cavity Quantum Electrodynamics

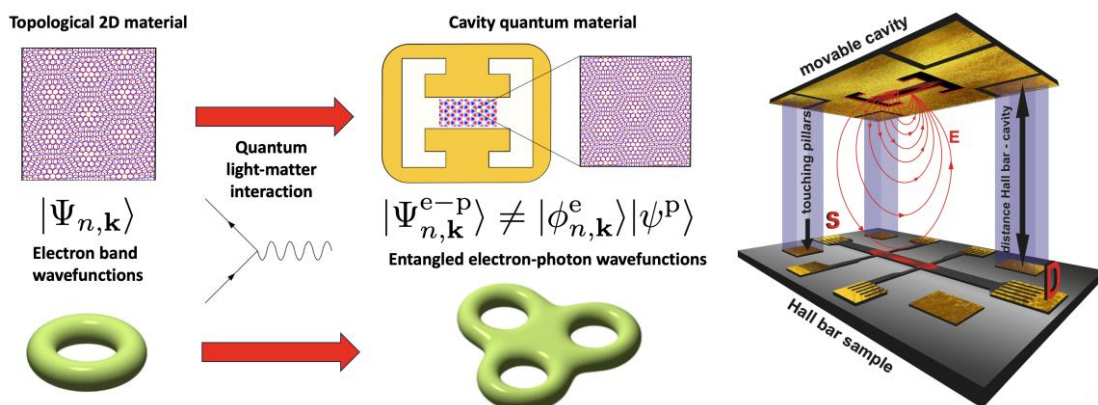
We have recently demonstrated the significant influence that interactions between cavity quantum electromagnetic fields and topological quantum materials—such as quantum Hall systems and 2D moiré materials—can have on their quantum transport and topological properties [1-4]. In this theoretical internship, the Master's student will gain expertise in and apply advanced theoretical techniques from quantum many-body physics and cavity Quantum Electrodynamics (QED). This internship, which may lead to a subsequent PhD, will focus on exploring non-trivial topological phases in fractional quantum Hall systems [4] and fractional Chern insulators. These are crucial strongly correlated quantum materials for both fundamental physics and applications in topological quantum information.

[1] F. Appugliese, J. Enkner, G. L. Paravicini-Bagliani, M. Beck, C. Reichl, W. Wegscheider, G. Scalari, C. Ciuti, J. Faist, *Breakdown of topological protection by cavity vacuum fields in the integer quantum Hall effect*, [Science 375, 1030-1034 \(2022\)](#)

[2] G. Arwas, C. Ciuti, *Quantum electron transport controlled by cavity vacuum fields*, [Physical Review B 107, 045425 \(2022\)](#)

[3] D.P. Nguyen, G. Arwas, Z. Lin, W. Yao, C. Ciuti, *Electron-photon Chern number in cavity-embedded 2D moiré materials*, [Phys. Rev. Lett. 131, 176602 \(2023\)](#)

[4] J. Enkner et al., *Enhanced fractional quantum Hall gaps in a two-dimensional electron gas coupled to a hovering split-ring resonator*, [arXiv:2405.18362](#)



Condensed Matter Physics : YES
Quantum Physics : YES

Macroscopic Physics and complexity : YES
Theoretical Physics : YES