POSTDOCTORAL POSITION IN THEORETICAL PHYSICS

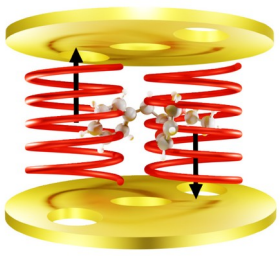
Topic: Open-system approaches to chiral light-matter interactions in chiral electromagnetic cavities
Supervisors: David Hagenmüller & Rémi Avriller
Contact: dhagenmuller@unistra.fr, remi.avriller@u-bordeaux.fr
Duration: 2 years
Possible hiring date: Between October 1st 2024 and October 1st 2025 (flexible)
Location: CESQ-ISIS (Strasbourg) + Visits to LOMA (Bordeaux)
Profile: The project is focused on the development of theory models. The candidate should have a taste and background in analytical calculations, but numerical skills will also be greatly appreciated. The candidate must have a PhD in theoretical physics (date of PhD defense typically less than 2 years before hiring), and a strong background in quantum optics models, and/or condensed-matter theory (solid-state/molecular systems), and/or quantum transport. The postdoc will eventually collaborate with PhD students working on similar topics.
How to apply: Send to supervisors a CV, a list of publications, and one recommendation letter.

Over the past decades, a new paradigm emerged aiming at controlling the properties of materials embedded inside an electromagnetic cavity, or put in close contact with a photonic structure. In such geometries, extreme regimes of light-matter interactions have been reached when the coupling strength gets larger than all other relevant energy scales. This leads to drastic modifications of the material properties including charge[1,2] and energy[3,4] transport, chemical reactivity[5,6], and intermolecular interactions[7]. A full understanding and exploitation of such effects is still lacking. In this context, the emerging research field of *chiral polaritonics*[8,9] is promizing, for which chiroptical properties of materials might be boosted upon reaching the chiral strong-coupling regime, in specifically designed chiral cavity resonators[9,10,11]. Chiral vacuum fields could indeed be used to control the enantioselectivity of chemical reactions in cavities[12], or topological properties of 2D materials[13], with potential applications in pharmacology and quantum information processing, respectively. There is thus a timely need for developing open-system theoretical approaches[14] that enable to compute optical signatures developping in chiral cavities, like transmittance, reflectance, or absorbance, in close collaboration with experimentalists.

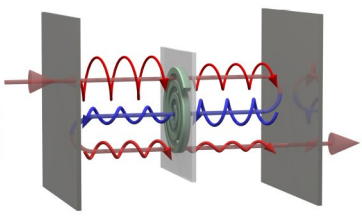
The goal of this project is to propose and develop new theoretical approaches to compute cavity-induced modifications of chiroptical and topological properties of materials embedded inside open Fabry-Perot cavities or plasmonic structures, that are specifically designed to host chiral modes.

The postdoc will benefit from stimulating environments in Strasbourg (D. Hagenmüller, CESQ-ISIS) and Bordeaux (R. Avriller, LOMA) for carrying theoretical work, and will collaborate with a local experimental group (C. Genet/T. Ebbesen, ISIS) with strong expertise in chiral light-matter interactions and strongly-coupled molecular systems in cavities. The project is part of the national project TORNADO funded by the PEPR LUMA involving 13 different laboratories with outstanding expertise in chiral light-matter interactions.

[1] E. Orgiu et al., *Nature Materials* **14**, 1123 (2015)
[2] S. Kumar et al., *J. Am. Chem. Soc.* (2024)
[3] X. Zhong et al., *Angew. Chem. Int. Ed.* **56**, 9034 (2017)
[4] A. Bard et al., *Adv. Optical Mater.* **10**, 2200349 (2022)
[5] J.A. Hutchison et al., Angew. Chem. Int. Ed. **51**, 1592 (2012)
[6] A. Thomas et al., *Science* **363**, 615 (2019)
[7] B. Xiang et al., *Science* **368**, 665 (2020)
[8] C. Schäfer et al., JPCL **14**, 3777 (2023).
[9] H. Hübener et al., *Nature Materials* **20**, 438 (2021)
[10] J. Gautier et al., *ACS photonics*, **9**, 778-783 (2022).
[11] L. Mauro et al., *Phys. Rev. A* **109**, 023528 (2024).
[12] R. Riso et al., *arXiv:2308.06181 (2023)*.
[13] T. Chervy et al., *ACS Photonics* **5**, 1281 (2018).
[14] C. Ciuti et al., *Phys. Rev. A*, **74**, 033811 (2006).



Adapted from Ref.[12]



Adapted from Ref.[10].