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Thesis possibility after internship: NO
Funding: NO

Master 2 Internship: "Input-output" theory of light-matter interactions in optical Fabry-Pérot cavities

Over the past years, there has been a renewed interest in investigating **light-matter interactions in optical Fabry-Pérot cavities** [1]. When molecular materials are put inside such cavities, they interact collectively through their electric-dipole moment with quantum vacuum fluctuations of the cavity electromagnetic field [2]. This leads to the formation of **hybrid light-matter excitations** called *polaritons*, when the collective light-matter coupling strength gets larger than the dissipation rate of the cavity [1,2]. It was shown experimentally that various physico-chemical properties of cavity-embedded materials were **deeply modified in such a polaritonic regime**, like charge and energy transport [3,4], chemical reactivity [5,6], and intermolecular interactions [7].

While most of the available quantum mechanical theoretical models used to describe such properties consider the cavity mode and material inside to be a closed system, the computation of experimentally relevant signals like the cavity ***optical spectra*** (transmittance, reflectance, or absorbance), ***fluctuation spectra*** (power spectra) and higher-order correlation functions of the field ($g_2(\tau)$-correlation functions) necessitate to « open » the cavity. One thus has to deal with the cavity and molecular losses at the origin of both ***dissipation and noise*** in the evolution of the cavity dynamical variables.

The goal of this M2 internship is to develop and implement an *« input-output theory »* [8] for computing optical properties of polaritonic Fabry-Pérot cavities, taking into account both the *mirror losses* and *polarization of light*. The application of this theory to *chiral mirrors* [9] and *chiral light-matter interactions* [10] for which optically active molecules are embedded inside the cavity constitute an open problem in this field.

The candidate will benefit from a dynamical and stimulating research environment in **IPCMS (Strasbourg)** for carrying this work. He/she will join the ***Mesoscopic Quantum Physics team*** and collaborate with its members (**R. Avriller**, **D. Hagenmuller** and **G. Weick**) having a strong expertise in ***quantum transport problems in open systems*** and ***light-matter interactions*** in Fabry-Pérot cavities. This project will also be strongly connected to the research network proposed by the national project TORNADO funded by the PEPR LUMA involving different laboratories with outstanding expertise in chiral light-matter interactions.

References:

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