INTERNSHIP PROPOSAL

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Thesis possibility after internship: YES
Funding: YES If YES, which type of funding: Doctoral school

Exploiting many-body properties for advanced quantum devices

The optical properties of highly doped semiconductor quantum wells are a paradigmatic manifestation of P. Anderson's "More is different". Indeed, for high electronic densities, there are no more optical transitions between electronic states and the absorption spectrum of the system shows a unique resonance associated with a collective mode of the system: the quantum plasmon[1,2].

Our group has demonstrated that quantum plasmons have a superradiant behavior[3], meaning that the energy decay from an excited state is radiative with a lifetime depending on 1/N, where N is the number of carriers involved in the interaction with the light. This superradiant spontaneous emission is so efficient that becomes the dominant decay mechanism. Such dependence has been exploited to create monochromatic perfect absorbers, giving rise to thermal emitters with unity emissivity[4].

In this project, we plan to exploit the superradiant properties of quantum plasmons to realize novel mid-infrared optoelectronic devices. In particular, we plan to exploit the radiative decay of quantum plasmons to create efficient cold sources, operating as mid-infrared light emitting diodes (LEDs).
As a further step, we will explore the possibility of using plasmons for realizing a quantum battery[5], based on superabsorption (the reverse phenomenon of superradiance).

References

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3. T. Laurent, Y. Todorov, A. Vasanelli, A. Delteil, and C. Sirtori, G. Beaudoin, I. Sagnes, *Superradiant Emission from a Collective Excitation in a Semiconductor*, Phys. Rev. Lett. **115**, 187402 (2015).

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5. James Q. Quach, Kirsty E. McGhee, Lucia Ganzer, Dominic M. Rouse, Brendon W. Lovett, Erik M. Gauger, Jonathan Keeling, Giulio Cerullo, David G. Lidzey, Tersilla Virgili, *Superabsorption in an organic microcavity: Toward a quantum battery*, Sci. Adv. **8**, eabk3160 (2022)

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