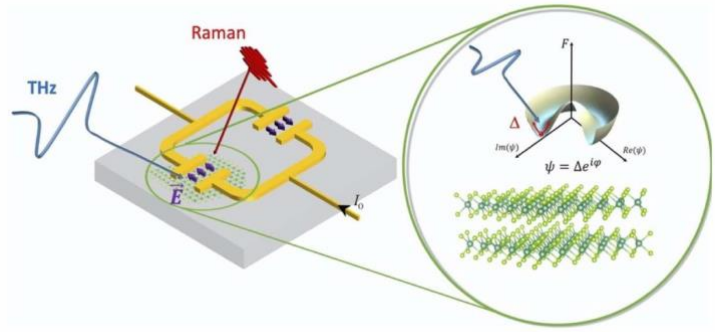
Post-doctoral opening
Probing and manipulating the superconducting state of $NbSe_2$ in the 2D limit

Context:. The dynamics of superconductors (SC) is governed by their collective mode spectrum, and in particular the SC amplitude mode which is an analog of the Higgs mode in high-energy physics [1]. In many materials the coexistence of SC with other competing phases and/or the presence of competing SC pairing states leads to a rich spectrum of collective excitations. Examples include materials like the transition metal dichalcogenide (TMD) $NbSe_2$ where SC Higgs and charge-density-wave (CDW) amplitude modes displays coupled dynamics [2]. These SC collective modes not only give fingerprints of the nature of the ground state [3], but also a path to dynamically drive or even control SC order.

TMDs like $NbSe_2$ are among the few SCs that can be isolated in the few-layer limit while retaining excellent crystalline quality and sizable $T_c > 4K$. This allows their integration into THz cavities to achieve both strong THz light fields for collective mode driving, and strong-light matter coupling in equilibrium. 2D TMDs also offer an ideal playground to explore novel exotic SC states due to their quasi-2D character and strong spin-orbit coupling [4,5].

Goals: The present project, funded by a collaborative ANR grant between several labs in the Paris region and Strasbourg (MPQ-Université Paris Cité, INSP-Sorbonne Université, LSI-Ecole Polytechnique and ISIS-Université de Strasbourg), aims at exploring the collective mode spectrum of the exotic SC state of 2D TMDs using complementary Raman and THz spectroscopies. We will also investigate SC 2D TMDs in the unchartered regimes of periodically driven out-of-equilibrium and strong light-matter coupling when embedded in THz cavities [6].



2D TMD embedded in a THz split ring cavity (left) The resulting coupled light-SC matter state is probed by Raman and THz spectroscopy. The SC Higgs mode is a collective oscillation of the SC condensate (right) that can couple to cavity photon to form cavity-Higgs polariton

Tasks: The post-doc will be in charge of TMD sample fabrication and their integration into van der Waals heterostructures and cavities using state of the art 2D material transfer techniques at MPQ lab. He/she will then probe the SC state using low temperature Raman scattering and pump-probe set-ups available at MPQ labs. He/she will also be involved in complementary THz spectroscopy measurements with our partner at LSI, Ecole Polytechnique.

Profile of the candidate: the candidate is expected to have a strong expertise in 2D sample fabrication and transfer. A background in optical spectroscopy is a plus but not mandatory.

Duration of the contract: 24 months

Salary: between 3000 and 3500 euros gross per month depending on experience.

Location: MPQ lab, Université Paris Cité, 75013 Paris
www.mpq.u-paris.fr/squap

Contact: Yann Gallais yann.gallais@u-paris.fr

References

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[2] Grasset, R., T. Cea, Y. Gallais, A. Sacuto, L. Cario, L. Benfatto, and M.-A. Méasson. *Phys. Rev. B* 97, 094502 (2018).
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[4] Xi, X., Z. Wang, H. Berger, L. Forró, J. Shan, et K. F. Mak. *Nat. Phys.* 12, 2, 13943 (2016)
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