Nanostructures at the Nanosecond Group @ LPS (Orsay)

Proposition de stage / Internship proposal

Date de la proposition : 12 novembre 2021

Responsable du stage / *internship supervisor*:

Nom / *name*: QUAY Prénom/ *first name* : Charis

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Nom du Laboratoire / *laboratory name*:

Etablissement / *institution* : Laboratoire de Physique des Solides Code d'identification : UMR 8502

Site Internet / *web site*: https://www.equipes.lps.u-psud.fr/ns2/

Adresse / *address:* Bâtiment 510, Université Paris-Saclay 91400 Orsay

Lieu du stage / *internship place*: Laboratoire de Physique des Solides

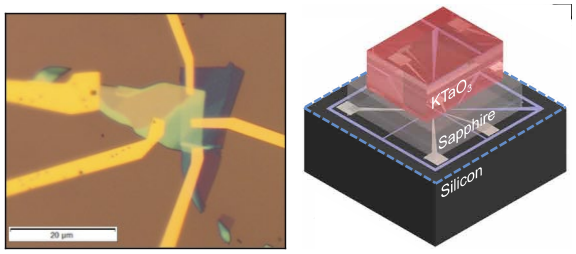
Titre du stage / *internship title*: Towards a direct probe of triplet superconductivity via spin resonance

Résumé / *summary*

While the ground state of conventional (Bardeen Cooper Schrieffer) superconductors is a spin singlet state of paired electrons (Cooper pairs), triplet superconductivity is expected to arise in systems with superconducting correlations in which non-colinear magnetic fields exist, perhaps most notoriously in magnetic textures. Triplet pairs have recently been predicted to exist in superconductors with Ising (or valley Zeeman) spin-orbit coupling (ISOC), such as the transition metal dichalcogenide $NbSe_2$, due to the non-colinearity between the Ising field, which pins Cooper pair spins out-of-plane, and an applied in-plane magnetic field.

Despite significant efforts and some preliminary evidence, the existence of equal-spin triplet superconductivity remains an unsettled question. We propose a novel approach: coupling directly to the triplet pairs' spin degree of freedom in resonance measurements.

This internship will focus on simulations, fabrication and characterisation of resonators (either superconducting or dielectric) for spin resonance measurements. We shall begin with tests on better-known systems such as ferromagnetic metals or insulators, with a view to using the technology thus developed for spin resonance of triplet pairs in superconducting $NbSe_2$. Resonance detection will be either in the microwave regime, or through quantum transport (critical current, kinetic inductance, tunnel conductance…). The Nanostructures at the Nanosecond timescale (NS2) group has extensive experience in mesoscopic superconductivity, spin-orbit and 2D systems, as well as low-temperature transport and microwave measurements.



Left: a typical $NbSe_2$ device with contacts. Right: a dielectric resonator (cf. Vahapoglu et al., Science Advances 2021).

References

M Kuzmanović, T Dvir, D Möckli, S Ilić, JSM Meyer, M Houzet, M Aprili, M Khodas, H Steinberg, CHL Quay, 'Tunneling spectroscopy of few-monolayer NbSe2 in high magnetic field : Ising protection and triplet superconductivity', arXiv:2104.00328.

CHL Quay, Y Chiffaudel, C Strunk and M Aprili, 'Quasiparticle spin resonance and coherence in superconducting aluminium,' Nature Communications 6, 8660 (2015).

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Yes**

Si oui, financement de thèse envisagé ou acquis / *financial support for the PhD* **? Yes**

Financement acquis / *Secured funding*	x	Nature du financement */Type of funding*	ANR (TRIPRES)
Financement demandé / *Requested funding*		Nature du financement */Type of funding*	