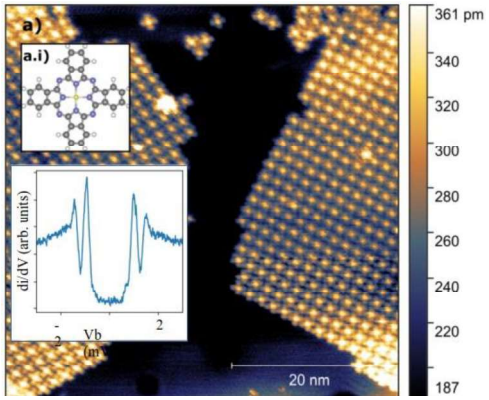
Master / PhD Thesis Project

Magnetic bound states in 2D superconductors



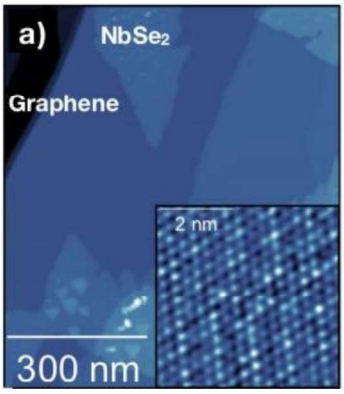
STM image of an array of MnPc magnetic molecules on a Pb surface. The upper inset shows the structure of the molecule. The lower inset shows the spectroscopy with MBS in the superconducting gap. Measured in Grenoble.

The presence of a nanoscale magnetic scatterer (a single atom, a molecule, a quantum dot etc.) on the surface of a superconductor can lead to the emergence of magnetic bound states (MBS) with peculiar spatial and spectral properties within the superconducting gap [1]. These states can be topologically trivial (the case of so-called Shiba states) or not (predicted Majorana zero modes).

The project aims at investigating MBS in two-dimensional (2D) superconductors where they can have a much longer spatial extension [2], a situation which has not been studied experimentally in novel 2D materials. We will use 2D superconductors like graphene in which superconductivity can be induced by proximity or $NbSe_2$ in which superconductivity is unusual in the mono layer limit. First, experiments will aim at tracking the signatures of the MBS and possible topological superconductivity with high spatial and energetic resolution near single magnetic adsorbates. In a second step, using the larger spatial extension of MBS on 2D superconductors, we will couple two of these states to study Shiba molecular states or even Shiba bands in larger ensembles [3]. The two-dimensional superconductors will be prepared with the Molecular Beam Epitaxy facilities of the CEA/SPINTEC laboratory. MBS will be studied and manipulated with a milliKelvin STM operated by the joint STM group in Grenoble (Néel/CNRS and IRIG/CEA) and within a larger collaboration with the university of Berlin. Interpretation of the measurements will be performed in collaboration with theory groups.

We are looking for a motivated candidate with a strong background in condensed matter physics, willing to work at the interface between surface physics and quantum transport. The candidate will be involved in the project from the preparation of superconducting substrates and magnetic nanostructures, by self-assembly or single-atom manipulation (see images) to low temperature scanning probe measurements and analysis and interpretation.

[1] A. Yazdani *et al.* Science **275**, 1767 (1997)
[2] G. Ménard *et al.* Nature Physics **11**, 1013 (2015)
[3] L. Schneider *et al.* Nature Physics **17**, 943 (2021)



STM image of 2D superconductor NbSe2. Inset shows atomic resolution. Measured in Grenoble.

APPLY NOW!

To apply for this position, send your application (including your CV) to:
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