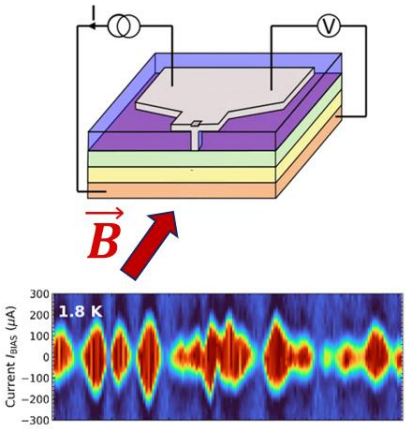
Tunable Josephson junctions based on 2D materials and d-wave Superconductor

laboratoire Albert Fert

Scientific Context



Superconducting electronics plays a central role in diverse fields, from astrophysics to telecommunications and quantum information. Among its fundamental components, the Josephson junction is a key building block for developing devices that exploit quantum coherence and the specific properties of superconductivity. When coupled with two-dimensional materials, it enables the development of new tunable functionalities.

This project aims to develop and characterize novel Josephson junctions combining high-critical-temperature d-wave superconductors with various families of two-dimensional (2D) materials, beyond graphene. Thanks to their tunable electronic properties and atomic thickness, 2D materials offer numerous opportunities to design hybrid devices with controllable properties. The project will focus on two complementary architectures: planar junctions, where transport occurs laterally within the 2D material, and vertical junctions based on multilayer heterostructures. The goal is to explore how material choice, geometry, and interfaces influence superconducting coupling and device properties.

During the internship, we will fabricate devices using home-developed processes and characterize them through low-temperature electronic transport measurements. Electrostatic control will enable the study of Fermi level influence on the critical current and Josephson properties. This work will establish the foundations for new tunable junctions with fundamental interest and application prospects in superconducting electronics and quantum information, particularly through the group's existing collaborations.

References: Seurre et al., APL 125, 092603 (2024) ; Perconte et al., Annalen der Physik 534 (8), 2100559 (2022), Perconte et al., PRL 125 (8), 087002 (2020)

Work program & skills acquired during internship

The internship will involve the fabrication of superconducting heterostructures, and measuring their electronic transport in a cryogenic setup with magnetic field . The candidate should have experience in **transport measurements** and **lithography**, basic knowledge of thin film growth, and strong **teamwork, rigor, enthusiasm, and scientific curiosity** for collaboration across research groups.

Work environment

The selected candidate will be working under the supervision of **Vincent Humbert** and **Javier Villegas** at Laboratoire Albert Fert and work closely with other members of the team.

https://laboratoire-albert-fert.cnrs-thales.fr/
Laboratoire Albert Fert
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Requested background: **Master 2**
Duration: **3-6 months**
Start period : **Feb 2026**
Possibility of the PhD thesis: **YES**

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