Master 2 Internship

Title: **Fermi surface signatures of unconventional density waves**

Type: **theoretical**

Supervisor(s): **Sébastien Burdin**

Email(s): **Sebastien.burdin@u-bordeaux.fr**

PhD funding (if any): **subject to financing**

Project:

Density wave states play an important role in quantum materials, but they lack our understanding. Unconventional density waves have been observed experimentally in various materials involving electrons with charge, spin, and orbital degrees of freedom. The compound CeRh2As2 is one of the remarkable examples that was recently synthesized in the team of our collaborators in Germany: quite uniquely, two superconducting states of different nature and an unconventional quadrupole-density wave state have be realized and tuned by temperature and magnetic field in this compound [1][2][3]. A general microscopic ingredient common to many density-wave states in quantum materials is the coexistence of fermionic (electrons) and bosonic (waves and order parameters) degrees of freedom. The interplay between them is crucial in the emergence of some macroscopic quantum states like superconductivity.

In this internship, we will study a microscopic theoretical phenomenological model describing a conduction electron band possibly coupled with a density wave. Using this model we will compute and predict the Fermi Surface of the system. It can be measured experimentally in some crystalline materials with Angle Resolved Photo-Emission Spectroscopy (ARPES), which measures electronic (fermionic) excitations. The study will be based on two central key ingredients: the lattice symmetry of the periodic crystal, and the local symmetry of the (bosonic) order parameter forming density waves.

This theoretical research is part of a collaborative project with experimentalists from France, Germany and San Sebastian in Spain, synthesizing crystalline materials and performing measurements including ARPES.
There are possibilities to continue this work as part of a thesis (subject to financing).

[1] S. Khim & J. Landaeta et al., *Science* **373**, 1012–1016 (2021).
[2] D. Hafner *et al*., Phys. Rev. X 12, 011023 (2022).
[3] K. Semeniuk *et al*., arXiv:2301.09151v2.