Master thesis on kinetic inductance measurements in few-layer $NbSe_2$

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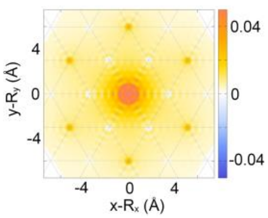
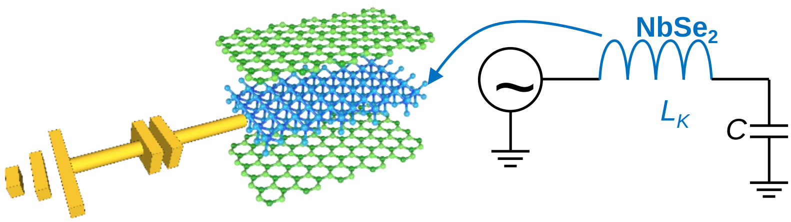
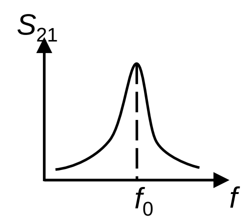
THE PROJECT

The group of Prof. C. Strunk offers a **master thesis project** on the **measurement of kinetic inductance in few-atomic-layer-thick $NbSe_2$ crystals.**

What is the kinetic inductance?
Electrical currents have a certain inertia because ramping up a current requires filling the space with a magnetic field, which requires energy. Beyond this classical effect, there is an additional contribution arising from the kinetic energy of charge carriers. In normal (resistive) conductors, this contribution is masked by dissipation. However, in superconductors—where electrical current is carried by a lossless superfluid condensate—this inertial effect becomes significant and can be measured directly as a (kinetic) **inductance**.







What is $NbSe_2$?
Niobium diselenide ($NbSe_2$) is a member of the family of transition metal dichalcogenides (TMDCs), layered crystals composed of strong in-plane covalent bonds and weak van der Waals coupling between layers—exactly as graphene. This structure allows them to be exfoliated into atomically thin layers, down to the single-layer limit.

Why is $NbSe_2$ interesting?
$NbSe_2$ is intrinsically superconducting, even in the monolayer form. It features strong spin-orbit coupling (SOC), which splits the Fermi surface into sectors with spin locked perpendicular to the layers. The influence of SOC on superconductivity in this material is still not fully understood and is the focus of active theoretical research—for example, by the group of Prof. Grifoni @UR.
Experimentally, our group has recently demonstrated the **superconducting diode effect** in $NbSe_2$, marking the first observation of this phenomenon in a TMDC [Bauriedl *et al.*, *Nature Commun.* **13**, 4266 (2022)].

What you will learn/What you will do

In this project, you will learn how to exfoliate few-layer $NbSe_2$ and fabricate nanoscale electronic devices suitable for both DC and radio-frequency measurements. These experiments will be carried out at cryogenic temperatures and under high magnetic fields. For that, you will learn how to operate dilution refrigerators for measurements in the milliKelvin regime.