

Why do interacting Weyl electrons form a wave?

Master 1 / Master 2

Summary

This Master project investigates a topological material whose Weyl electrons have potential for future electronics and renewable energies. The internship takes place in the nuclear magnetic resonance group which studies strongly correlated materials using the same technique as magnetic resonance imaging (MRI).

Detailed subject

Topological materials differ from standard crystals in that the electrons on the surface conduct electricity very well, even if the bulk of the crystal is insulating. In Weyl semimetals not only the surface is conducting but the semimetallic bulk is also conducting. This combination makes them a promising new type of catalyst to produce renewable energies such as hydrogen gas [1].

You will use nuclear magnetic resonance to look into what happens in the crystals of the Weyl semimetal (TaSe₄)₂I. Our research is about understanding the formation of a periodic charge modulation, also called a charge density wave. We don't know why exactly interacting Weyl electrons form a charge density wave, but when the wave forms, the promising catalytic properties disappear together with the conducting surface state.

We will first study the properties of the charge density wave. Then, to get a handle on this phenomenon, we will squeeze the crystals using a uniaxial pressure cell [2]. Careful measurements will show how pressure changes both the Weyl electrons and/or the charge density wave. This will clarify the interplay of topological properties and electron interactions in this rapidly evolving class of materials.

Feel free to contact us to know more about our research and other internship opportunities.

Publications linked to the theme

[1] Weyl semimetals as Hydrogen Evolution Catalysts, Adv. Mater. 29, 1606202 (2017).
<https://doi.org/10.1002/adma.201606202> (open access version <https://arxiv.org/pdf/1608.03783>)

[2] <https://razorbillinstruments.com/>

Background and skills expected :

Background in solid state physics. Motivation for experimental work.

Supervisors :

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