



**FZU**

Institute of Physics  
of the Czech  
Academy of Sciences



**Czech Academy  
of Sciences**

## Open PhD position

### Thin film growth of altermagnets by magnetron sputtering

Magnetically ordered materials were so far categorized by the arrangement of their magnetic moments into three main groups. Namely ferromagnets with all their moments aligned parallel, ferrimagnets with some moments aligned antiparallel but with a resulting net magnetization, and in antiferromagnets with fully compensated moments. While already Néel stated that: "Effects in antiferromagnets depending on the square of the spontaneous magnetisation should show the same variation as in ferromagnetic substances" [1,2] many other properties of systems with compensated moments remained more elusive. Traditionally spin splitting in the band structure and related effects like the anomalous transport effects were thought to be limited to ferro- and ferrimagnets. Recently, however, by considering not only the magnetic moments, but also the effect of the non-magnetic atoms [3], it was found that certain magnets although having compensated magnetic order can host such effects. Under the light of these new discoveries the categorization of magnetic materials was revisited and the term altermagnetism was coined [4]. These altermagnets were delimited via nonrelativistic spin symmetries as separate magnetic phase which can host many of the effects of ferromagnets while having compensated magnetic order. First experiments already show [5, 6] that these materials can exhibit an anomalous Hall effect while having compensated magnetic order.

The goal of this thesis will be to synthesize epitaxial altermagnetic thin films with compensated magnetic order by magnetron sputtering, and to explore their structural, magnetic and electronic properties. The characterization may include X-ray diffraction, SQUID magnetometry, lithographic patterning, and magnetotransport measurements. Furthermore the PhD candidate will participate in experiments at large scale facilities to further study the obtained materials (neutron diffraction, XMCD/XMLD-PEEM, ARPES). The candidate would work at the Institute of Physics of the Czech Academy of Sciences [7] in Prague and perform his/her studies at the Charles University.

In case you are interested contact Dr. Dominik Kriegner ([kriegner@fzu.cz](mailto:kriegner@fzu.cz)).



[1] Louis Néel, Nobel Lecture (1970) <https://www.nobelprize.org/uploads/2018/06/neel-lecture.pdf>

[2] D. Kriegner et al. Nat. Comm. 7, 11623 (2016)

[3] L. Šmejkal, R. González-Hernández, T. Jungwirth, and J. Sinova, Sci. Adv. 6, eaaz8809 (2020).

[4] L. Šmejkal, J. Sinova, T. Jungwirth Phys. Rev. X 12, 031042 (2022)

[5] H. Reichlova, D. Kriegner, et al., arXiv:2012.15651

[6] R. D. Gonzalez Betancourt, D. Kriegner, et al. arXiv:2112.06805

[7] <https://www.fzu.cz/en/research/divisions-and-departments/division-3/department-15>