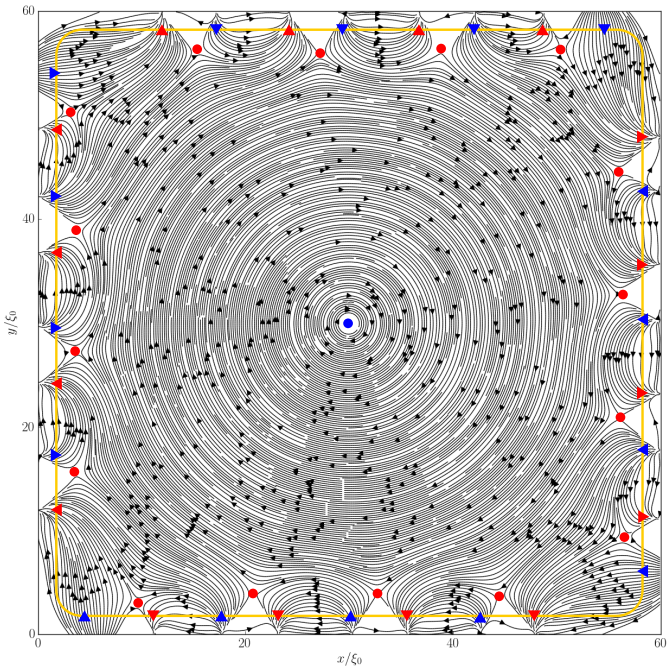
Master's thesis project
Competing orders at surfaces of high-temperature superconductors

Background: The different phases of matter can be described by their type of order. At a phase transition the physical properties of the medium, and the type of order, suddenly change as function of for instance temperature or pressure. The archetypical example is water: ice, liquid, and vapor phases. In condensed matter physics we study intricate phases of the electronic system. A recent hot topic has then been the competition between different types of order. That means that depending on the conditions the phase transition may occur along different routes ending up with a phase with very different properties, for instance magnetic, superconducting, or a mix with its own unique properties.



Project description: In this project you will study high-temperature superconductors, where time-reversal symmetry may be broken in different ways. One route leads to spontaneous supercurrents flowing in beautiful patterns (see the figure and Ref. [1]). Another route leads to magnetism [2]. In the project we will study which route is the shortest (which order wins) depending on the strength of electron-electron interactions. In the project we will

- investigate the competition between spontaneous supercurrents and magnetic ordering due to electron-electron interactions
- crown the winning phase transition
- do high performance computing and develop codes running on graphics cards (depending on interest of the student)

Learning outcomes:
You will develop your analytic problem-solving skills, work with high-performance computing and big data, and work in a team with a goal-oriented project in a competitive field. All these skills are highly desirable both in academia and industry.

Contact:
Prof. Tomas Löfwander (tomas.lofwander@chalmers.se), Dr. Pascal Stadler (post-doc), Patric Holmvall (PhD student), Prof. Mikael Fogelström

References:
[1] P. Holmvall, A. Vorontsov, M. Fogelström, and T. Löfwander, Nature Comm. **9**, 2190 (2018)
[2] A. C. Potter and P. A. Lee, Phys. Rev. Lett. 112, 117002 (2014)