Master thesis topic for the academic year 2016-2017

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Numerical model for the critical state of high-Tc superconductors

Context

High-Tc superconductors can delay the penetration of an applied magnetic flux, or can trap a magnetic induction which is 'forced' into their bulk. These properties can be exploited to design very effective magnetic shields or trapped field magnets developing inductions of a few to a ten of teslas.

The penetration of magnetic flux is a complex physical process, where the flux is carried by vortices ('bundles' of magnetic flux) which can move within the system and be trapped by impurities or defects. These processes are faithfully described in several macroscopic models (E-J models), with however numerical challenges associated with their non-linear constitutive laws.

Critical state models neglect the magnetic relaxation of vortices, but keep the essence of the electrodynamics of superconductors. They can be understood as a limit of very strong pinning forces and their numerical implementation can be simpler in a series of situations.

In this master's thesis, you will

- learn these models and their physics,
- implement their method in a code,
- compare their results with other E-J models in the context of a magnetic shielding or trapped field magnet applications.

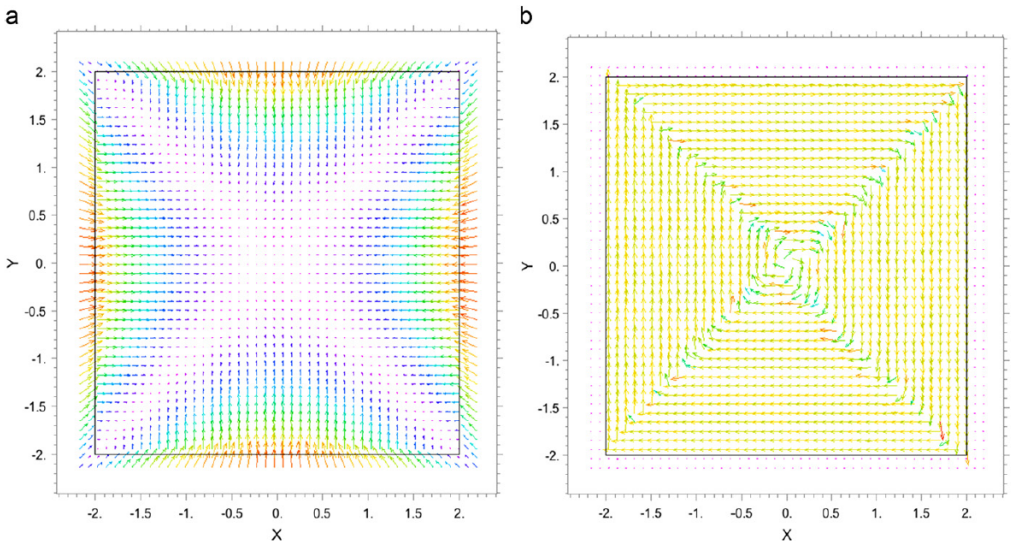

Figure 12. (a) The vortex displacement. (b) The current density.

From Campbell's model, SUST 27 (2014) 124006

This topic is addressed to a student in Engineering in Physics, or in Electrical Engineering.

It is recommended to follow the courses “ELEN0047-1, Superconductivity” and “ELEC0041-1, Modeling and design of electromagnetic systems”.