

Exercises Condensed Matter Physics (Experimentalphysik 5c), WS16/17

1) Upper critical field (3 credits)

In the vortex state of a type II superconductor magnetic flux lines (vortices), which carry a magnetic flux quantum $\Phi_0 = h/2e$, penetrate the superconductor. The radius of these vortices, which repel each other, is given by the coherence length ζ of the superconductor.

- The upper critical field B_{c2} of the superconductor is reached, if the normal conducting cores of the vortices start to overlap. What is the relation between B_{c2} and ζ ?
- Calculate the critical field of type II superconductors with $\zeta = 200\text{nm}$ (conventional superconductor) and 2nm (High-Temperature-superconductor).
- Sketch the temperature dependence of B_{c2} close to T_c .

2) Magnetic field inside a thick superconducting film (3 credits)

A superconducting film with thickness d is positioned in a magnetic field B parallel to the film plane. For $B < B_c$ the magnetic field b inside the superconducting film can be constructed from a symmetrical combination of exponential functions. At both surfaces of the thick film $b = B$. Calculate the spatial dependence of b inside the superconducting film.

3) Ginzburg-Landau free energy (3 credits)

Show, how eq. (6) of the lecture (section G-L-Theory) is derived from eq. (1).