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Theory of Superconductivity, Frühjahrsemester 2023

Points that you will (hopefully) understand by the end of the course

(1) Ideal diamagnetism and zero resistance – equivalent?

(2) "zero resistance" – really zero or just very small?

(3) Is superconductivity related to Bose-Einstein condensation?

(4) Are Cooper pairs bosons?

(5) Is an energy gap necessary or sufficient for superconductivity?

(6) The BCS wave function does not conserve particle number – is this a problem? Doesn't one use the same trick in the grand-canonical approach?

(7) What is the "coherence length": size of a Cooper pair? typical length scale on which the order paramter varies? Something else?

(8) Meaning of "coherence factors".

(9) How do nonmagnetic / magnetic impurities influence the transition temperature T_C?

(10) How do nonmagnetic / magnetic impurities influence the penetration depth λ_L of a magnetic field ?

(11) Meissner screening currents and persistent currents in a ring – equivalent?

(12) Difference between type I / type II superconductors

(13) Difference between the critical fields H_C, H_{C1}, H_{C2}, H_{C3}

(14) Equations like $\mathbf{j}_s = -\frac{1}{\mu_0 \lambda_L^2}\mathbf{A}$ between the supercurrent density $\mathbf{j}_s$ and the vector potential $\mathbf{A}$ – do they contradict gauge invariance?