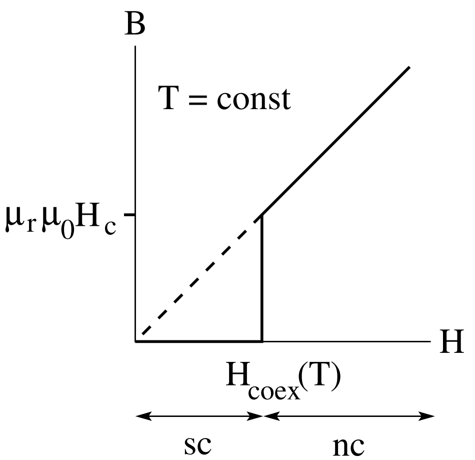
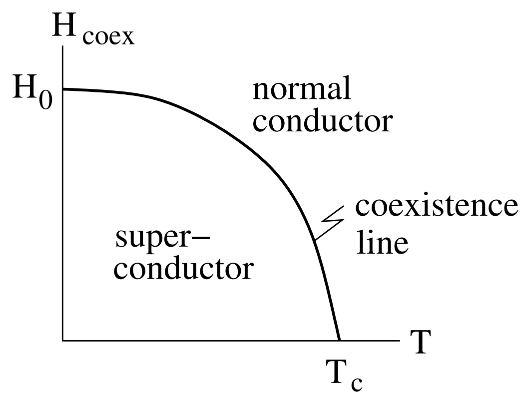
Superconducting transition [tln35]

Meissner-Ochsenfeld effect:
Observation that the magnetic induction $B = \mu_r \mu_0 H$ vanishes inside a superconductor (of type I). B is expelled by surface supercurrents. However, a sufficiently strong external magnetic field H destroys superconductivity.





Coexistence between the superconducting and the normal conducting phases requires $G^{(sc)}(T,H) = G^{(nc)}(T,H)$ (Gibbs free energy per unit volume).

Along the coexistence line: $dG^{(sc)} = dG^{(nc)}$.

$$\Rightarrow \quad -S^{(nc)}dT - B^{(nc)}dH = -S^{(sc)}dT - B^{(sc)}dH$$

with $B^{(nc)} = \mu_r \mu_0 H_{coex}(T)$ and $B^{(sc)} = 0$.

Clausius-Clapeyron equation: $S^{(nc)} - S^{(sc)} = -\mu_r \mu_0 H_{coex}(T) \left(\frac{dH}{dT}\right)_{coex}$.

Latent heat: $L = T\left(S^{(nc)} - S^{(sc)}\right)$.

As H increases, $G^{(sc)}$ stays constant but $G^{(nc)}$ decreases:

$$G^{(nc)}(T,H) - G^{(nc)}(T,0) = -\int_0^H B^{(nc)} dH = -\frac{1}{2}\mu_r \mu_0 H^2.$$

On the coexistence line: $G^{(nc)}(T, H_{coex}) = G^{(sc)}(T, H_{coex})$.

$$\Rightarrow \; G^{(sc)}(T,0) - G^{(nc)}(T,0) = -\frac{1}{2}\mu_r \mu_0 H^2_{coex}(T).$$