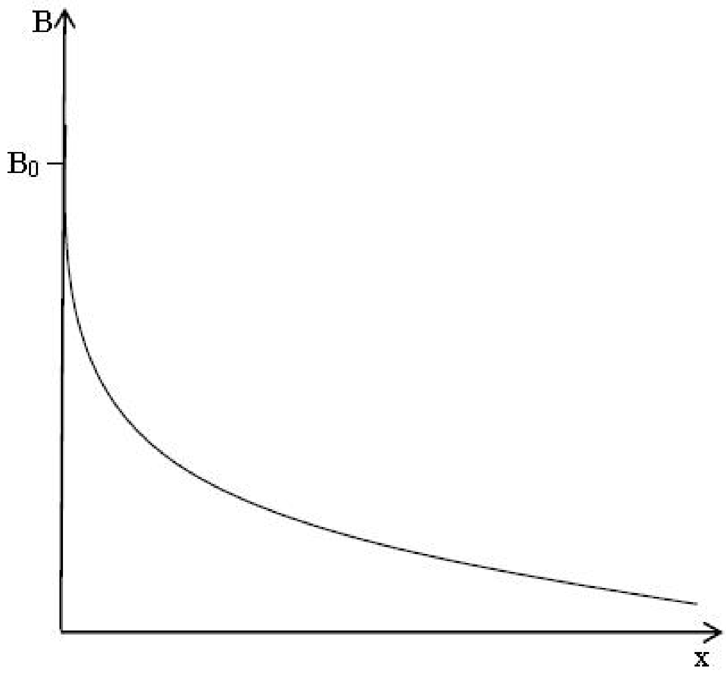
The solution to equation (9) is of the form

$$B(x) = B_0 exp(\frac{-x}{\lambda_l}) \tag{10}$$

where x is the distance inside the conductor.



Thus the London equation predicts exponential decay of magnetic field into a superconductor occupying the region $x > 0$.

COHERENCE LENGTH, (ϵ)

This is the measure of the distance within which the superconducting electron concentration cannot change drastically to the partially varying magnetic field.

Consider a plane wave

$$\psi(x) = e^{ikx} \tag{1}$$

and a strongly modulated wave function

$$\varphi(x) = \frac{1}{\sqrt{2}}(e^{i(k+q)x} + e^{ikx}) \tag{2}$$

where q is the modulating wave vector.

The kinetic energy of the wave

$$E_1 = \frac{\hbar^2 k^2}{2m} \tag{3}$$

where as for the modulated density distribution the kinetic energy is higher and is given by

$E_2 = \int \psi^* (\frac{-\hbar^2}{2m} \frac{d^2}{dk^2}) \varphi$

$E_2 = \frac{1}{2}(\frac{\hbar^2}{2m})[(k+q)^2 + k^2]$

$$E_2 \approx \frac{\hbar^2 k^2}{2m} + \frac{\hbar^2 kq}{2m} \tag{4}$$

(neglected q^2 for $q << k$).

Comparing (3) and (4) it is seen that there is an increase of energy by $\frac{\hbar^2 kq}{2m}$.

If this increment exceeds the energy gap, E_g superconductivity will be destroyed. The critical value q_0 of the modulation wave vector is given by $E_g = \frac{\hbar^2}{2m} k_F q_0$.

$\Rightarrow q_0 = \frac{2m}{\hbar^2} \frac{E_g}{k_F}$.

Define the intrinsic coherence length, $\epsilon_0 = \frac{1}{q_0}$.

$\Rightarrow \varepsilon_0 = \frac{\hbar^2 k_F}{2mE_g}$.

But $mv_F = \hbar k_F$, $v_F = \frac{\hbar k_F}{m}$.

$\varepsilon_0 = \frac{\hbar v_F}{2E_g}$, where v_F is the electron velocity.

TYPE I SUPERCONDUCTORS

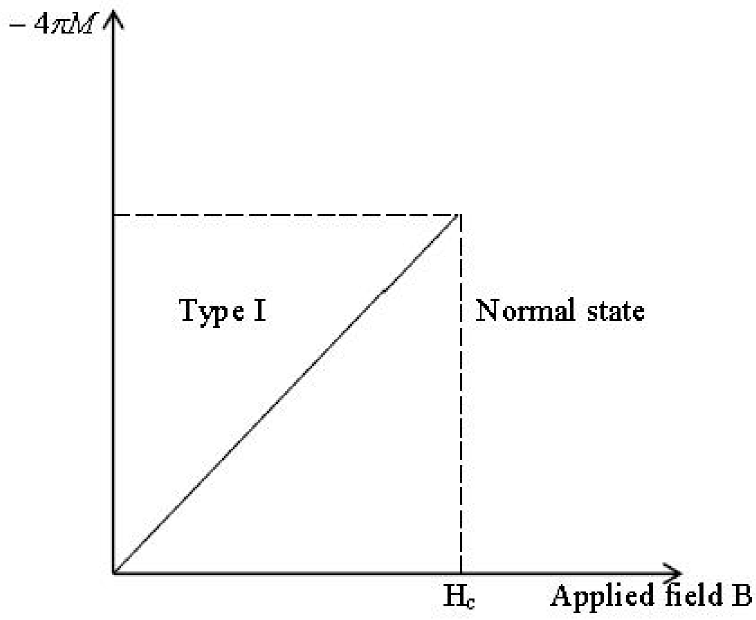
The temperature dependence of a critical field $\vec{B}_c$ can be given by

$B_c(T) = B_c(0)[1 - (\frac{T}{T_c})^2]$

where T_c is the critical temperature.

Agraph of magnetisation versus applied field is as shown below

In type 1 superconductors above the critical field H_c the specimen is a normal conductor



and the magnetisation is too small to be seen on scale. In general for type 1 superconductors, the superconducting state is destroyed and the normal state is restored by application of an external magnetic field in excess of a critical value H_c. Aternatively, we can say that superconductivity is destroyed by a modest applied magnetic field.

TYPE II SUPERCONDUCTORS

These are alloyed or transition with high values of electrical resistivity in the normal state i.e the electronic mean free path in the normal state is short.