Estado Sólido Avanzado
Tarea 06: Superconductividad

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Problema 1 *Specific heat variations*

Find the temperature T where,

$$C_s(T) = C_n(T),$$

where $C_i(T)$ is the specific heat in the $i = s, n$ state (s=superconducting, n=normal).

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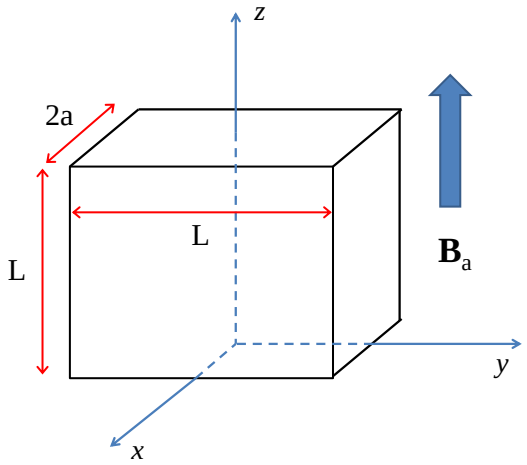
Problema 2 *London equations: superconducting flat slab*

For a flat SC slab of finite thickness $2a$ in an applied parallel magnetic field $\mathbf{B}_a = B_a\hat{\mathbf{k}}$,



(a) Demostrate that the field inside the superconducting slab is given by,

$$B(x) = \frac{\text{Cosh}(x/\lambda_L)}{\text{Cosh}(a/\lambda_L)} B_a.$$

(b) Find that,

$$\mu_0 M(x) = -\left(\frac{1}{8\lambda_L^2}\right)\left[(2a)^2 - 4x^2\right] B_a \quad \forall \quad a \ll \lambda_L$$

where $M(x)$ is the magnetization of the system.

(c) Finally, calculate the value of the critical field B_c when $a \ll \lambda_L$ and $a \gg \lambda_L$.

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Problema 3 *Ginzburg-Landau equations*

Obtain the London equation,

$$\nabla^2 \mathbf{B} = \mathbf{B}/\lambda^2,$$

from the Ginzburg-Landau equations.

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Problema 4 *BCS Hamiltonian: Bogoliubov-Valatin transformation*

Demonstrate that the kinetic-energy expression, H_T, from the BCS Hamiltonian,

$$H_T = \sum_k \epsilon_k \left(c_k^\dagger c_k + c_{-k}^\dagger c_{-k} \right),$$

can be transformed, through the Bogoliubov operators $\gamma_k, \gamma_k^\dagger$ and $\gamma_{-k}, \gamma_{-k}^\dagger$, to:

$$H_T = \sum_k \epsilon_k \left[2v_k^2 + \left(u_k^2 - v_k^2 \right) (m_k + m_{-k}) + 2u_k v_k \left(\gamma_k^\dagger \gamma_{-k}^\dagger + \gamma_{-k} \gamma_k \right) \right].$$

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