Fundamentals of Nanoelectronics

ECE495 - Session 40, Dec 7, 2009

Exchange Field

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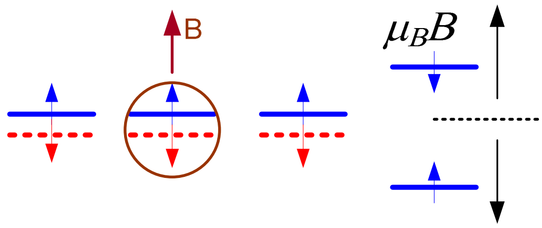
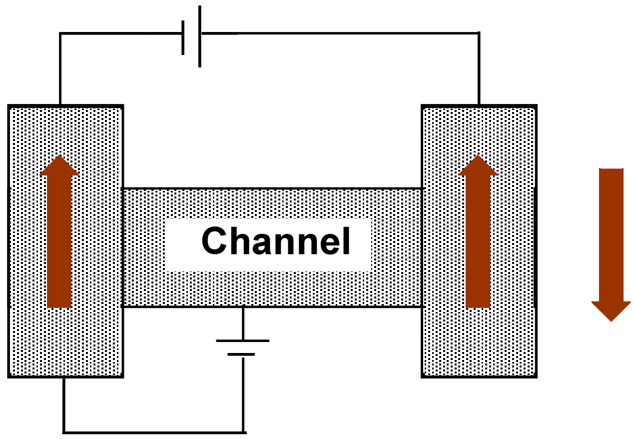
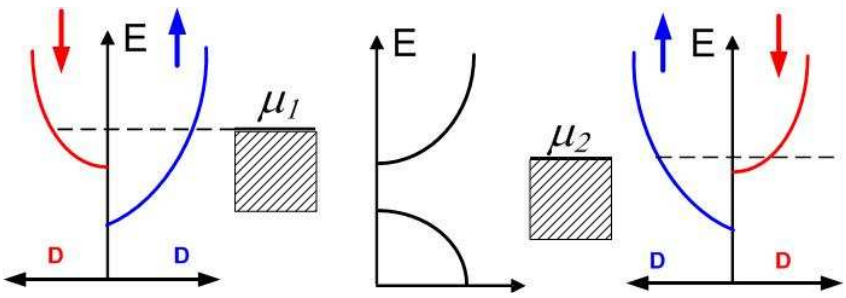
Class notes taken by: Mehdi Salmani

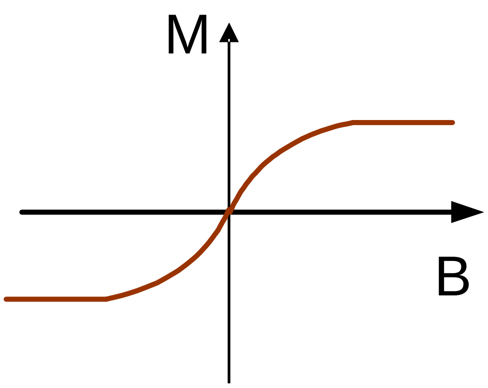




$\frac{N_\uparrow}{N_\downarrow} = \frac{e^{\mu_B B/kT}}{e^{-\mu_B B/kT}}$ and we assume $x = \mu_B B/kT$

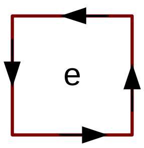
Then: $\frac{N_\uparrow - N_\downarrow}{N_\uparrow + N_\downarrow} = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} = \tanh x$



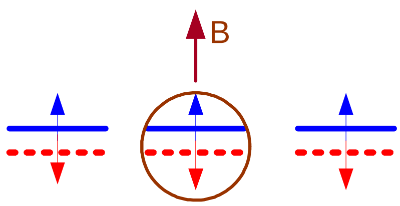


$$M = N \tanh \frac{\mu_B B}{kT}$$

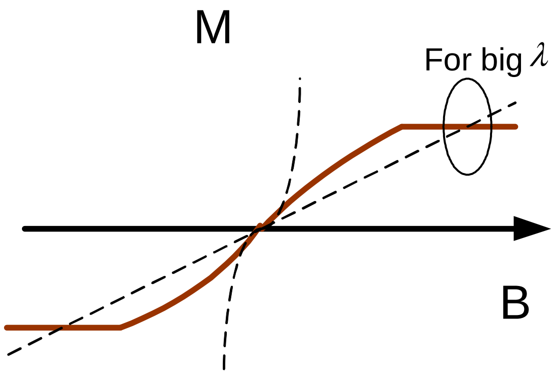
$$M \sim \mu_B \frac{N}{V} \tanh \frac{\mu_B B}{kT}$$



$\sim 10^{-23} A.m^2$



$$M \sim N \tanh \frac{\mu_B}{kT} \left(\underbrace{B}_{External} + \lambda M \right)$$



$$M \sim N \tanh \frac{\mu_B}{kT} \lambda M$$

For big λ we will have two solutions

Curie temperature: When the temperature of a material is increased, what is happening on the atomic scale is an increase in the random motion of the atoms of which the material is made. You might think that random motion of atoms could affect the alignment of magnetic domains, so that increasing the temperature of a magnet would tend to decrease its strength. In fact, each ferromagnetic material has a ***Curie temperature*** (named after Pierre Curie), above which it can no longer be magnetized.

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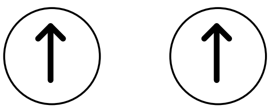
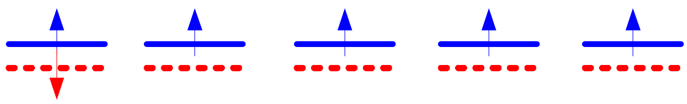


^{26}Fe $1s^2\ 2s^2 2p^6$ $4S^2$

$3s^2 3p^6$ $3s^6$



$$10^{-23} A - m^2 \times 1T = 10^{-23} J \sim 10^{-4} eV$$