PHYS 212, Honors Section – Review Material

Chapter 30: Sources of the Magnetic Field

- Biot-Savart law: The magnetic field contribution from a line element d**s** of wire carrying a current i is

$$d\mathbf{B} = (\mu_0/4\pi)\,(I\, d\mathbf{s} \times \mathbf{r})/r^2 \ , \ \text{where} \ \ \mu_0 = 4\pi \times 10^{-7}\ \text{T·m/A} \ \ \text{and} \ \ \mathbf{r} \ \ \text{is a unit vector} \ .$$

- Long line of current: The magnetic field due to a long straight wire carrying a current i is

$$B = (\mu_0/2\pi)\, I/r \ .$$

- Arc of wire: The magnetic field due to a circular wire carrying a current i and forming an angle ϕ is

$$B = (\mu_0/4\pi)\, I\, \phi/r \ .$$

- Magnetic force between wires carrying currents: For two long straight wires a distance a apart,

$$F = (\mu_0/2\pi)\,(I_1 I_2/a)\, L \ .$$

  As can be seen from the right-hand rule, the force is attractive for currents in the same direction, and repulsive for forces in opposite directions.

- Ampère's law: For any closed loop C in space enclosing a current I_{enc},

$$\int_C \mathbf{B} \cdot d\mathbf{s} = \mu_0\, I_{enc} \ .$$

- Magnetic field of a long solenoid: The magnitude of the field is

$$B = \mu_0 n I \qquad (n = N/L) \ ,$$

  and the direction is obtained from the right-hand rule. [We did not cover the magnetic field of a toroid.]

- [Magnetic behavior of materials: Diamagnetism, paramagnetism and ferromagnetism.]

Note: You are not required to know the topics and equations inside square brackets.

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