Magnetic Fields in Matter

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- Torque on a Dipole

$$\vec{N} = \vec{m} \times \vec{B}$$

  - This is akin to the torque on an electric dipole:

$$\vec{N} = \vec{p} \times \vec{E}$$

  - We can calculate the torque to be:

$$\vec{N} = m\vec{B}\sin(\theta)$$

  - The energy can be defined as:

$$U = -\vec{m} \cdot \vec{B}$$

  - The bound bulk and surface currents can be defined as:

$$\vec{J_b} = \vec{\nabla} \times \vec{M} \quad \text{and} \quad \vec{K_b} = \vec{M} \times \hat{\mathbf{n}}$$

  - For a uniform magnetized sphere:

$$\vec{J_b} = 0 \quad \text{and} \quad \vec{K_b} = M\sin(\theta)\hat{\phi}$$