PHY 712 Electrodynamics 9-9:50 AM MWF Olin 103

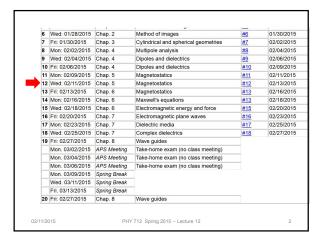
Plan for Lecture 12:

Continue reading Chapter 5

- A. Examples of magnetostatic fields
- **B.** Magnetic dipoles

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WFU Physics Colloquium

TITLE: Bio-inspired Tensegrity Structures

SPEAKER: Dr. Cornel Sultan,

Department of Aerospace and Ocean Engineering Virginia Polytechnic Institute and State University

TIME: Wednesday February 11, 2015 at 4:00 PM

PLACE: Room 101 Olin Physical Laboratory

Refreshments will be served at 3:30 PM in the Olin Lounge. All interested persons are cordially invited to attend.

ABSTRACT

Tensegrity structures are assemblies of stretched tendons and disjoint bars that originated in the abstract art of the 1900s. Today they are perceived as promising structural systems in areas ranging from space applications to bioengineering. In this talk the artistic context of the late 1800s and early 1900s is briefly revisited and tensegrity's invention by artist Kenneth Snelson is discussed.

The presentation then focuses on tensegrity deployment (i.e. how they can be folded/unfolded). A deployment strategy inspired by the way biological organisms control motion via tendons and muscles is presented. First, the equations of motion are derived

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Various forms of Ampere's law:

$$\nabla \times \mathbf{B}(\mathbf{r}) = \mu_0 \mathbf{J}(\mathbf{r})$$

Vector potential: $\mathbf{B}(\mathbf{r}) = \nabla \times \mathbf{A}(\mathbf{r})$

For Coulomb gauge: $\nabla \cdot \mathbf{A}(\mathbf{r}) = 0$

$$\Rightarrow \nabla^2 \mathbf{A}(\mathbf{r}) = -\mu_0 \mathbf{J}(\mathbf{r})$$

For confined current density:

$$\mathbf{A}(\mathbf{r}) = \frac{\mu_0}{4\pi} \int d^3 r' \frac{\mathbf{J}(\mathbf{r}')}{|\mathbf{r} - \mathbf{r}'|}$$

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Other examples of current density sources:

Quantum mechanical expression for current density

for a particle of mass M and charge e and of probability amplitude $\Psi(\mathbf{r})$:

$$\mathbf{J}(\mathbf{r}) = -\frac{e\hbar}{2Mi} \left(\Psi^*(\mathbf{r}) \nabla \Psi(\mathbf{r}) - \Psi(\mathbf{r}) \nabla \Psi^*(\mathbf{r}) \right)$$

For an electron in a spherical potential (such as in an atom):

$$\Psi(\mathbf{r}) = \Psi_{nlm}(\mathbf{r}) = R_{nl}(r)Y_{lm}(\hat{\mathbf{r}})$$

$$\mathbf{J}(\mathbf{r}) = \frac{e\hbar}{2Mi} |R_{nl}(\mathbf{r})|^2 \frac{1}{r\sin\theta} \left(Y_{lm}^*(\hat{\mathbf{r}}) \frac{\partial Y_{lm}(\hat{\mathbf{r}})}{\partial \phi} - Y_{lm}(\hat{\mathbf{r}}) \frac{\partial Y_{lm}^*(\hat{\mathbf{r}})}{\partial \phi} \right) \hat{\mathbf{\phi}}$$

$$= \frac{e\hbar}{M} \frac{m}{r\sin\theta} |\Psi_{nlm}(\mathbf{r})^2| \hat{\mathbf{\phi}}$$

$$= \frac{e\hbar}{M} \frac{m}{r \sin \theta} |\Psi_{nlm}(\mathbf{r})|^2 |\hat{q}$$

Note that: $\hat{\mathbf{\phi}} = -\sin\phi\hat{\mathbf{x}} + \cos\phi\hat{\mathbf{y}} = \frac{\hat{\mathbf{z}} \times \mathbf{r}}{r\sin\theta}$ $\mathbf{J}(\mathbf{r}) = \frac{e\hbar}{M} \frac{m}{r^2 \sin^2\theta} |\Psi_{nlm}(\mathbf{r})|^2 (\hat{\mathbf{z}} \times \mathbf{r})$

$$\mathbf{J}(\mathbf{r}) = \frac{e\hbar}{M} \frac{m}{r^2 \sin^2 \theta} |\Psi_{nlm}(\mathbf{r})|^2 (\hat{\mathbf{z}} \times \mathbf{r})$$

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