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

6	Wed: 01/28/2015	Chap. 2	Method of images	#6	01/30/2015
7	Fri: 01/30/2015	Chap. 3	Cylindrical and spherical geometries	#7	02/02/2015
8	Mon: 02/02/2015	Chap. 4	Multipole analysis	#8	02/04/2015
9	Wed: 02/04/2015	Chap. 4	Dipoles and dielectrics	#9	02/06/2015
10	Fri: 02/06/2015	Chap. 4	Dipoles and dielectrics	#10	02/09/2015
11	Mon: 02/09/2015	Chap. 5	Magnetostatics	#11	02/11/2015
12	Wed: 02/11/2015	Chap. 5	Magnetostatics	#12	02/13/2015
13	Fri: 02/13/2015	Chap. 6	Magnetostatics	#13	02/16/2015
14	Mon: 02/16/2015	Chap. 6	Maxwell's equations	#13	02/18/2015
15	Wed: 02/18/2015	Chap. 6	Electromagnetic energy and force	#15	02/20/2015
16	Fri: 02/20/2015	Chap. 7	Electromagnetic plane waves	#16	02/23/2015
17	Mon: 02/23/2015	Chap. 7	Dielectric media	#17	02/25/2015
18	Wed: 02/25/2015	Chap. 7	Complex dielectrics	#18	02/27/2015
19	Fri: 02/27/2015	Chap. 8	Wave guides		
	Mon. 03/02/2015	*APS Meeting*	Take-home exam (no class meeting)		
	Mon. 03/04/2015	*APS Meeting*	Take-home exam (no class meeting)		
	Mon. 03/06/2015	*APS Meeting*	Take-home exam (no class meeting)		
	Mon. 03/09/2015	*Spring Break*			
	Wed. 03/11/2015	*Spring Break*			
	Fri. 03/13/2015	*Spring Break*			
20	Fri: 02/27/2015	Chap. 8	Wave guides		

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

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 :

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

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) :

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

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

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

Note that : $\hat{\boldsymbol{\varphi}} = -\sin\phi\hat{\mathbf{x}} + \cos\phi\hat{\mathbf{y}} = \frac{\hat{\mathbf{z}} \times \mathbf{r}}{r\sin\theta}$

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