PHY 712 Electrodynamics
11-11:50 AM MWF Olin 107

Plan for Lecture 12:

Continue reading Chapter 5

A. Examples of magnetostatic fields

B. Magnetic dipoles

Course schedule for 2013

(Preliminary schedule -- subject to frequent adjustment.)

	Date	JDJ Reading	Topic	Assign.
1	01-16(Wed)	Chap. 1	Introduction, units and Poisson equation.	#1
2	01-18(Fri)	Chap. 1	Electronstatic energy calculations	#2
	01-21(Mon)	*No class*	*MKL Holiday*	
3	01-23(Wed)	Chap. 1	Poisson Equation and Green's Functions	#3
4	01-25(Fri)	Chap. 1 & 2	Green's Theorem and Functions	#4
5	01-28(Mon)	Chap. 1 & 2	Brief introduction to numerical methods	#5
6	01-30(Wed)	Chap. 2	Method of images	#6
7	02-01(Fri)	Chap. 3	Cylindrical and spherical geometries	#7
8	02-04(Mon)	Chap. 4	Multipole moments	#8
9	02-06(Wed)	Chap. 4	Dipoles and dielectrics	#9
10	02-08(Fri)	Chap. 4	Microscopic and macroscopic polarizability	
11	02-11(Mon)	Chap. 4	Magnetostatics	#10
12	02-13(Wed)	Chap. 4	Magnetostatic fields	

FOREST
RSITY

Department of Physics

WFU Physics Colloquium

TITLE: Physics for Realists: What Is Momentum?

SPEAKER: Professor Murray S. Daw,

R. A. Bowen Professor of Physics,
Department of Physics and Astronomy,
Clemson University, Clemson, South Carolina

TIME: Wednesday February 13, 2013 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

"In the science of nature, our first task will be to try to determine what relates to its principles. The natural way of doing this is to start from the things which are more knowable and obvious to us and proceed towards those which are what is more clear and more knowable by its nature." --- Aristotle (Physics)

"[Modern science] takes common sense for granted.". --- J. Robert Oppenheimer (Science and the Common Understanding)

"The last word from modern science is not the first word that the human mind can utter about

Varioius forms of Ampere's law :

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

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

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

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

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):

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

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

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

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

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