UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Lecture 26

Today

- International study of **English-medium Instruction** lecture comprehension (by prof. Glenn Ole Hellekjær)
- You will be give a survey at the end:
  - The survey is anonymous
  - Answering the survey is entirely voluntary.
  - The survey asks for volunteers for possible follow-up interviews.

This week

- **Wednesday:** Magnetostatic equation and multipole expansion. Force on static charges and currents. (Section 11.2)
- **Thursday:** Last problem set! Three old exam questions on electromagnetism. (We will accept answers with only two questions completed.)
- **Friday:** Electromagnetic radiation from time-dependent sources. Retarded solutions. (Sections 12.1)

Recap

- The **electrostatic solution** for the potential is

$$\phi(\vec{r}) = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\vec{r})}{|\vec{r}-\vec{r}\,'|} \, d^3\vec{r}\,'$$

- At large distances from the charges this can be approximated in the **multipole expansion**

$$\rho(\vec{r}) = \rho_0(\vec{r}) + \rho_1(\vec{r}) + \rho_2(\vec{r}) + \ldots$$

with the **monopole** and **dipole** contributions

$$\rho_0(\vec{r}) = \frac{Q}{4\pi\epsilon_0 r}, \quad \rho_1(\vec{r}) = \frac{\vec{r}\cdot\vec{p}}{4\pi\epsilon_0 r^3}$$

where p is the **dipole moment** $\vec{p} = \int \rho(\vec{r})\vec{r} \, d^3\vec{r}\,'$

Today

- The magnetostatic solution for a static current
  - General solution for vector potential and magnetic field for any static current density.
  - Biot-Savart's law as a special case.
  - Multipole expansion.
- Force and torque on charge density and current from external fields

Summary

- The **magnetostatic solution** for the potential is

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

- At large distances from the current this can be approximated in the **multipole expansion**

$$\vec{A}(\vec{r}) = \vec{A}_0(\vec{r}) + \vec{A}_1(\vec{r}) + \vec{A}_2(\vec{r}) + \ldots$$

where the **monopole** contribution is $A_0 = 0$.

- The force and torque from external fields are

$$\vec{F}_e = Q\vec{E} + (\vec{p}\cdot\vec{\nabla})\vec{E} + \ldots, \quad \vec{\tau}_e = \vec{p}\times\vec{E} + \ldots$$

$$\vec{F}_m = (\vec{m}\cdot\vec{\nabla})\vec{B} + \ldots, \quad \vec{\tau}_m = \vec{m}\times\vec{B} + \ldots$$