UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Lecture 27

This week

- **Monday:** Maxwell's equations with time dependent sources, retarded solutions. Lienard-Wiechert potentials. (Sections 12.1 and 12.2)
- **Wednesday:** Radiation fields. (Sections 12.2 and 12.3)
- **Problem session:** two exam questions from Part 3 of the course.
- **Next week:** last ordinary lecture on Monday. Wednesday devoted to repetition or a look at last years exam set.

Recap

- 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

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

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

Today

- Solution to time dependent sources
  - Green's functions (light).
  - Fourier transformation to Helmholtz' equation.
  - Solution in terms of retarded sources.

Summary

- The scalar and vector potential for time-dependent sources is

$$\phi(\vec{r},t) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r}\,',t_-)}{|\vec{r}-\vec{r}\,'|}\,d^3\vec{r}\,'$$

$$\vec{A}(\vec{r},t) = \frac{\mu_0}{4\pi}\int \frac{\vec{j}(\vec{r}\,',t_-)}{|\vec{r}-\vec{r}\,'|}\,d^3\vec{r}\,'$$

where the time for the source is the retarded time

$$t_- = t - |\vec{r}-\vec{r}\,'|/c$$