Lecture 1

01/17/2023

Course: Electrodynamics II

Physics of time-dependent $\vec{E}$ and $\vec{B}$ fields and dynamics of their interaction.

Previous course EDI has been focused on the statical $\vec{E}$ and $\vec{B}$ fields.

Recapitulation (EMI)

Maxwell's Equations for the static EM field

Differential form	Integral form
$\vec{\nabla}\cdot\vec{E} = \rho/\varepsilon_0$	$\oint \vec{E}\, d\vec{S} = q/\varepsilon_0$
$\vec{\nabla}\cdot\vec{B} = 0$	$\oint \vec{B}\, d\vec{S} = 0$
$\vec{\nabla}\times\vec{E} = 0$	$\oint \vec{E}\, d\vec{\ell} = 0$
$\vec{\nabla}\times\vec{B} = \mu_0\vec{J}$	$\oint \vec{B}\, d\vec{\ell} = \mu_0 I$

Continuity equation for the density of electric charge and current

$$\frac{\partial\rho}{\partial t} + \vec{\nabla}\cdot\vec{J} = 0, \quad \text{where} \quad \vec{J} = \rho\cdot\vec{v}.$$

EM II { Maxwell's Equations for Time-Dependent $\vec{E}(t)$ and $\vec{B}(t)$ Fields

Experimental data have been used to formulate time dependent Maxwell equations

(1) $\vec{\nabla}\cdot\vec{E} = \rho/\varepsilon_0$ (2) $\vec{\nabla}\cdot\vec{B} = 0$

(3) $\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$ (4) $\vec{\nabla}\times\vec{B} = \mu_0\left(\vec{J} + \varepsilon_0\frac{\partial\vec{E}}{\partial t}\right)$

New equations! We will derive these equations using results of several experiments.

Eqs. (1) and (2) are identical for static and time-dependent EM fields. Eqs (3) and (4) essentially depend on the time (t) via $\partial\vec{B}/\partial t$ and $\partial\vec{E}/\partial t$ terms. We will analyze Eq. (3) and Eq. (4) on our next lectures.