Lecture 34 outline: 11/06/2020

- Four homework problems about P, E, D
- What is current?
- Ohm's Law
- Force on a current
- Force between wires
- Field of a solenoid
- Questions!
- Monday – Biot Savart

Capacitor with a dielectric

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P}$$

$$\vec{D} = \epsilon_0 (1 + \chi_E) \vec{E}$$

$$\vec{D} = \epsilon_0 \epsilon_r \vec{E}$$

Charged wire

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P}$$

$$\vec{D} = \epsilon_0 (1 + \chi_E) \vec{E}$$

$$\vec{D} = \epsilon_0 \epsilon_r \vec{E}$$

Polarized wire

Force on a current $\vec{F} = I\vec{L} \times \vec{B}$

RS 8-06

Force between Wires? (RS 8-05)

$$F = \mu_0 \frac{I_1 I_2 L}{2\pi r}$$

Solenoid (RS 8-10)

$$\vec{B}_{\text{solenoid}} = \mu_0 \, n \, I$$

Current (RS 8-11, 8-12)

$$I \stackrel{\text{def}}{=} \frac{\Delta Q}{\Delta t} \qquad I = \lambda \vec{v}$$

$$I \stackrel{\text{def}}{=} \vec{J} \cdot \vec{A} \qquad \vec{J} = \rho \vec{v}$$

Ohm's Law

$$\vec{J} = \sigma \vec{E} = \frac{\vec{E}}{\rho}$$

$$R = \rho \frac{L}{A}$$

$$V = I R$$

Clicker

$\vec{J} = \sigma \vec{E}$

σ represents:

A) Surface charge density

B) Volume charge density

C) Resistivity

D) Conductivity

Clicker

$\vec{J} = \rho \vec{v}$

ρ represents:

A) Surface charge density

B) Volume charge density

C) Resistivity

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Clicker

$\vec{J} = \frac{\vec{E}}{\rho}$

ρ represents:

A) Surface charge density

B) Volume charge density

C) Resistivity

D) Conductivity

Ch 5 Questions:

Magnets snap together. How can you say B does no work? (Edelman)

- Magnetic forces change particle's direction, how can this not do work?
- What's going on on p 218?
- Is Lorentz force really "empirical"?
- Is there magnetic potential energy? (Reed)
- J? (Taylor)
- What is relativistic Lorentz Force? (Smith)
- Is f_electrostatic E? (Privett)
- Why does Griffith's call water an insulator? (Sahd)
- How can you say E=0 in a conductor? (Pedrozza, Kelso, Gandarilla)
- Is there magnetic potential energy?

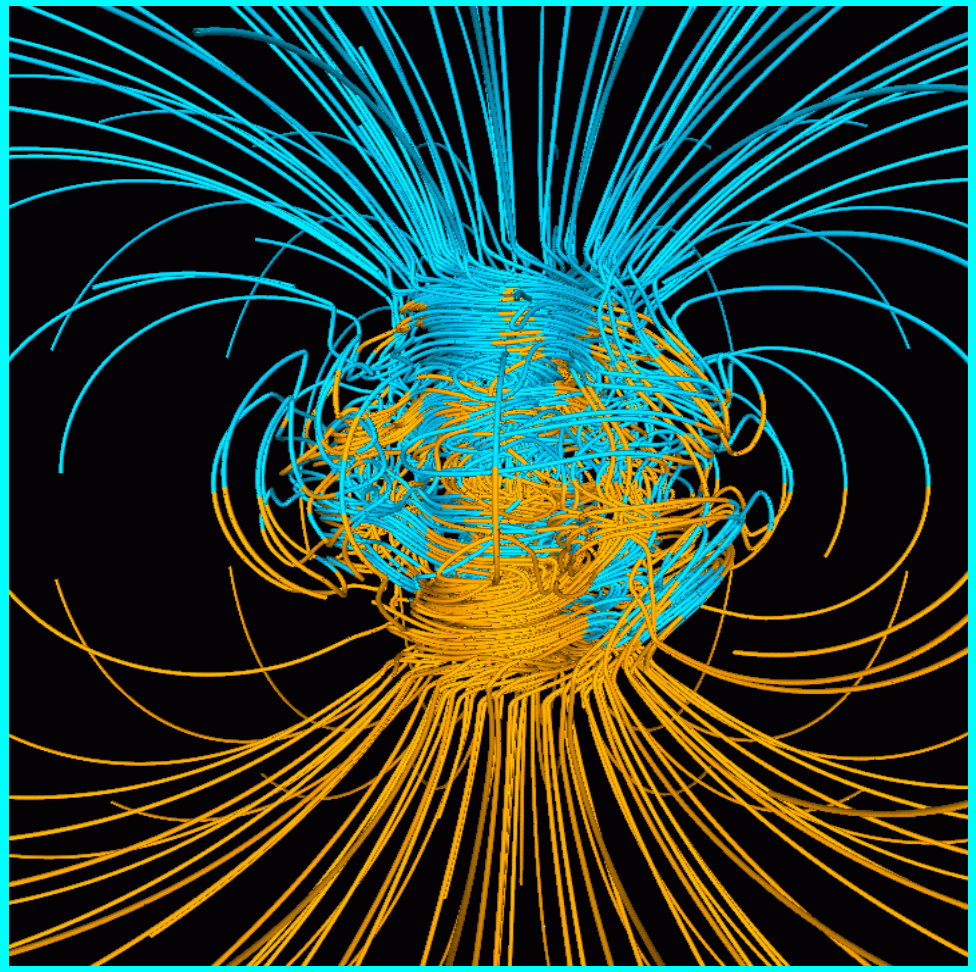
Lorentz Force $\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$

B does no work?

Cyclotron motion / Aurora

$$\vec{F} = q\,\vec{v} \times \vec{B}$$

https://www.nasa.gov/mission_pages/sunearth/aurora-videos/index.html



Maxwell's Equations

Gauss's Law

$$\oiint \vec{E} \cdot d\vec{a} = \frac{Q}{\epsilon_0}$$

$$\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

The "no monopole" equation

$$\oiint \vec{B} \cdot d\vec{a} = \mu_0 Q_{\text{monopole}} = 0$$

$$\nabla \cdot \vec{B} = 0$$

Ampere's Law

$$\oint \vec{B} \cdot dl = \mu_0 I$$

$$\nabla \times \vec{B} = \mu_0 \vec{J}$$

Faraday's Law

$$\varepsilon = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$