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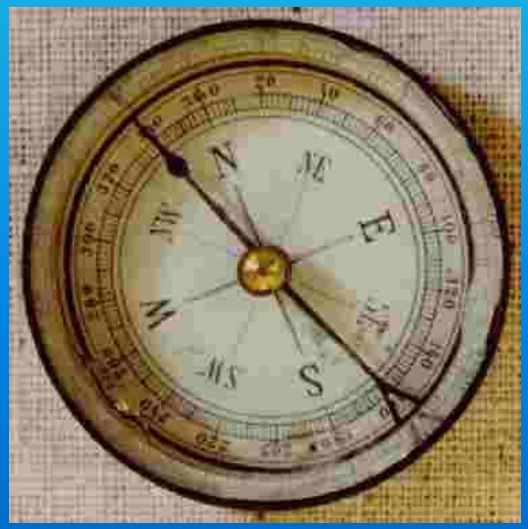
Is that all there is about E&M then???

F*@# no!!

Electricity and Magnetism… no more! Electromagnetism!!

- Hans Christian Ørsted
  - Professor at Copenhagen
  - Discovered (in 1820) one connection!!
  - This one →
  - Well actually..



- One problem… he didn’t follow his experiment, but he published it tough. ! =D
- Meanwhile in the Faraday world.. Devy kept Faraday performing tasks that were not desired by him..
- 1821 → Ampère published his research….

Ampère

- Force between two wires with electricity
- They attract or repel each other .. Depending on the direction of the current!!

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

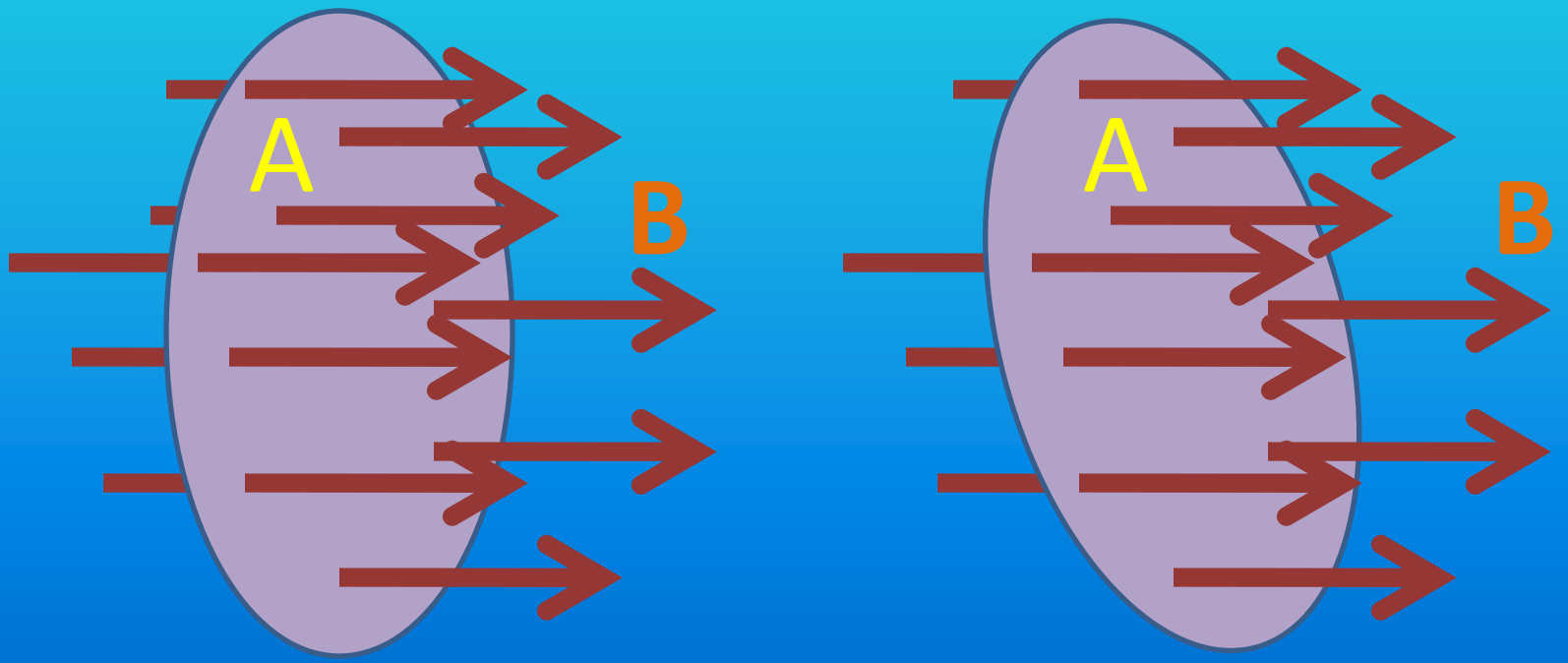
- Led to the foundation of Electrodynamics

$$\oint_C \mathbf{B} \cdot \mathrm{d}\boldsymbol{\ell} = \mu_0 I_{\mathrm{enc}}$$

- It was not until 1831 that Faraday finally started working in E&M and explained…
- ..
- Induction!!!!

But First!!, Flux

- Magnetic Flux $\Phi_B = \vec{B} * \vec{A}$



Induction

- Explained by Faraday! (this guy) →

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

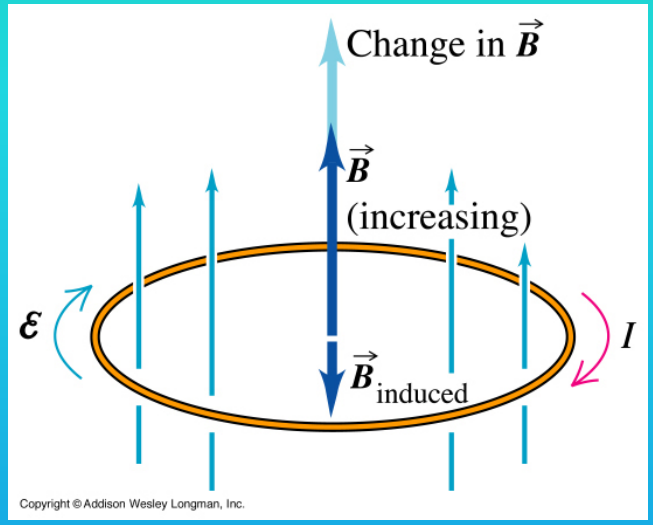
- That is faraday's law… well the easy form..
- It means the following….
- Well this is better…

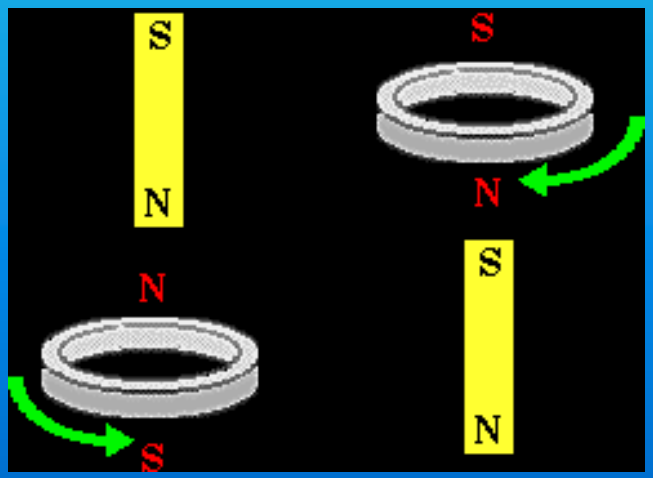
$$\Phi_B = \vec{B} * \vec{A}$$

Lenz's Law

- *Corollary of Faraday's Law and Ohm's Law*
- *The emf induced in an electric circuit always acts in such a direction that the current it drives around the circuit opposes the change in magnetic flux which produces the emf.*

$$\Phi_B = \vec{B} * \vec{A}$$





Maxwell

- And then.. There was Maxwell
- *On Physical Lines of Force*, March 1861 , Published 20 equations with 20 variables which were a compilation of what was know at the time.
- Then on *A Treatise on Electricity and Magnetism* in 1873 he published what are known as the Maxwell's Equations.

Maxwell's Equations

- 4 PDE's that describe the "Fields."
- They are in descending order (in free space):
- Gauss's law for E-fields
- Gauss's law for B-fields
- Faraday's Law
- Ampère's Law

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

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

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

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}$$

And then, there was light…

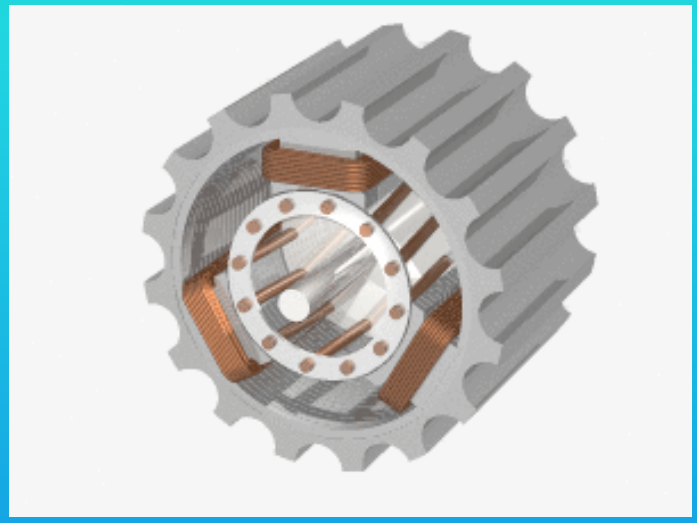
- Turns out Maxwell's Equations describe fields that Oscillate through space.
- Furthermore he calculated the speed of this waves to be….
- 310,740,000 m/s
- Can anyone tell me what speed is this??
- Not quite .. There were experimental and numerical errors at the time, the actual value is 299,792,458 m/s .. The speed of light!!

The speed of light

- This led to the work of ..
- That’s another talk.. ☺

Enough.. For now.

- The Motor



- And some other cool stuff...