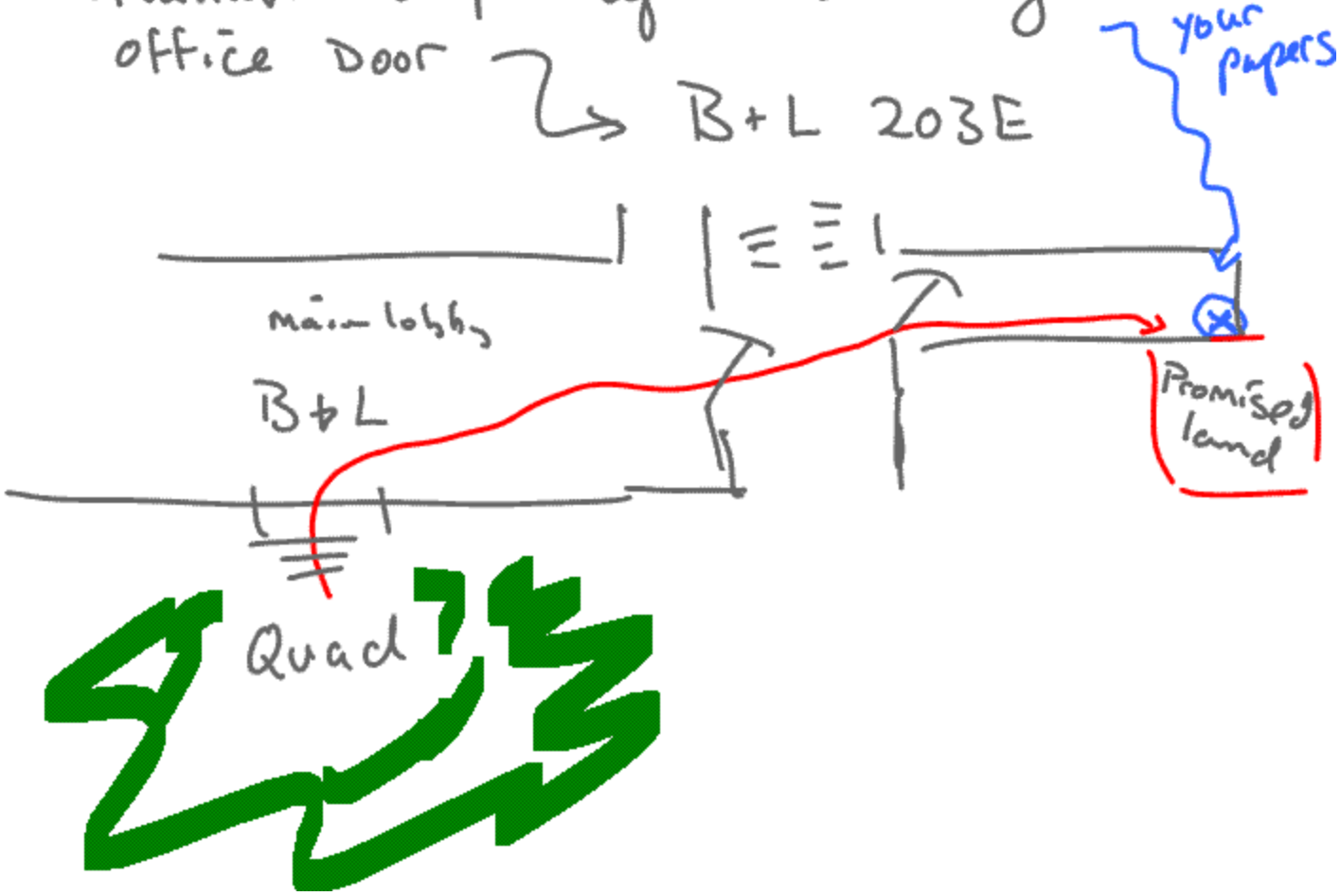
Physics 100 - February 4, 2009

- Your solutions to Problem Sets Available for pick up outside My office Door → B+L 203E



Last Time

Special Theory of Relativity relates observations (of measurable things) between inertial reference frames

Lorentz Transformations

for space + time →

$$x = \gamma(x' + vt')$$
$$y = y'$$
$$z = z'$$
$$t = \gamma\left(t' + v\frac{x'}{c^2}\right)$$

Space + Time get all mixed up → Spacetime

Other physical quantities ... force, energy, momentum, electric field, etc.

also transform and can get mixed together

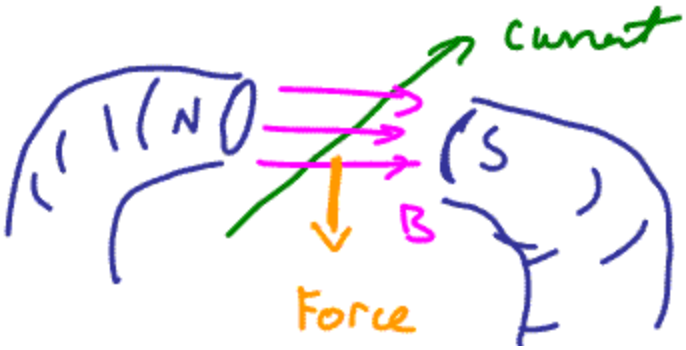
Energy + Momentum → $E = mc^2$

Electric + Magnetic fields

Moving electric charge creates a magnetic Field

We saw this with demo

Also magnetic field causes force on moving charged particles



Saw this in demo with current-carrying wire in strong magnetic field

Maxwell's Equations

1873

James Clerk Maxwell

1831-1879 (Edinburgh)

integral Form of Maxwell's eqns

$$\oint_s \vec{E} \bullet d\vec{a} = \frac{Q_{encl}}{\varepsilon_o}$$

$$\int_s \vec{B} \bullet d\vec{a} = 0$$

$$\int_c \vec{E} \bullet d\vec{l} = -\frac{d\int_s B \bullet d\vec{a}}{dt}$$

$$\int_c \vec{B} \bullet d\vec{l} = \mu_o I_{encl} + \mu_o \varepsilon_o \frac{d\int_s \vec{E} \bullet d\vec{a}}{dt}$$

"E" is symbol for electric field

"B" is symbol for Magnetic Field

What comes out of Maxwell's equations ?

Maxwell

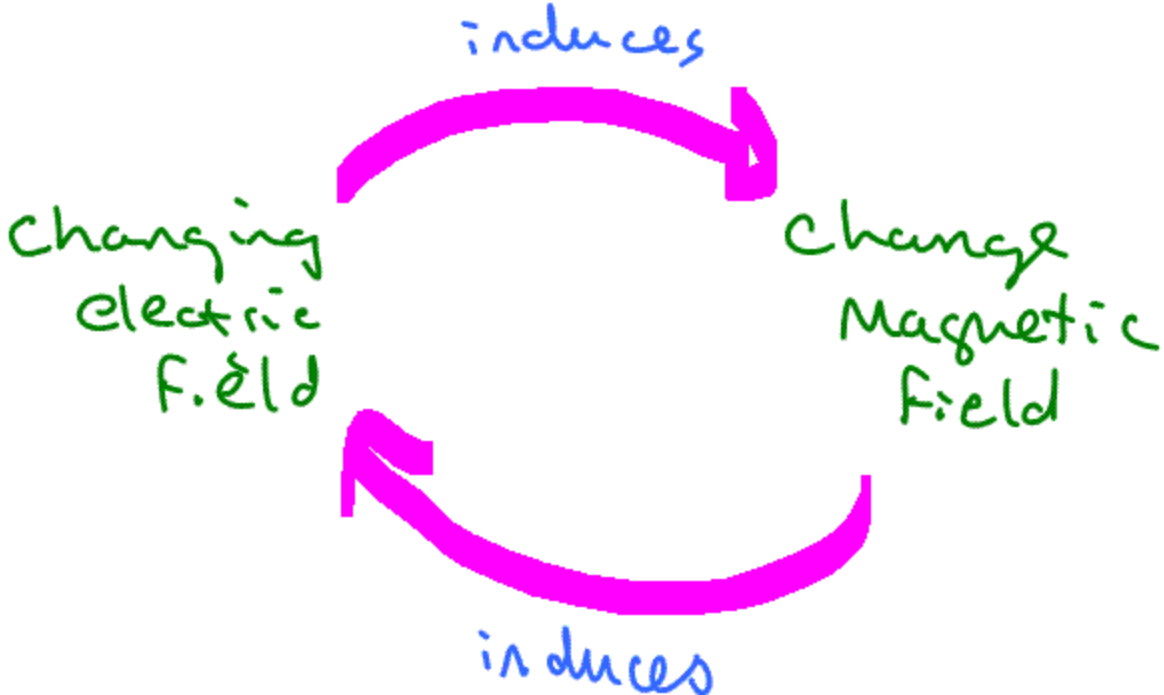
Electric
Magnetic
} Force

intimate relation between electricity and magnetism

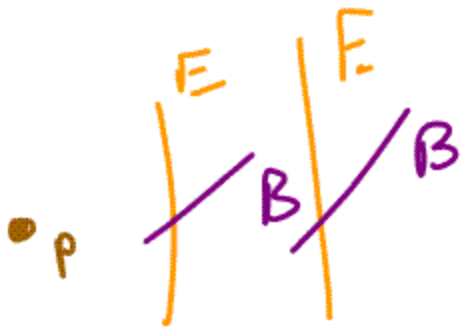
Electric + Magnetic Forces "unified" under one theory

Electromagnetism

Also



Fist full of Electric charge → creates changing E which induces changing B which induces changing E ...



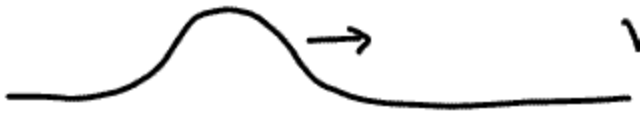
Propagates outward at speed of light

→ it is light

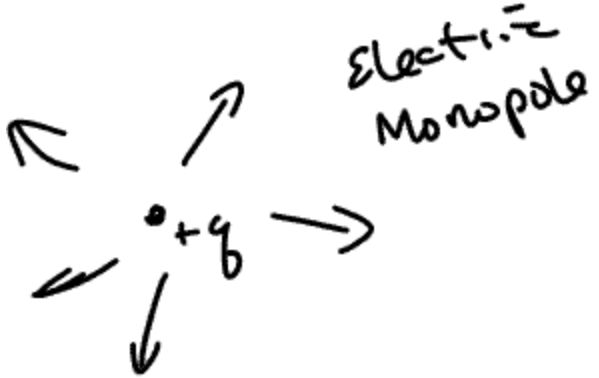
observer very far Away

Maxwell's eqns also tell us that E, B satisfy wave equations

Waves are a well-known mechanical phenomenon



Wave pulse traveling on a string



Electric Monopole

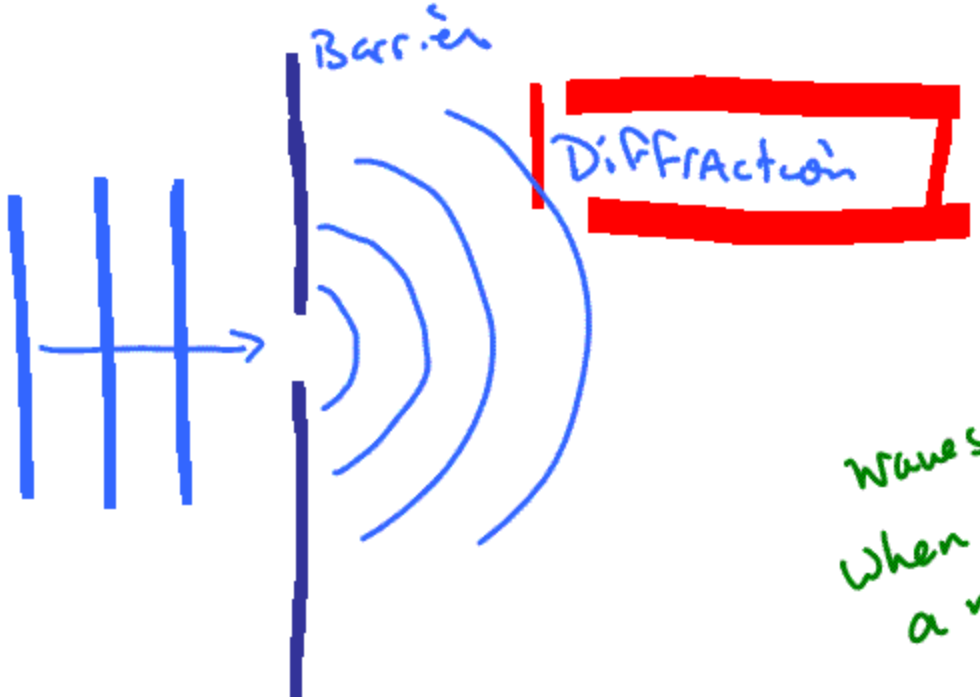
electric Dipole

Magnetic dipole

Maxwell's equations exhibit a "beautiful" Mathematical symmetry (would be perfect if magnetic "monopoles" existed)

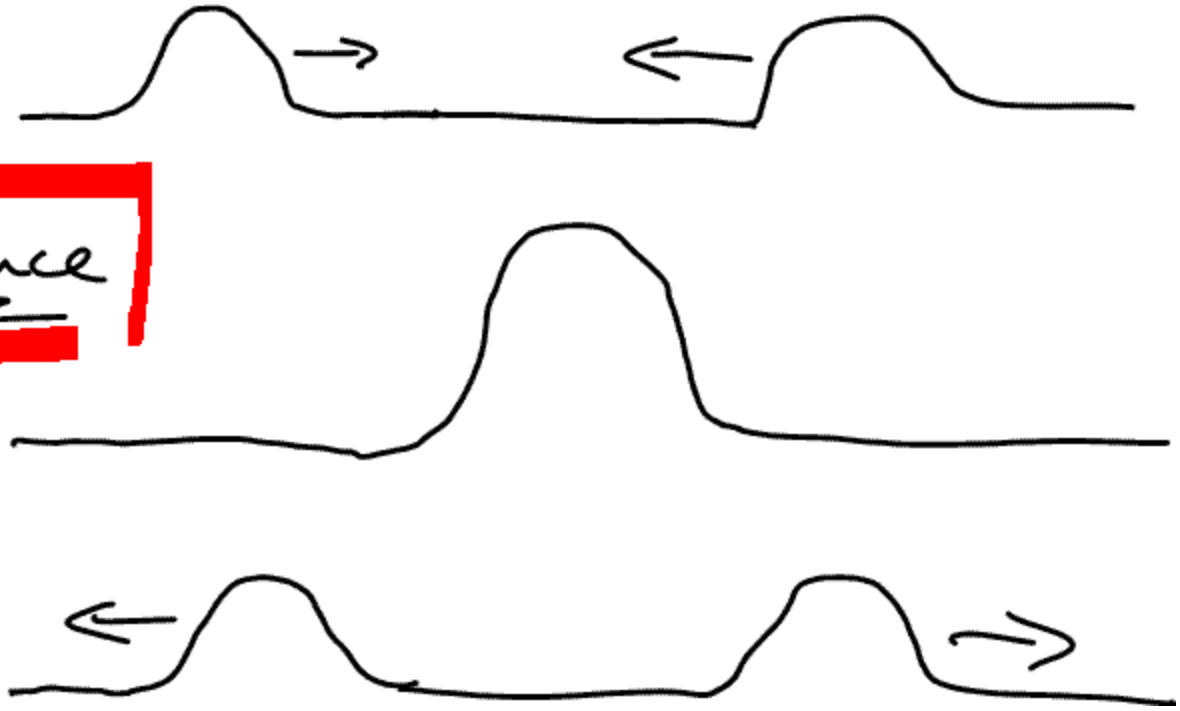
E, B are Waves in light

meaning what?



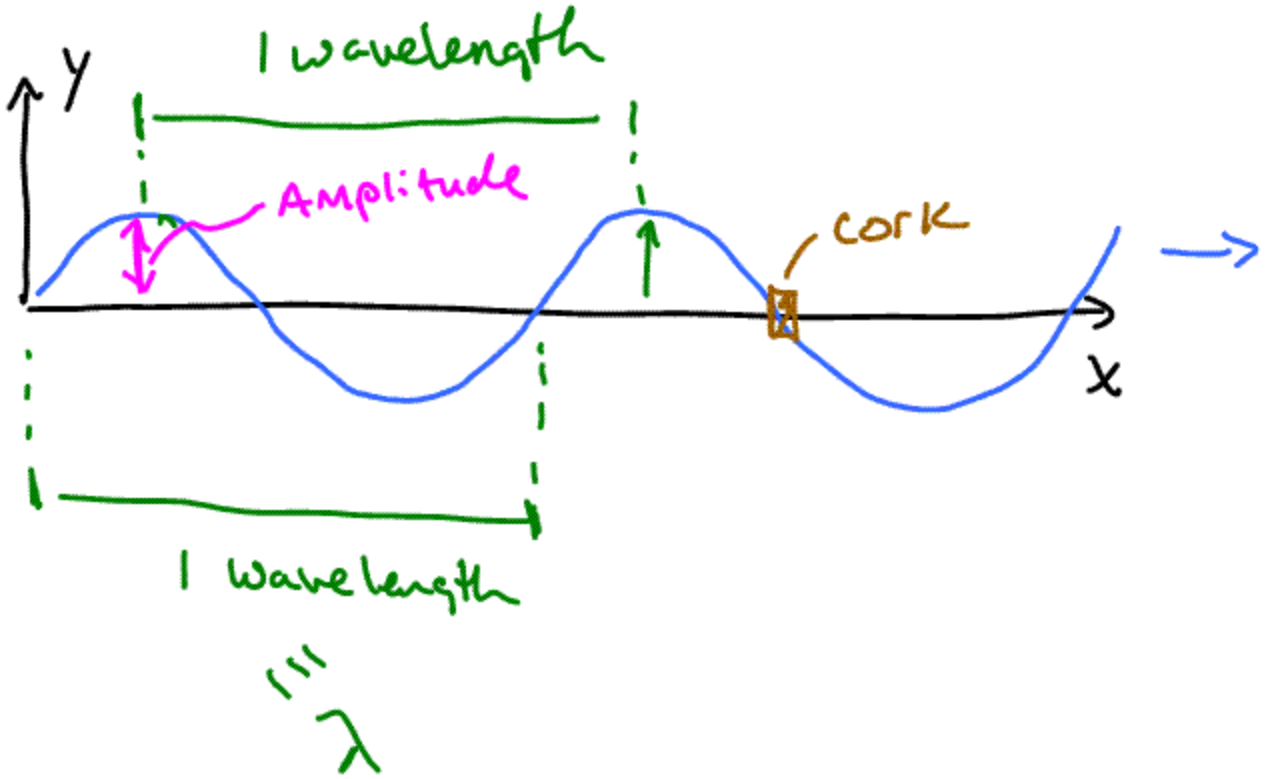
Waves spread out when going through a narrow opening

Interference



Waves

Anatomy of wave



Period ≡ T of wave is time for

"cork" to go through 1 full motion

$$\text{Frequency} \equiv \frac{1}{T}$$