Physics 100 - February 12, 2007

- 12/9 Lecture - Notes online
  hope to have streaming video available soon
  Will need RealMedia player
  probably need to be in UR domain

- Exam 1 - Feb 21
  Thru ~1/2 way 12/9 lect. (Marked in Notes)
  P.S. 3
  Recitation
  } + Associated reading

- Project group listings

Maxwell tells us that light is a wave phenomenon.

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

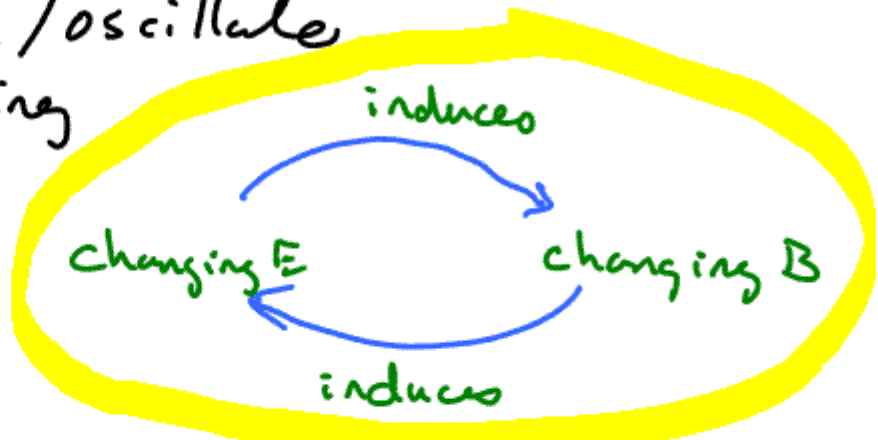
$$\int_s \vec{B} \cdot d\vec{a} = 0$$

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

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

E, B fields wave/oscillate

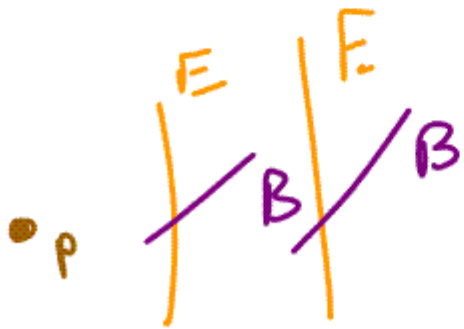
Self propagating



E ≡ symbol for electric field

B ≡ symbol for magnetic field

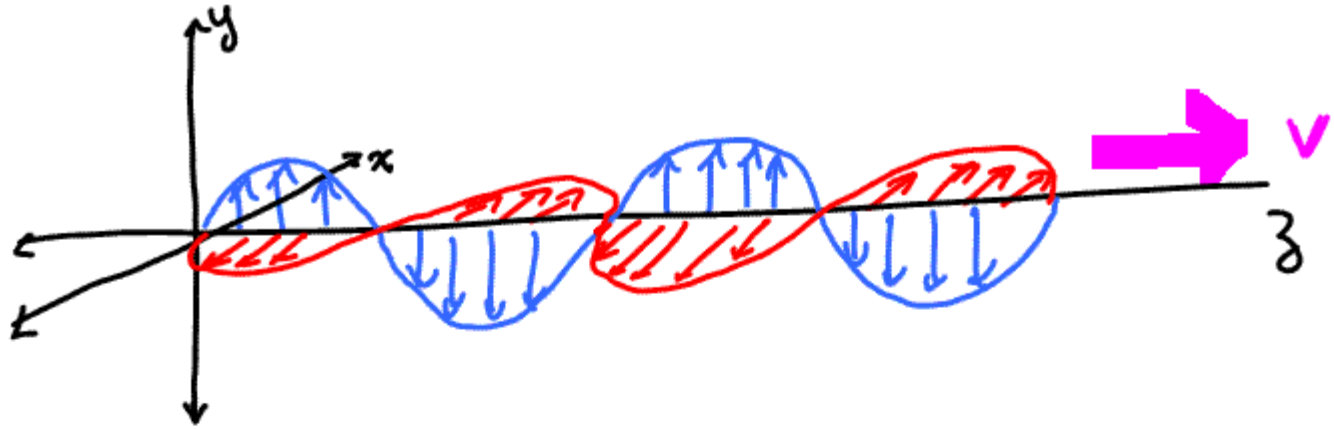
First full of Electric charge → creates changing E which induces changing B which induces changing E ...



Propagates outward at speed of light

→ it is light

observer very far Away



Wave propagates in z direction

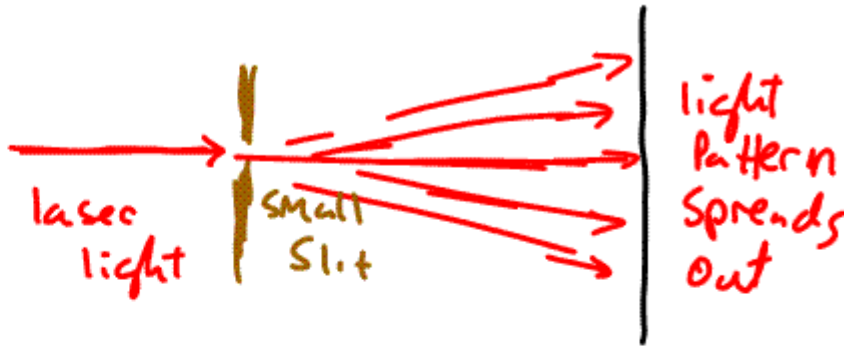
↑ represents direction and magnitude of E field in plane TRANSverse to motion

↑ represents direction and magnitude of B field in plane TRANSverse to direction of motion

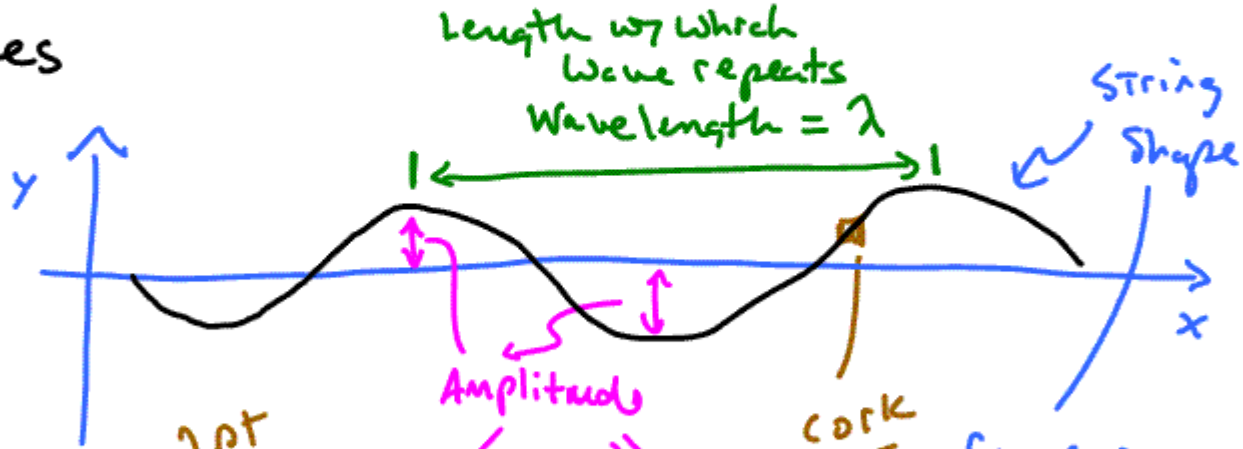
Waves — Sound, pulse on string, water, light

All share certain characteristics

Diffraction – waves spread out passing thru small hole



Waves



Period
T ≡ Time for 1 λ to pass by fixed pt
Time for 1 cork cycle

Frequency
f or ν ≡ 1/T

Meas. of energy and intensity

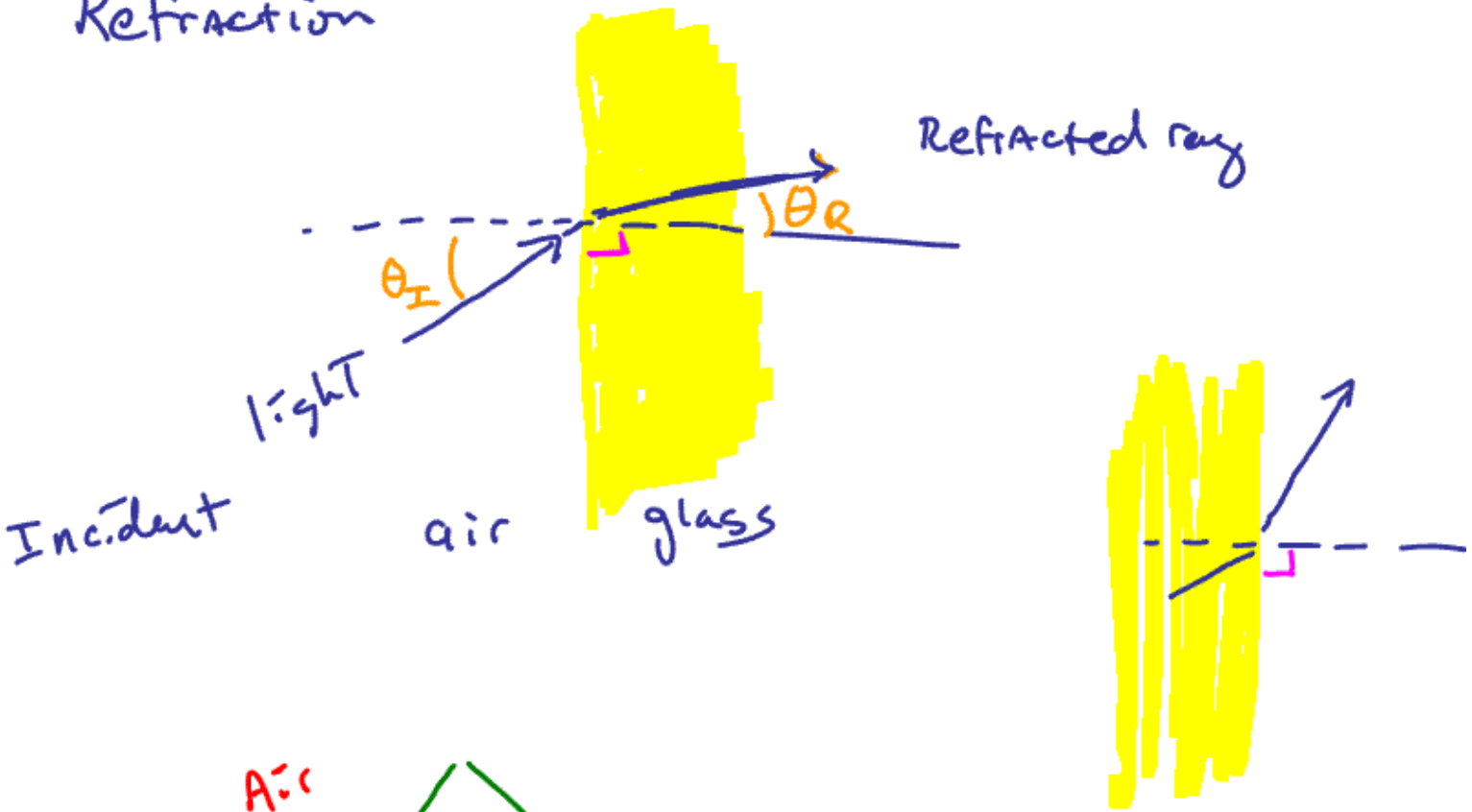
$v = \lambda \nu$

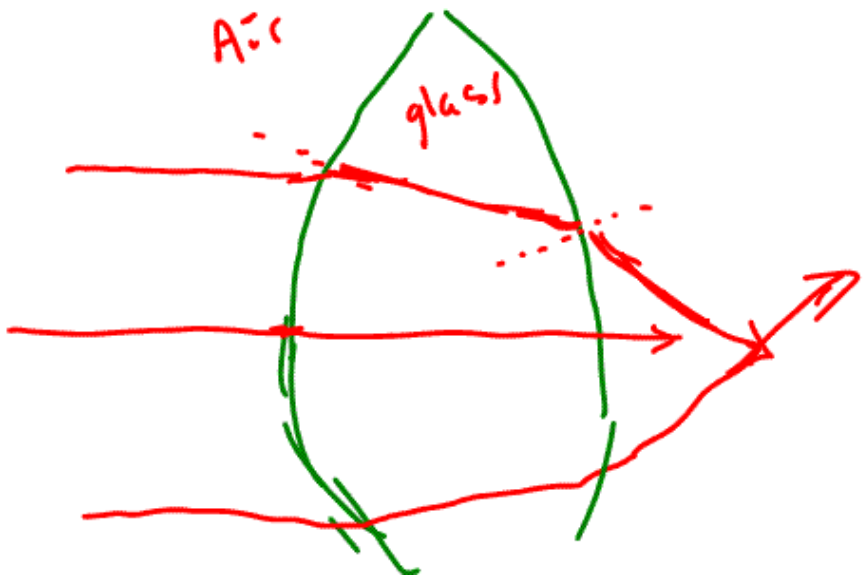
$m/s \quad m\frac{1}{s}$

Constructive Interference

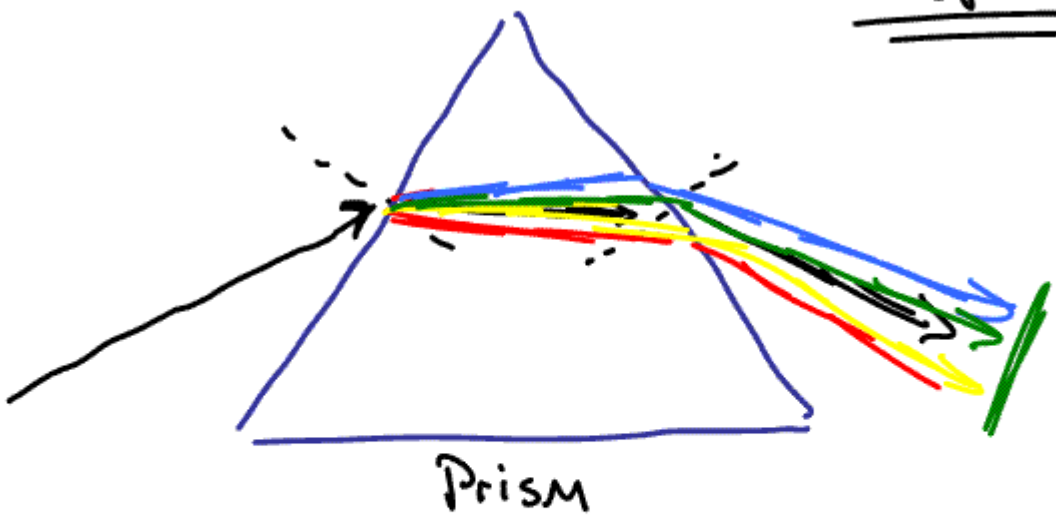
Destructive Interference

Refraction

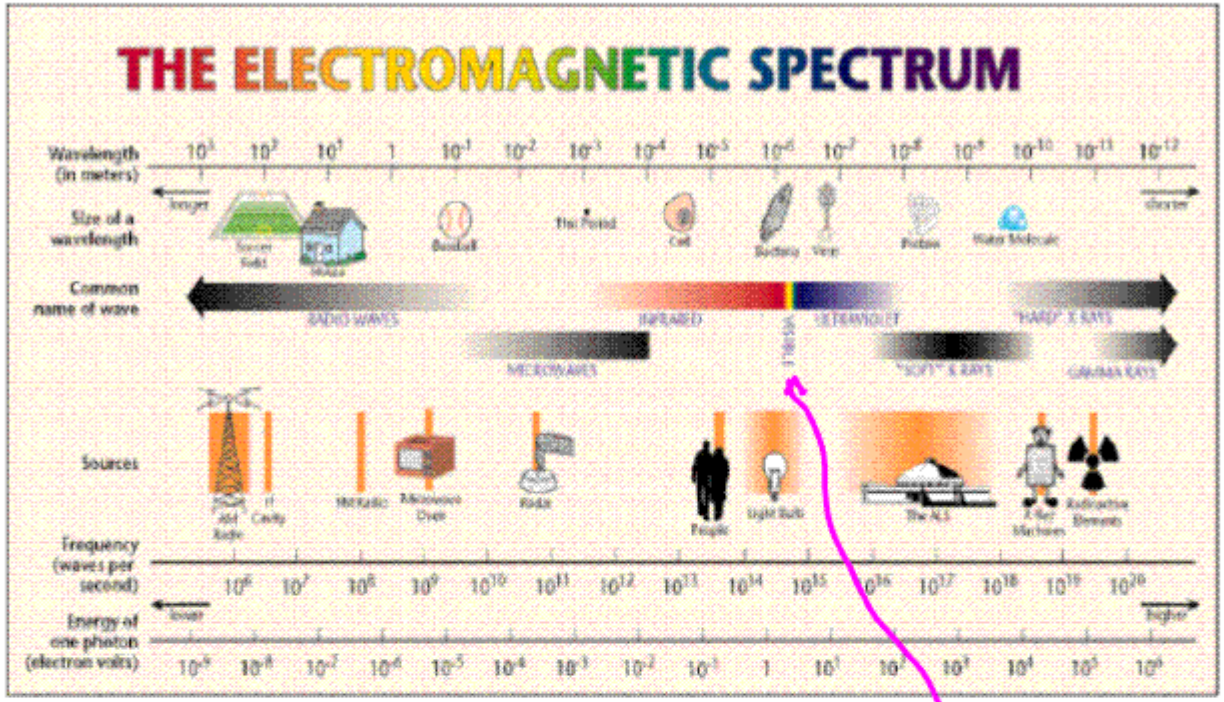

Refracted ray
θ_R
θ_I
light
Incident
air
glass


Air
glass

dispersión



degree by which light is bent
depends on frequency



- no real limits on wavelength / frequency
- visible light is but a tiny fraction of "colors" in universe

interaction of light w/ matter is a very fundamental way to study the structure of matter.

Best to study light emitted by object (not reflected)

Max Planck

(1858-1947)

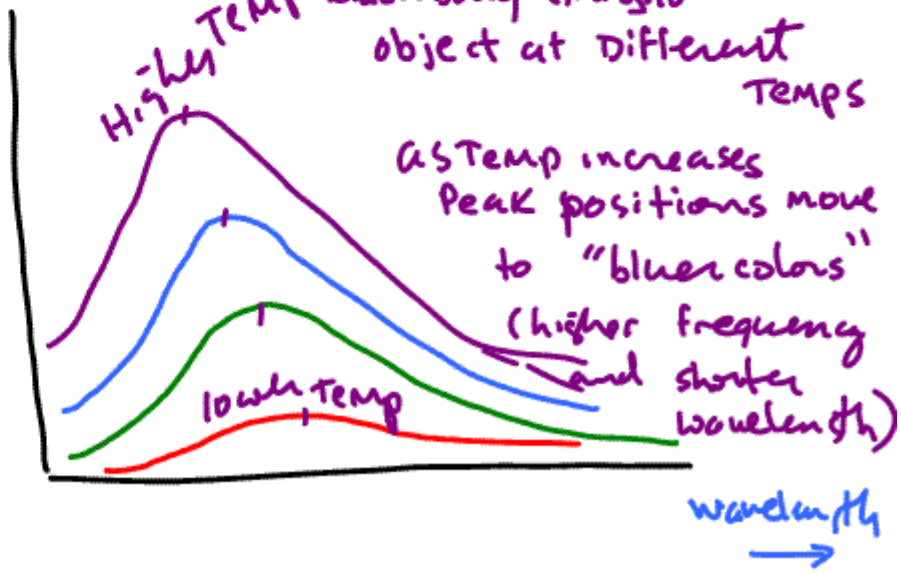
German national

Awarded 1918 Nobel Prize in physics for analysis of blackbody radiation which contributed to rise of quantum Mechanics

http://www-history.mcs.st-andrews.ac.uk/Mathematicians/Planck.html

observer

"Blackbody radiation (emitted by object)



At time w/ best models of atoms and understanding of light as a wave physicists could NOT understand blackbody spectra theoretically.

Planck Succeeded!

But to do so he hypothesized

light → little packets w/ Energy given by

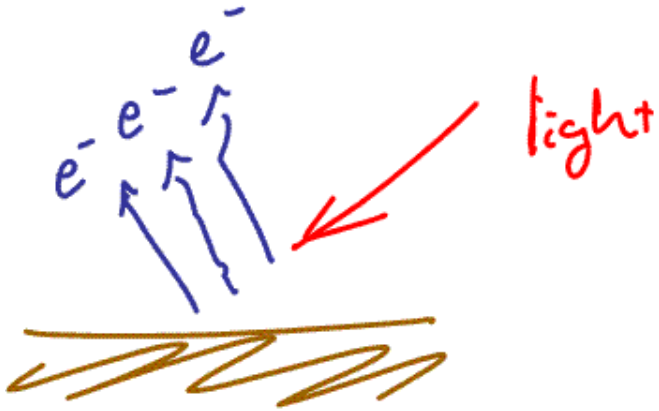
$$E = h\nu$$

Energy — Planck's constant — Freq.

$\Rightarrow$ Blackbody

Planck's Theory worked perfectly ... but physicists thought it was a fortuitous accident ... after all, light is a wave.

Another phenomenon that was NOT understood



Photoelectric effect

Study electric current depends on Intensity + color of light

Einstein in 1905 $E = h\nu$

Einstein able to explain photoelectric effect
Assuming light to come in little packets
with energy $E = h\nu$

Suddenly world has to face fact that light is both a wave and a particle
... Sounds crazy ... but that's what nature tells us.

It gets worse ... if light (known to be a wave) can be a particle, perhaps particles like electrons can be waves

Prince Louis-Victor Pierre Raymond de Broglie

1892 - 1987 (France)

1929 Nobel Prize in physics

(1924 - doctoral thesis)

Matter Waves

$$\lambda = \frac{h}{p}$$

recall $p \sim mv$

λ: wavelength of particle of matter

h: plank's constant

p: momentum

Yikes! Quantum Mechanics is born