Physics 100 – October 1, 2007

- Exam 1 – Week from Wed.
- Presentation topics → send suggestions if you have them

Maxwell's Eqns tell us light is a

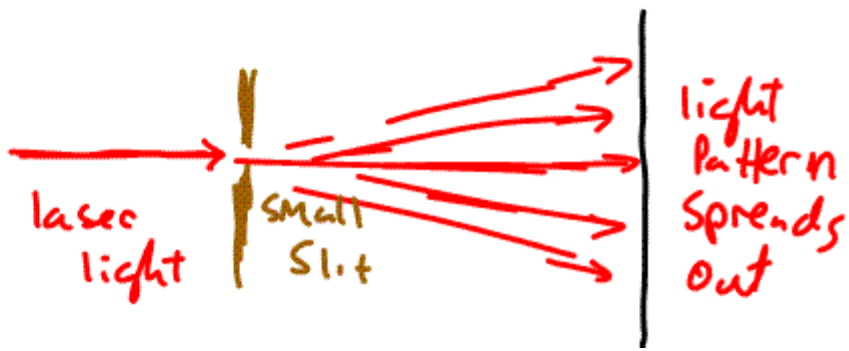
Wave phenomenon

Similar to all other types of waves

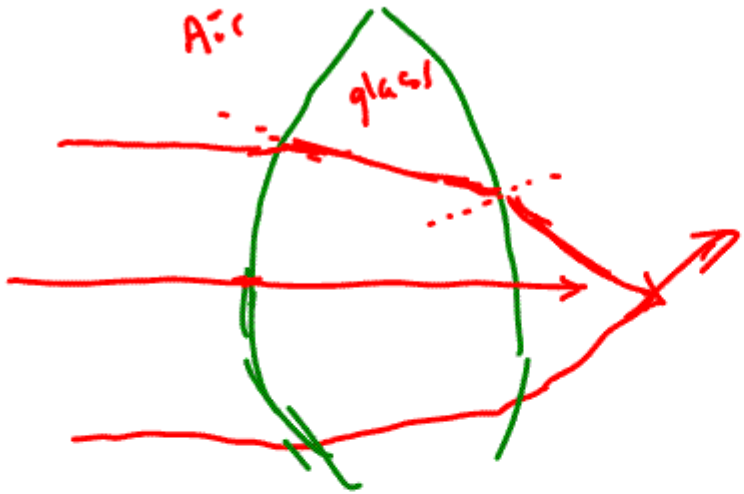
↝ Such as water waves, wave pulses on strings, sound waves, earthquake waves...

So light exhibits typical wave characteristics

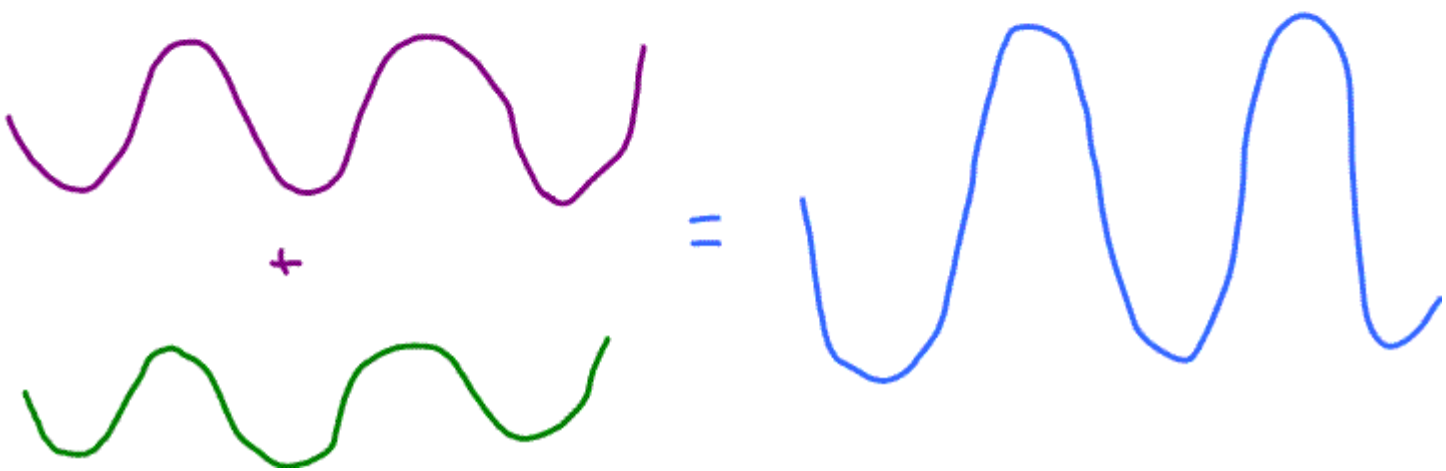
Diffraction – waves spread out passing thru small hole



Refraction - waves bend at interface between media



Interference - Wave Amplitudes Add together



So, we know light is a wave

Fine ...

let's use light to try to understand matter ...

Want to look at light emitted by matter

(imagine glow from hot fireplace poker)

Max Planck

(1858-1947)

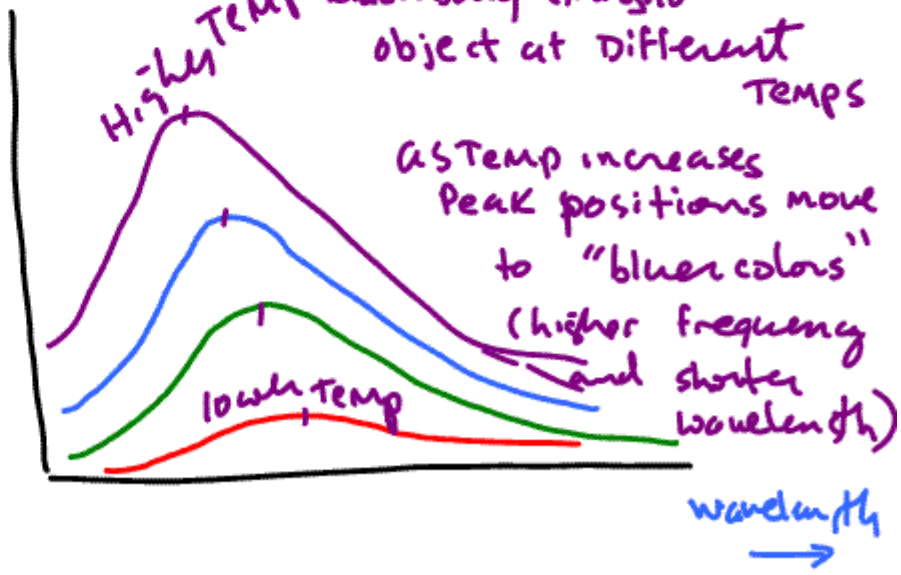
German national

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 my 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

$$E = h\nu$$

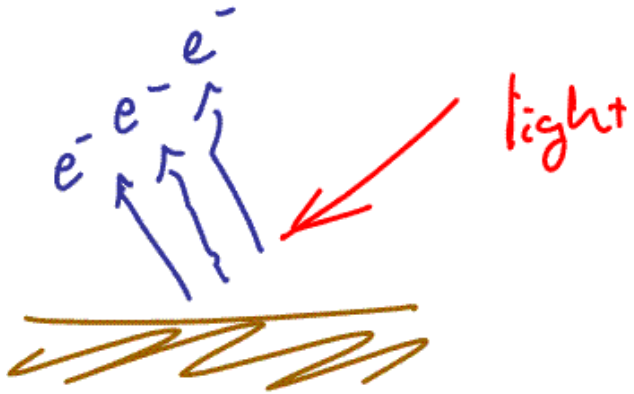
Energy — Freq. — CONSTANT

Planck's CONSTANT

$\Rightarrow$ 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

$h = 6.6 \times 10^{-34}$ Joule-Sec

$h = (2\pi)(6.6 \times 10^{-22})$ MeV-Sec

$\frac{1}{\text{seconds}}$

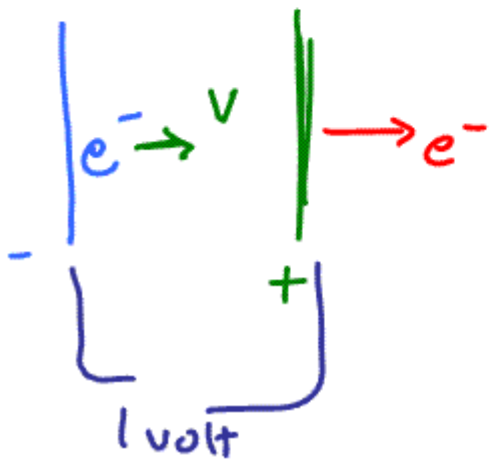
$E = h\nu$

Joules

Joule - unit of energy ~ also work

$$\text{Work} = (\text{Force})(\text{dist}) = (\text{Newton})(\text{Meters})$$

$$1 \text{ Joule} = 1 \text{ N m}$$



Energy gained by electron = 1 eV

as it moves from one terminal to the other in 1 V battery

eV = unit of energy — Convenient unit for nuclear + particle physics

$1\,eV = 1.6 \times 10^{-19}\ J$

We will use ...

eV

keV Thousands of eV

MeV Millions of eV

GeV Billions of eV

TeV Thousands of Billions

$E = mc^2$