Physics 102 - February 9, 2011

Last Time

Maxwell's Equations

1873

James Clerk Maxwell

1831 - 1879 (Edinburgh)

Integral form of Maxwell's Equations

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

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

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

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

"E" is symbol for electric field

"B" is symbol for magnetic field

Fist full of Electric charge → creates changing $\vec{E}$ which induces changing $\vec{B}$ which induces changing $\vec{E}$ ...

Propagates outward at speed of light

⇝ it is light

observer very far Away

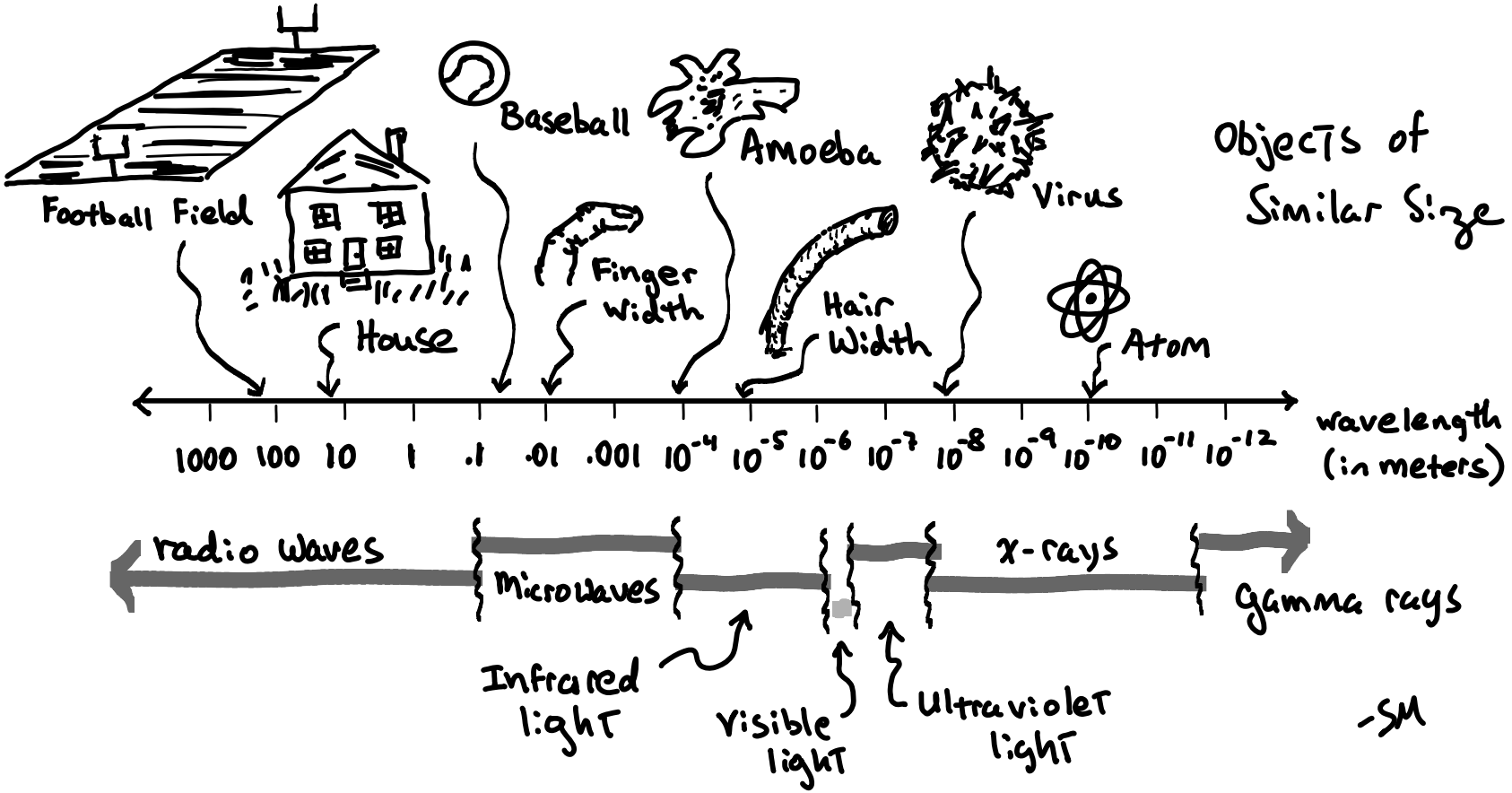
Maxwell's eqns also tell us that

$\vec{E}$, $\vec{B}$ satisfy wave equations

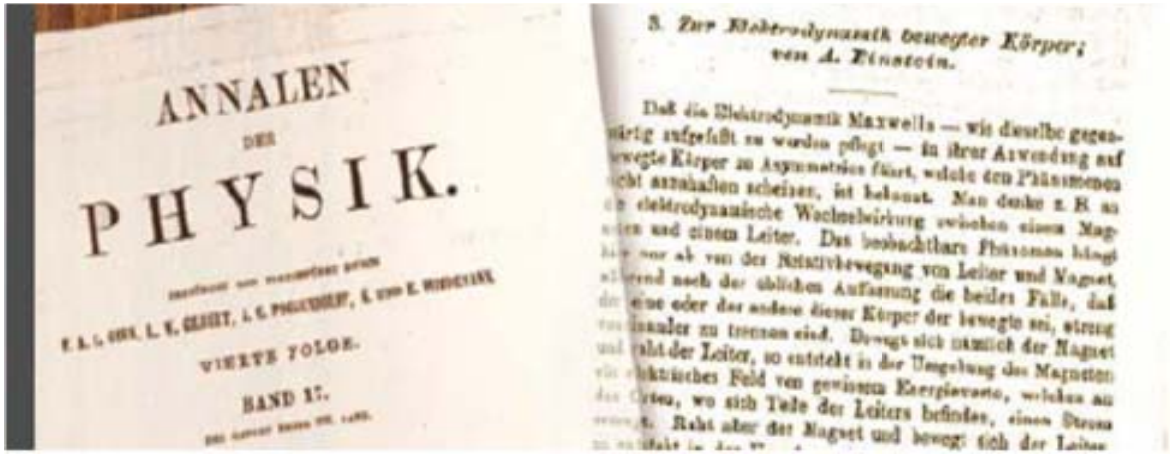
Waves are a well-known mechanical phenomenon

Wave pulse traveling on a string

The variety of electromagnetic Waves



Relativity + the intimate relationship between electricity and magnetism



ANNALEN
DER
PHYSIK.

VIERTE FOLGE.
BAND 17.

5. *Zur Elektrodynamik bewegter Körper;*
von A. Einstein.

Daß die Elektrodynamik Maxwells — wie dieselbe gegenwärtig aufgefaßt zu werden pflegt — in ihrer Anwendung auf bewegte Körper zu Asymmetrien führt, welche den Phänomenen nicht anzuhaften scheinen, ist bekannt. Man denke z. B. an die elektrodynamische Wechselwirkung zwischen einem Magneten und einem Leiter. Das beobachtbare Phänomen hängt hier nur ab von der Relativbewegung von Leiter und Magnet, während nach der üblichen Auffassung die beiden Fälle, daß der eine oder der andere dieser Körper der bewegte sei, strenge voneinander zu trennen sind. Bewegt sich nämlich der Magnet und ruht der Leiter, so entsteht in der Umgebung des Magneten ein elektrisches Feld von gewissem Energiewerte, welches an den Orten, wo sich Teile der Leiters befinden, einen Strom erzeugt. Ruht aber der Magnet und bewegt sich der Leiter

+Q

+Q

at rest

Electric

$Q \longrightarrow V$

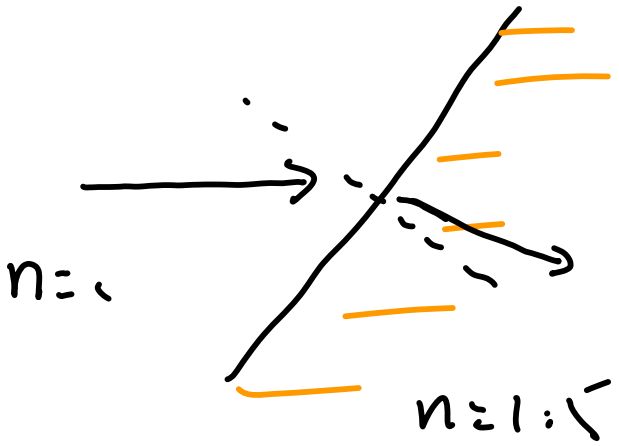
$Q \longrightarrow V$

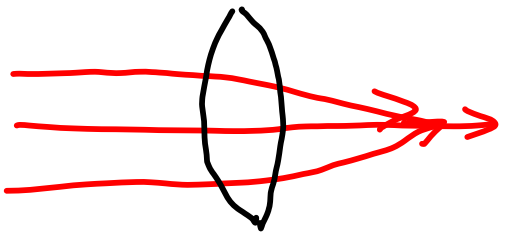
currents

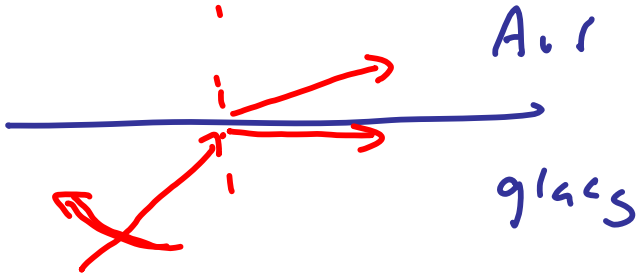
Magnetic

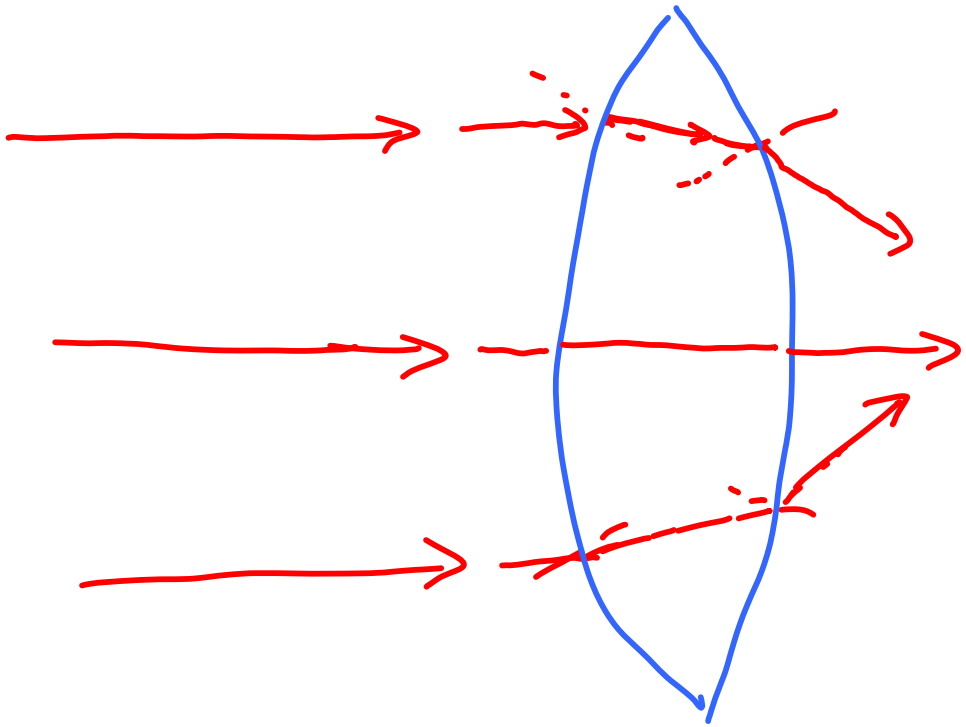
light is a wave

index of refraction $n = \frac{c}{v} > 1$






Air
glass



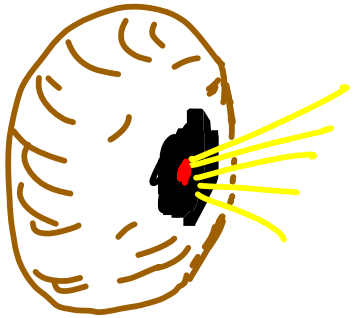
Max Planck

(1858-1947)

German national

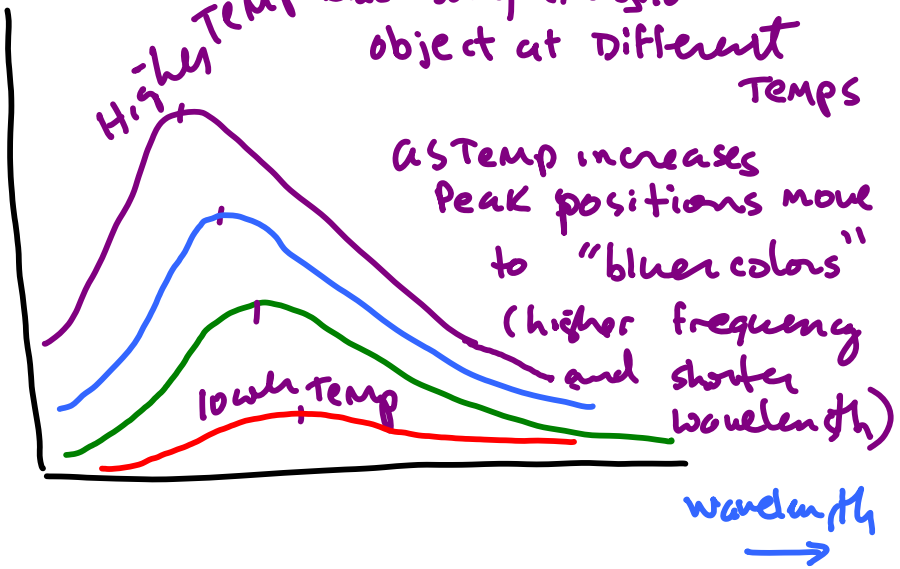
Awarded 1918 Nobel Prize in physics for analysis of blackbody radiation which contributed to rise of quantum Mechanics

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



observer

"Blackbody" radiation (emitted by object)

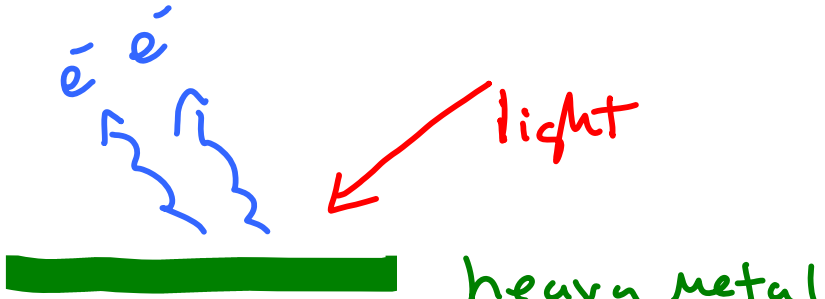


Planck assumed

$$E_{packet} = h\nu$$

Planck's constant

Photoelectric effect



Study
e^-
energy e^-
as function of
Intensity + color
light