Physics 102 - Feb 16, 2010

- Exam 1 ... here ... 1 week from now
- Link to past exams on class website and sent via email
- Formula sheet
- 3x5 index card
- Calculator w/ powers of ten
- Will only cover material through material read last week
  Recitation ending this coming Monday (Not standing waves)
  Lect thru 2/14/11, but not de Broglie stop w/ Blackbody + Photoelect

[redacted]

Maxwell's equations
interference
diffraction
Refraction
dispersion
⋮

light is a wave!

Planck

Blackbody Radiation

Einstein

Photoelectric effect

1905

light comes in little packets with energy

$E = h\nu$

light is a particle!

Louis Victor Pierre Raymond, 7th duc de Broglie

French, Nobel Prize 1929

mid-1920's

de Broglie hypothesized matter can have wave characteristics with a wavelength given by

So-called de Broglie Wavelength

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

From special relativity ← form of "$E = mc^2$" when particle moving

$$E = \sqrt{p^2c^2 + m^2c^4}$$

For photon, $m = 0$

$$E = pc \text{ or } p = \frac{E}{c}$$

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

From Blackbody + Photoelectric

$$E = h\nu \longrightarrow E = \frac{hc}{\lambda} \rightarrow \frac{h}{\lambda} = \frac{E}{c}$$

$v = \lambda\nu$

deBroglie: Perhaps Also true for Particle with Mass

$\lambda = h/p$

baseball at 92 mph

142 grams

41 m/s

p of baseball = mv

= 5.7 kg m/s

$$\lambda = \frac{6.6 \times 10^{-34} \text{ J.s}}{5.7 \text{ kg m/s}}$$

$E = h\nu$ (J.s)

$\lambda = 1 \times 10^{-34}$ m

Wavelength of a baseball so short it cannot be observed

→ We don't have to worry about wave character of everyday objects

1 eV electron

↳ 1.6×10^{-19} Joules

Kinetic Energy of something $= \frac{1}{2}mV^2$

↳ $V = 596\ m/s$

$$p = mV = (9 \times 10^{-31}\ kg)(596\ m/s)$$

$$= 5 \times 10^{-28}\ kg\ m/s$$

$$\lambda_{e^-} = \frac{6.6 \times 10^{-34}}{5 \times 10^{-28}} = 1.3 \times 10^{-6}\ m$$

$$\sim 1\ \mu m$$

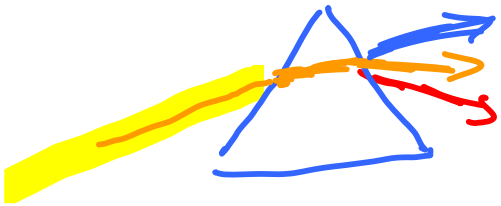
this is something that <u>can</u> be observed in a lab

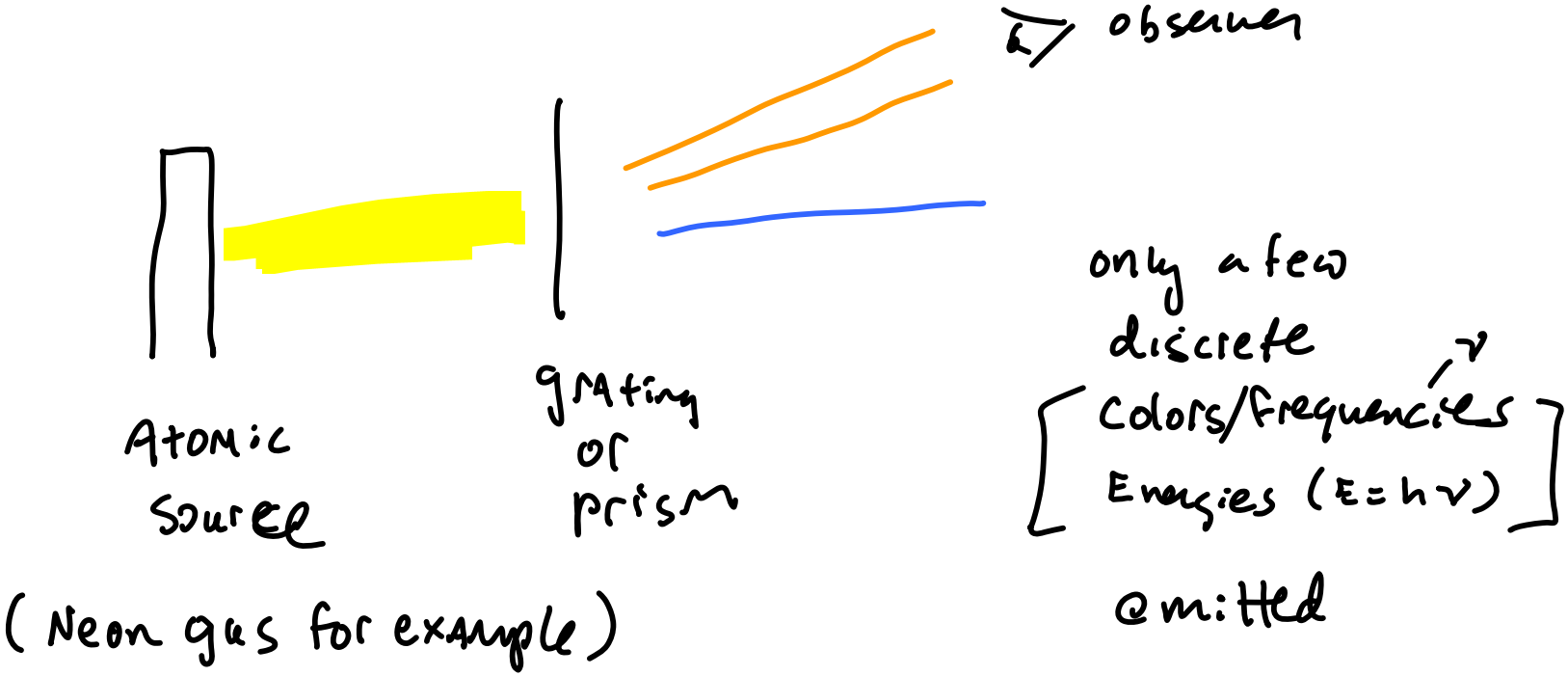
Particles have Wavelike characteristics!

Atomic spectra problem

do grating demo

dispersion





(Neon gas for example)

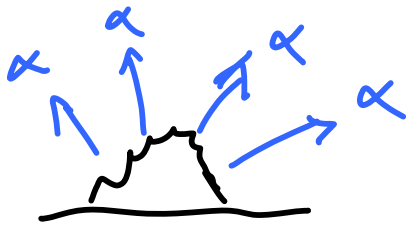
Niels Bohr

(1885 - 1962) (Denmark)

1922 Nobel Prize in Physics

Atomic (planetary) model with fixed orbits

nicely motivated by de Broglie's matter waves in 1924



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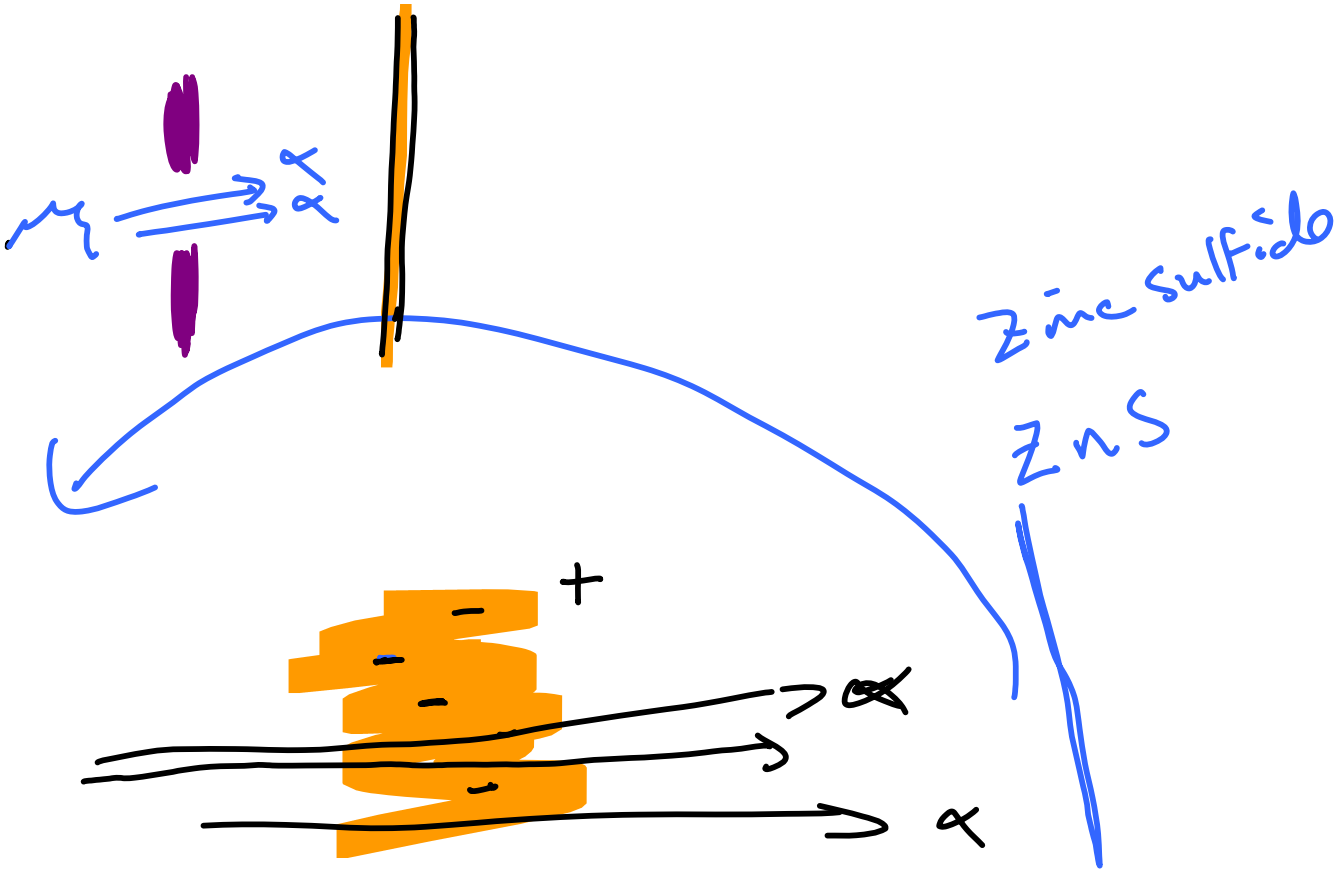
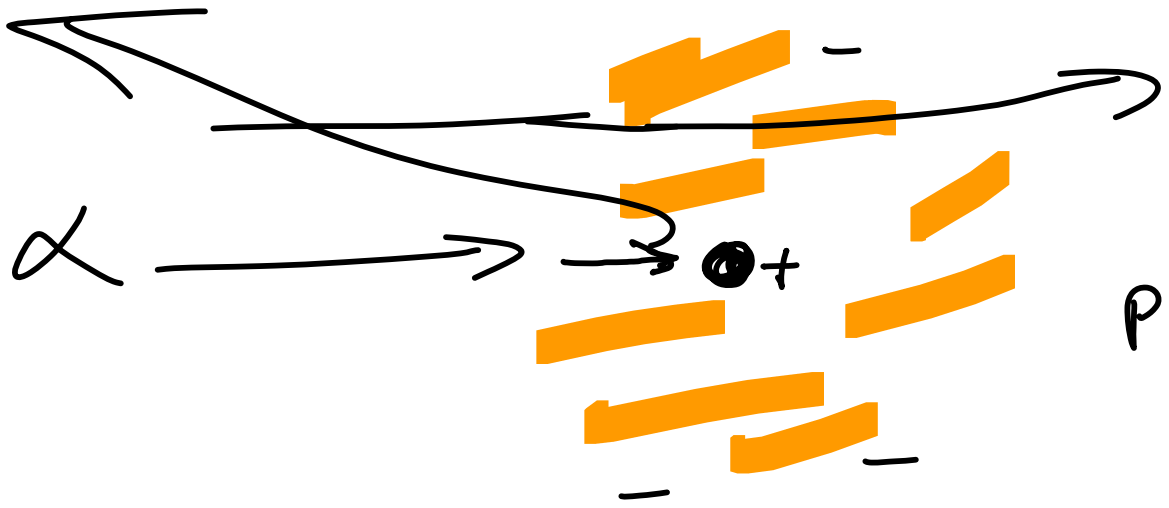


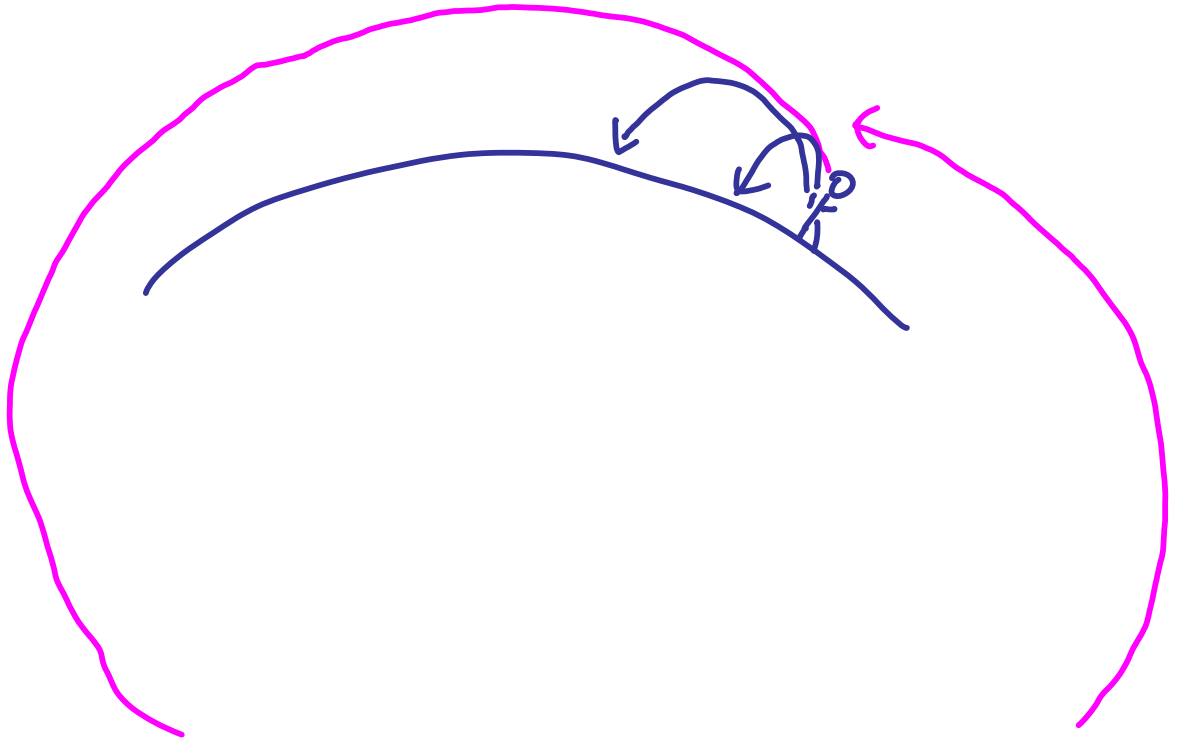
Rutherford



Planetary Model of Atom

Bohr Model of the atom

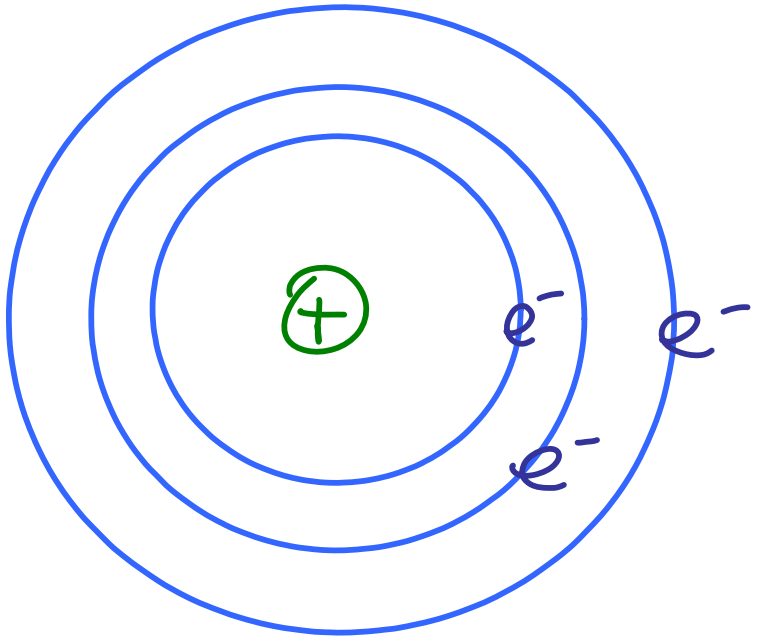
- Positive Nucleus
  planetary geometry
- electrons orbit + nucleus
  in circles



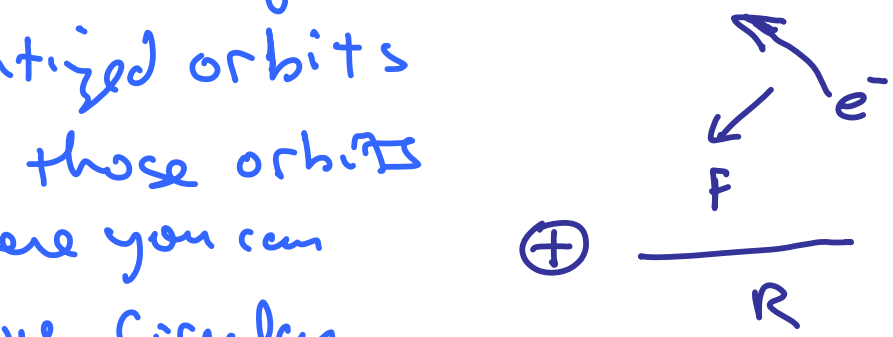
only particular "discrete" orbits are allowed

quantization

Electric Force holds e⁻ in a circle as it orbits



can think of quantized orbits as those orbits where you can have circular standing waves for the electron.



$$F = \frac{mv^2}{R}$$

$$KE = \frac{1}{2}mv^2$$