Physics 100 - February 19, 2007

- Project Presentation groups

  Grp 24 → Galileo

  → other

- Exam on Wednesday

- Q+A session Tuesday ... B+L 270

  5pm — 6:30 ish

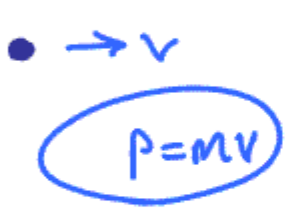
Last time

Light is a wave $v = \lambda\nu$

And

a particle $E = h\nu$ Einstein Planck

Particles (like electrons)



are

particles And waves

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

$h = 6.67 \times 10^{-34}$ J·s $\Rightarrow$ very small

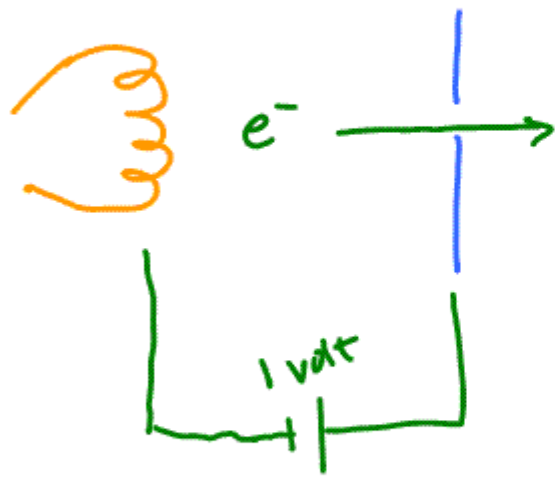
So p must be very small for λ

to be large

impt for small particles moving slow

particle energy often Meas. in eV

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



1eV electron beam

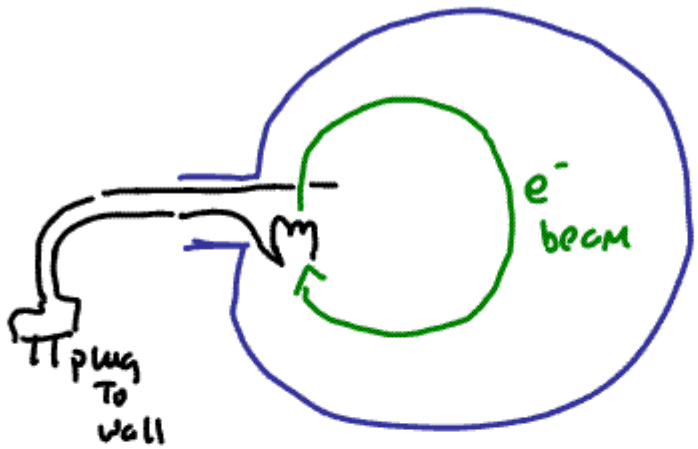
KeV
MeV
GeV
TeV
⋮

Mass — eV/c^2

$E = mc^2$

$E/c^2 = M$

- e/m of electron demo



Magnetic field into paper

- Microwave + Radiowave EM wave demos

  ↳ interference and Polarization

SAW demos – 2 slit interference pattern for Microwaves

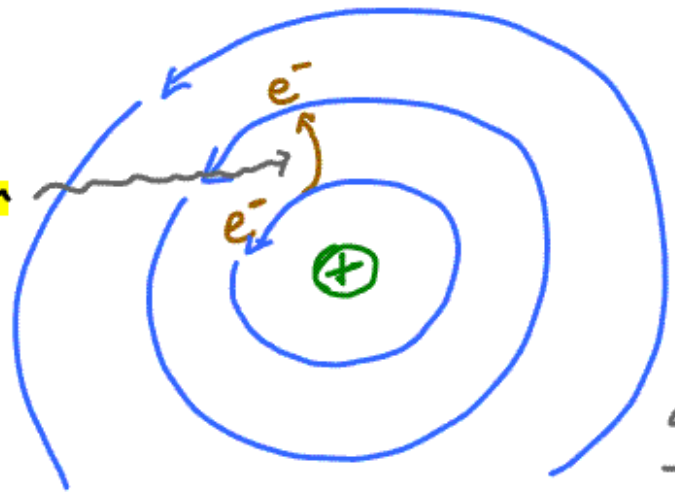
– polarization of EM wave (Radiowaves)

Detector – lightbulb comes on when antenna oriented correct way.

Bohr model of the atom (1912)

- positive Nucleus
- electrons orbit in circles
- only particular "discrete" orbits
  - ↑ known as quantization
- electric (Coulomb) force holds electron on circle as it orbits ... attracts electron toward Nucleus

Absorb γ (photon) – e⁻ makes transition from low Energy orbit to high energy orbit



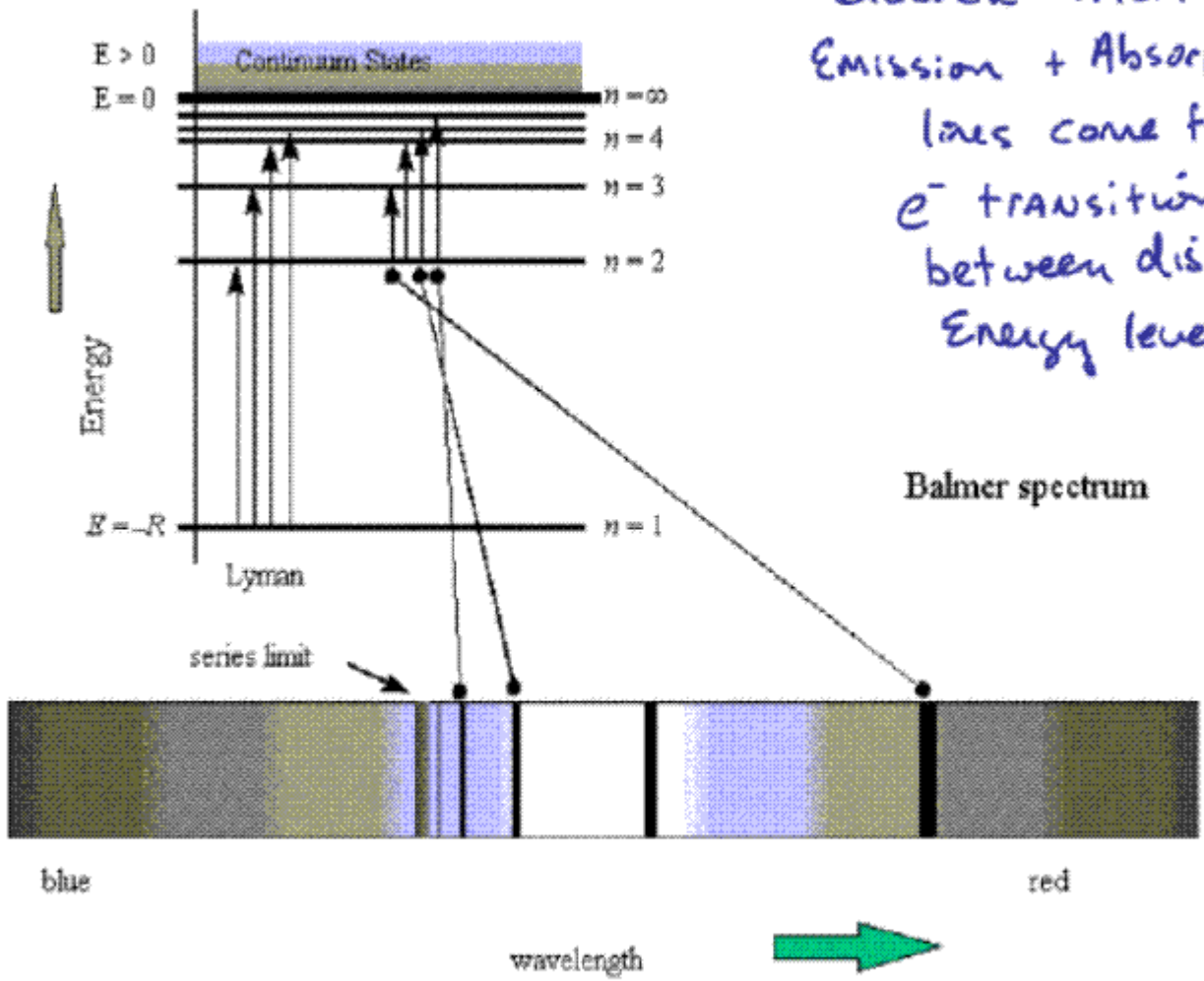
possible orbits for electron

Transition from high energy orbit to low energy orbit → emission of photon

only a few discrete colors/frequencies (ν) Energies ($E = h\nu$) emitted

(Neon gas for example)

* Do Bohr Model Applet (see links page on website)



Discrete Atom Emission + Absorption lines come from e^- transitions between discrete Energy levels

Balmer spectrum

Figure from

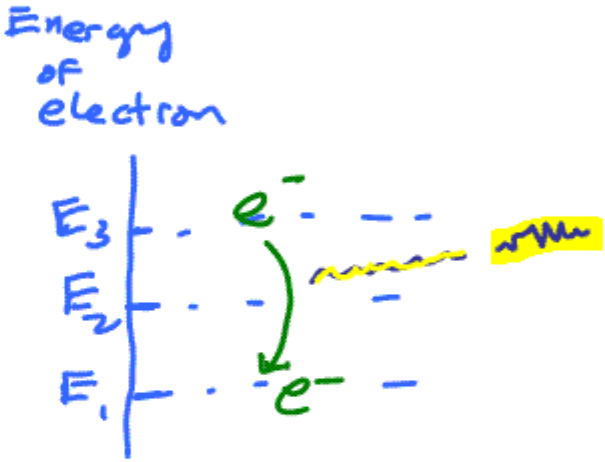
http://www.uclan.ac.uk/facs/science/physastr/x99/PAM98/UCert/Ch06/6_6ato~1.htm

- Bohr model of atom worked well in describing the discrete spectra observed coming from atoms.
- In this model photons are only absorbed/emitted as electron makes transitions between specific allowed energy states.

So photons have fixed energies

$E = h\nu$

↑ means light is emitted with specific colors



- Bohr model orbits are stable ... not easily understandable with classical physics
  NOT motivated by Bohr ... just put in ad hoc to get discrete spectra

Next step: development of true wave equation/solution for matter

Werner Karl Heisenberg

(1901 - 1976)

Nobel Prize in physics - 1932

for "the creation of quantum Mechanics"

(Max Born, Pascual Jordan - co-workers)

Erwin Rudolf Josef Alexander Schrödinger

(1887 - 1961) Austria

1933 Nobel Prize in physics

1926 - Paper on wave Mechanics of Matter

Annalen der Physik

"for discovery of new and productive forms of atomic theory"

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + V\psi(x) = E\psi(x)$$ Schrödinger's Equation

Just so you've seen it

Schrödinger's equation → general wave equation for matter waves

for any specific situation – feed in description and solve eqn

such as ⊕ charge surrounded by an electron by electric force between them

Hydrogen Atom, for example

Solution only works for particular STATES with different energy and spatial characteristics

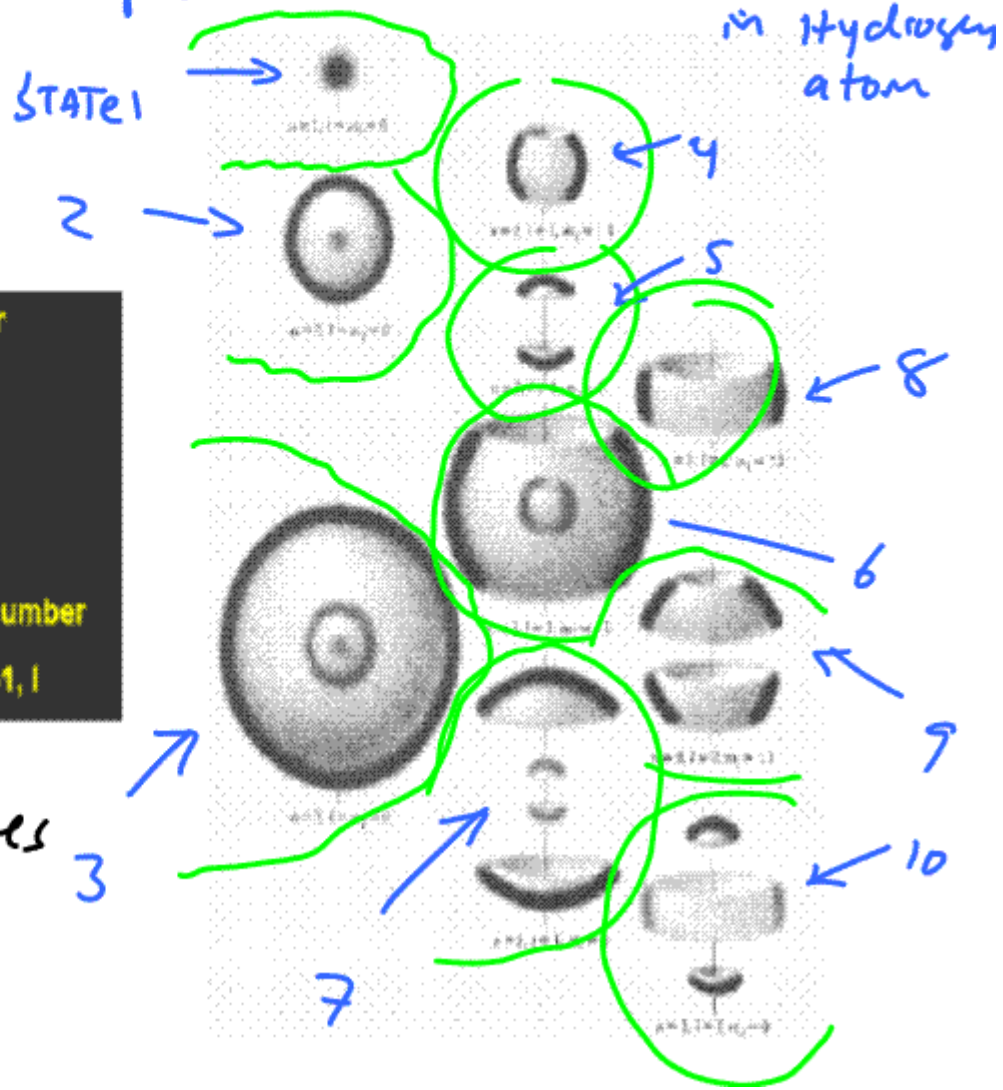
→ called allowed "quantum states"

→ specified by numbers known as "quantum numbers"

QM treatment of H atom wave mechanics

Spherical Symmetry

Shapes of allowed electron STATES in Hydrogen atom



Energy or principal quantum number

n = 1, 2, 3 ...

Orbital quantum number

l = 0, 1, ... n-1

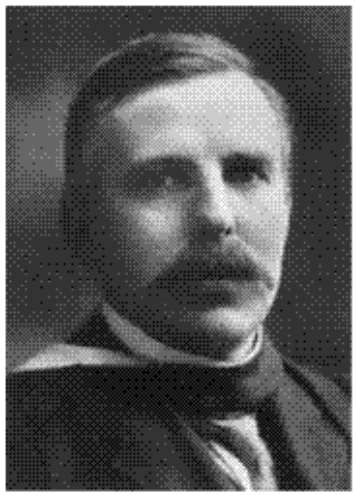
Magnetic quantum number

-l, -|l-1|, ..., 0, 1, ... l-1, l

Similar to Bohr – discrete STATES

But orbits are not circular

How did Bohr know to use "nuclear" model of Atom ??



Ernest Rutherford

(1871 - 1937)

(New Zealand Farmboy → England)

1908 Nobel Prize in Chemistry

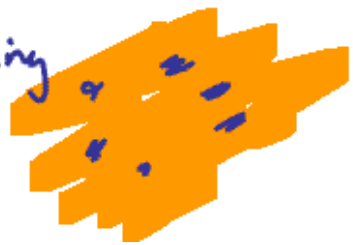
Established Nuclear Model of Atom

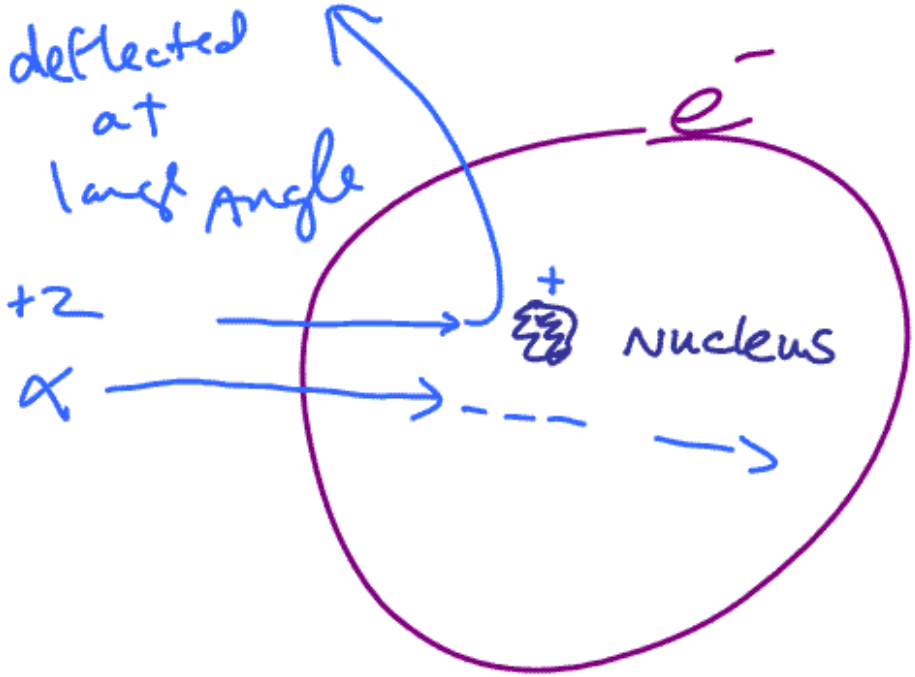
Rutherford
(Manchester)

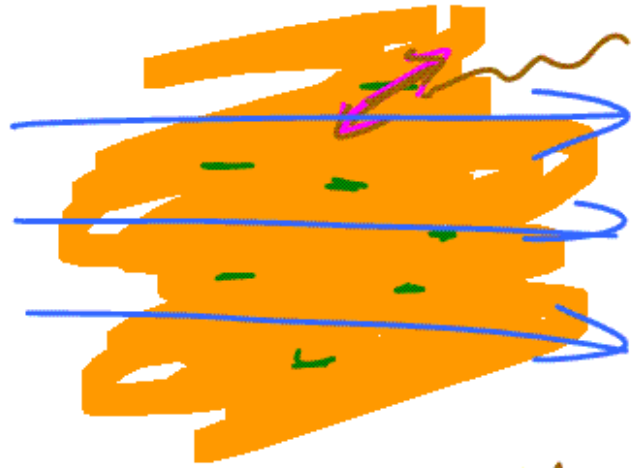
nuclear

J.J. Thompson
(cambridge)

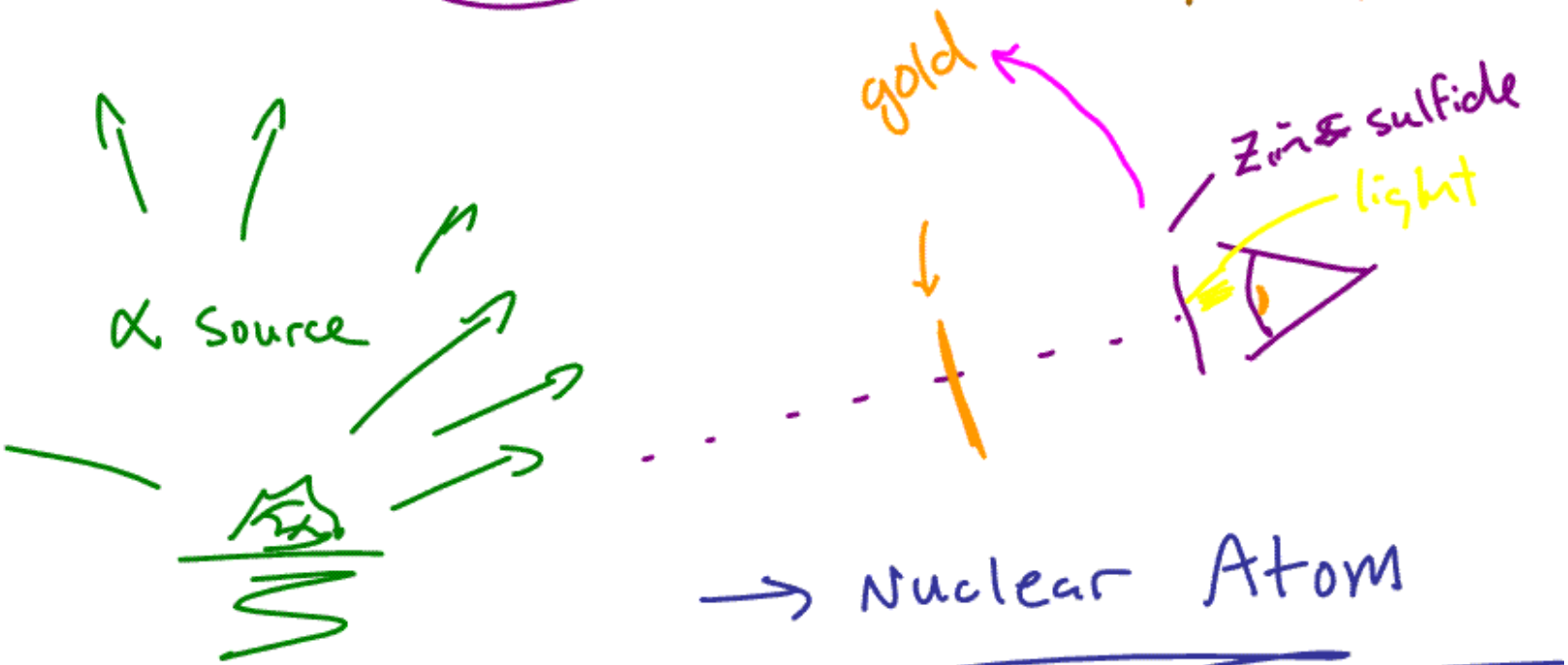
Plum Pudding





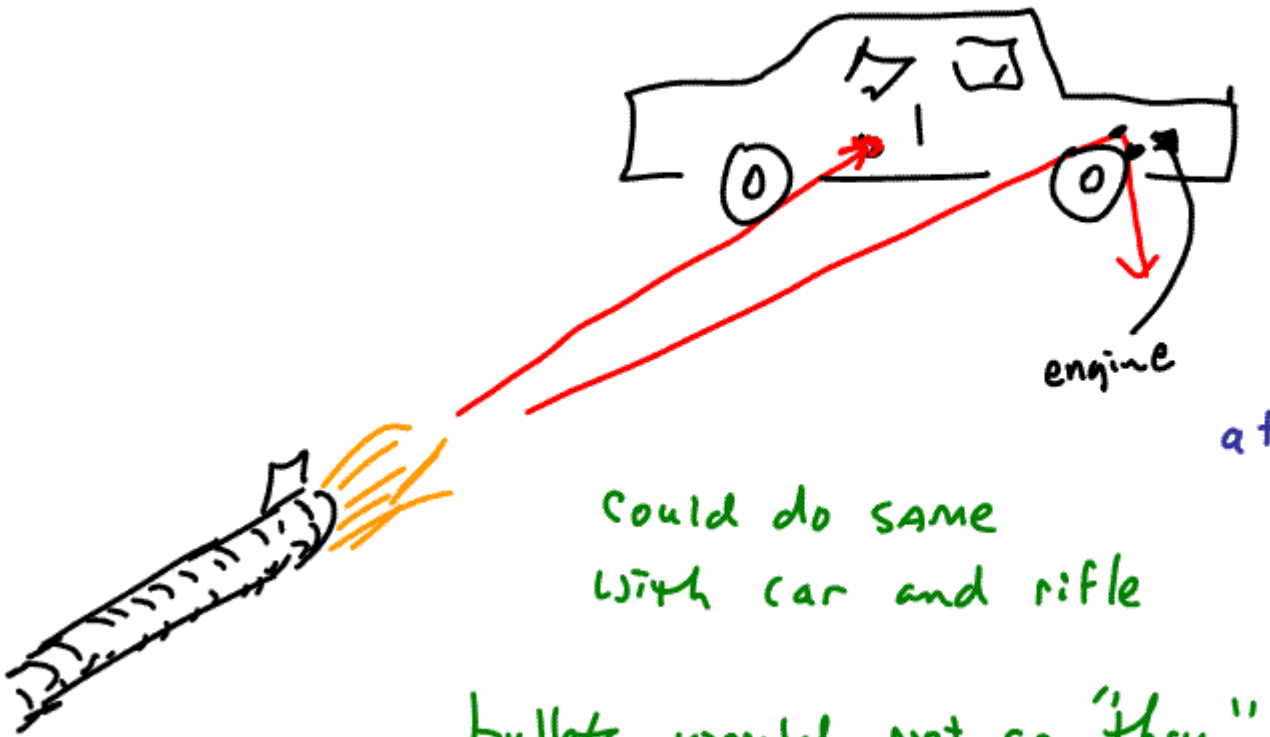


Plum pudding



→ Nuclear Atom

Can Think of Rutherford expt. as Mapping out Mass (charge) distribution of atom by probing w/ "bullets" and looking at ricochets



Could do same with car and rifle

bullets would not go "thru" car when hitting engine.