Radioactivity I.

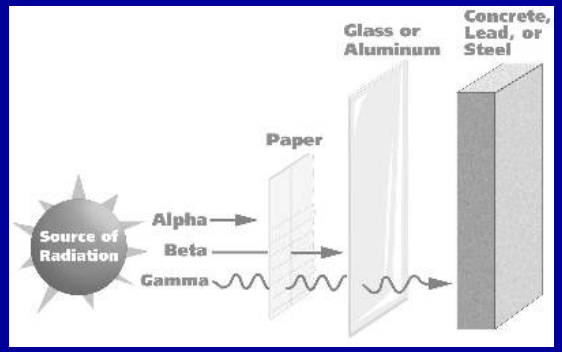
Henri Becquerel:
- darkened photographic film
- Nobel 1903

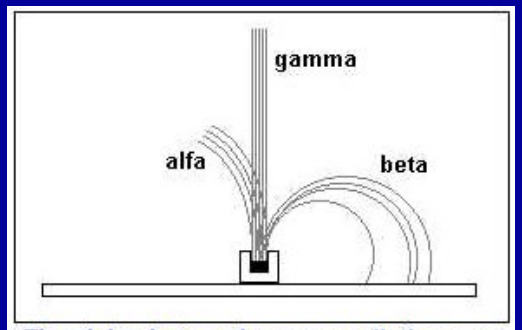

Bertha's hand. Röntgen X-rayed his wife's hand with ring. This picture caused a sensation. Led to over 1,100 publications about X-rays in the first year after Röntgen first announced it.

W.C. Roentgen:
- medical application
- Nobel 1901

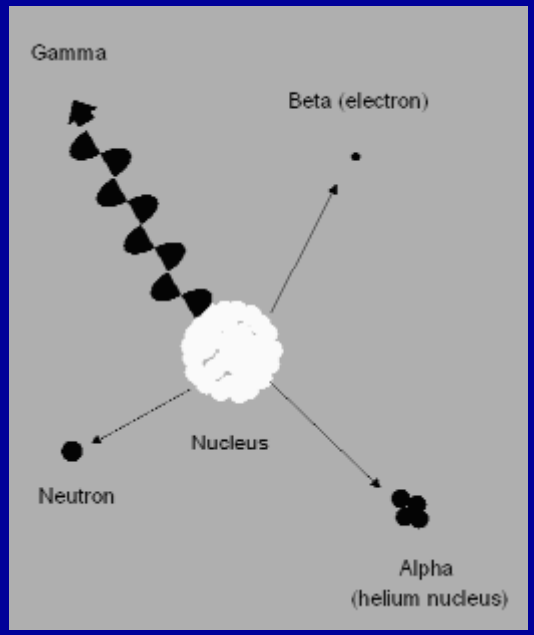
Marie Curie:
- discovered radium
- discovered polonium
- coined “radioactivity”
- Nobels 1903, 1911

Radioactivity II.





The alpha, beta and gamma radiation can be separated using the magnetic field. The alpha and beta particles have the contrary charges - they undergo aberration in the opposite directions; the gamma rays don't transfer any charge - they don't undergo aberration.



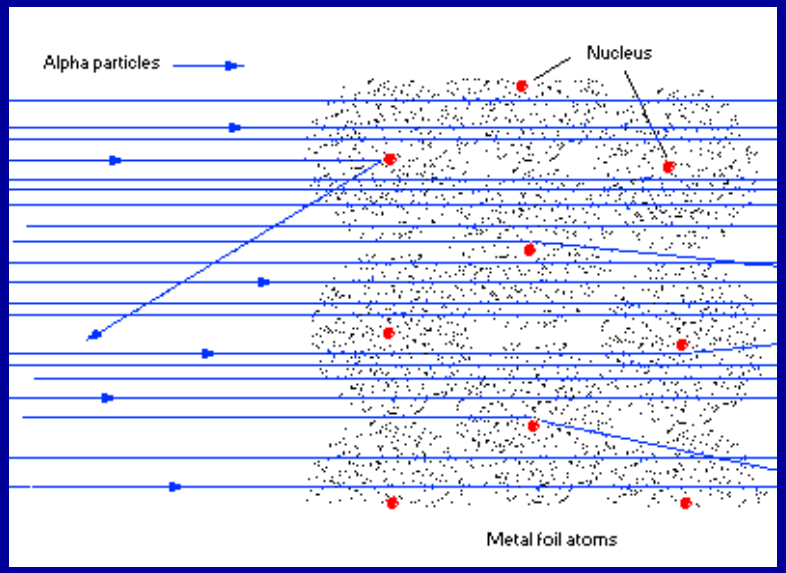
absorption

magnetic field

Some materials emit particles:

α – helium nucleus
β – electron
γ - photon

Atomic Nucleus

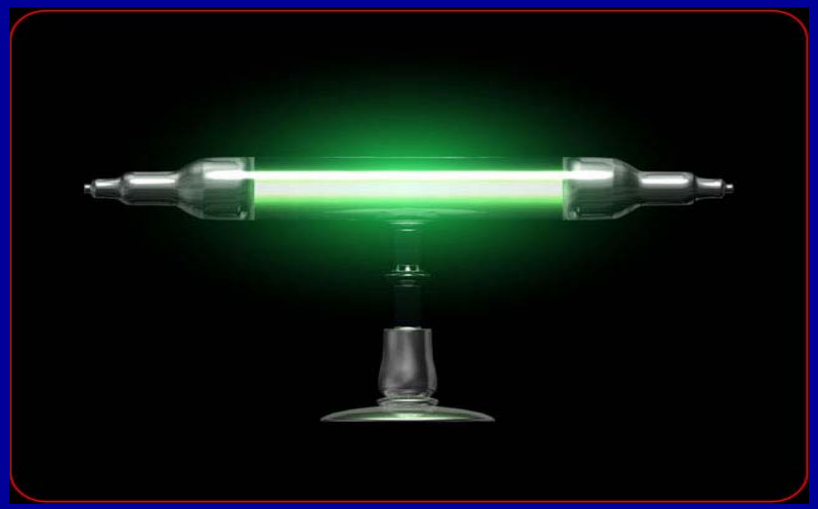


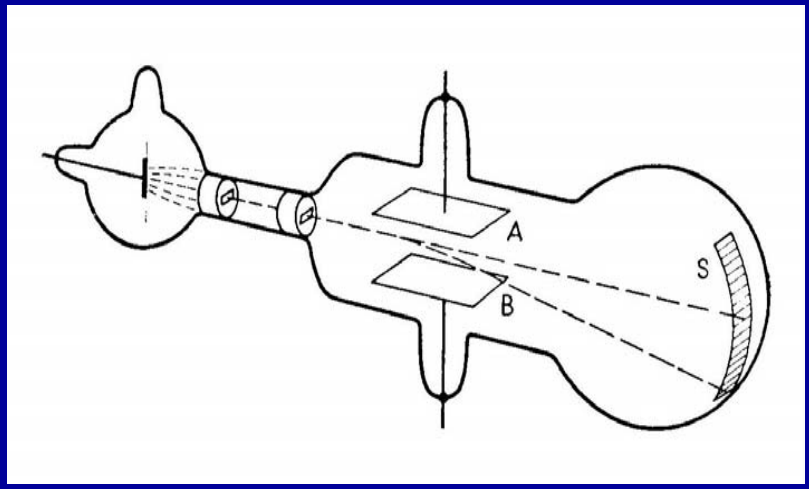
What is the structure of atoms?
Rutherford: scattering experiment (1911, Nobel 1908)

shoot tiny particles at a gold foil: - most particles travel through undeflected
- a few scatter strongly

Most of matter is empty space!
Mass is concentrated in very small regions: in a “nucleus” of the atom

But Atoms are Neutral





J.J. Thomson (1897):

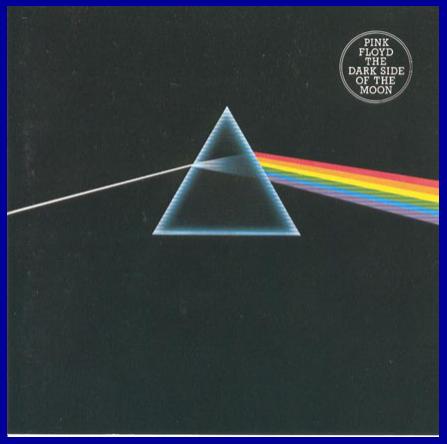
- particles emitted from hot electrodes

Nobel 1906

- electric field: charge is negative

- magnetic field: charge/mass ratio

Atoms = Nucleus + Electrons

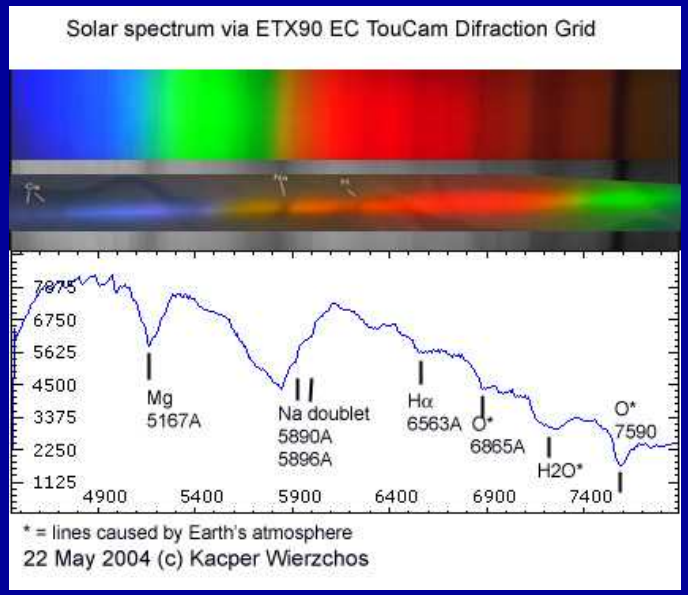


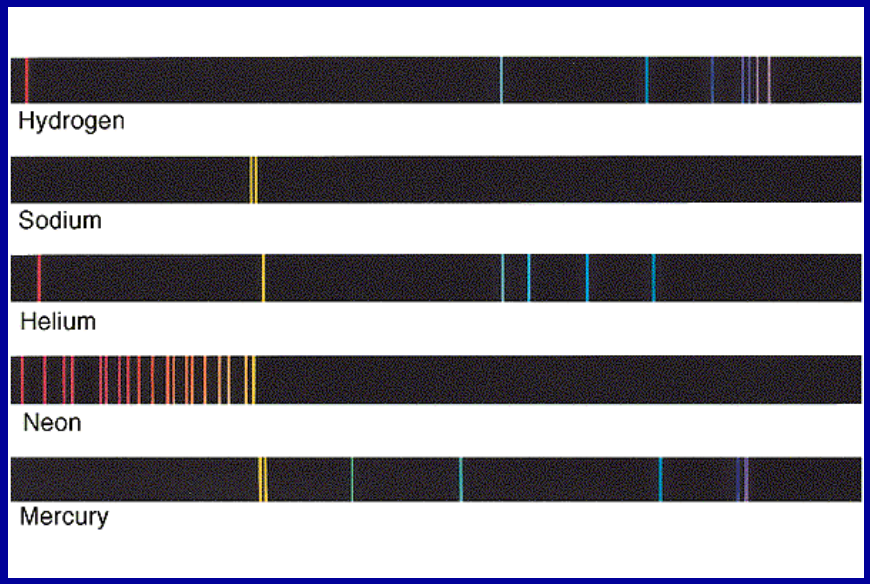
Atoms = positive nucleus + negative electrons

More info from tube experiments:

- suck out air
- fill it up with various gases
- pull spark across
- detect light coming out
- analyze spectrum: “color components”

Spectra





Solar spectrum:

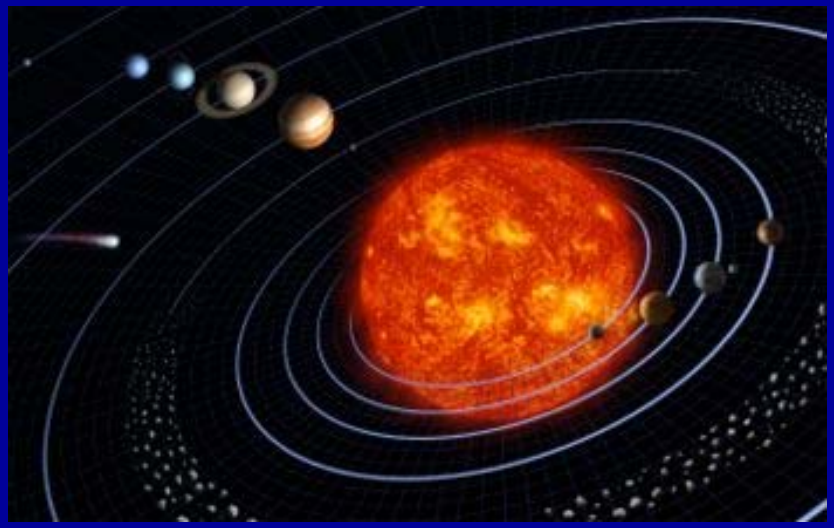
- continuous
- some lines reduced/missing

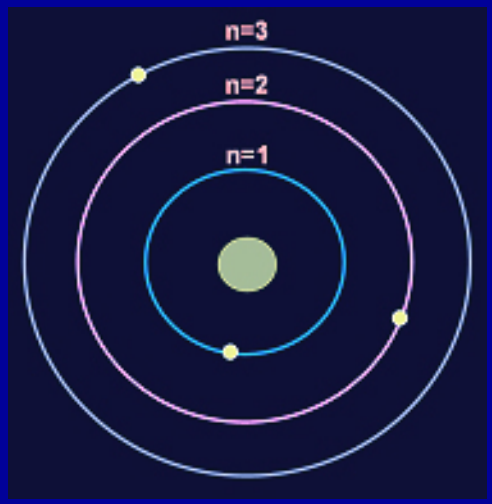
Spectrum of elemental gases:

- discrete: lines
- solar missing lines: absorbed by elements
- Balmer, Lyman series for hydrogen:

$$f = const.(\frac{1}{m^2} - \frac{1}{n^2})$$

Electron Orbits: Mini Solar System





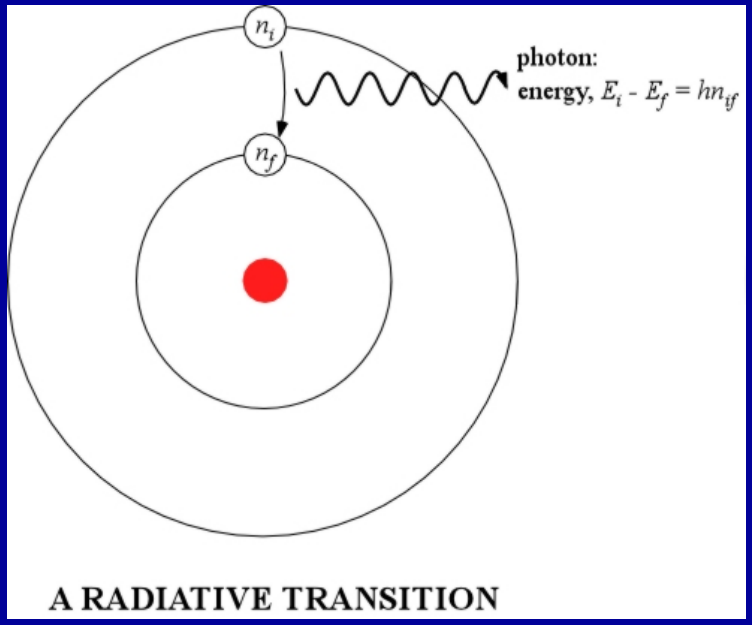
Solar system:

- held together by gravitational attraction

Bohr atom (1913, Nobel 1922):

- held together by electric attraction
- light emitted during transitions
- orbits discrete

The Bohr Model: Transitions

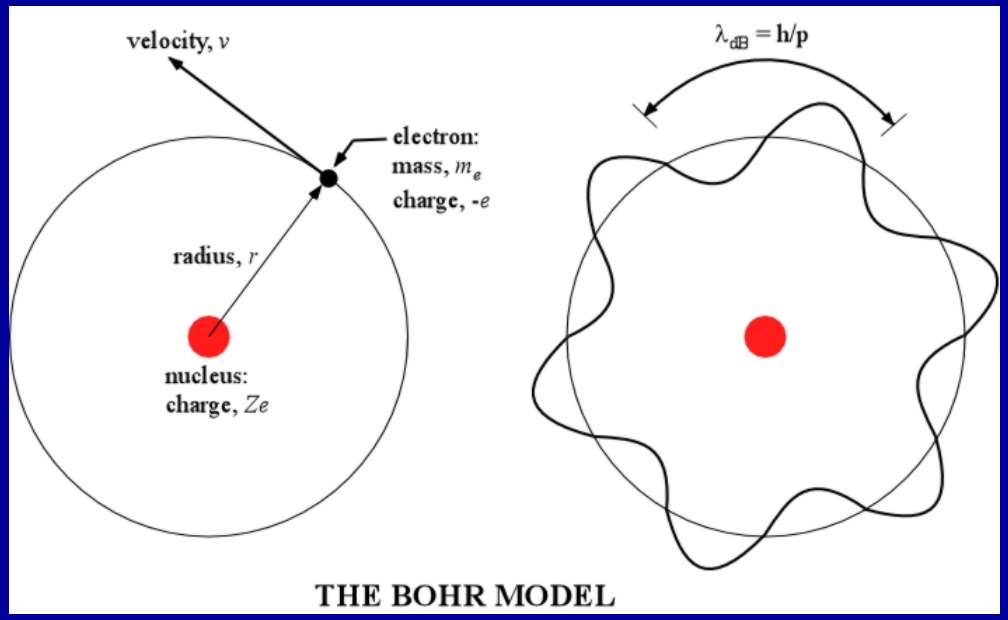


A RADIATIVE TRANSITION

$$E(n) = -\frac{const.}{n^2}$$

$$hf_{tr} = E(n) - E(m) = const.(\frac{1}{m^2} - \frac{1}{n^2})$$

The Bohr Model: Quantization



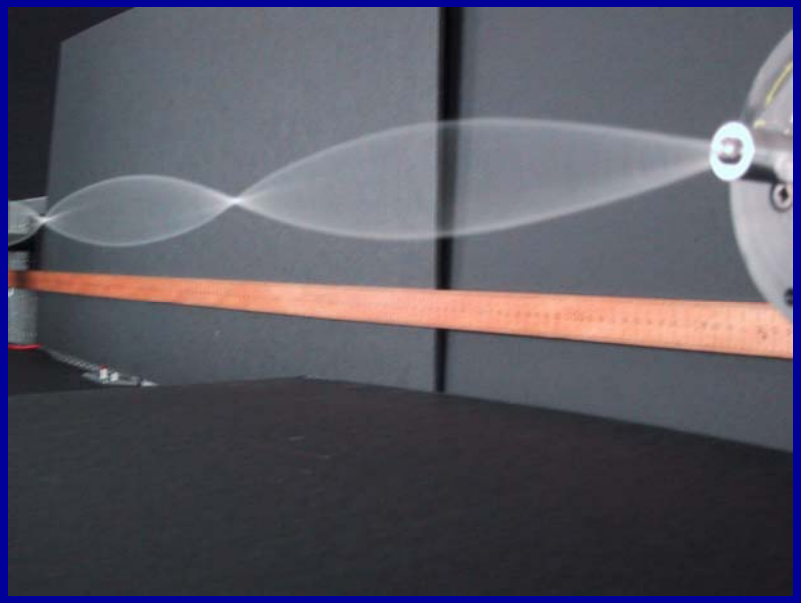
THE BOHR MODEL

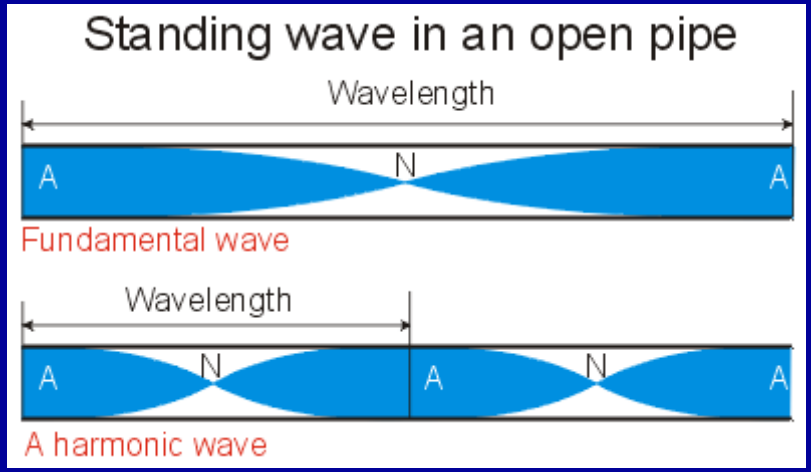
Planck (1900):
light is quantized into photons

Bohr (1913):
electron orbits are quantized

De Broglie (1924):
because an integer number of wavelength has to fit on orbit

Standing Waves





Quiz

Consider the two slit experiment with waves (e.g. in water).

1. Show the derivation of the interference term in the intensity of the wave.

2. What are the consequences of this interference term?