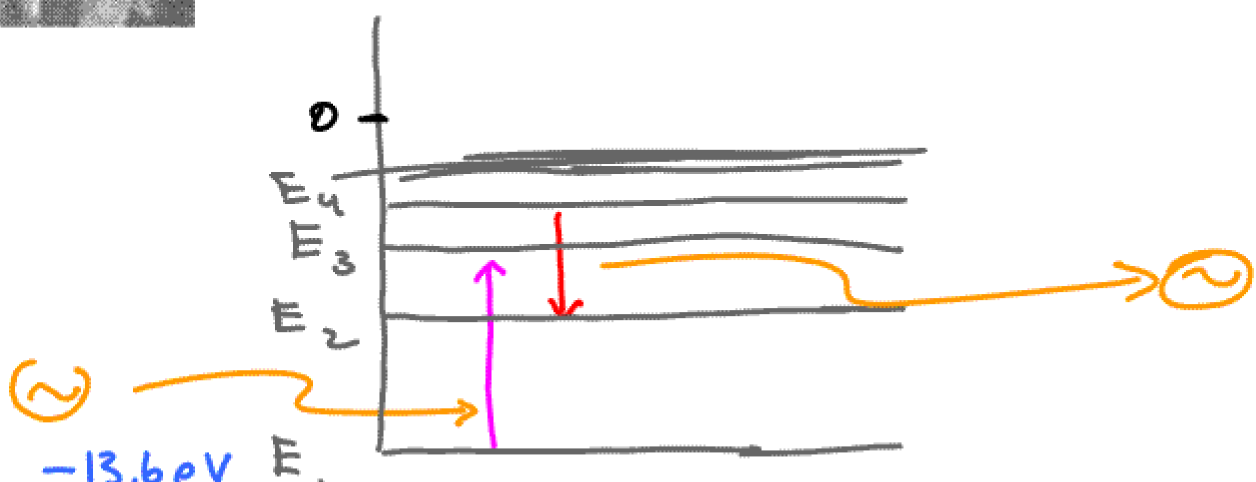
P114 - April 27, 2006

Last Time -

Bohr Atom - Semi-classical

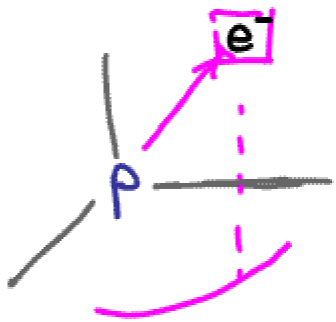
Coulomb
+
Circular Motion
+
quantization of
Angular Momentum



QM treatment of H atom

wave mechanics

Spherical Symmetry



Energy or principal quantum number

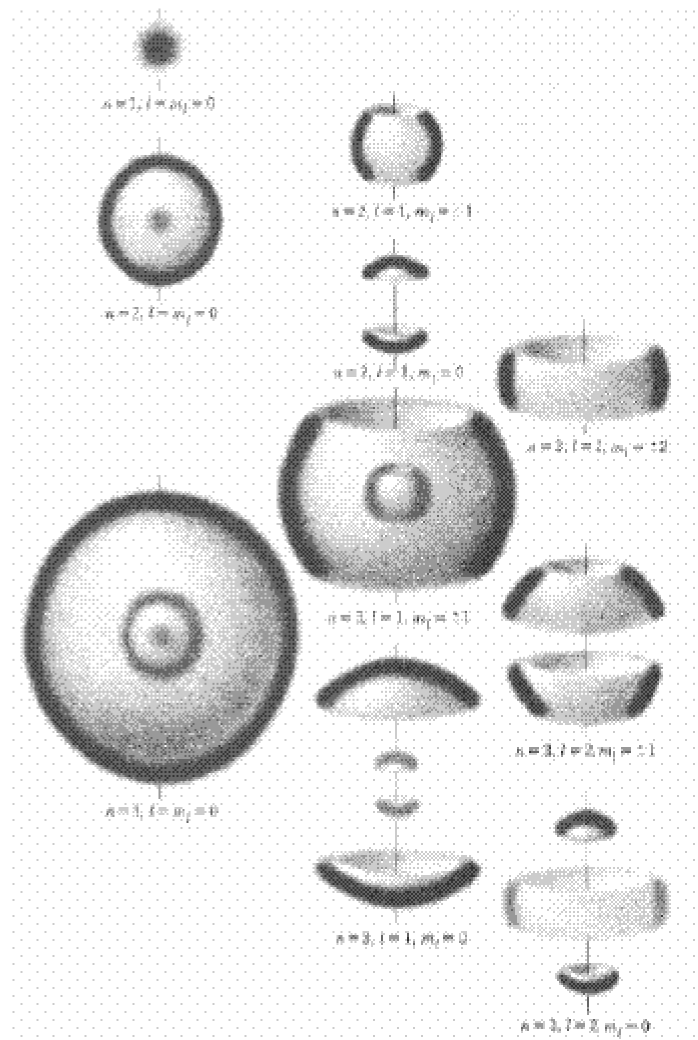
$n = 1, 2, 3 \ldots$

Orbital quantum number

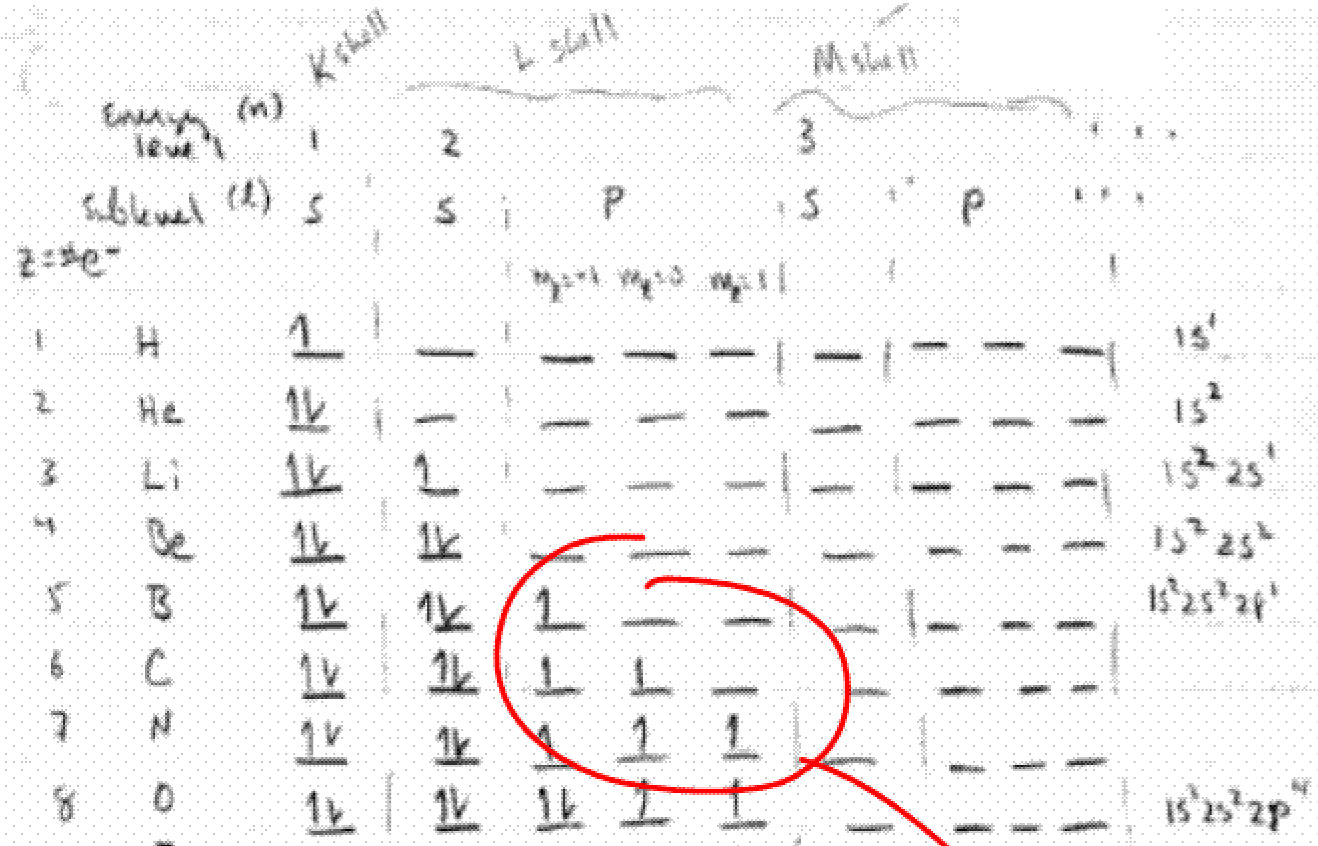
$l = 0, 1, \ldots n-1$

Magnetic quantum number

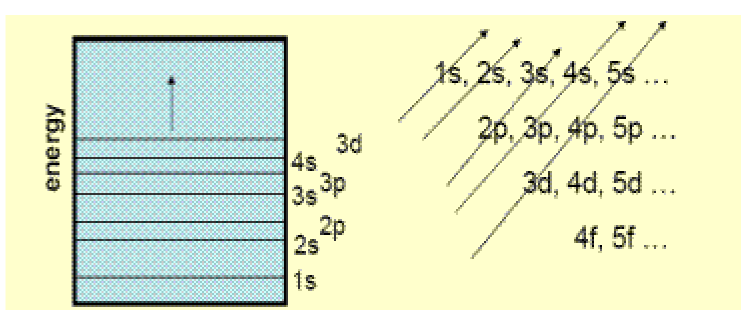
$-l, -|l-1|, \ldots, 0, 1, \ldots l-1, l$



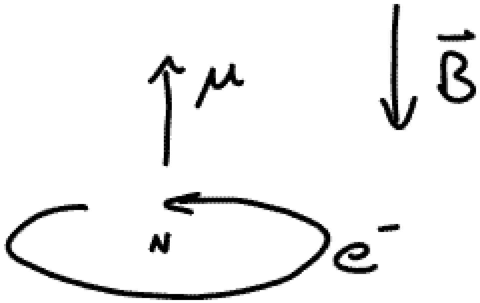
multi-electron Atoms



Aufbau



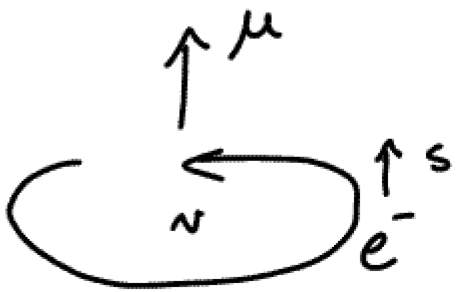
Hund's rule
fermion symmetrization
plus coulomb



Zeeman Effect

magnetic moment of e^-
in external field

⇒ Split spectral lines



Spin-orbit coupling

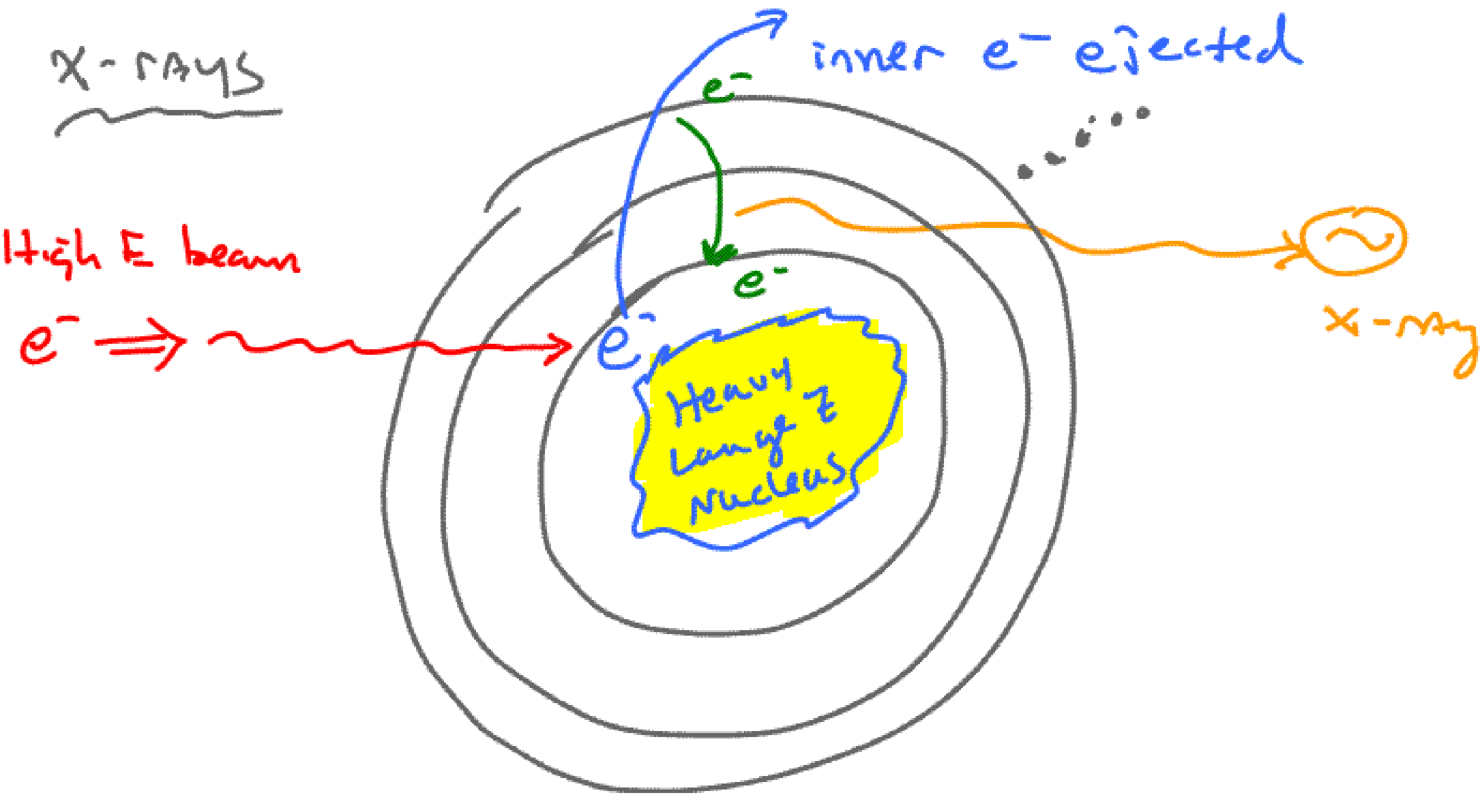
e^- energy depends on
orientation of spin
w/ respect to orbital
magnetic moment
(or Angular Momentum)

⇒ Fine Structure

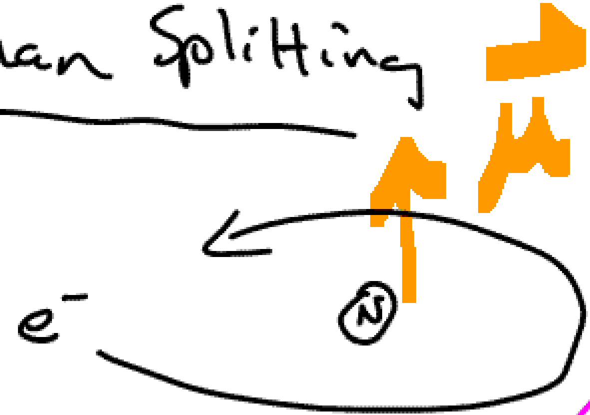
Hyperfine Splitting

Interaction between orbital magnetic moment of e^- and spin magnetic moment of nucleus

X-rays



Zeeman Splitting

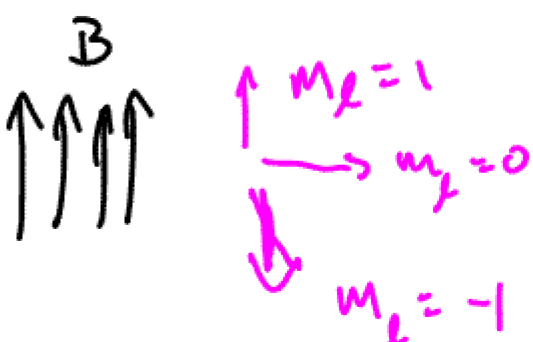


Bohr Magneton

$$\vec{\mu} = \frac{\mu_b}{\hbar}\vec{L} = \left(\frac{e}{2m}\right)\vec{L}$$

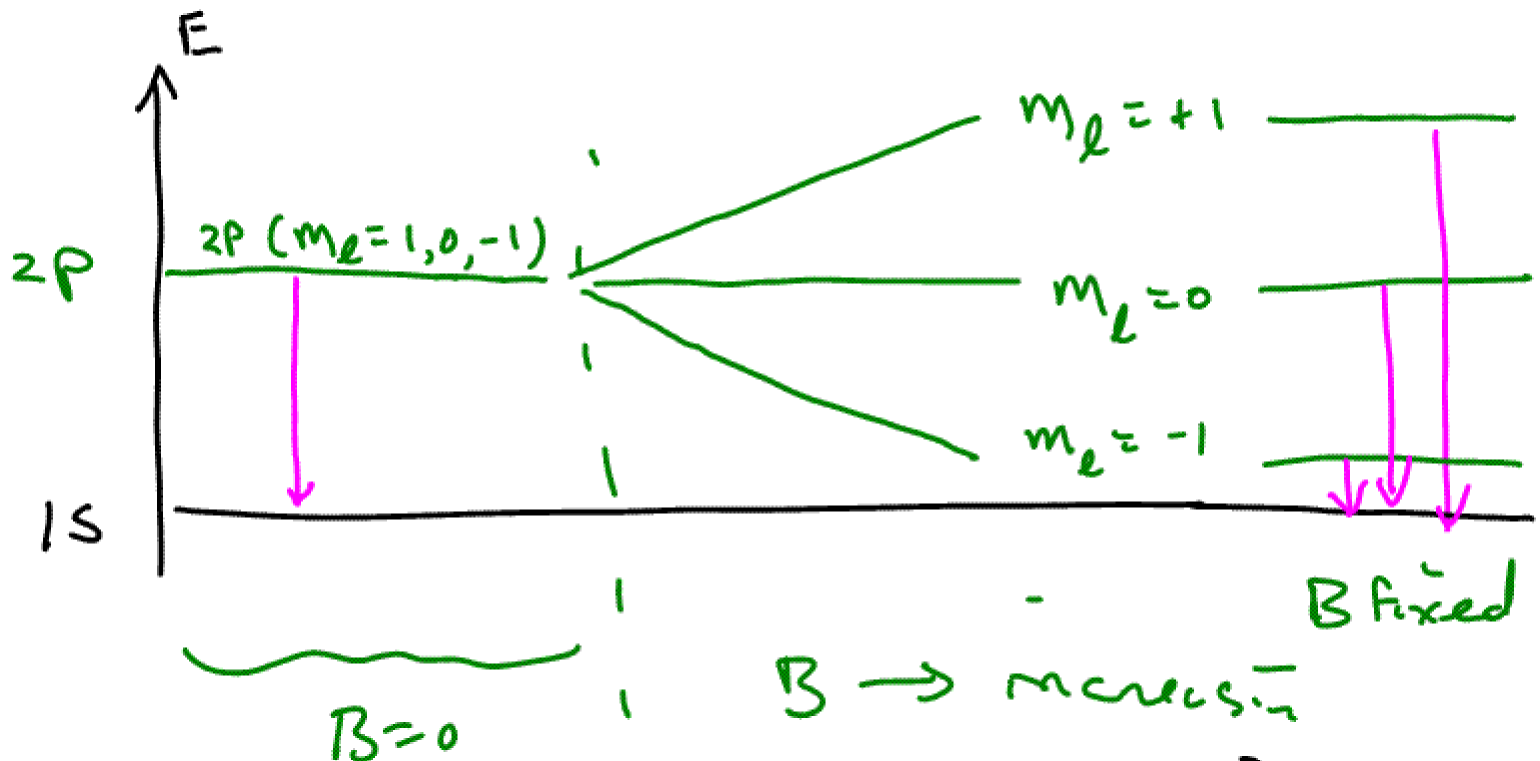
2p state $\rightarrow$ $\ell = 1$ $m_\ell = +1, 0, -1$

Let $\vec{B}$ define z axis $\Delta x \Delta p \sim \hbar$



$$V = -\vec{\mu}\cdot\vec{B}$$

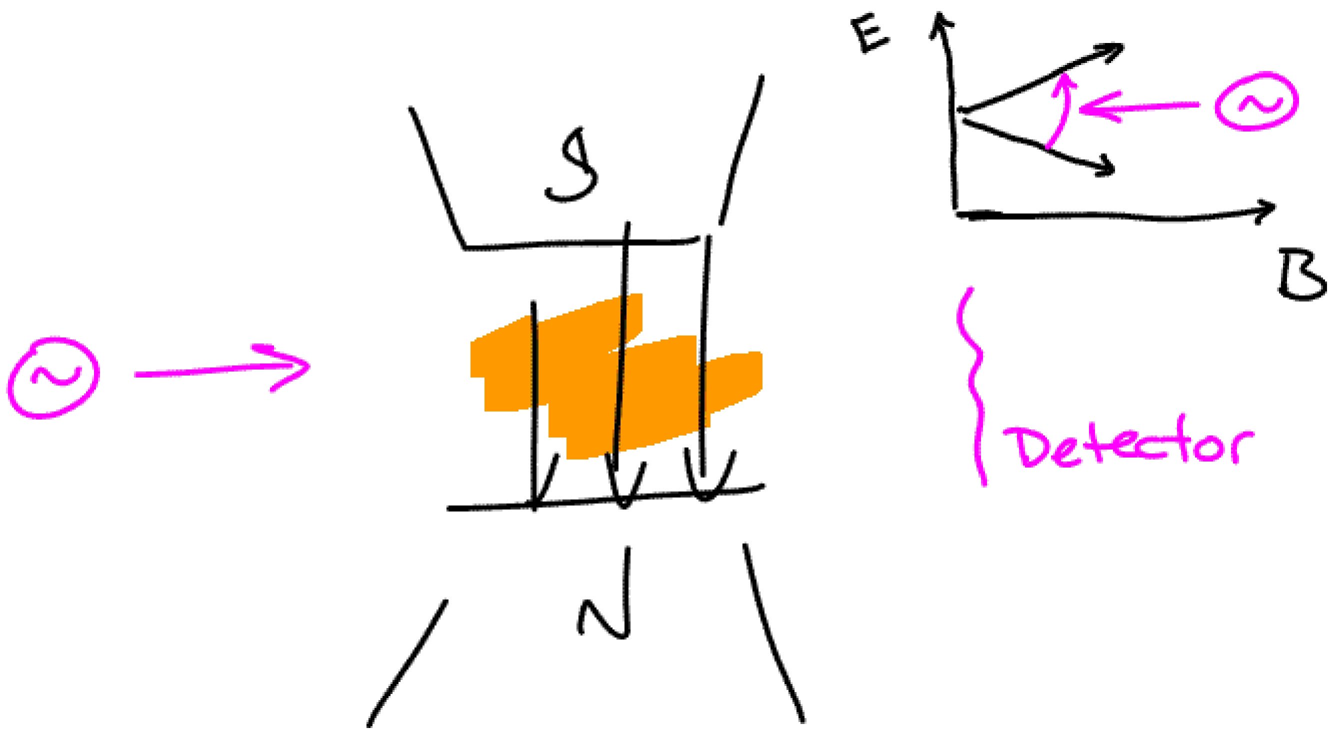
$$V \sim \frac{e}{2m}\vec{L}\cdot\vec{B} = \mu_b m_l B$$

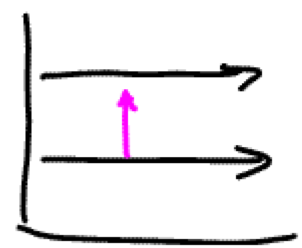


$$\Delta\lambda = \frac{hc}{\mu_b B}$$

Electron Spin Resonance ESR

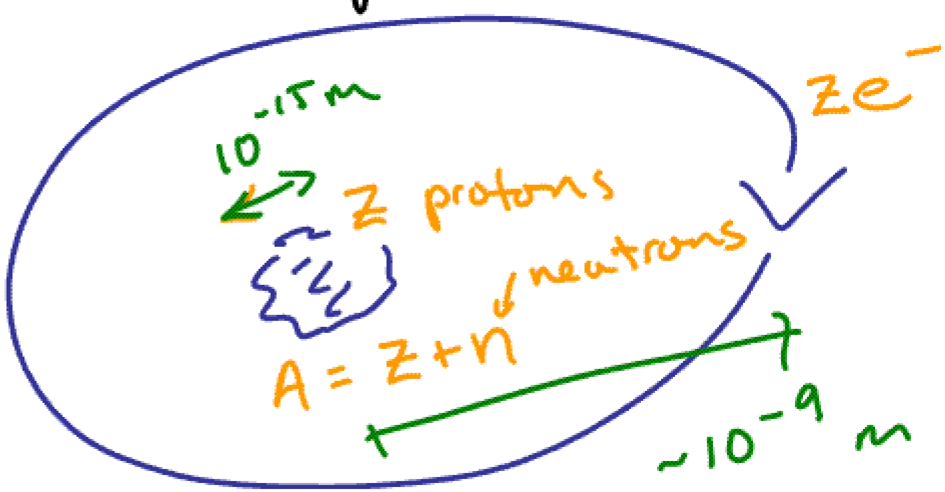
Nuclear Magnetic Resonance NMR



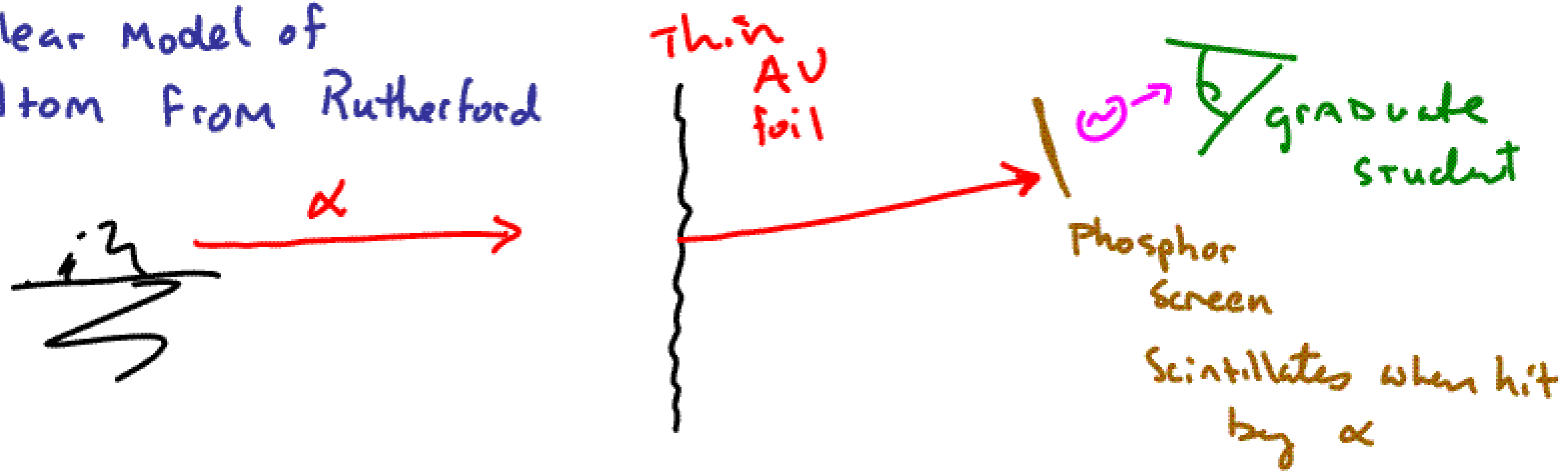


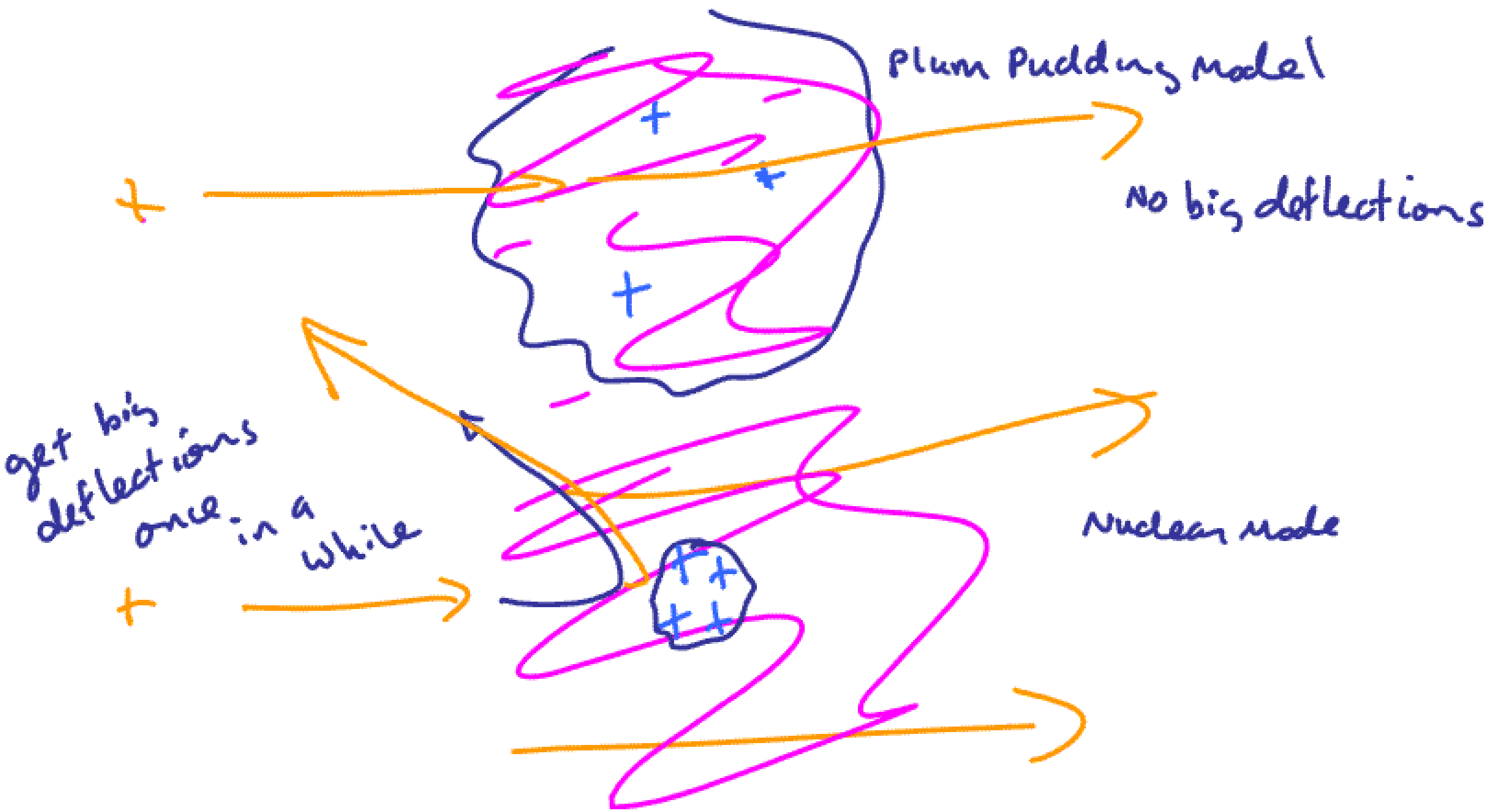
Nuclear Physics

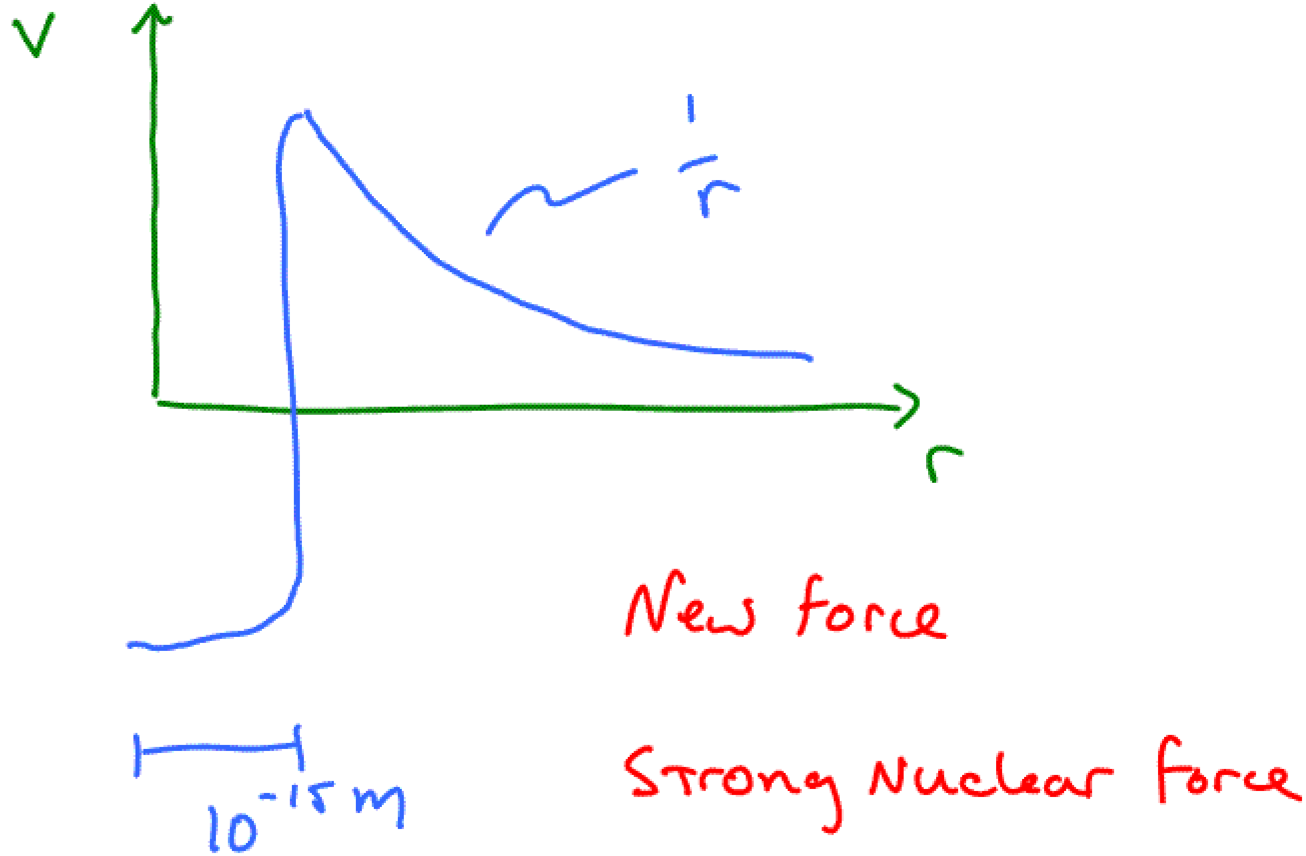
Nuclear Model of Atom



Nuclear Model of Atom from Rutherford







Nuclear radius ~ 1 – 10 Fermi (10^{-15} m)

Nuclear density is constant

$$\frac{A}{\frac{4}{3}\pi R^3} \sim \text{const.} \qquad A \sim R^3$$

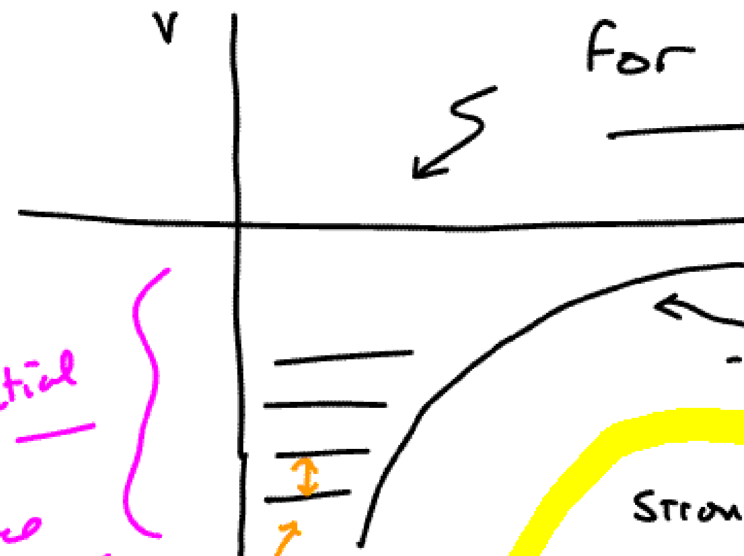
$$R \sim A^{1/3}$$

$\rho \sim 10^{17}\ kg/m^3$

At this density

$M_{earth} \rightarrow$ ball 140 m in radius

For H ATOM



$-\frac{1}{r}$ ~ coulomb potential

negative potential well

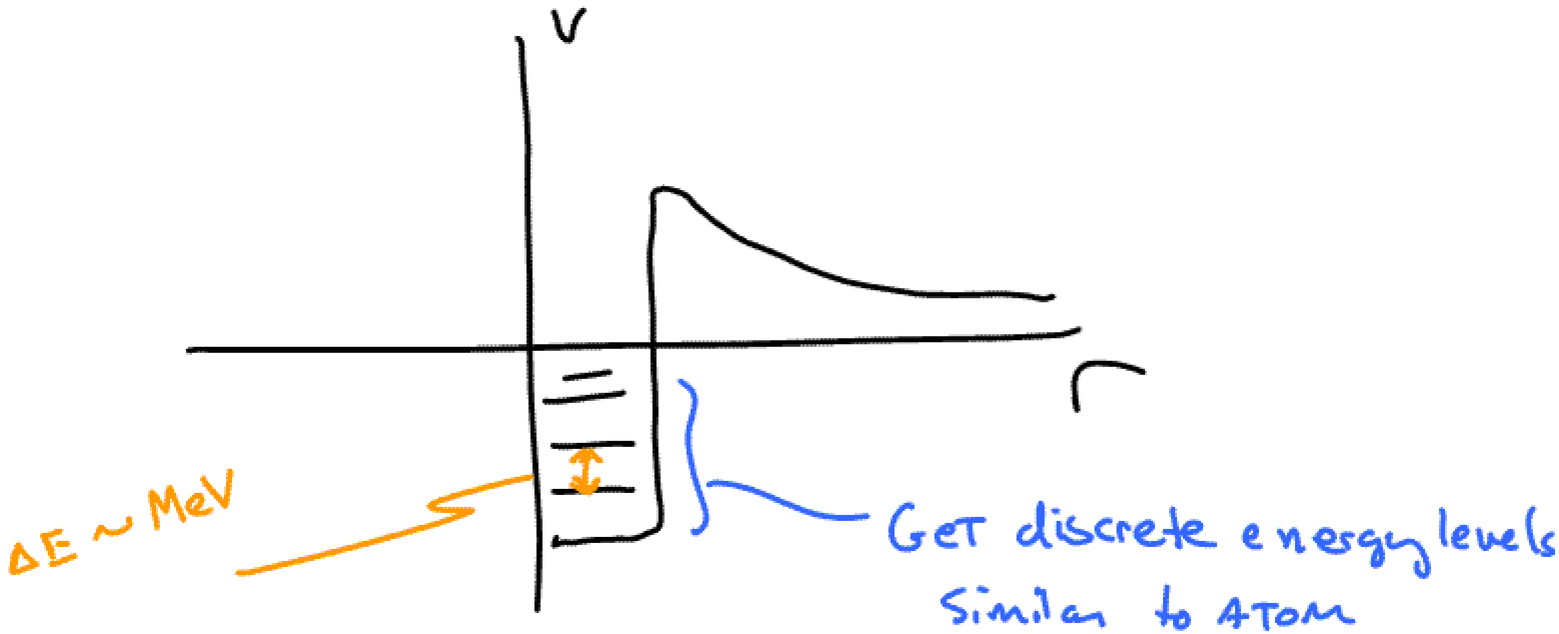
Because force is ATTRACTIVE

$\Delta E \sim 10\ eV$

Strong Nuclear interaction

potential is

ATTRACTIVE too



p, n spin 1/2

fill shells w/ protons + neutrons in much the same way we fill atomic shells