# Atomic Physics

Gas $\longrightarrow$ Has radiation

dielectric strength
↳ max electric field it can withstand before it breaks down
↳ starts conducting electricity

If a gas is subject to an electric field higher than its dielectric strength, then there will be radiation
↳ line spectrum


Line spectrum

Each gas has unique line spectrum

Balmer Series → mainly for hydrogen atom

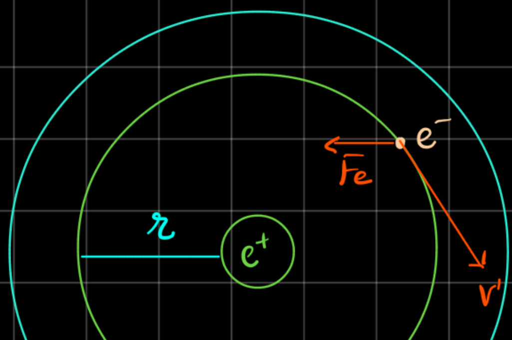
$$\frac{1}{\lambda} = R_H \left[ \frac{1}{2^2} - \frac{1}{n^2} \right]$$

↳ integer where $n \geq 3$

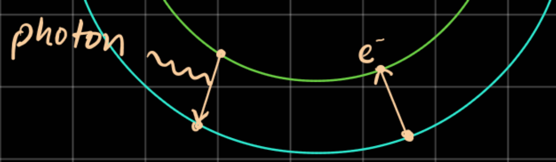
$R_H = 1.09 \times 10^{-7} \ m^{-1}$

Bohr's Model of Hydrogen

$$F_e = \frac{k_e e^2}{r^2} = m_e a = m_e \frac{v^2}{r}$$



$$v = \sqrt{\frac{k_e e^2}{m_e r}}$$




Electron is in a stationary orbit if atom does not lose any energy

High energy state $\xrightarrow{\text{electron}}$ lower energy state

↳ loss of energy appears as radiation

In case of opposite, energy is absorbed

$$E_i - E_f = hf$$

$E_i$ ↓ Energy of initial orbit

$E_f$ ↳ Energy of final orbit

$$r = n^2 a_0 \qquad n \geq 1$$

$n$ → orbit number

$n$ ↳ integer

$a_0$ ↳ 0.0529 nm

$r$ ↓ radius of orbit

$r = a_0,\ 4a_0,\ 9a_0,\ 16a_0,\ \ldots$

$$E_n = \frac{-13.606}{n^2}\ \text{eV} \qquad n = 1, 2, 3, \ldots$$

$$f = \frac{E_i - E_f}{h}$$

$$\lambda = \frac{c}{f}$$

$$\frac{1}{\lambda} = R_H \left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

# Other Atoms

$C \rightarrow 6$ electrons

$r = n^2 a_0 \Rightarrow$ Hydrogen

$r = \frac{n^2 a_0}{Z} \Rightarrow$ atomic number

$\rightarrow$ all other atoms

$$E_n = \frac{-13.606}{n^2} Z^2$$

# Quantum Numbers

Every electron has 4 unique quantum numbers

shell 1) $n \rightarrow$ principal quantum number $1, 2, 3, 4, ----$

sub shell 2) $l \rightarrow$ orbital quantum number $0, 1, 2, ---, n-1$

3) $m_l \rightarrow$ magnetic orbital quantum number $[-l, l]$

4) $m_s \rightarrow$ spin number $-1/2, 1/2$

$n = 3$ (18 total electrons)

$l = \quad 0 \qquad 1 \qquad 2$

$m_l = \quad 0 \qquad -1, 0, 1 \qquad -2, -1, 0, 1, -2$

$m_s = \quad \frac{1}{2} \;\; -\frac{1}{2} \qquad \frac{1}{2} \;\; -\frac{1}{2} \quad - - - - - - -$

number of electrons $= 2n^2$

$l \Rightarrow L = \sqrt{l(l+1)}\,\hbar$

$\downarrow = m_e v r$

angular momentum

$\hookrightarrow \hbar = \frac{h}{2\pi} \Rightarrow$ Planck's constant

$m_\ell \Rightarrow L_z = m_\ell \hbar \quad \Longrightarrow \quad \cos\theta = \frac{L_z}{L} = \frac{m_\ell}{\sqrt{\ell(\ell+1)}}$

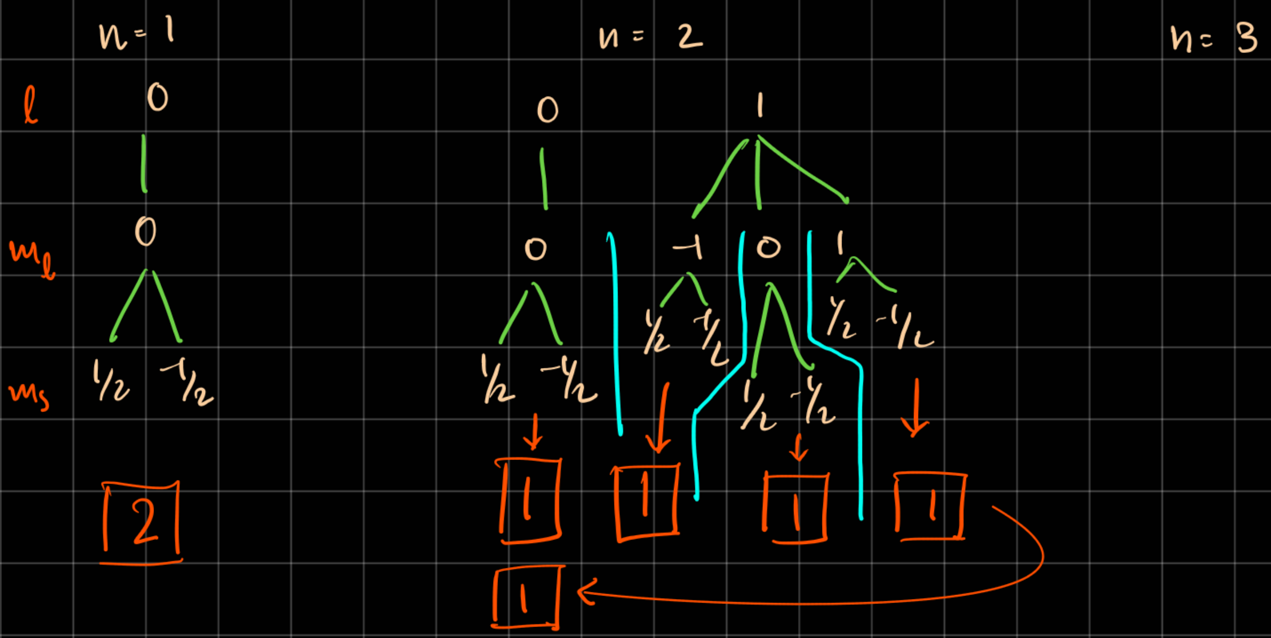
↳ z component of $\ell$

$m_s \Rightarrow S = \sqrt{m_s(m_s+1)}\ \hbar = \frac{\sqrt{3}}{2}\hbar \quad \Longrightarrow \quad S_z = m_s\hbar = \pm\frac{1}{2}\hbar$

↓ Spin angular momentum

↳ z component of S

## Nitrogen Atom




## Hund's Principle

Minimize elections which have same $n\ \ell\ m_\ell$