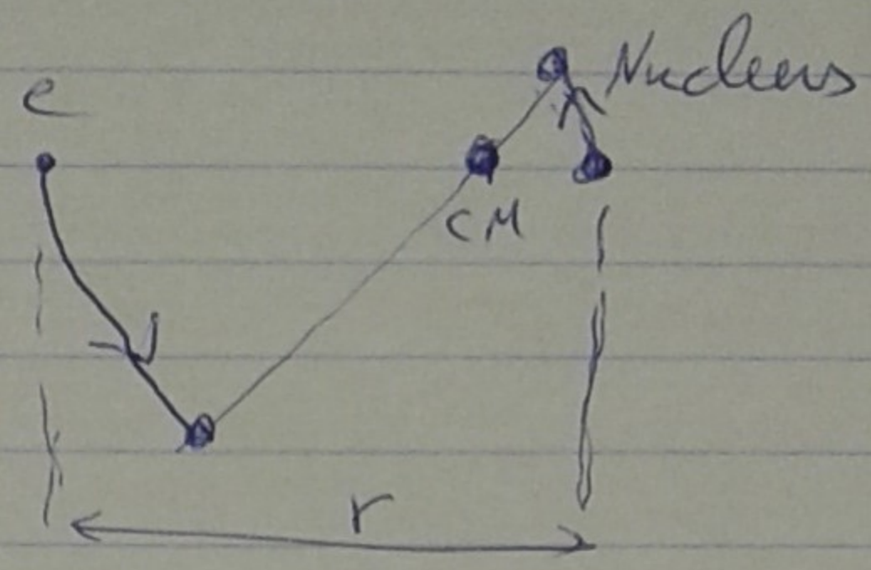
Ch. 4

Problem 32 : The nucleus also moves
The nucleus & electron rotate about CM



replace

m_e by $\mu = \left(\frac{M}{m_e + M}\right) m_e$

reduced mass

for H atom $E_n \propto m_e$ $\quad E_n = \left(\frac{M}{m_e + M}\right) \frac{-13.6\,eV}{n^2}$

$E_n \propto \frac{1}{a_0}$ $\quad a_0 \propto \frac{1}{m_e}$

M = mass of the proton $= 1.007825\,u = 938.78 \frac{MeV}{c^2}$

for deuterium : Nucleus = proton + neutron

$M_d = 1876.12\ MeV/c^2$ ← Masses from Appendix B

for Tritium : Nucleus = 1p + 2n

$M_t = 2809.431\ MeV/c^2$ $\quad \lambda = \left(\frac{m_e + M}{M}\right) \lambda_0$

using m_e $\quad \lambda_0 (n=3 \longrightarrow n=2) = 656\ nm$

using μ $\quad \lambda (n=3 \longrightarrow n=2) = 656.357\ nm$ for H

This is how deuterium was discovered (193) from the shift in λ

$\Delta\lambda = 0.18\ nm = 1.8\ \text{Å}$ (can be measured)

$= 656.178\ nm$ for Deuterium

$= 656.119\ nm$ for Tritium

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