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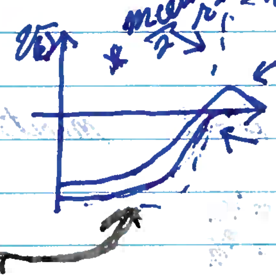
Nucleons ← potential energy for two nucleons at distance r

$V \sim \frac{1}{r} e^{-\alpha r}$ $r \to \infty$ at large distances



$$H = \frac{p^2}{2m} + V(r) \qquad p = \frac{\hbar}{i}\frac{\partial}{\partial r}$$

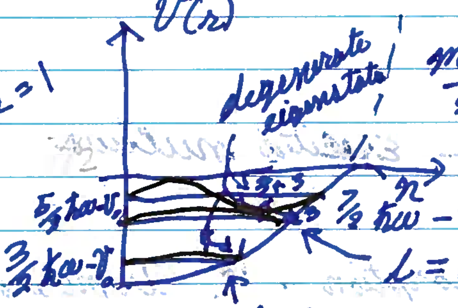
$$H\psi(r, \theta, \varphi) = \mathcal{E}\,\psi(r, \theta, \varphi)$$

$$\psi(r, \theta, \varphi) = R(r)\, Y_{lm}(\theta, \varphi)$$ → Eigenstate to L^2, L_z

OR

$$\psi(\vec{r}) = \varphi_i(x)\,\varphi_j(y)\,\varphi_k(z)$$ ← 1D harmonic oscillator eigenstate

$$\mathcal{E}_{ijk} = \left(i + j + k + \tfrac{3}{2}\right)\hbar\omega - V_0$$



$\frac{7}{2}\hbar\omega - V_0$ ← second excited state: $l=0, m=0$ and $l=2, m=-2,-1,0,1,2$

$l=1, m=-1,0,1$ first excited state

$l=0, m=0$ lowest energy

Atomic Physics:

$n=1$	$l=0$	lowest state
$n=2$	$l=0,1$	
$n=3$	$l=0,1,2$	

Nuclear Physics:

$n=1$	$l=0$	lowest state
$n=1$	$l=1$	
$n=1$	$l=2$	$n=2$ $l=0$ (same energy level)
$n=1$	$l=3$	$n=2$ $l=1$
	⋮	

nucleus (possible # of nucleons in nucleus)

~~# of~~ protons   ~~# of~~ neutrons $n=1, l=0$ lowest energy level
up to 2 protons + 2 neutrons → ^4He

$n=1, l=1$ next energy level
Li   + up to 6 p, 6 n → ^{16}O

BUT   S↑↓L   S ∥ L   } $n=1, l=1$ $j=\frac{1}{2}$, $j=\frac{3}{2}$ > split between antiparallel s, l ($j=\frac{1}{2}$) and parallel s, l ($j=\frac{3}{2}$)

^{12}C another quantum number
j = total angular momentum

LS coupling (spin; angular momentum) (related to binding Energies) $= l+s$

→ Magic numbers: 2, 8, 20, 28, 50, 82, 126

See Nuclear level scheme graph

lead - heaviest stable nucleus possible : 82 p, 126 n

Decays

C^{12} ← Excited nucleus

absorption - ^{12}C bombarded with gamma ray - $^{12}C^*$

spontaneous emission - ^{12}C emits a gamma ray

See graph Evidence for excited states
^{232}Th decay by α decay to ^{228}Ra which inturn gives off γ ~~decay~~ emission

excited state $\longrightarrow$ γ emission

~~fission~~

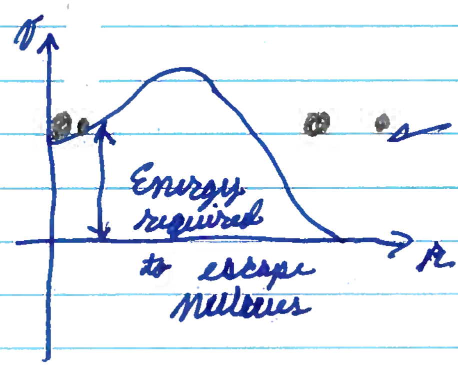
$^{4}_{2}He = \alpha$ particle

α decay

fission

α – decay!

Tunneling



in Quantum mechanics there exists a probablity particle can be found outside nucleus

τ = life time

N = number of Nucleons

$$\frac{dN}{dt} = \frac{1}{\tau} N$$

$$N(t) = N_0 e^{-t/\tau}$$