

3. SINAVLA İLGİLİ SABİT VE FORMÜLLER

$$\begin{array}{lll}
 1\text{mW} = 10^{-3}\text{W} = 10^{-3} \text{ J s}^{-1} & 1\text{nm} = 10^{-9}\text{m} & 1\text{eV} = 1.602 \times 10^{-19} \text{ J} \\
 h = 6.63 \times 10^{-34} \text{ J s} & \hbar = 1.05 \times 10^{-34} \text{ J s} & c = 3.0 \times 10^8 \text{ m s}^{-1} \\
 hc = 2.0 \times 10^{-25} \text{ J m} & m_e = 9.11 \times 10^{-31} \text{ kg} & e = 1.602 \times 10^{-19} \text{ C} \\
 \lambda\nu = c & \varepsilon_0 = 8.854 \times 10^{-12} \text{ Cs}^2\text{kg}^{-1}\text{m}^{-3} & E = h\nu \quad \lambda = h/p \\
 l_n = mrv = n\hbar & r_n = n^2 a_0 & a_0 = 5.29 \times 10^{-11} \text{ m}
 \end{array}$$

Bir kutudaki parçacık

$$E_n = \frac{n^2 h^2}{8ma^2} = \frac{n^2 \hbar^2 \pi^2}{2ma^2} \quad E_n = \frac{n^2 \hbar^2}{8ma^2} = \frac{n^2 \hbar^2 \pi^2}{2ma^2} \quad \psi_n(0 \leq x \leq a) = \left(\frac{2}{a}\right)^{1/2} \sin\left(\frac{n\pi x}{a}\right)$$

Harmonik Osilatör

$$E_n = \left(n + \frac{1}{2}\right) h\nu = \left(n + \frac{1}{2}\right) \hbar\omega \quad \alpha = \frac{\sqrt{km}}{\hbar} = \frac{m\omega}{\hbar}, \quad \tilde{\nu} = \frac{1}{2\pi c} \left(\frac{k}{\mu}\right)^{1/2}, \quad V = \frac{1}{2} m\omega^2 x^2$$

$$\int_{-\infty}^{\infty} e^{-\alpha x^2} dx = \sqrt{\frac{\pi}{\alpha}} \quad \int_{-\infty}^{\infty} x^2 e^{-\alpha x^2} dx = \sqrt{\frac{\pi}{\alpha}} \frac{1}{2\alpha} \quad \int_{-\infty}^{\infty} x^{2n} e^{-\alpha x^2} dx = 2 \frac{1 \cdot 3 \cdot 5 \cdots (2n-1)}{2^{n+1} \alpha^n} \sqrt{\frac{\pi}{\alpha}}$$

$$\psi_0(x) = \left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2/2} \quad \psi_1(x) = \frac{1}{\sqrt{2}} \left(\frac{\alpha}{\pi}\right)^{1/4} (2\alpha^{1/2} x) e^{-\alpha x^2/2}$$

$$\psi_2(x) = \frac{1}{\sqrt{8}} \left(\frac{\alpha}{\pi}\right)^{1/4} (4\alpha x^2 - 2) e^{-\alpha x^2/2} \quad \psi_3(x) = \frac{1}{\sqrt{48}} \left(\frac{\alpha}{\pi}\right)^{1/4} (8\alpha^{3/2} x^3 - 12\alpha^{1/2} x) e^{-\alpha x^2/2}$$

Artırma ve azaltma operatörleri

$$a_{\pm} \equiv \frac{1}{\sqrt{2\hbar m\omega}} (mp + m\omega x)$$

$$\hat{x} = \left(\frac{\hbar}{2m\omega}\right)^{1/2} (a_+ + a_-) \quad \hat{p} = i \left(\frac{\hbar m\omega}{2}\right)^{1/2} (a_+ - a_-)$$

Normalizasyon sabitleri

$$\hat{a}^+ |\psi_n\rangle = \hat{a}^+ |n\rangle = \sqrt{n+1} |\psi_{n+1}\rangle = \sqrt{n+1} |n+1\rangle$$

$$\hat{a}^- |\psi_n\rangle = \hat{a}^- |n\rangle = \sqrt{n} |\psi_{n-1}\rangle = \sqrt{n} |n-1\rangle$$

Rijit Rotor

$$Y_0^0 = \frac{1}{(4\pi)^{1/2}} \quad Y_1^0 = \left(\frac{3}{4\pi}\right)^{1/2} \cos \theta \quad Y_1^{\pm 1} = \left(\frac{3}{8\pi}\right)^{1/2} \sin \theta e^{\pm i\phi}$$

$$Y_2^0 = \left(\frac{5}{16\pi}\right)^{1/2} (3\cos^2 \theta - 1) \quad Y_2^{\pm 1} = \left(\frac{15}{8\pi}\right)^{1/2} \sin \theta \cos \theta e^{\pm i\phi} \quad Y_2^{\pm 2} = \left(\frac{15}{32\pi}\right)^{1/2} \sin^2 \theta e^{\pm 2i\phi}$$

$$E_J = \frac{\hbar^2}{2I} J(J+1) \quad B \equiv \frac{h}{8\pi^2 I} \quad (\text{Hz}) \quad \bar{B} \equiv \frac{h}{8\pi^2 c I} \quad (\text{cm}^{-1})$$

Hidrojen Atomu

Küresel koordinatlarda üç boyutlu operatörler

$$\hat{H}(r, \theta, \phi) = -\frac{\hbar^2}{2\mu} \left[\frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial}{\partial r} \right) + \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2}{\partial \phi^2} \right] + V(r, \theta, \phi)$$

$$\hat{L} = -\hbar^2 \left[\frac{1}{\sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{\sin^2 \theta} \frac{\partial^2}{\partial \phi^2} \right] \quad \hat{L}_z = -i\hbar \frac{\partial}{\partial \phi}$$

$$U = \frac{-Ze^2}{4\pi\epsilon_0 r}, \quad E_n = \frac{-Z^2 e^2}{8\pi\epsilon_0 a_0 n^2} = \frac{-Z^2}{2n^2} \quad (\text{atomik birim}) \quad n = 1, 2, 3, \dots, \quad a_0 = \frac{4\pi\epsilon_0 \hbar^2}{\mu e^2}$$

$$\int_0^\infty x^n e^{x/a} dx = n! a^{n+1}$$

H atomu uzaysal dalga fonksiyonları (Burada $\sigma = Zr / a_0$. Atomik birimde $a_0 = 1$ ve $\sigma = Zr$.)

$$\begin{aligned}
n=1 \quad l=0 \quad m=0 \quad \psi_{100} = \psi_{1s} &= \frac{1}{\sqrt{\pi}} \left(\frac{Z}{a_0} \right)^{3/2} e^{-\sigma} \\
n=2 \quad l=0 \quad m=0 \quad \psi_{200} = \psi_{2s} &= \frac{1}{\sqrt{32\pi}} \left(\frac{Z}{a_0} \right)^{3/2} (2-\sigma) e^{-\sigma/2} \\
l=1 \quad m=0 \quad \psi_{210} = \psi_{2p_z} &= \frac{1}{\sqrt{32\pi}} \left(\frac{Z}{a_0} \right)^{3/2} \sigma e^{-\sigma/2} \cos \theta \\
l=1 \quad m=\pm 1 \quad \psi_{21\pm 1} &= \frac{1}{\sqrt{64\pi}} \left(\frac{Z}{a_0} \right)^{3/2} \sigma e^{-\sigma/2} \sin \theta e^{\pm i\phi} \\
n=3 \quad l=0 \quad m=0 \quad \psi_{300} &= \frac{1}{81\sqrt{3\pi}} \left(\frac{Z}{a_0} \right)^{3/2} (27-18\sigma+2\sigma^2) e^{-\sigma/3} = \psi_{3s}
\end{aligned}$$

Bağımsız Elektron Modeli

$$\Psi(1,2,3,4..) = \begin{pmatrix} \psi_{k_1}(1) & \psi_{k_2}(1) & \dots & \psi_{k_n}(1) \\ \psi_{k_1}(2) & \psi_{k_2}(2) & & \dots \\ \dots & & \dots & \\ \psi_{k_1}(n) & \dots & & \psi_{k_n}(n) \end{pmatrix}$$

$$E = \sum_i \varepsilon_i + \sum_i \sum_{j<i} \tilde{J}_{ij} - \tilde{K}_{ij} \quad \text{burada} \quad \tilde{J}_{ij} = J_{ij} \quad \text{ve} \quad \tilde{K}_{ij} = \begin{cases} K_{ij} & S_i = S_j \text{ ise} \\ 0 & S_i \neq S_j \text{ ise} \end{cases}$$