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E21 050 P05

Interaction of the Heavy Particle with the Nucleus

$$H = \frac{1}{2M}p^2 + \left(\frac{1-\tau_3}{2}\right)V + \frac{(\tau_1+i\tau_2)}{2}J + \frac{(\tau_1-i\tau_2)}{2}K + \left(\frac{1-\tau_3}{2}\right)D$$

$$\tau_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \qquad \tau_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \qquad \tau_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$\frac{(\tau_1+i\tau_2)}{2}\begin{pmatrix} \psi_1 \\ \psi_2 \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}\begin{pmatrix} \psi_1 \\ \psi_2 \end{pmatrix} = \begin{pmatrix} \psi_2 \\ 0 \end{pmatrix}$$

$$\frac{1}{2M}p^2 = \frac{-\hbar^2}{2M}\Delta = \frac{-\hbar^2}{2M}\left\{\frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} - \frac{l(l+1)}{r^2}\right\}$$

$$\frac{2M}{\hbar^2}E = E', \qquad \frac{2M}{\hbar^2}V = V' \qquad \frac{2M}{\hbar^2}J = J'$$

$$\frac{2M}{\hbar^2}K = K' \qquad \frac{2M}{\hbar^2}D = D'$$

$$\left[\frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} - \frac{l(l+1)}{r^2} + \left\{E' - \frac{1-\tau_3}{2}(V'+D') - \frac{\tau_1+i\tau_2}{2}J' - \frac{\tau_1-i\tau_2}{2}K'\right\}\right]\psi_{l,m}(r,\tau_3) = 0$$

$$\psi_{l,m}(r,\tau_3) = \frac{\psi'}{r}$$

$$\left[\frac{d^2}{dr^2} - \frac{l(l+1)}{r^2} + \left\{E' - \frac{1-\tau_3}{2}(V'+D') - \frac{\tau_1+i\tau_2}{2}J' - \frac{\tau_1-i\tau_2}{2}K'\right\}\right]\psi' = 0.$$

$$\frac{d^2\psi_1'}{dr^2} - \frac{l(l+1)}{r^2}\psi_1' + E'\psi_1' - J'\psi_2' = 0$$

$$\frac{d^2\psi_2'}{dr^2} - \frac{l(l+1)}{r^2}\psi_2' + E'\psi_2' - (V'+D')\psi_2' - K'\psi_1' = 0.$$

$$(A_0 + A_1\tau_1 + A_2\tau_2 + A_3\tau_3)(a_0 + a_1\tau_1 + a_2\tau_2 + a_3\tau_3)$$

$$= (a_0 + a_1\tau_1 + a_2\tau_2 + a_3\tau_3)(B_0 + B_3\tau_3)$$

$$(A_0 - B_0)a_0 + A_1 a_1 + A_2 a_2 + (A_3 - B_3)a_3 = 0$$

$$A_1 a_0 \quad + (A_0 - B_0)a_1 +$$

$$V' + D'$$

$$\frac{d^2}{dr^2}(a_1\psi_1' + a_2\psi_2') + (E'a_1 - K'a_2)\psi_1' + \{(E' - V' + D')a_1$$

$$- J'a_1\}\psi_2' = 0.$$

$$a_1\{(E' - V' - D')a_2 - J'a_1\} = a_2(E'a_1 - K'a_2)$$

$$J'a_1^2 + (V' + D')a_1 a_2 - K'a_2^2 = 0$$

$$a_1 = \frac{-(V'+D') \pm \sqrt{(V'+D')^2 + 4J'K'}}{2J'}\, a_2$$

$$\frac{E'a_1 - K'a_2}{a_1} = E' + \frac{2J'K'}{V'+D' \mp \sqrt{(V'+D')^2 + 4J'K'}}$$

$$L_1 = \frac{2J'K'}{\sqrt{(V'+D')^2 + 4J'K'} - (V'+D')}$$

$$L_2 = \frac{2J'K'}{\sqrt{} + (V'+D')}$$

$$\frac{d^2X_1}{dr^2} + (E' - L_1)X_1 = 0,$$

$$\frac{d^2X_2}{dr^2} + (E' + L_2)X_2 = 0.$$

$$\frac{d^2}{dr^2} - l(l \qquad J = J_{12}, \quad \tilde{J} = J_{21}$$

$$\left(\frac{d^2}{dr^2} + E + J_{1}\right) f_1 + J f_2 = 0$$

$$\lambda_1 \qquad \left(\frac{d^2}{dr^2} + E - D + J_2\right) f_2 + \tilde{J} f_1 = 0.$$

$$\left.\begin{aligned} h_1 &= f_1 + \lambda_1 f_2 \\ h_2 &= f_1 + \lambda_2 f_2 \end{aligned}\right\},$$

$$\lambda\{(E + J_1) + \lambda \cancel{(E - D + J_2)}\, \tilde{J}\}$$

$$= \{J + \lambda(E - D + J_2)\}$$

$$\tilde{J}\lambda^2 + (D + J_1 - J_2)\lambda - J = 0.$$

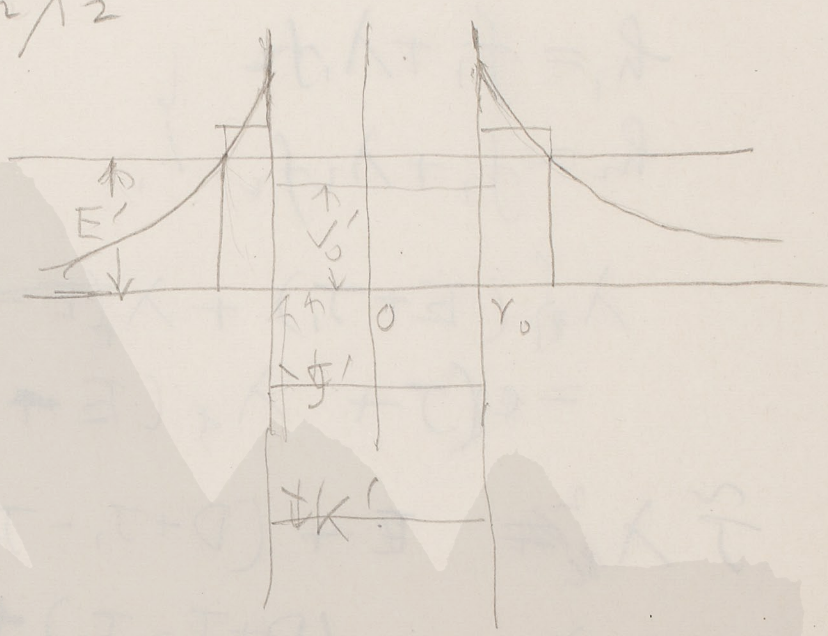
$$\lambda = \frac{-(D + J_1 - J_2) \pm \sqrt{(D + J_1 - J_2)^2 + 4|J|^2}}{2\tilde{J}}$$

$$X_1 = C_1 e^{i\sqrt{E'-L_1}} + D_1 e^{-i\sqrt{E'-L_1}}$$

$$X_2 = C_2 e^{i\sqrt{E'+L_2}} + D_2 e^{-i\sqrt{E'+L_2}}$$

$$\psi_1' = b_{11} X_1 + b_{12} X_2$$

$$\psi_2' = b_{21} X_1 + b_{22} X_2$$



$Y < Y_0$ $\quad V' = V_0'$