

Module 10: Time Independent Perturbation Theory

10.1 Consider a 4-fold degenerate state with orthonormal eigenfunctions u_1, u_2, u_3 and u_4 . There is a perturbation H' . It is given that $H'_{12} = H'_{21} = -g$; $g > 0$ and all the other matrix elements are zero. Find the splitting and corresponding wavefunctions.

- (a) $g, -g, 0, 0$
- (b) $2g, g, 0, 0$
- (c) $g, g, 0, 0$
- (d) $g, 0, 0, 0$

[Answer (a)]

10.2 Consider a 4-fold degenerate state with orthonormal eigenfunctions u_1, u_2, u_3 and u_4 . There is a perturbation H' . It is given that $H'_{12} = H'_{21} = -g$; $g > 0$, and all the other matrix elements are zero. Find the wave functions of the split levels.

- (a) u_1, u_2, u_3 and u_4
- (b) $\frac{u_1 - u_2}{\sqrt{2}}, \frac{u_1 + u_2}{\sqrt{2}}, u_3$ and u_4
- (c) $\frac{u_1 - 2u_2}{\sqrt{2}}, \frac{u_1 + 2u_2}{\sqrt{2}}, u_3$ and u_4
- (d) $\frac{u_1 - 3u_2}{\sqrt{2}}, \frac{u_1 + 3u_2}{\sqrt{2}}, u_3$ and u_4

[Answer (b)]

10.3 Consider a 4-fold degenerate state with orthonormal eigenfunctions u_1, u_2, u_3 and u_4 . There is a perturbation H' . It is given that $H'_{11} = H'_{22} = 2g$, $H'_{12} = H'_{21} = g$ and all the other matrix elements are zero. Find the splitting and corresponding wavefunctions.

- (a) $g, g, 0, 0$
- (b) $2g, g, 0, 0$
- (c) $3g, g, 0, 0$
- (d) $4g, g, 0, 0$

[Answer (c)]

10.4 Consider a 4-fold degenerate state with orthonormal eigenfunctions u_1, u_2, u_3 and u_4 . There is a perturbation H' . It is given that $H'_{11} = H'_{22} = 2g$, $H'_{12} = H'_{21} = g$ and all the other matrix elements are zero. Find the wave functions of the split levels.

- (a) u_1, u_2, u_3 and u_4
(b) $\frac{u_1 - u_2}{\sqrt{2}}, \frac{u_1 + u_2}{\sqrt{2}}, u_3$ and u_4
(c) $\frac{u_1 - 2u_2}{\sqrt{2}}, \frac{u_1 + 2u_2}{\sqrt{2}}, u_3$ and u_4
(d) $\frac{u_1 - 3u_2}{\sqrt{2}}, \frac{u_1 + 3u_2}{\sqrt{2}}, u_3$ and u_4

[Answer (b)]