

Lecture 5

Quantum dot: particle trapped in all three dimensions

Quantum wire: particle trapped in two dimensions, free in third

Quantum well: particle trapped in one dimension, free in two

Separable Hamiltonian in Cartesian coordinates

$$\hat{H} = -\frac{\hbar^2}{2m}\nabla^2 + V_1(x) + V_2(y) + V_3(z)$$

TISE breaks up into 3 one-dimensional eigenvalue problems

$$-\frac{\hbar^2}{2m}\frac{d^2X}{dx^2} + V_1(x)X(x) = E_x X(x) \quad \text{etc}$$

Full wave function (product), n_i : quantum no's for each direction

$$\Psi_{n_1 n_2 n_3}(x, y, z) = X_{n_1}(x) Y_{n_2}(y) Z_{n_3}(z)$$

Energy eigenvalue (sum)

$$E_{n_1 n_2 n_3} = E_x(n_1) + E_y(n_2) + E_z(n_3)$$