

## Lecture 6

### Circular quantum dot

Thin disc of undoped semiconductor between insulating layers

Hamiltonian

$$\hat{H} = -\frac{\hbar^2}{2m^*}\nabla^2 + \frac{1}{2}m^*\omega^2(x^2 + y^2)$$

with high barriers at  $z = 0, a$

Separates: 2 harmonic oscillators ( $x, y$ ) and one square well ( $z$ )

Energy eigenvalues

$$E_{n_1 n_2 n_3} = (n_1 + n_2 + 1)\hbar\omega + \frac{\hbar^2}{2m^*}\left(\frac{n_3\pi}{a}\right)^2$$

Quantum numbers  $n_1, n_2 = 0, 1, 2, \dots$  and  $n_3 = 1, 2, 3, \dots$

Degeneracies of levels

“magic numbers” (closed shells)

$E_{001}$	1	$2$ (spin states) $\times 1 = 2$
$E_{101}$	2	$2 \times (1 + 2) = 6$
$E_{201}$	3	$2 \times (1 + 2 + 3) = 12$
$E_{301}$	4	$2 \times (1 + 2 + 3 + 4) = 20$