Solution

Consider a particle in a 2D well, with $L_x = L_y = L$.

1. Compare the energies of the (2,2), (1,3), and (3,1) states?

   a. $E_{(2,2)} > E_{(1,3)} = E_{(3,1)}$
   b. $E_{(2,2)} = E_{(1,3)} = E_{(3,1)}$
   c. $\boxed{E_{(2,2)} < E_{(1,3)} = E_{(3,1)}}$

$$E_{(1,3)} = E_{(3,1)} = E_0\,(1^2 + 3^2) = 10\,E_0$$

$$E_{(2,2)} = E_0\,(2^2 + 2^2) = 8\,E_0$$

$$E_0 \equiv \frac{h^2}{8mL^2}$$

2. If we squeeze the box in the x-direction (*i.e.*, $L_x < L_y$) compare $E_{(1,3)}$ with $E_{(3,1)}$.

   a. $\boxed{E_{(1,3)} < E_{(3,1)}}$
   b. $E_{(1,3)} = E_{(3,1)}$
   c. $E_{(1,3)} > E_{(3,1)}$

Because $L_x < L_y$, for a given n, E_0 for x motion is larger than E_0 for y motion. The effect is larger for larger n. Therefore, $E_{(3,1)} > E_{(1,3)}$.

Example: $L_x = ½$, $L_y = 1$:

$E_{(1,3)} \propto 4\times1^2 + 1\times3^2 = 13$
$E_{(3,1)} \propto 4\times3^2 + 1\times1^2 = 37$

We say "the degeneracy has been lifted."