1) \( n = 2, \quad l = 1 \)

Allowable \( j \) values are \( j = l + \frac{1}{2}, \quad j = |l - \frac{1}{2}| \)

So, \( 2p \rightarrow 2P_{3/2} \)

\[ 2P_{3/2} \]

\[ E = E_0 + \mu_B B \]

And \( \mu_B = \pm \frac{1}{2} \mu_B \)

Or \( \approx \mu_B \)

Then \( \Delta E = E_{3/2} - E_{1/2} = (E_0 + \mu_B B) - (E_0 - \mu_B B) = 2\mu_B B \)

So \( B = \frac{\Delta E}{2\mu_B B} = \frac{4.5 \times 10^{-5} \text{eV}}{2 \left(\frac{1}{2}\right) \left(5.79 \times 10^{-5} \text{eV/T}\right)} = 0.78 \text{T} \)

This is 10,000 times larger than the magnitude of the Earth's magnetic field measured in College Station.
2) Recall \( m = 0, \pm 1, \pm 2, \ldots, \pm l \)

so

\[
\sum_{m=-l}^{l} \text{ number of terms} \quad \sqrt{l \text{ number of terms}}
\]

1 term

\[
\sum_{m=-l}^{l} m = l + l + 1 = 2l + 1
\]

possible \( m \) values for each \( l \)

3) Each \( n \) gets a number of \( l \) values up to \( n-1 \) and each \( l \) gets \( 2l + 1 \) terms.

Then

\[
\sum_{l=0}^{n-1} (2l+1) = 2(0) + 1 + 2(1) + 1 + 2(2) + 1 + \ldots + 2(n-3) + 1 + 2(n-2) + 1
\]

\[
+ 2(n-1) + 1
\]

\[
\text{add the largest term to the least, add 2nd largest to 2nd smallest,}
\]

\[
\sum_{l=0}^{n-1} (2l+1) = (1 + 2n-1) + (3 + 2n-3) + (5 + 2n-5) + \ldots + \text{now that are} \frac{n(n-1)}{2} \text{ total terms, each of which is} \ 2n
\]

The total number is then \( (dn) \Delta \frac{n}{2} = \frac{n^2}{2} \)

Each \( n \) has \( n^2 \) possible combinations of \( l \) and \( m \).

This is why hydrogenic energy levels \( E_n \propto \frac{1}{n^2} \) are each \( n^2 \) degenerate, since \( E_n \) is the same for any \( \ell \pm m \).
3d : \( n=3, \ l=2 \)

Spin-orbit gives 2 values for \( j \), since \( S=\frac{1}{2} \):

\[
j = 2 + \frac{1}{2} = \frac{5}{2}, \quad j = |2 - \frac{1}{2}| = 3/2
\]

"Full" notation is \( n^2s^1 \) \( A_j \), so \( 3^2D_{5/2}, \ 3^2D_{3/2} \)

2 different energy levels