Assignment 11

1. The allowed angular momenta \( j \) when we add two particles with angular momenta \( j_1 = 3 \) and \( j_2 = 1/2 \) are:
   \[ j = |3 + 1/2|, |3 + (-1/2)|, |3 - 1/2|, |3 - (-1/2)| = 3.5, 2.5, 2.0, 1.5 \]

2. The magnetic quantum number \( m_j \) for each angular momentum \( j \) are:
   
   **For \( j = 3.5 \):**
   - \( m_j = -3.5, -3.0, -2.5, -2.0, -1.5, -1.0, -0.5, 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 \)

   **For \( j = 2.5 \):**
   - \( m_j = -2.5, -2.0, -1.5, -1.0, -0.5, 0.0, 0.5, 1.0, 1.5, 2.0, 2.5 \)

   **For \( j = 2.0 \):**
   - \( m_j = -2.0, -1.5, -1.0, -0.5, 0.0, 0.5, 1.0, 1.5, 2.0 \)

   **For \( j = 1.5 \):**
   - \( m_j = -1.5, -1.0, -0.5, 0.0, 0.5, 1.0, 1.5 \)

   **For \( j = 0.0 \):**
   - \( m_j = 0.0 \)

3. The decay from \( j = 2 \) to \( j = 1/2 \) is allowed. The selection rule is \( 
\Delta j = \pm 1, \Delta m_j = 0 \), so the transition can occur.

4. Consider two electrons in an atom. Let the electron be at zero potential. Using the values of \( j \) and \( m_j \) for the two electrons, calculate the angular momentum quantum number \( \ell \) for two different states. Include the limiting cases for the allowed states.

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6. In the product of the two wave function components, \( \psi_{1} \) is a spin up and \( \psi_{2} \) is a spin down component, \( \psi' \) will be:

   \[ \psi' = \psi_{1} \psi_{2} + e^{-i\theta} \psi_{2} \psi_{1} \]

   

7. The Clebsch-Gordan coefficients \( C_{11}^{00} \) are \( 1 \), \( C_{11}^{11} \) are \( 2 \), \( C_{11}^{02} \) are \( 1 \), and \( C_{11}^{12} \) are \( 1 \), where the states of \( \ell \) are:

   \[ \ell = 0, 1, 2 \]

   

8. Let \( \psi(x) \) be a wave function that has a maximum at \( x = 1,2 \) and \( x = 3,4 \). The values of the function at these points are equal. If we expand the function, it will be:

   \[ \psi(x) = A_{1}^{0} e^{i\theta(x)} + A_{2}^{0} e^{-i\theta(x)} \]

   where \( A_{1}^{0} \) and \( A_{2}^{0} \) are the coefficients.

   

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