your name(s)_____

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Physics 852 Quiz #11 - Friday, Jan. 31st

An atom undergoes a transition from a state with $\boldsymbol{L = 2, S = 0}$, to a state with $\boldsymbol{L = 1, S = 0}$. The original state was polarized, with $\boldsymbol{M_L = 2}$. Consider the electromagnetic decay in the dipole approximation.

1. What values of $\boldsymbol{M_L}$ are allowed in the final state?
2. If a photon is observed in the $\hat{z}$ direction, what is its polarization?
3. If a photon is observed in the $-\hat{z}$ direction, what is its polarization?
4. If a photon is observed in the $\hat{x}$ direction, what is its polarization?
5. What is the angular distribution of photons emitted from the decay? (shape only)
6. If the decay rate above is γ, what is the decay rate for each of the other four original polarizations? ($\boldsymbol{M_L = 1, 0, -1, 2}$).
7. For each of the 5 values for $\boldsymbol{M_L}$ of the original state, find the branching ratios into each of the three possible $\boldsymbol{M_f}$ values of the final state. Use the Wigner Eckart theorem.

1. $M_L = 1$
2. $\hat{x} + i\hat{y}$, RCP
3. $\hat{x} + i\hat{y}$, LCP
4. $\hat{y}$ ($\hat{x}$ part does not couple to $\vec{\epsilon}$)
5. $\langle f | \vec{r} | i \rangle = \gamma(\hat{x} - i\hat{y})$

$$\sum_{s=1,2} |\vec{\epsilon}_s \cdot (\hat{x} - i\hat{y})|^2 = \sum_{s=1,2,3} |\hat{\epsilon}_s (\hat{x} - i\hat{y})|^2 - |\hat{k} \cdot (\hat{x} - i\hat{y})|^2$$

$$= (2 - \sin^2\theta)\,\gamma^2$$

6. All must be the same

7. $M_i = -2, -1, 0, 1, 2$

$M_i = +2$ { $m_f = +1$, 100 %

$M_i = +1$ {
- $m_f = +1$ ~ $\left| C^{21}_{+10\,;\,1\,+1} \right|^2 = 3/5$
- $m_f = 0$ ~ $C^{21}_{1\,-1\,;\,1\,0} = 3/10$

$M_i = 0$ {
- $m_f = 1$ ~ $\left| C^{21}_{0\,1\,;\,1\,1} \right|^2 = 1/10$
- $m_f = 0$ $\left| C^{21}_{0\,0\,;\,1\,0} \right|^2 = 2/5$
- $m_f = -1$ ~ $\left| C^{21}_{0\,-1\,;\,1\,-1} \right|^2 = 1/10$