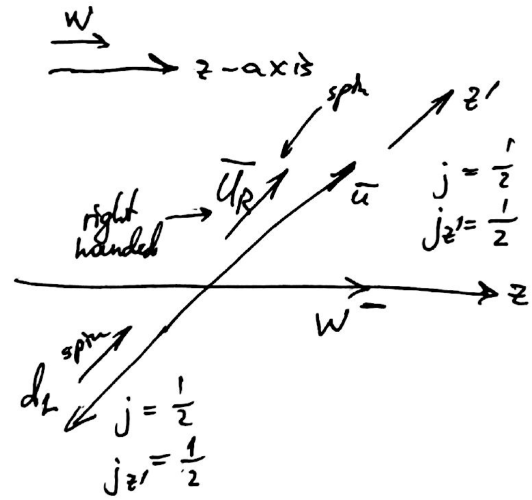
3 possible helicities $\leftarrow$, $\rightarrow$, $\uparrow$ longitudinal polariz.

op.	eigenval.
J^2	$j(j+1)$
J_z	j_z

$j=1$

$\leftarrow$, $\bullet$, $\rightarrow$

$j_z=-1$, $j_z=0$, $j_z=1$



Initial state

W

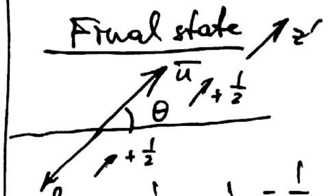
$\rightarrow$

$+1$

$j=1$

$j_z=1$

Final state



$j_d=\frac{1}{2}$ $\quad j_u=\frac{1}{2}$

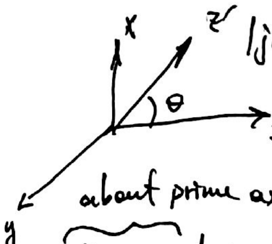
$j_{z'd}=\frac{1}{2}$ $\quad j_{z'u}=\frac{1}{2}$

$j_{total}=0, 1$

$j_{z'tot}=1 \Rightarrow j_{total}\neq 0$

this is a consequance of our assumptions of helicity of $\bar{u}$ & d, which we made because W has only left coupling

$$\begin{array}{llll} & & J\ m' & J\ m \\ A^+ & \sim & \langle 1\ \ m' | & 1\ \ 1\rangle C_j \\ A^- & \sim & \langle & 1\ \ {-1}\rangle C_j \\ A^0 & \sim & \langle & 1\ \ 0\rangle C_j \end{array}$$



$|jm\rangle' = e^{-i\vec{J}\cdot\hat{y}\,\theta}\,|j\ m\rangle$ passive rotation

$= e^{-iJ_y\theta}\,|jm\rangle$

conjugate of

$$\underbrace{\langle j_f\ m_f|}_{\text{about prime axis}}\underbrace{j_i\ m_i\rangle}_{\text{about unprimed axis}} = \langle j_f m_f|\, e^{iJ_y\theta}\,|j_i m_i\rangle$$

$$\langle 1\ +1|\, e^{+iJ_y\theta}\,|1\ \begin{matrix}+1\\0\\-1\end{matrix}\rangle$$

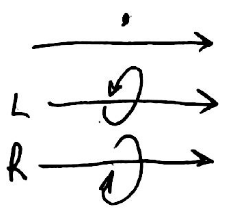
Wigner-Eckart

$$\underbrace{\begin{pmatrix}1&0&0\\0&0&0\\0&0&-1\end{pmatrix}}_{\hat{J}_z}\underbrace{\begin{pmatrix}+\\0\\-\end{pmatrix}}_{\chi}$$ spin 1 $\longrightarrow$ Easier basis $\begin{pmatrix}\frac{1}{\sqrt{2}}(|+\rangle+|-\rangle)\\ \frac{1}{\sqrt{2}}(|+\rangle-|-\rangle)\\ |0\rangle\end{pmatrix}$

$J_z|+\rangle = +1|+\rangle$

$u\begin{pmatrix}+\\0\\-\end{pmatrix} = \begin{pmatrix}\ \\ \ \\ \ \end{pmatrix} \Rightarrow u = \begin{pmatrix}1/\sqrt{2}&0&1/\sqrt{2}\\1/\sqrt{2}&0&-1/\sqrt{2}\\0&1&0\end{pmatrix}$

$u J_z u^{\dagger} u|+\rangle = u\lambda|+\rangle$



$\begin{pmatrix}+\\0\\-\end{pmatrix}$

circular polarizations

$u J_z u^\dagger =$

$e^{iJ_z\theta}$

$$\begin{pmatrix} c_\theta & s_\theta & 0 \\ -s_\theta & c_\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix}$$

$$\sim 1 + i\theta \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

<u>linear polariz</u>

$J_z = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$, $J_y = \begin{pmatrix} 0 & 0 & i \\ 0 & 0 & 0 \\ -i & 0 & 0 \end{pmatrix}$ $J_z^{\text{linear}} = u J_z u^\dagger$

Wigner d^J functions

$d^J_{MM'}(\theta)$, $D^J_{MM'}(\theta,\varphi)$? $\frac{1+\cos\theta}{\sqrt{2}}$ $\frac{1-\cos\theta}{\sqrt{2}}$

$\sin\theta$

$$\begin{pmatrix} 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} \square & \square & \square \\ & & \\ & & \end{pmatrix} \begin{pmatrix} + \\ 0 \\ - \end{pmatrix}$$

?

$$A_{+1} \sim \frac{1+\cos\theta}{\sqrt{2}}\, C_J$$

$$A_{-1} \sim \sin\theta\, C_J$$

$$A_0 \sim \frac{1-\cos\theta}{\sqrt{2}}\, C_J$$

$P(\theta)$