

$3D_1$

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$$\begin{aligned}\langle 0|\bar{c}\gamma^\mu c|^3D_1\rangle &= \int d\Omega \sum_{\lambda_1\lambda_2S_zm} \text{tr}\{\Pi_1\gamma^\mu\} \langle 1J_z|2m;1S_z\rangle Y_{2m}(\theta,\phi) \\ \text{tr}\{\Pi_1\gamma^\mu\} &= \frac{\sqrt{2}p^\mu(p\cdot\epsilon)}{E(E+m)} + \epsilon^\mu\end{aligned}$$

Chosen polarization vectors:

$$\begin{aligned}\epsilon^{(-)} &= (0, 1, -i, 0), \epsilon^{(0)} = (0, 0, 0, -1), \epsilon^{(+)} = (0, 1, +i, 0) \\ \begin{pmatrix} \langle 0|\bar{c}\gamma^\mu c|^3D_1\rangle^{(-)} \\ \langle 0|\bar{c}\gamma^\mu c|^3D_1\rangle^{(0)} \\ \langle 0|\bar{c}\gamma^\mu c|^3D_1\rangle^{(+)} \end{pmatrix} &= \begin{pmatrix} 0 & -\frac{2\sqrt{\pi}(E^2-m^2)}{15E(m+E)} & \frac{2i\sqrt{\pi}(E^2-m^2)}{15E(m+E)} & 0 \\ 0 & 0 & \frac{2i\sqrt{2\pi}(E^2-m^2)}{5E(m+E)} & \frac{8\sqrt{\pi}(E^2-m^2)}{15E(m+E)} \\ 0 & -\frac{2\sqrt{\pi}(E^2-m^2)}{15E(m+E)} & -\frac{2i\sqrt{\pi}(E^2-m^2)}{15E(m+E)} & 0 \end{pmatrix} \\ \langle 0|\bar{c}\gamma^\mu c|^3D_1\rangle^{(0)} &= \int d\Omega \frac{-e^{-i\phi}\bar{p}^\mu (\bar{p}\cdot\bar{\epsilon}1) (6e^{i\phi}\cos^2(\theta) + 3\sqrt{2}(-1+e^{2i\phi})\sin(\theta)\cos(\theta) - 2e^{i\phi})}{4\sqrt{\pi}E(E+m)} \\ &\quad \left\{ 0, 0, -\frac{2i\sqrt{2\pi}p^2}{5E(E+m)}, -\frac{8\sqrt{\pi}p^2}{15E(E+m)} \right\}\end{aligned}$$