Spinless particles scattering through states of J=0,1, or 2 (from the problem set)

For spinless particles A and B in two to two scattering A+B→C→A+B through the state C with J=0, 1, or 2, the general result for the scattering amplitude specializes to $T(\theta,\varphi) = \sum_J T_J P_J(\cos\theta)$. (This was given in a handout. The energy dependence in T and T_J is suppressed.) Thus if a single J channel dominates, we have $\frac{d\sigma}{d\Omega} \propto \left|P_J(\cos\theta)\right|^2$, and the angular distribution is 1, $\cos^2\theta$, and $[(3/2)\cos^2\theta - 1/2]^2$ for J=0, 1, and 2, respectively. For $J \neq 0$, this is not spherically symmetric because not all the J_3 states are available. In particular, spinless particles approaching along the 3-axis can have $J_3=0$ only.