Topics in Spin - Homework 5

April 4, 2014

Problem SS-12: The angular distributions of spin-$\frac{1}{2}$ particles from the decay of a spin-1 particle

In class, we saw how we could obtain the angular distributions by considering the matrix elements of the rotation operator using the total-j state of $|1,1,0\rangle$. We computed $\langle j', m'| U(\Omega) |j, m = \lambda_1 - \lambda_2\rangle$ and used the appropriate Wigner d-function.

1. Confirm that this result is robust if, instead, you consider the matrix elements using the product kets, $|j_1, m_1, \lambda_1; j_2, m_2, \lambda_2\rangle = |j_1, m_1, \lambda_1\rangle |j_2, m_2, \lambda_2\rangle$to obtain the corresponding matrix elements (in terms of Wigner d-functions). *HINT: write the state of total-j in terms of its product ket(s).*

Problem SS-13: The decay of a spin-1 or spin-0 particle to a pair of spin-1 particles

Consider a newly discovered particle that is observed to decay into pairs of spin-1 particles. Spin-1 particles have 3 possible helicity states: $\lambda = +1, 0, -1$. We do not know the spin of the parent *a priori* (e.g. we have no definite information about its production mechanism, for instance, as in a hadron collider where many processes could contribute to its production). We wish to determine its spin by comparing measured angular distributions of final-state bosons to predicted angular distributions expected from each parent spin hypothesis.

1. What are the possible angular distributions of the final-state bosons if the spin of the parent is S=0? Show each term in the amplitude and make some plots with different choices of coefficient that emphasize each component separately and sum of each component with equal coefficients.

2. What about if the spin of the parent is S=1? Repeat the exercise of plotting the distributions, as well as just reporting each term in the amplitude and its angular dependence.