Physics 491: Recitation #7
October 2, 2015

Recall the photon circular polarization basis in terms of the linear polarization basis are

$$|\underline{R}\rangle = \frac{1}{\sqrt{2}}\left(|\underline{X}\rangle + i\,|\underline{Y}\rangle\right)$$

$$|\underline{L}\rangle = \frac{1}{\sqrt{2}}\left(|\underline{X}\rangle - i\,|\underline{Y}\rangle\right)$$

1. Write the transformation matrix $\hat{\mathcal{S}}$ to change from the linear photon basis to the circular polarization basis. Verify that $\hat{\mathcal{S}}$ is unitary.

   Suppose $|\psi\rangle = \psi_x\,|\underline{X}\rangle + \psi_y\,|\underline{Y}\rangle$. What are the components of $|\psi\rangle$ in the circular polarization basis?

2. What is the photon angular momentum operator $\hat{J}_z$ in the circular polarization basis? Transform this operator to the linear polarization basis. What are the eigenstates of $\hat{J}_z$ written as column vectors in the linear basis?

3. Show that the photon angular momentum operator $\hat{J}_z = \hbar\,|\underline{R}\rangle\,\langle\underline{R}| - \hbar\,|\underline{L}\rangle\,\langle\underline{L}|$. What is the operator $|\underline{R}\rangle\,\langle\underline{R}|$ represented in the linear basis? Operator $|\underline{L}\rangle\,\langle\underline{L}|$ in the linear basis?