

Solve one the following problems :

1. Particle $1/2$ spin is in a mixed state. It was measured to have a probability p to be in the $|+z\rangle$ state (the eigenstate of \hat{s}_z with eigenvalue $\hbar/2$) and probability q to be in $|+x\rangle$ state (the eigenstate of \hat{s}_x with eigenvalue $\hbar/2$).
 - a) What can you determine from these results about the state of the spin?
 - b) Should the p and q be assumed to obey $p + q = 1$? Other relation? Any relation at all?
 - c) What can you say about the direction of the spin in this state? Does the spin point along it or opposite to it? What is the entropy of this state? How do your answers depend on p ? Are there special interesting values of p worth indicating?
2.
 - a) Explain how would you answer the following "natural" question - what is the magnetic or the electric fields of a single photon? Hint: Formulate this question in the proper q. m. way. Note that conceptually this is similar to asking what is the coordinate or the momentum or some linear combination of them in the 1-st excited state of a harmonic oscillator.
 - b) For simplicity do the calculations for one of the two fields \mathbf{E}_{op} or \mathbf{B}_{op} . But explain what will be needed to do for the other field.
 - c) What does the non commutativity of \mathbf{E}_{op} and \mathbf{B}_{op} between themselves and with H_{rad} mean for answering the question in p. a)?