

Ph195 – Study problems for 10/15

1. In the lecture notes for October 8 ("Operator moments revisited..."), take a close look at equations (21) and (22). Note that \mathbf{AB} is replaced by $\frac{1}{2}(\mathbf{AB} + i\mathbf{C} + \mathbf{BA})$ although the more obvious choice would have been to replace \mathbf{AB} by $i\mathbf{C} + \mathbf{BA}$. This judicious yet seemingly arbitrary move contributes a factor of $1/2$ in the Heisenberg Uncertainty Relation (23). What's going on?

2. Suppose we have a system prepared in a mixed initial state characterized by the density operator ρ . Given an arbitrary pure state $|\Psi\rangle$ (from the same Hilbert space), what is the significance of the quantity $\langle \Psi | \rho | \Psi \rangle$?

3. As we discussed at the end of class on October 10, try to figure out what's going on with the "non-orthogonal projector" that Parsa wrote on the board in class,

$$\mathbf{P} = \begin{pmatrix} 3/2 & i\sqrt{3}/2 \\ i\sqrt{3}/2 & -1/2 \end{pmatrix}.$$

4. From the final section ("Random-basis quantum cryptography") of the lecture notes for October 10, compute the density operator corresponding to Alice's ensemble of quantum states. Also, after each measurement that Bob makes, what are his chances of correctly identifying the state that Alice transmitted?