# Physics 430I
# Online Essay Questions

1. What do you think about "the mystery of the other glove"? Real gloves, of course, don't act this way. Should anything be allowed to act this way? Is your response to this story similar to the views of Einstein, as described in the reading? Or is it more like that of Bohr? Include in your response any questions you have about the reading.

2. So what do you think: Are photons "real" or are they "just a useful idea for explaining experimental results"? Is there a difference between these two? If we accept that photons are at least "sort of" real, in what way is a polarizer like a Stern-Gerlach analyzer?

3. On page 48, near the top, Lindley offers his "cautious" way of thinking about wavefunctions: "The most elementary way to think about wavefunctions ... is that they encapsulate the information you need to know in order to figure out the probabilities of different possible outcomes of a given experiment or measurement." What do you think of this approach? Do you find it satisfying that our most fundamental theory of nature can only produce a means for calculating probabilities of experimental outcomes, and nothing more substantial? Or would it be more satisfying to think of the wavefunction as representing something deep and fundamental about the particle (i.e. somehow the particle IS the wavefunction)? How does Lindley's approach fit with the way we have used wavefunctions in class?

4. You can perform your own simulated double-slit experiment using the Shockwave program at `http://phys.educ.ksu.edu/vqm/html/doubleslit/index.html` (you'll need Macromedia Shockwave player installed). Play around with this experiment. You can fire beams of photons, electrons, neutrons, even pions through the double-slit. See what kind of interference patterns you get for different particles at different energies. How does the interference pattern change when you change the energy? How about when you change the particle?

5. Defend one of the following statements regarding the Schrodinger's Cat experiment:

   (a) The cat is never in a superposition of states because there is some "irreversible act of amplification" that causes its wavefunction to collapse right away. So it is always either alive or dead. Note: you must address what brings about the "irreversible act of amplification".

   (b) The cat does go into a superposition of being alive and dead, but when we open the box and see the cat the cat's wavefunction will collapse. It is our conscious observation that brings about the "irreversible act of amplification". Note: you need to address the issue of Wigner's friend.

   (c) The cat will forever be in a superposition of states. It's wavefunction never collapses. It's not appropriate to talk about "measurements" because in doing so we are acting as though quantum mechanics doesn't apply to the measuring device (or the experimenter). But quantum mechanics applies to everything, so everything ends up in a superposition. Note: you will need to address why we never see cat's that are simultaneously alive and dead.

   (d) It doesn't matter if the cat is ever in a superposition of states. Quantum mechanics predicts the probability of the cat being alive or dead when we open the box, and it gives the right probabilities. It doesn't make sense to talk about what the cat is doing when we aren't looking at it. Note: you should address how the cat might feel about this point of view.

6. In Modern Physics you learned that Special Reltivity demands that all observers agree about observations, but it allows different observers to make different inferences (such as the length of an object, or the time that passes between two events) based on those observations. In what way are Einstein's "elements of physical reality" like the inferences of different observers in Special Relativity? If "elements of physical reality" are really only inferences, is it appropriate to call them "elements of physical reality"? Or should we side with Neils Bohr and say that the only true "elements of physical reality" are the results of measurements?

7. Which of the three interpretations of quantum mechanics discussed by Lindley (Copenhagen, Everett's many-worlds interpretation, or Bohm's "guide wave" theory) do you prefer and why? Or do you think it doesn't even make sense to worry about interpretations as long as the calculations are clear? Do interpretations of quantum mechanics help us understand how quantum particles behave? Defend your position.

8. In your own words, describe what is meant by the "measurement problem" of Quantum Mechanics. What is it, and why is it such a problem?

9. Suppose you have 45 blue chips and 5 red chips. If you mix them together randomly, and then pull them out one by one, what is the probability that the last five chips you draw out will be red? (Note: if you need some help on this don't hesitate to ask - I'm asking this question to mathematically illustrate a point about Lindley's dried peas story).

10. Consider a box filled with dried peas. Ten thousand of the peas are green and 10 of them are yellow. Initially, all of the yellow peas are in one corner of the box. If we shake the box, causing the system of 10,010 peas to basically wander randomly through all possible configurations, why should we expect to see a progression from an ordered state (all the yellow peas in one corner) to a disordered state (with the yellow peas mixed in randomly with the green peas)?