

QUANTUM MECHANICS A (PHY-5645)

HOMEWORK 9

(November 1, 2016)

Due on Tuesday, November 8, 2016

PROBLEM 25 - Quantum Mysteries for Anyone?

Read and make a short summary (of at most one page) of the wonderful article *Quantum Mysteries for Anyone?* by David Mermin; you may find a copy of the article on blackboard under Course Library. Make sure that you understand the implications of *Case a*. That is, according to Mermin, having both detectors always flash the same color when the switches are at the same setting requires that both particles carry *pre-determined identical instructions*. To some extent, this was the original argument of Einstein, Podolsky, and Rosen. A critical insight was developed later by Bell who showed that if both particles leave box C with a pre-determined set of instructions, then *Case b*, namely the observed $1/4$ vs $3/4$ ratio, will never be fulfilled.

PROBLEM 26 - Quantum Mysteries for Anyone?

At the end of the paper, following an idea by Bohm, Mermin tells you how to construct the “device”. In this problem you will obtain quantitatively the results of the *gedanken* experiment by assuming that: *The two particles emerging from the box are spin $1/2$ particles in the singlet state. The two detectors contain Stein-Gerlach magnets, and the three positions determine whether the orientation of the magnets are vertical or at ± 120 degrees to the vertical in the plane perpendicular to the line of flight of the two particles. When the switches have the same settings the magnets have the same orientation. One detector flashes red or green according to whether the measured spin is along or opposite to the field; the other uses the opposite color convention. Thus when the same colors flash the measured components are different.* Using this device, verify that the conditions for *Case a* and *Case b* are both satisfied if you follow the rules of Quantum Mechanics.

PROBLEM 27 - Loophole-free Bell Inequality

Read and make a short summary (of at most one page) of the remarkable new paper *Loophole-free Bell Inequality violation using electron spins separated by 1.3 kilometres* by B. Hensen *et al.* You may find a copy of this paper together with two interpretations of the experiment (“Sorry Einstein” and “Death by Experiment”) on blackboard under Course Library. Note that Einstein, Podolsky, and Rosen conceived the “device” as part of a *gedanken* experiment; the group on the Netherlands seems to have removed the word *gedanken* from the experiment!