

Physics 162a, Fall 2000 – Problem Set 3

Due in class Wednesday, October 14

1. Linear algebra and classical mechanics. These are from Shankar, I will hand out copies of the relevant pages. The point is to remind you that the linear algebra I've covered has applications outside of quantum mechanics.
 - (a) Problem 1.8.11, Shankar.
 - (b) Problem 1.8.12, Shankar.
2. Sakurai, Chapter 1, problem 13.
3. A Stern-Gerlach device is like a polarizer for the spin of a spin-1/2 particle. Consider a Stern-Gerlach device which allows spins with $S_z = \frac{\hbar}{2}$. Then consider a second device which allows spins to pass through when they have eigenvalue $\frac{\hbar}{2}$ along an axis with angle ϵ from the z axis on the $x - z$ plane. Then use a third device which allows through states with eigenvalue $\frac{\hbar}{2}$ along an axis with angle 2ϵ from the z axis along the $x - z$ plane. Continue this n times, with the last device allowing through spins with eigenvalue $\frac{\hbar}{2}$ along an axis with angle $\theta = n\epsilon$ from the z axis in the $x - z$ plane. In the limit $n \rightarrow \infty$, $\epsilon \rightarrow 0$, $n\epsilon \rightarrow \theta$, with θ finite and nonvanishing, what fraction of the initial spins make it through the n detectors?
4. Consider a free particle in one dimension. At time $t = 0$, the wavefunction is some function $\psi(x)$, and we do a measurement of the position of the particle, with resolution Δ . Let us say that we find the particle in the interval $I_n = [n\Delta, (n + 1)\Delta]$.
 - (a) Give a criterion – some restriction on the wavefunction – for approximating the wavefunction as constant over I_n .
 - (b) Making this assumption, compute the probability for the particle to be in I_{n+2} as a function of time. You may use numerical methods, so long as you make the physics clear. Give the limiting behavior of this probability as $t \rightarrow 0$ and $t \rightarrow \infty$, and explain this physically.

5. Baym, Chapter 3, problem 1.
6. Sakurai, Chapter 2, problem 9.