PHYS 313: Quantum Mechanics I

Problem set # 4 *(due October 4)*

All problems are mandatory, unless marked otherwise. Each problem is 10 points.

Townsend, Ch. 3: 3.15, 3.16, 3.17, 3.21(a,b), 3.23, 3.24

Q1 Using the known commutation relations between the Pauli matrices, find the commutators $[\hat{\sigma}_x + i\hat{\sigma}_y, \hat{\sigma}_x - i\hat{\sigma}_y]$ and $[\hat{\sigma}_x + i\hat{\sigma}_y, \hat{\sigma}_z]$.

Q2 In class we found the eigenstates of $\hat{S}_y$ for a spin-1 particle to be:

$$\begin{aligned} |y_{+1}\rangle &= \frac{1}{2}\Big(|1,1\rangle + i\sqrt{2}|1,0\rangle - |1,-1\rangle\Big) \\ |y_0\,\rangle &= \frac{1}{\sqrt{2}}\left(|1,1\rangle + |1,-1\rangle\right) \\ |y_{-1}\rangle &= \frac{1}{2}\Big(|1,1\rangle - i\sqrt{2}|1,0\rangle - |1,-1\rangle\Big) \end{aligned}$$

Spin-1 particles with random spin orientation are sent through the following sequence of Stern-Gerlach setups. What fraction of particles from the initial random source make it all the way through?