Quantum Computing:
An Applied Approach

Chapter 1 Problems:
Superposition, Entanglement, and Reversibility

1. Express the result of the double-slit experiment in Dirac notation. Express the result in Dirac notation of the version of the experiment in which single particles are sent one at a time through the system. Express the result in Dirac notation of the version of the experiment in which single particles are sent one at a time through the system and a decision is made to monitor that particle in each case. How do these results differ from the previous setup?

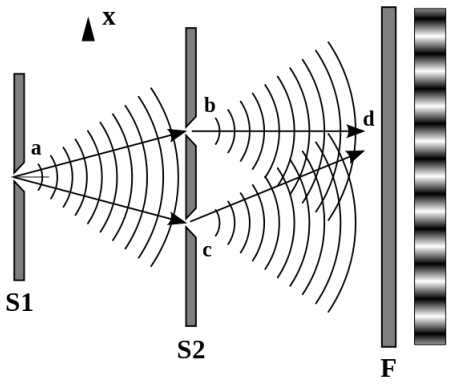

Figure 1: Double slit experiment. Source: Wikimedia

2. Investigate the Stern-Gerlach experiment of 1921.

   What was the expectation from classical theory for the outcome and what actually occurred? Here is the postcard that X sent to Y after the experiment – Interpret the results:

Express the results of the SG experiment in Dirac notation

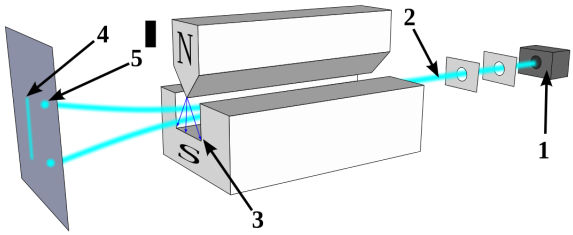

Figure 2: Stern-Gerlach apparatus. Source: Wikimedia

3. Given the Landauer bound of $kT \ln 2$: compute the dissipation of energy in a system where there are five erasures of bits. What if the bits are correlated with each other? Does this change the dissipation calculation? See https://www.osti.gov/servlets/purl/1374013.

4. Is every state represented in a Hilbert space a superposition of other states?

5. Born's rule tells us that the square of the modulus of the amplitude of a state gives us the probability of observing that outcome upon measurement. Why?

6. What does non-separable mean for two states and what does that tell us about these states?