1 Spin One Half Unknowns (Brief)

Using the SPINS simulation for a spin-$\frac{1}{2}$ system (Spins simulation), for the unknown initial state $|\psi_4\rangle$, perform measurements of S_x, S_y, and S_z separately, and for each measurement determine the probability of obtaining each possible measurement value.(We carried out the same procedure for $|\psi_3\rangle$ in class; you may refer to that example.)

(a) Use the probabilities you observed from the measurements to express $|\psi_4\rangle$ as a linear superposition of the S_z-basis states $|+\rangle$ and $|-\rangle$.

(b) *Articulate a Process:* Write a set of general instructions that would allow another student in next year's class to find an unknown state from probabilities obtained from spin measurements.

(c) *Compare Theory with Experiment:* Design an experiment that will allow you to test whether the state you identified in Question (a) for the unknown state $|\psi_4\rangle$ is correct. Describe your experiment here, clearly but succinctly, as if you were writing it up for a paper. Do the experiment and discuss your results.

(d) *Make a Conceptual Connection:* In general, are the probabilities obtained from spin-component measurements along only two spin directions (for example, the z direction and the y direction) sufficient to determine a spin-$\frac{1}{2}$ quantum state? Why or why not?