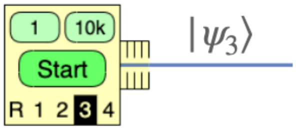
Finding the Unknown States Leaving an Oven (Spin-$\frac{1}{2}$)

1. Launch the Spins Laboratory simulation and choose Unknown # 3 on the oven. This causes the atoms to come out of the oven in a definite quantum state (instead of a random state), which we call $|\psi_3\rangle$.



2. Assume that we want to write the unknown state vectors in terms of the $|\pm\rangle$ basis, *i.e.* $|\psi_3\rangle = a|+\rangle + be^{i\gamma}|-\rangle$, where a and b are real. We thus must use the data to find the values of a, b and γ. Measure the six probabilities $|{}_n\langle\pm|\psi_3\rangle|^2$, where $|\pm\rangle_n$ corresponds to the spin states ("spin up" and "spin down") along the three axes $n = x, y$ or z. Fill in the table for $|\psi_3\rangle$ on the worksheet.

3. Using the probabilities determined from your experiments, calculate Unknown #3 ($|\psi_3\rangle$) and write it in the $|\pm\rangle$ basis.

4. Using the SPINS program, design and run a simulated experiment to verify your calculated state (Hint: recall the general spin-$\frac{1}{2}$ state vector can be written as $|+\rangle_n = \cos\frac{\theta}{2}|+\rangle + \sin\frac{\theta}{2}e^{i\phi}|-\rangle$).

5. Repeat this exercise for Unknown # 4 ($|\psi_4\rangle$).

Unknown $|\psi_3\rangle$

Probabilities	Spin Component		
Result	S_x	S_y	S_z
$\mathcal{P}(\frac{\hbar}{2})$			
$\mathcal{P}(-\frac{\hbar}{2})$			

Unknown $|\psi_4\rangle$

Probabilities	Spin Component		
Result	S_x	S_y	S_z
$\mathcal{P}(\frac{\hbar}{2})$			
$\mathcal{P}(-\frac{\hbar}{2})$			