

Finding the Unknown States Leaving an Oven (Spin-1/2)

1. Start the SPINS program and choose Unknown # 1 under the initialize menu. This causes the atoms to leave the oven in a definite quantum state, which we call $|\psi_1\rangle$. Now measure the six probabilities $|\langle\phi|\psi_1\rangle|^2$, where $|\phi\rangle$ corresponds to spin up and spin down along the three axes. Fill in the table for $|\psi_1\rangle$ on the worksheet. Assume that we want to write the unknown state vectors in terms of the $|\pm\rangle$ basis, *i.e.* $|\psi_1\rangle = a|+\rangle + b|-\rangle$, where a and b are complex coefficients. We thus must use the data to find the values of a and b .
2. Repeat this exercise for Unknown # 2 ($|\psi_2\rangle$), Unknown # 3 ($|\psi_3\rangle$), and Unknown # 4 ($|\psi_4\rangle$).
3. Design an experiment to verify your results (Hint: recall the general spin 1/2 state vector can be written as $|+\rangle_n = \cos\frac{\theta}{2}|+\rangle + \sin\frac{\theta}{2}e^{i\phi}|-\rangle$).

Unknown $|\psi_1\rangle$

Probabilities	Axis		
Result	x	y	z
Spin up \uparrow			
Spin down \downarrow			

Unknown $|\psi_2\rangle$

Probabilities	Axis		
Result	x	y	z
Spin up \uparrow			
Spin down \downarrow			

Unknown $|\psi_3\rangle$

Probabilities	Axis		
Result	x	y	z
Spin up \uparrow			
Spin down \downarrow			

Unknown $|\psi_4\rangle$

Probabilities	Axis		
Result	x	y	z
Spin up \uparrow			
Spin down \downarrow			