1 Prerequisite Knowledge

- Spin 1/2 systems
- Familiarity with how to calculate measurement probabilities
- Solutions to the Schrodinger equation for a time independent Hamiltonian
- Dirac notation

2 Activity: Introduction

Little introduction is needed, although you may want to review how to find a time-evolved state for a time-independent Hamiltonian.

Students work in groups to solve for the time dependence of two quantum particles under the influence of a Hamiltonian. Students find the time dependence of the particles' states and some measurement probabilities.

3 Student Task

Student handout

Time Evolution of a Spin-1/2 System

Consider a spin-1/2 system with a Hamiltonain that is proportional to $\hat{S}_z$:

$$\hat{H} = \omega_0 \hat{S}_z$$

At $t = 0$:

1. one particle is in the state $|+\rangle_x$.
2. another particle is in the state $|+\rangle$

For each particle:

1. What values of energy could you measure?
2. What are the energy eigenstates?
3. What state is each particle in at a later time t?
4. What are the probabilities for each energy measurement?
5. What is the probability that you would measure $S_x = \frac{\hbar}{2}$ state at time t? Does this probability change with time?

6. What is the probability that you would measure $S_z = \frac{\hbar}{2}$ at time t? Does this probability change with time?

7. Given a Hamiltonian, how would you determine which states are stationary states (states where no probabilities change with time)? Under what circumstances do measurement probabilities change with time?

4 Activity: Wrap-up

The main points of this activity are addressed in the last question. Students should recognize:

- a pattern of how these calculations proceed,
- to recognize a stationary state
- that measurement probabilities of non-stationary states will be time-dependent UNLESS you measure a quantity that commutes with the Hamiltonian.