

**Physics 5645**  
**Quantum Mechanics A**  
**Problem Set I**

Due: Tuesday, Sep 11, 2018

1.1 Consider a spin-1/2 particle in a state described by the (unnormalized) ket

$$|\psi\rangle = |+\rangle + (3 + i)|-\rangle.$$

- (a) Normalize  $|\psi\rangle$  and expand it in the  $\{|+\rangle, |-\rangle\}$ ,  $\{|+\rangle_x, |-\rangle_x\}$ , and  $\{|+\rangle_y, |-\rangle_y\}$  bases, (i.e., the  $S_z$ ,  $S_x$ , and  $S_y$  bases).
- (b) Determine the probabilities for the possible results of measuring  $S_z$ ,  $S_x$ , or  $S_y$  for a particle in the state  $|\psi\rangle$ .

1.2 Given the following,

$$S_x|\pm\rangle_x = \pm\frac{\hbar}{2}|\pm\rangle_x, \quad S_y|\pm\rangle_y = \pm\frac{\hbar}{2}|\pm\rangle_y, \quad S_z|\pm\rangle = \pm\frac{\hbar}{2}|\pm\rangle,$$
$$|\pm\rangle_x = \pm\frac{1}{\sqrt{2}}|+\rangle + \frac{1}{\sqrt{2}}|-\rangle, \quad |\pm\rangle_y = \frac{1}{\sqrt{2}}|+\rangle \pm i\frac{1}{\sqrt{2}}|-\rangle,$$

obtain the matrix representations of  $S_x$ ,  $S_y$ , and  $S_z$  in the  $S_z$  basis.

1.3 Problem 1.8, Sakurai and Napolitano, Pg. 59.

1.4 Problem 1.9, Sakurai and Napolitano, Pg. 59.

1.5 Problem 1.13, Sakurai and Napolitano, Pg. 61.