University of Hyderabad
School of Physics

M.Sc.-I/IMSc.-IV | Quantum Mechanics | **May 24, 2019**

May 14-Jul 6 (2019) | **MM: 20**

Tutorial-I

Click for Theory Needed for this set

[1] Compute the spin wave function for a spin half particle in the following special cases when the value of projection, in the direction specified, is as given below.

Direction	Spin Projection	Direction	Spin Projection
(1,0,0)	$+\frac{\hbar}{2}$	(1,0,0)	$-\frac{\hbar}{2}$
(0,1,0)	$+\frac{\hbar}{2}$	(0,1,0)	$+\frac{\hbar}{2}$
(1,-1,0)	$+\frac{\hbar}{2}$	(1,1,0)	$-\frac{\hbar}{2}$
(1,1,1)	$+\frac{\hbar}{2}$	(1,1,1)	$-\frac{\hbar}{2}$

[2] (*a*) Compute the (unnormalized) spin wave functions for a spin $\frac{1}{2}$ particle having spin projection $\pm\frac{\hbar}{2}$ along the direction given by the unit vector $\hat{n} = (n_1, n_2, n_3)$.

(*b*) For each of the following six vectors determine if it represents one of the two state found by you.

$$\chi_1 = \begin{pmatrix} 1+n_3 \\ n_1 - in_2 \end{pmatrix}, \qquad \chi_2 = \begin{pmatrix} 1-n_3 \\ n_1 + in_2 \end{pmatrix}, \qquad \chi_3 = \begin{pmatrix} n_1 + in_2 \\ 1-n_3 \end{pmatrix},$$

$$\chi_4 = \begin{pmatrix} n_1 - in_2 \\ 1+n_3 \end{pmatrix}, \qquad \chi_5 = \begin{pmatrix} 1-n_3 \\ n_1 - in_2 \end{pmatrix}, \qquad \chi_6 = \begin{pmatrix} n_1 + in_2 \\ 1+n_3 \end{pmatrix}$$

Click for Assistance

⊘ Use answers for [2] to solve the following problems.

[3] (*a*) Find the spin wave functions for a spin 1/2 particle with spin projections $\pm 1/2$ along $(2, 2, 1)$. Verify that the two wave functions are orthogonal.

(*b*) If a spin 1/2 particle has spin pointing along the direction (2,2,1), compute the average values of S_x, S_y, and S_z. Do you expect to get real values? Why?

[4] Find the direction along which the spin projection is 1/2 for a spin half particle if the spin wave function the particle is given to be

$$\chi = \begin{pmatrix} \frac{3}{5} \\ -\frac{4}{5} \end{pmatrix}$$

Due Date: May 27, 2018