University of Hyderabad
School of Physics

M.Sc.-I/IMSc.-IV Quantum Mechanics **May 27, 2019**

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

Tutorial-II

[1] Spin wave function of a spin $\frac{1}{2}$ particle is given to be

$$|\phi\rangle = \begin{pmatrix} \frac{3}{5} \\ -\frac{4}{5} \end{pmatrix}$$

(a) Find the ratio of probabilities that S_z has values $\pm\hbar/2$.

(b) Find the probabilities that S_x has values $\pm\hbar/2$.

(c) Compute the average value of spin projection along the direction (1,1,1). [*Remember to get unit vector first*]

(d) When do need to use normalized state vector? For probabilities? For ratio of probabilities? For average values?

[2] Given that an electron has spin wave function $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$ compute the probability that a measurement of S_y gives a value (i) $\frac{1}{2}$, (ii) $-\frac{1}{2}$.

[3] For a spin half particle in a magnetic field the Hamiltonian is given to be

$$H = \gamma(3S_x + 4S_z).$$

If the particle is known to have spin along the z- axis at time $t = 0$, compute the average value of S_z at time t.

[4] In the basis in which S_z is taken to be diagonal, show that the spin matrices for a spin one particle are given by

$$S_x = \frac{\hbar}{\sqrt{2}} \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}; \quad S_y = \frac{\hbar}{\sqrt{2}} \begin{pmatrix} 0 & -i & 0 \\ i & 0 & -i \\ 0 & i & 0 \end{pmatrix}; \quad S_z = \hbar \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}.$$

[5] For a spin one particle find the spin wave function given to be

$$\begin{pmatrix} 3 \\ 12 \\ 4 \end{pmatrix} \tag{1}$$

(*a*) Find the probabilities that the spin a measurement of S_z will give value

(i) $\hbar$; (ii) 0; (iii) $-\hbar$.

(*a*) Find the probability that the spin a measurement of S_x will give value $\hbar$.

(*b*) Find the average value of spin along direction $(2, 2, 1)$.

Assistance

For assistance and a similar solved example(s), click on the links given below

(*a*) Making Q[1] Matrix Represention of Operators

(*b*) Computation of Probability

Due Date: May 27, 2018