# University of Hyderabad

## School of Physics

Jul 2010 - Dec 2010 | Time : 1hr
M.Sc. III-Semester | Quantum Mechanics-II | MM : 20

Session-I::Tutorial Spin

[1] Find the spin wave function for a spin $\frac{1}{2}$ particle. It is given that spin projection along the x- axis has a definite value

(a) $\frac{\hbar}{2}$ (b) $-\frac{\hbar}{2}$

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

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

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

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

(*c*) Compute the average value of the spin projection along $(1, 1, 1)$. [ What will be the operator for the spin projection along a vector $(a, b, c)$?]

[3] An electron, having spin along the $x$ axis, enters a uniform magnetic field along the $z$ axis. Write the electron spin wave function at time $t = 0$. Taking the magnetic field to be along the $z$ axis, $\vec{B} = B_0\hat{k}$, find

(*a*) the spin wave function at time $T$;

(*b*) the average value of Sx after time $\pi/3\gamma$;

where $\gamma = gB_0$. Note that ignoring the orbital motion, the Hamiltonian of an electorn in magnetic field is $-\vec{\cdot}\,\vec{B}$, and the intrinsic magnetic moment of the electron is proportional to the spin, $\vec{}= g\vec{S}$.

[4] Answer the following for a spin $\frac{1}{2}$ particle.

(*a*) If it is known that the spin is along the direction $(n_1, n_2, n_3)$. Verify that the unnormalized spin wave function can be written as

$$\chi = \begin{pmatrix} 1 + n_3 \\ n_1 + in_2 \end{pmatrix}$$

(*b*) If the spin projection of the particle is along the unit vector $(n_1, n_2, n_3)$ is $-\hbar/2$. Verify that the unnormalized spin wave function can be written as

$$\chi = \begin{pmatrix} n_1 - in_2 \\ -1 - n_3 \end{pmatrix}$$