Physics 828: Problem Set 2

Dr. Stroud

Due Wednesday, January 23 at 11:59:59 P. M.

Each problem is worth 10 points unlesss otherwise specified.

1. **Some properties of the Pauli spin matrices.**

   (a). Verify Shankar, eq. (14.3.32).

   (b). Verify Shankar, eq. (14.3.38).

   (b). Verify Shankar, eq. (14.3.39).

2. Shankar, exercise 14.3.2.

3. Shankar, exercise 14.3.7.

4. (20 pts.) Conser a spin 1/2 particle. Call its spin $\mathbf{S}$, its orbital angular momentum $\mathbf{L}$, and its state vector $|\psi\rangle$. The two functions $\psi_\pm(\mathbf{r})$ are defined by $\psi_\pm(\mathbf{r}) = \langle \mathbf{r}, \pm|\psi\rangle$. (These are the two components of the spinor wave function discussed in class.) Assume that

$$\psi_+(\mathbf{r}) = R(r)\left[Y_0^0(\theta,\phi) + \frac{1}{\sqrt{3}}Y_1^0(\theta,\phi)\right]$$
$$\psi_-(\mathbf{r}) = \frac{R(r)}{\sqrt{3}}\left[Y_1^1(\theta,\phi) - Y_1^0(\theta,\phi)\right] \quad (1)$$

   where r, θ, and ϕ are the coordinates of the particle and $R(r)$ is a given function of r.

   (a). What condition must R(r) satisfy in order for $|\psi\rangle$ to be normalized?

   (b). S_z is measured with the particle in state $|\psi\rangle$. What results can be found and with what probabilities? Same question for L_z and then for S_x.

   (c). A measurement of $\mathbf{L}^2$ with the particle in state $|\psi\rangle$ yielded zero. What state describes the particle just after this measurement?