Physics 828: Problem Set 2

Dr. Stroud

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

Each problem is worth 10 points unless otherwise specified.

1. Some properties of the Pauli spin matrices.

2. Shankar, exercise 14.3.2.


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

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

(1)

where $r$, $\theta$, and $\phi$ 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 $L^2$ with the particle in state $|\psi\rangle$ yielded zero. What state describes the particle just after this measurement?