

PHY-852 QUANTUM MECHANICS II

Homework 3, 30 points

January 30 - February 6, 2002

Orbital momentum. Central field.

Reading: *Merzbacher*, Chapter 11, sections 3 - 5; Chapter 12.

1. a. /5/ Show that an arbitrary angular wave function of a particle with orbital momentum $l = 1$ can be written as

$$\psi(\mathbf{n}) = (\mathbf{a} \cdot \mathbf{n}), \quad (1)$$

where \mathbf{a} is some *complex* vector independent on the direction of $\mathbf{n} = \mathbf{r}/r$.

- b. /3/ Let $|\psi\rangle$ be a state of a particle with orbital momentum $l = 1$, and \mathbf{e} a unit vector in some direction. Find the result of action

$$\left[(\hat{\mathbf{l}} \cdot \mathbf{e})^2 - 1 \right] (\hat{\mathbf{l}} \cdot \mathbf{e}) |\psi\rangle. \quad (2)$$

- c. /4/ For the state (1) find the expectation values of the orbital momentum components \hat{l}_k .

2. a. /6/ *Merzbacher*, Problem 7, p. 276.

- b. /6/ *Merzbacher*, Problem 8, p. 276.

3. /6/ *Merzbacher*, Problem 14, p. 276.