Quantum Mechanics I
Problem Set 6

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Due: Monday, March 10th 2014

Problem 6.1

Name or describe the following quantum mechanical symbols or expressions in a few buzz words each. If there is more than one meaning associated with an expression, mention them all.

(a) a

(b) m

(c) $H\psi = E\psi$

(d) σ_x

(e) $\langle L^2 \rangle$

(f) $\int |\Psi|^2 d^3r = 1$

(g) S_z

(h) V

(i) $\phi(p) = (2\pi\hbar)^{-3/2} \int e^{i(p\cdot r)/\hbar} \psi(r) d^3r$

(j) l

(k) Y_2^2

Problem 6.2

A spin-$\frac{1}{2}$ particle is prepared in the state

$$\chi = \frac{1}{\sqrt{3}} \begin{pmatrix} i+1 \\ 1 \end{pmatrix}.$$

(a) What is the probability of finding the particle in a spin up state when you measure S_x, S_y or S_z?

(b) What are the expectation value of S_x, S_y and S_z?

(c) What are the uncertainties σ_{S_x}, σ_{S_y} and σ_{S_z}?

(d) Check if the uncertainty principle is satisfied:

$$\sigma_{S_x} \sigma_{S_y} \geq \frac{\hbar}{2} |\langle S_z \rangle|$$

Also check the other two permutations.

(e) What is the probability of finding each of the particles in a spin up state of S_x after you meassured S_z? No calculation allowed.

Problem 6.3

Consider a spin-1 particle ($s = 1$). What values are allowed for m? Construct the matricies S_x, S_y and S_z. Do it the same way we did it in the lectures for a spin-$\frac{1}{2}$ particle by looking at the action of S_z, S_+ and S_- on each state.