Quantum Physics (II): Homework 3  
Due: Oct. 14, 2002

Ex.1 Ex. 2.11  
Ex.2 Ex. 2.16  
Ex.3 Ex. 2.17  
Ex.4 Ex. 2.18  
Ex.5 Ex. 2.19

Ex.6 20 As we mentioned in the class, there is an ambiguity to interpret the observable $xp$ in quantum mechanics. Verify that for any wavefunction $\Psi(x, t)$, neither $\langle xp \rangle$ nor $\langle px \rangle$ is real. The symmetrized quantity $\langle \frac{x^2 + px}{2} \rangle$, however, is real. Therefore, we may use

$$\frac{x \frac{\hbar}{i} \frac{\partial}{\partial x} + \frac{\hbar}{i} \frac{\partial}{\partial x} x}{2}$$

to represent $xp$.

Ex.7 A particle is described by the following wavefunction

$$\Psi(x, t) = Ae^{-|x|/L}e^{-iEt/\hbar}$$

where $E$ is the total energy and $A$ is a normalization constant. (a) 15 Find $\langle x \rangle$, $\langle x^2 \rangle$ and $\Delta x$. (b) 10 Find the probability for finding this particle in the range $(-L, L/2)$. What is the probability of finding the particle exactly at $x = 3L$? (c) 5 Find the probability current at $x$. (d) 10 Evaluate $\langle p \rangle$ and $\langle p^2 \rangle$

Ex. 8 10 Show by explicit calculation that

$$\int_{-\infty}^{\infty} dx \psi^*(x) x \psi(x) = \int_{-\infty}^{\infty} dp \phi^*(p) \left( i\hbar \frac{\partial}{\partial p} \right) \phi(p)$$