PHY-851 QUANTUM MECHANICS I
Homework 2, 30 points
September 12 - 19, 2001
Wave function and uncertainty relation.

Reading: *Merzbacher*, Chapters 1,2.

1. /5/ *Merzbacher*, Exercise 2.2, p. 16.

2. /4/ *Merzbacher*, Exercise 2.7, p. 21.

3. /7/ *Merzbacher*, Problem 3, p. 24.

4. /6/ Find the relation between the wave functions $\Psi(x,t)$ and $\Psi'(x',t)$ describing free motion of a nonrelativistic particle in the inertial frames K and K', respectively, if the frame K' uniformly moves relative to the frame K with velocity u in the positive direction of the x-axis.

5. /8/ An initial wave packet ($t = 0$) for a free moving nonrelativistic particle of mass m is a superposition of the De Broglie waves with the amplitude

$$\phi(k) = Ne^{-\alpha^2(k-k_0)^2}, \tag{1}$$

where N is a normalization constant, k_0 and α are real parameters.
a. Find the probability density $\rho(x, t = 0)$ of the particle localization.
b. Test the uncertainty relation at $t = 0$.
c. Find the wave function of the packet and probability density for the coordinate and momentum at arbitrary $t > 0$.
d. Determine the position of the centroid of the packet, uncertainties of the position and the momentum of the particle, and the uncertainty relation as a function of time.