

Homework #3 for Physics 371

Due 4pm Friday, February 5

For problems 1–5, consider the wavepacket

$$\psi(x) = A \exp \left[ik_0 x - \frac{(x - x_0)^2}{4\sigma_x^2} \right].$$

- 1) Determine A (i.e., normalize ψ).
- 2) Find $\tilde{\psi}(k)$.
- 3) Determine $\langle x \rangle$ and Δx .
- 4) Calculate $\langle p_x \rangle$ and Δp_x .
- 5) Calculate the probability current $j(x)$.
- 6) Show that the energy of the lowest state of a particle in a one-dimensional box is consistent with the uncertainty in momentum as required by the uncertainty principle. Would a state with $E = 0$ satisfy the uncertainty principle?
- 7) Consider the Schrödinger equation for a complex potential

$$V_1(x) + iV_2(x),$$

where V_1 and V_2 are real functions. Follow through the derivation of the continuity equation with this potential, and find the additional terms that appear when $V_2 \neq 0$. Describe in words the effect of the additional terms for both positive and negative V_2 .