Physics 309

Matter Waves - 2

A particle beam has a continuous wave function that can be described by

$$\Psi(x,t) = e^{i(k_0 x - \omega t)} \qquad .$$

This equation describes a wave train moving in the positive x direction. A beam 'pulse' of length L is produced by sending the beam through a 'chopper' that opens long enough to let part of the original beam through and then closes again, cutting off the remainder. The wave function of the pulse at time $t = 0$ is:

$$\begin{aligned} \Psi(x,0) &= \frac{1}{\sqrt{L}} e^{ik_0 x} \qquad |x| \leq L/2 \\ &= 0 \qquad\qquad\quad |x| > L/2 \qquad . \end{aligned}$$

1. Find the spectral distribution (i.e. the spectrum of wave numbers) necessary to produce such a wave packet.

2. Plot the spectral distribution. What do the maxima and minima correspond to? What criteria would you use to measure the width of the distribution?

3. Use the criteria established in part 2 to calculate the width of the spectral distribution.

4. Generate an uncertainty principle appropriate for this wave packet.

5. What do you think will happen to this wave packet at time increases?