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Übungen zur Vorlesung
Quantenmechanik für Nanostrukturwissenschaftler und Lehrer

Exercise 2

Task 1

The relation between the wavelength λ and the frequency ν in a waveguid is given by

$$\lambda = \frac{c}{\sqrt{\nu^2 - \nu_0^2}} \, .$$

Calculate the group velocity of the wave.

Task 2

Let's consider a double slit experiment, where the wavefunction of slit 1 has a random phase, over which it will be averaged. The entire wavefunction on the screen will be $\Psi(x,t) = e^{i\phi}\Psi_1(x,t) + \Psi_2(x,t)$. (Possible by a incoherent source of electrons in front of one of the slids). Show that with these conditions the interference disappears.

Task 3

The wavepacket is given with

$$A(k) = \begin{cases} N & , -K \leq k \leq K \\ 0 & , sonst \end{cases} \quad .$$

Calculate $\Psi(x,0)$ and show that for a suitable choice of the width, the bandwidth product fulfills the conditions introduced in the lecture (book).
AID: Definition of the wavepacket

$$\Psi(x,0) = \int_{-\infty}^{\infty} dk A(k) e^{ikx}$$

Task 4

What is the probability current $j(x,t) = \frac{\hbar}{2im}\left(\psi^* \frac{\partial \psi}{\partial x} - \frac{\partial \psi^*}{\partial x}\psi\right)$ for a wavefunction with
a) $Ae^{ikx} + Be^{-ikx}$ and **b)** $Ae^{-\alpha x}$?
Interprete your results.