Exercises for the lecture:
"Experimental physics 5c, Condensed matter physics"
Winter semester 2019/20
Prof. Dr. H.J. Elmers
Dr. T. Mashoff

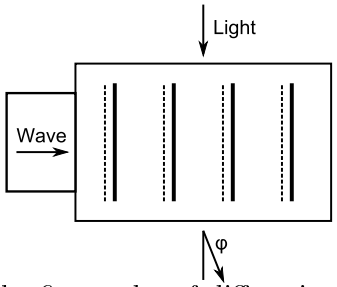
JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Exercise sheet # 6
Group A: Monday 13-14, Lorentz-Room
Group B: Tuesday 10-11, Seminar room A
Group C: Wednesday 10-11, Galilei-Room
Group D: Friday 14-15 Seminar room 1 KP

Issued: 18/11/2019
Due: 25/11/2019, 12:00 p.m.
Mailbox No. 23 in the physics building

Exercise 13 (2P)

An ultrasonic transmitter sends a plane wave through a fused quartz crystal ($\nu = 250MHz, c_s = 5930m/s$). Infrared light with a wavelength of $\lambda_L = 1.1\mu m$ is sent perpendicular to this wave through the crystal. The refraction index of fused quartz for this wavelength is $n = 1.45$.



At which angle with respect to the original light beam, one can observe the first order of diffraction?

Exercise 14 (1+2+2P)

Consider a two-dimensional solid of identical atoms of mass M on a square lattice of lattice constant a. Investigate vibrations perpendicular to the lattice plane. The interaction between nearest neighbors is given by the spring constant C. The deflection of an atom in column l amd row m perpendicular to the plane is described by $u_{l,m}$.
a) Write down the equation of motion for the atoms.
b) Determine the dispersion relation $\omega(\vec{q})$. (Use: $u_{l,m} = u_0 \exp\{i[q_x la + q_y ma - \omega t]\}$)
c) Calculate the speed of sound. Does it depend on the direction of $\vec{q}$?

Exercise 15 (2+2P)

Calculate, how strongly the following reflexes of silicon are reduced when measured at room temperature ($T = 300\,\mathrm{K}$) compared to very low temperatures ($T \approx 0\,\mathrm{K}$).
a) [100]-reflex
b) [400]-reflex
(Silicon: lattice constant $a = 543.1\,\mathrm{pm}$, atomic mass $M = 28\,\mathrm{u}$, phonon frequency $\nu = 1.4 \cdot 10^{13}\,\mathrm{Hz}$)