Modern Physics

Winter Semester 22/23

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Exercise 2

§ Classical Wave Optics §

Problem 1: Thin film interference at an aerial wedge

Two glass plates are separated by a single hair with a diameter of 40 μm. As a result, an aerial wedge is formed of length 10 cm. Light with a wavelength of 550 nm arrives vertically on the glass plates (take the 1st glass plate as the horizontal one). The light reflected off this aerial wedge shows a peculiar pattern of bright and dark fringes.

(1) How can you explain this modulation of the reflected intensity?

(2) Calculate the condition of the m-th dark fringe with respect to the point of contact of the two glass plates. & *Hint*: Use the small angle approximation $\tan(\theta) \approx \theta$.

(3) Determine the distance between two adjacent dark fringes.

(4) What changes when the aerial wedge is filled with water instead?

Problem 2: Fraunhofer diffraction: single slit, double split and optical grating

Parallel light with the wavelength of $\lambda = 600$ nm hits vertically on a single slit of width 5 μm. Behind the slit, a screen is placed at a distance of 1 m.

(1) Derive under which angles θ the first and second intensity minima are observed.

(2) Make a sketch of the intensity distribution viewed on the screen. What is the distance y_0 between the two minima of 1st order.

(3) Calculate the positions of the diffraction maxima in case of a double slit with a slit distance of $\mathrm{d} = 10\ \mu\mathrm{m}$ (from midpoint of one slit to midpoint of second slit) and a slit width of $a = \frac{d}{2} = 5\ \mu$m. Make a sketch of the intensity distribution.

(4) How does the intensity distribution change on the screen, when the light impinges now on a diffraction grid with N slits instead of a single slit or a double slit?

Problem 3: Michelson interferometer

A 5 cm long empty tube with glass windows at both ends is inserted into one arm of a Michelson interferometer. The pipe is evacuated and the mirrors of the interferometer are adjusted such that there is a bright fringe in the center of the screen (detector). When the pipe is slowly vented, a total of 49.6 rings move by. The wavelength of the light is 589.29 nm. How many wavelengths fit into the pipe, when ...

(1) ... the pipe is evacuated?

(2) ... the pipe is vented?

(3) What value for the refractive index of air can you deduce from this experiment.