

Micro-optics

Winter semester 07/08

Exercise 4

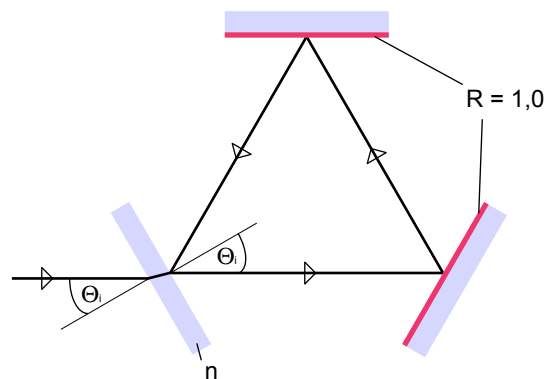
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Discussion sections: Nov 21 & 22, 2007

1 Triangular ring resonator (40 P)

Given a ring resonator in which the light is traveling on a triangular path. The incidence and reflection angle on all mirrors is 30° . Two of the mirrors are perfect, i.e., no losses upon reflection. The third is used for coupling in of light. It consists of a plane-parallel GaAs slab with a refractive index of $n = 3.45$ and a thickness of $380 \mu\text{m}$. The medium between the mirrors may be regarded as lossless.

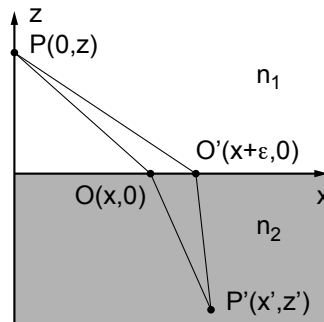


Consider the intensity of the circulating wave in the resonator. After how many circulations does the intensity drop below 1% of its initial value (i.e., immediately after coupling in)? Does the polarization make a difference?

2 Fermat and Snell (30 P)

Consider the physical situation shown in the image below. A light beam is traveling from a point P (situated in a medium with a refractive index n_1) to an image point

P' (situated in a medium with a refractive index n_2). The refraction happens at point O . Calculate the optical path difference (OPD) between alternative paths (POP' and $PO'P'$) as a function of the displacement ϵ of the refraction point, and, using this OPD, derive Snellius' refraction law from Fermat's principle!

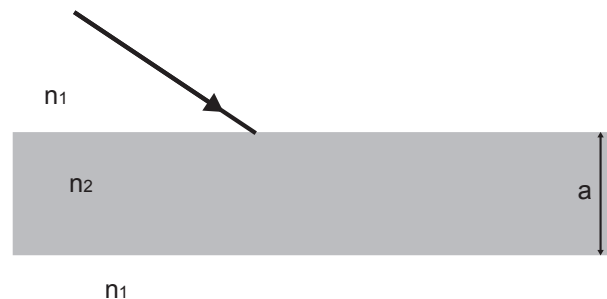


3 Refraction (30 P)

A monochromatic beam hits a plane-parallel transparent plate (s. drawing) at incidence angle θ_i . The refractive index n_2 of the plate is greater than n_1 .

3.1 Path of rays (5 P)

Sketch the optical path without reflections. Label according to Snell's law.



3.2 Parallel output beam (5 P)

Explain why the outgoing beam is parallel to the incoming one.

3.3 Beam displacement (15 P)

Calculate the displacement between incoming and outgoing beam for $n_1 = 1$.

3.4 Interpretation (5 P)

Which quantities do directly affect the displacement and how does the displacement qualitatively vary with these?

