Problem Set No. 1, Laser Physics I, WS 10/11 **29/10/10**

Topic: Fresnel-Reflection

Administratives:
The exercises will be every 2nd week. Everybody has to demonstrate at least 2 problems.
This problem sheet is to be done until 2010-11-10.

Problem 1.1
Explain: Can a glass plate (index of refraction n=1.5) be used to generate a linearly polarized light field (from an un-polarized beam) ? Describe the experimental setup. This setup constitutes a linear polarizer.

Problem 1.2
Assume that a source of light generates linear polarized, plane electro-magnetic fields of exactly that polarization, which is passed by the polarizer of problem 1.1, i.e. the light field polarization is optimized for maximum "transmission". Which fraction of the incident light is detected at the output of the polarizer (this is typically called "insertion loss", *Einfügedämpfung*). Would you like to use such kind of polarizer in your setup?

Problem 1.3
Background information: often laser beams are used, which can be described by the Gauss-Laguerre fundamental mode (more later). These laser beams ALWAYS have a non-zero beam divergence, i.e. they are not perfectly parallel beams. The half width divergence angle θ_0 measured in the far field (i.e. "sufficiently" far away from the focus) and the focus radius w_0 are related to each other according to

$$\theta_0 = \frac{\lambda}{\pi \cdot w_0}$$

As typically $w_0 >> \lambda$, the half width divergence angle will typically satisfy $\theta_0 << 1$.

Because of the far field divergence of the Gauss-Laguerre fundamental mode it is not too surprising that the latter can be decomposed into a superposition of plane waves which all share the same wave number (consequently also the same wavelength and frequency) but all propagate in slightly different directions. The typical angular separation of two such plane wave components is given by the half width divergence angle.

Explain qualitatively: does the non-zero far field divergence of a Gauss-Laguerre fundamental mode affect the performance of the polarizer of problem 1.1?