Problem Set Nr. 3 , Laser Physics, WS 10/11 **07/12/10**

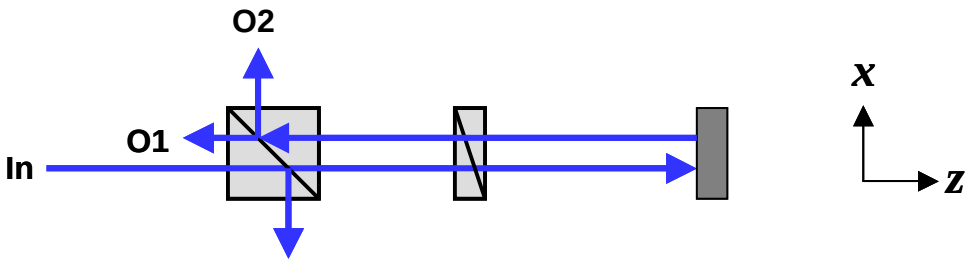
Topic: Polarisation

Problem 3.1
Analyze the function of the primitive optical diode shown below.

Problem 3.1.1
Determine the Jones-matrices which relate the polarization at the input **IN** with the polarization at the two outputs **O1** and **O2** of the optical diode. The quarter wave plate is oriented such that light linearly polarized along x- or y-direction is converted into purely circular polarized light, i.e. the fast axis of the wave plate is titled by 45 deg with respect to the x-axis.

Problem 3.1.2
Analyze how field amplitude and power of the light at the outputs **O1** und **O2** depend on the polarization of the light injected at the input. To this end describe the polarization of the injected field by a superposition of polarizations along the x- and y-axis (p and s polarization, respectively). Interpret the result: does this setup act like an optical diode?

Problem 3.1.3
Assume for the following that the mirror does not preserve polarization. In a real optical setup the reflected beam often has arbitrary polarization or can be considered unpolarized. Determine the performance of the optical diode if the light reflected by the mirror is unpolarized, i.e. half of the optical power corresponds to light which is p-polarized and s-polarized, respectively.



polarization beam splitter

QWP, fast axis under 45 deg with respect to x-axis

mirror

Topic: Beam Propagation

Problem 3.2
The Paper H. Kogelnik and T. Li. *Laser Beams and Resonators*, Applied Optics, Vol. 5, No. 10, 1550-1567 (1966) gives an overview about the propagation of Gaussian beams.

Problem 3.2.1
Assume you have a diode laser emitting at 780nm in the perfect Gaussian TEM_{00} mode with a beam divergence (FWHM) of 20°. That bea m propagates in air. Please calculate the focus radius (half width at $1/e^2$-value) and the Rayleigh range.

Problem 3.2.2
In general: What is the strategy to get a well collimated beam?

Problem 3.2.3
Assume you want to characterize the isolation of a Faraday isolator with a clear aperture of 1mm. To do that you need a beam with a diameter (full width at $1/e^2$-value) of about 2/3 of that aperture. Select an appropriate lens (e.g. from the Thorlabs online catalogue) and determine the optimal distance from the laser exit facet.