TFY4195 - Optics Suggestions

August 2020

1 Assignment 1

Matrix methods in paraxial optics. System of "random" surfaces for refraction and reflection, analyzed with matrix representations.

(a) Find matrix-representation of each part of the optical system (lenses, different apertures)

(b) Calculate the composite system matrix.

(c) Change refractive index and/or angle of incidence. Show how the refraction changes (show/explain Snell's law perhaps).

2 Assignment 2

(Fraunhofer) diffraction with ipywidgets (gliders, text-boxes, radio buttons, etc) in Jupyter Notebook. Makes it more dynamic when changing the values in the physical system (amount of slits, distance between slits, slit length, slit width (square aperture vs narrow slit), aperture geometry (circular, square), wavelength, distance to screen. Visualized by plotting with matplotlib: regular lines and heatmaps, as in Pedrotti page 331.

- Change some of the values listed above and describe how the plotted values/patterns change.
- Could plot electric field (this is complex) and irradiance on screen from different slit configurations, based on the results/equations from theory.
- Add in some diffraction grating, with the grating equation etc ?
- Specify some of the consequences of the Fraunhofer approximation ?

3 Assignment 3

Polarization: Work with Jones vectors and matrices.

(a) Given some Jones vectors, analyze them and plot the Lissajous figure. Perhaps show that linearly polarized light can be regarded as being made up of left- and right- circularly polarized light in equal proportions.

(b) Jones matrices: Play with linear polarizer, phase retarder, rotator and composite systems (matrices) of these polarizers.

4 Project

Fourier Optics.

- Spatial filtering perhaps: Use some filters and see how they change the Fourier spectrum and ultimately the image of the object. Improve quality of laser beams (lens fourier transform, look at point below) and remove undesired structures from images are some examples of use-cases of filtering.
- Lens Fourier Transform: A lens has a Fourier transform-property. The project could visualize this property.
- Could tie this to the Fraunhofer diffraction and use Fourier analysis to derive/explain some of the results used in the task on Fraunhofer diffraction. When using the Fourier transform we can have any slit configuration we want, by just changing the aperture function (Point Spread Function, PSF) (add phase, change opacity), which makes it powerful!

Sources: Pedrotti (Optics). Other sources on www.