LDA Exercise

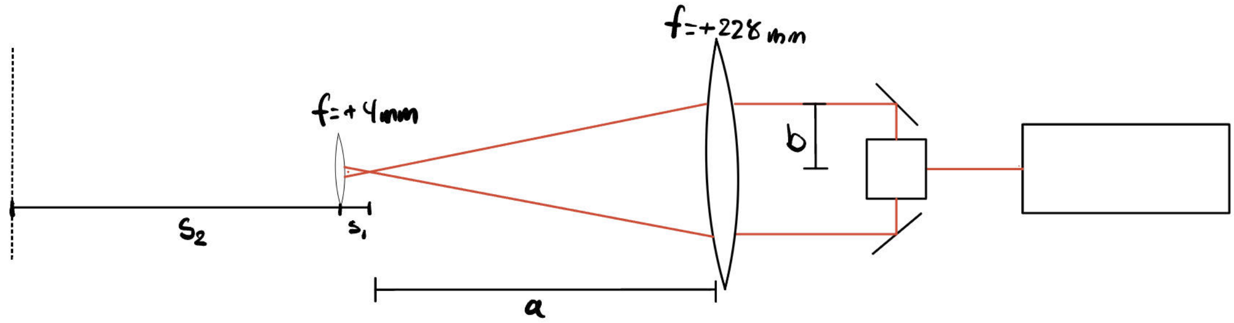

Figure 1: Relavent geometries of setup

For determining the fringe spacing in the interference pattern, magnification is utilized using a lens. For determining the magnification factor the following equation is used:

$$M = -\frac{s_2}{s_1}$$

For the first experiment, it is known the two beams interests $s_1 = 4\text{ mm}$ from the lens. This image is shown on a wall placed $s_2 = 319\text{ cm}$ from the lens. This gives a magnification of

$$M_1 = -\frac{3.19\text{ m}}{0.004\text{ m}} = -797.5$$

The fringe spacing is measured with an average of 10 maximums on the image, giving a measured fringe spacing of $d_{f,1,image} = 1.4\text{ mm}$. This is magnified so the actual measured fringe spacing is

$$d_{f,1,meas} = \frac{d_{f,1,image}}{M_1} = \frac{1.4\text{ mm}}{797.5} = 1.755\text{ µm}$$

This can be compared to the theoretical fringe spacing calculated with

$$d_f = \frac{\lambda}{2 \cdot \sin\left(\frac{\theta}{2}\right)}$$

Where λ is the wavelength of the plane wave and θ is the angle between the incoming waves. The wavelength of the used laser is $\lambda = 633\text{ nm}$. The angle is through geometry

$$\theta = 2\tan^{-1}\left(\frac{b}{a}\right)$$

Here b is measured to be 33.5 mm and a is measured to be 190 mm. This results in a angle of

$$\theta_1 = 2\tan^{-1}\left(\frac{33.5\text{ mm}}{190\text{ mm}}\right) = 0.3490441$$

Then the theoretical fringe spacing is

$$d_{f,1,theo} = \frac{633\ \mathrm{nm}}{2 \cdot \sin\left(\frac{0.3490441}{2}\right)} = 1.823\ \mathrm{nm}$$

Now the experimental setup is changed, so that the spacing between e.g. the two lenses is new. Now the new values of a and b is $228\ \mathrm{mm}$ and $34.5\ \mathrm{mm}$ respectively. This gives the angle:

$$\theta_2 = 2\tan^{-1}\left(\frac{34.5\ \mathrm{mm}}{228\ \mathrm{mm}}\right) = 0.3003531$$

The wavelength of the of the laser is still $\lambda = 633\ \mathrm{nm}$, leading to a theoretical fringe spacing of

$$d_{f,2,theo} = \frac{633\ \mathrm{nm}}{2 \cdot \sin\left(\frac{0.3003531}{2}\right)} = 2.115\ \mathrm{\mu m}$$

The distance between the object (interference pattern) and the lens is still $s_1 = 4\ \mathrm{mm}$ but now the distance between the image (wall) and the lens is $s_2 = 3.23\ \mathrm{mm}$. This gives an magnification of

$$M_2 = -\frac{3.23\ \mathrm{m}}{0.004\ \mathrm{m}} = -807.5$$

The measured fringe spacing shown in the image is $d_{f,2,image} = 1.55\ \mathrm{mm}$. This gives a measured fringe spacing of

$$d_{f,2,meas} = \frac{d_{f,2,image}}{M_2} = \frac{1.55\ \mathrm{mm}}{807.5} = 1.920\ \mathrm{\mu m}$$