5.1 Initial Observations

To start this investigation, you will explore some of the basic principles needed to understand this setup. Use the mercury lamp with the green filter to observe the interference pattern. Block one of the arms of the interferometer with a sheet of paper and see how the interference pattern changes (not the arm in the exit plane). Next, ensuring both arms of the setup are clear remove the ground glass plate. Take an image of the interference patterns at each of these steps.

Checkpoint 1: Check your understanding with your tutor and show them your analysis in your lab notebook.

We tuned the machine to show clear

Peaks of interference

5.2 Mirror Alignment

Next, the effect of relative mirror tilt will be examined. Ensure the interferometer is restored to its original state from the previous experiment.

Start by adjusting mirror two (the adjustable mirror) about one axis very slowly. Note down the direction of orientation change in the mirror and its effect on the observed interference. Take an image of

the resulting interference. Now restore the mirror to its original orientation and adjust the mirror about the other axis, take and image. Now restore the mirror to its original position.

Checkpoint 2: Check your understanding with your tutor and show them your analysis in your lab notebook.

As dials were changed the interference pattern become less clear as it strayed from its original position.

When focused, small adjustments caused the rings to move inward/outward.

5.3 Mirror Displacement

The derivation of the relationship based on equation (2) allows you to determine the wavelength of light while varying d. Conversely, if the wavelength is already known, then the distance the mirror is displaced for one increment of the micrometer can be found. Hence, calibrating the interferometer for finding unknown wavelengths.

To start, you will calibrate your interferometer and find the value for d for each increment on the micrometer. Set up a camera to observe the viewing plane and devise a method to count the number of rings that pass a single stationary point in the frame of the camera as the micrometer is adjusted. This will be needed as you will plot number of rings passing the reference points vs number of increments moved on the micrometer.

Adjust the micrometer (5 increments is a good start) and count the number of fringes that pass the reference point. Repeat the measurement but increase the number of increments the micrometer is adjusted. Do this for at least 5 different sets if increment changes (20 increments is a good place to end). From this create a plot of number of micrometer increments vs number of rings passing a reference point. Since the wavelength of this light is known from the gradient of this plot you can calculate the actual distance the micrometer displaces the mirror for one increment.

Checkpoint 3: Check your data with your tutor and show them your regression in your lab notebook.

$d = nL$ $\qquad$ $2d = m\lambda$

$\therefore 2nL = m\lambda$ — Number of waves

$n = \frac{m\lambda}{2L}$

number of increments

length mirror travels

First used known λ for Mercury to find d.
Then find λ for Sodium.

Data with λ_{Mer} => grad: $\frac{\lambda}{2L}$ => $L = \frac{\lambda}{grad \times 2}$

$\therefore L = 526\,nm$

$L_{Theory} = 500nm$

5.4 Wavelength calculation

Now that the displacement of the micrometer is known, replace the mercury lamp with the sodium lamp, repeat the same experiment but this time find wavelength from the gradient of the plot.

Checkpoint 4: Check your data with your tutor and show them your regression in your lab notebook.

Same Setup maintained 40 to higher

5.5 Wavelength Separation

In the previous experiment, you may have noticed that the contrast between the fringes at times is poor. The reason for this is that the sodium D 2 line 889nm is actually two closely spaced lines with wavelengths of 588.9950 and 589.5924. As according to theory, these lines will create slightly different interference patterns. Adjust the mirror distance until maximum contrast between fringes is seen. Then adjust the mirror until no contrast is seen then to the next point of maximum contrast. (Why might it be easier to go from max contrast to max contrast then half this distance than go from max to no contrast?). From this the wavelength separation can be found.

The derivation of a relationship based on equation (2) that allows you to determine the difference between two wavelengths that are used to illuminate the interferometer. [Hint: you will need to use equation (2) for both of the sodium wavelengths. This will give two equations, take the difference between these two and make relevant substitutions.]

Checkpoint 5: Check your data with your tutor and show them your regression in your lab notebook.

Finding distances between slits.

Find the distance between minima and maxima of interference discernability. Super position of the equation above and by approximating the two wavelengths as equal, delta lambda can be found using the wavelength of sodium calculated above.