4.2: Activities

Equipment

- microwave emitter & detector
- goniometer assembly
- aluminum double slit barrier
- laser & optical bench
- laser slit collection
- tape measure
- masking tape & paper

The General Idea

There are two parts to this lab, both of them involving the same phenomenon of two-source interference.

Part 1

We are given a microwave emitter and microwave detector, which are mounted on opposite arms of a goniometer (a device for measuring angles), with an aluminum barrier that includes two slits between them. The angle at which one or more "bright fringes" are deflected by the double slit interference can be measured by rotating the detector's goniometer arm until the gauge reads a local maximum. From this angle and measurements made on the apparatus, the frequency of the microwaves coming from the emitter are to be calculated.

Part 2

In this part we are given the wavelength of the laser light used ($633nm$), and use the interference pattern on a wall far away to compute the slit separation for a couple of different cases.

Some Things to Think About

These two experiments look very different, but involve exactly the same phenomenon. Each of them has a few features that are distinct from each other, however.

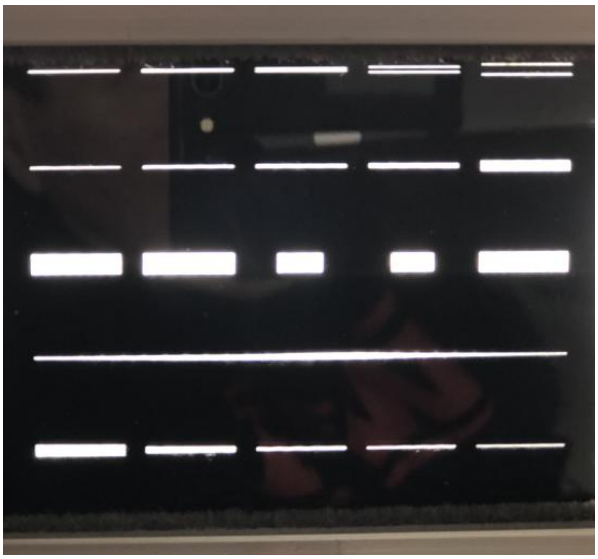
Part 1

- The amount of energy removed from the microwaves by the double slit barrier is substantial. When the emitter and detector are used together without a barrier, the detector does not need to be in a sensitive setting for the needle to move enough to get a good reading, but the sensitivity may have to be increased substantially to get an adequate reading through the double slit. Keep in mind that if you remove the barrier while the detector is in a sensitive setting, the sudden flood of microwaves can spike the needle in the detector, and over-ranging it like this is not good for it.
- The official "bright fringe" location is the point where the needle in the gauge makes its maximum deflection. The "play" you have in changing the angle while still measuring a max deflection is the uncertainty in the angle.
- As always, more data is better! If there are multiple bright fringes (there are at least two – one on each side of the center), you should seek to locate as many as you can. Each one give you an independent calculation of the same value, which you can then average for your best guess at the correct number.
- When you have a solid number for the frequency of the microwaves (with an uncertainty range), check to make sure it lies in the microwave part of the spectrum, and if it does, ask your TA how well you did in determining the frequency, and see if it comes out within the estimated uncertainty.

Part 2

- ***Safety first! Do not look directly into the laser beam, as it can damage your retina. All viewing of the laser should involve seeing it reflected from a dull, diffuse surface, like a piece of paper. It therefore goes without saying that it should not be pointed at anyone, either.***
- The laser is a delicate device, so handle it as little as possible. It is set up on the optical bench for you, and shouldn't need to be moved from there. To alter the vertical position where the laser strikes the plate, try to avoid raising or lowering the laser, and raise or lower the plate instead.
- The glass slide includes several transparent holes that include various combinations of slits. The 5 holes at the top of the slide are the ones we will use for this lab. In the picture below, it is clear that the right two holes are double slits, but all 5 of the

holes across the top feature double-slits, and you can use any two of them for your experiment. Find the separations of the slits for both cases, and provide uncertainty ranges.



- The interference pattern will include *lots* of bright fringes that are, to the extent of our measurements, equally-spaced. If you want to minimize percentage uncertainty, is it a good strategy to base your results on two *adjacent* fringes?
- When doing measurements with bright fringes, please do not write on the wall or on the blackboard (unless you use chalk, but chalk is very imprecise). There is paper and masking tape available for you to use for the purpose of marking fringe positions.

Lab Report

Craft a lab report for these activities and analysis, making sure to include every contributing group member's name on the front page. You are ***strongly encouraged*** to refer back to the Read Me as you do this, to make sure that you are not leaving out anything important. You should also feel free to get feedback from your lab TA whenever you find that your group is at an impasse.

Every member of the group must upload a separate digital copy of the report to their lab assignment in Canvas *prior to leaving the lab classroom*. These reports are not to be written outside the lab setting.
