Recitation 1

Wow, hey, look, interference!

Introductions

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- Lecture Hours: M 8AM, F 3PM
- Recitation Hours: T 10AM, 11AM; Th 9AM, 10AM, 11AM, 12PM
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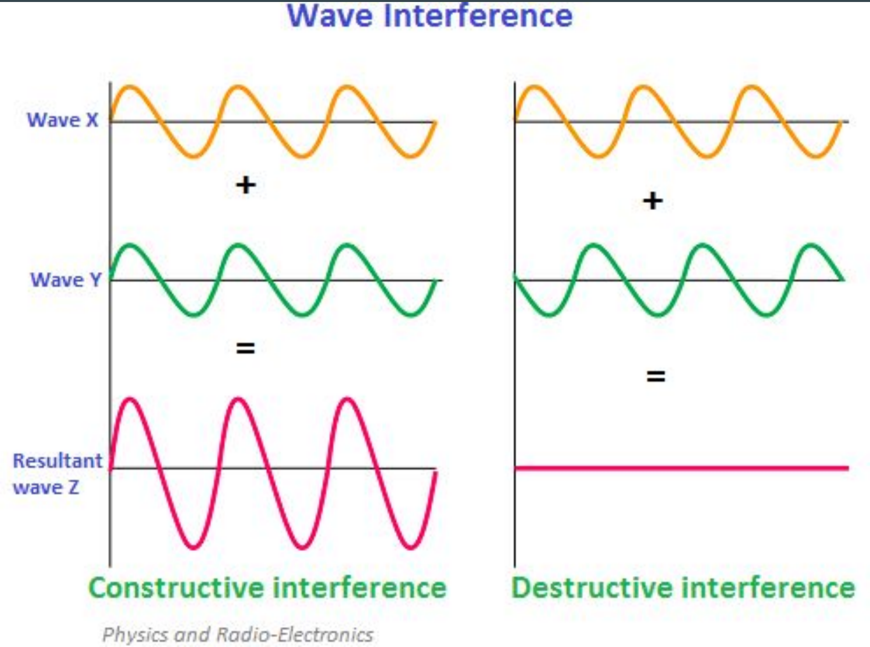
What we'll do in recitation

- Review some of the things you learned over the past week
- Show you why this stuff is cool!
- Practice solving exam-level problems
- Try to clear up confusion

Review: What you’ve done

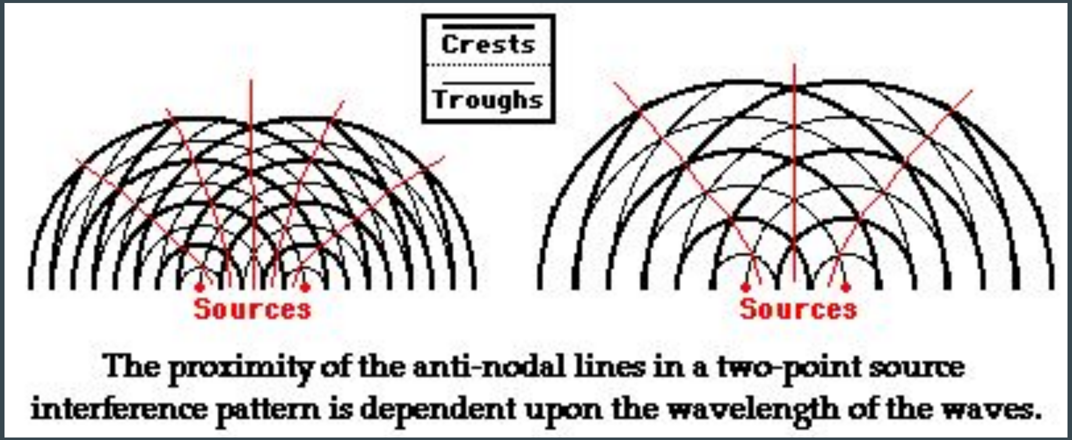
Superposition

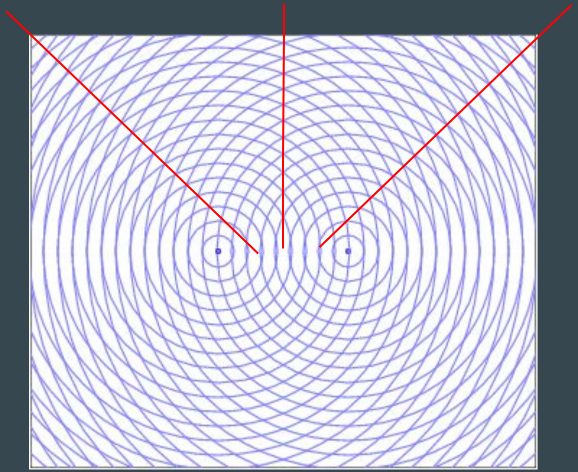
- At the same position in space, the value of two waves add together (superposition)
- Constructive interference
- Destructive interference
- Partially constructive/destructive
- Phase difference simulation



Two-source interference

- Two identical coherent sources (emit one frequency)
- When the sources are farther apart, the antinodal lines are closer together
- When the sources are closer together, there antinodal lines are spread out





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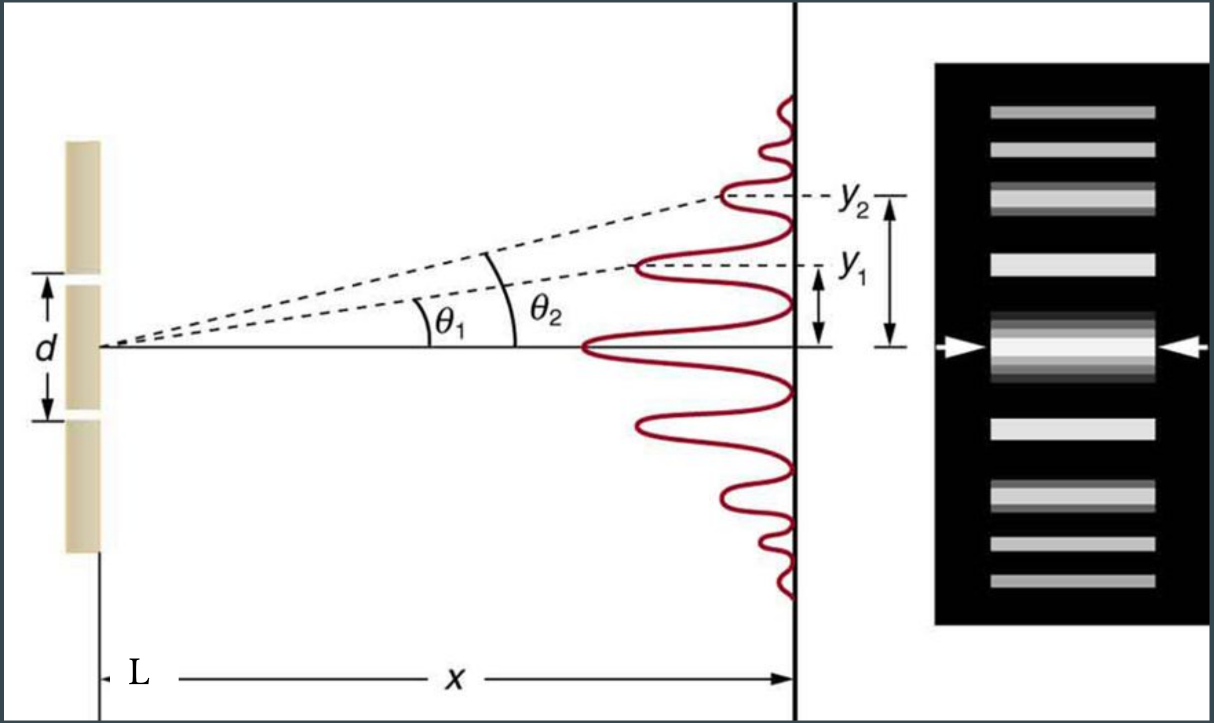
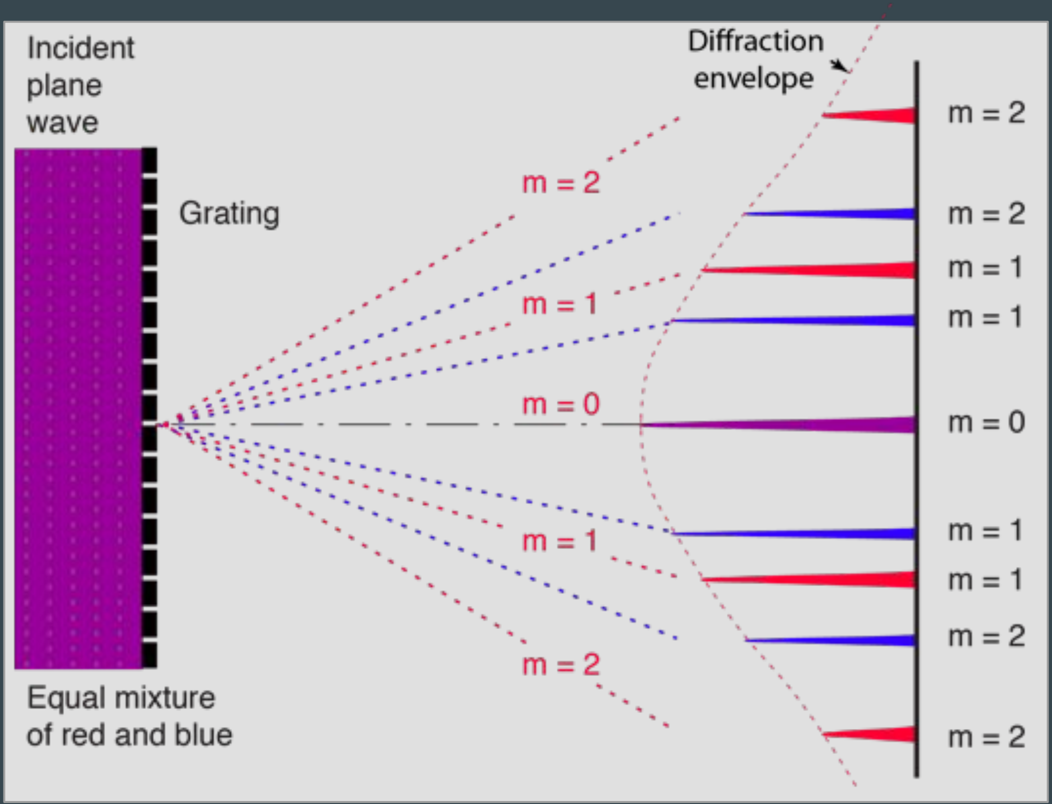
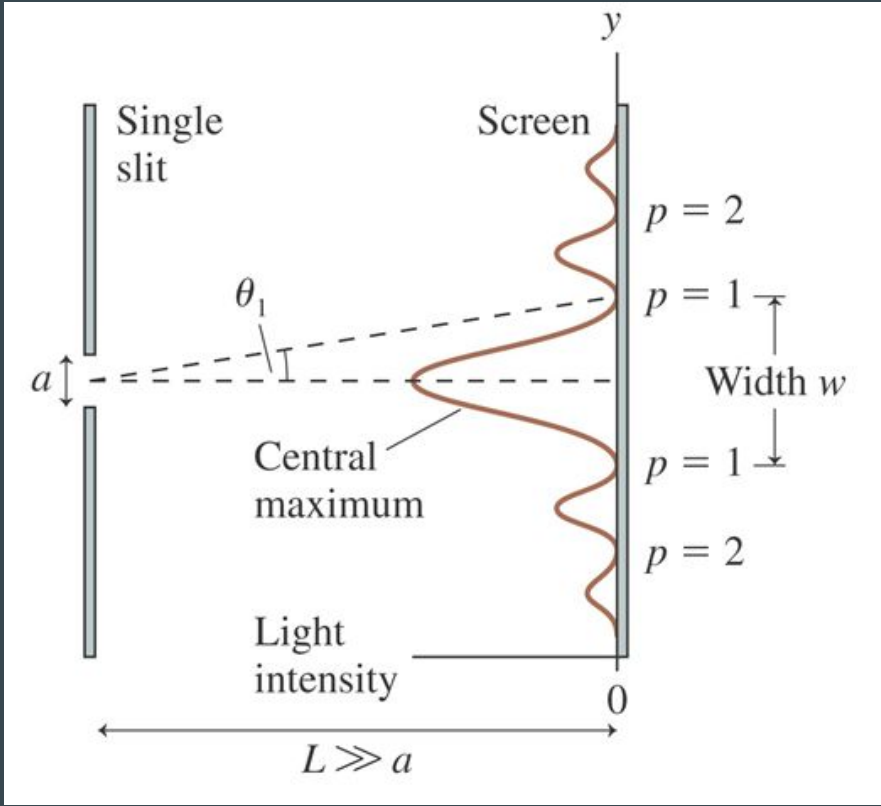
Double Slit Experiment



Diffraction Grating



Single-Slit Interference

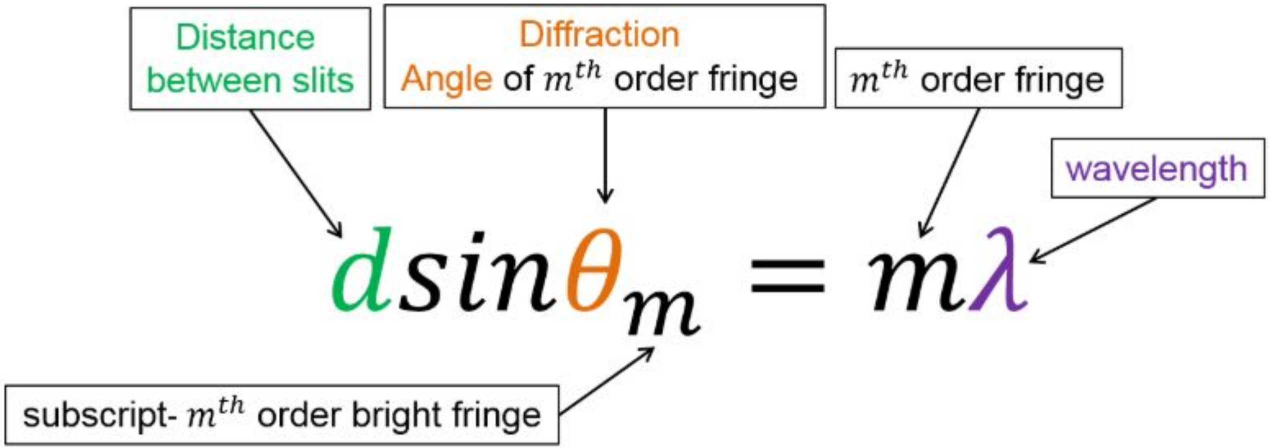


Models in Words

Young's Double Slit Interference

$$m\lambda = d\ sin\theta$$

Models in words



In words: The multiplication of the **distance between slits** and the sine of the **diffraction angle** of the $\boldsymbol{m^{th}}$ **order fringe** which is equal to the product of the $\boldsymbol{m^{th}}$ **order fringe value** and the **wavelength**.

Diffraction Grating Interference

Discuss with your neighbor how a diffraction grating is different from double slits

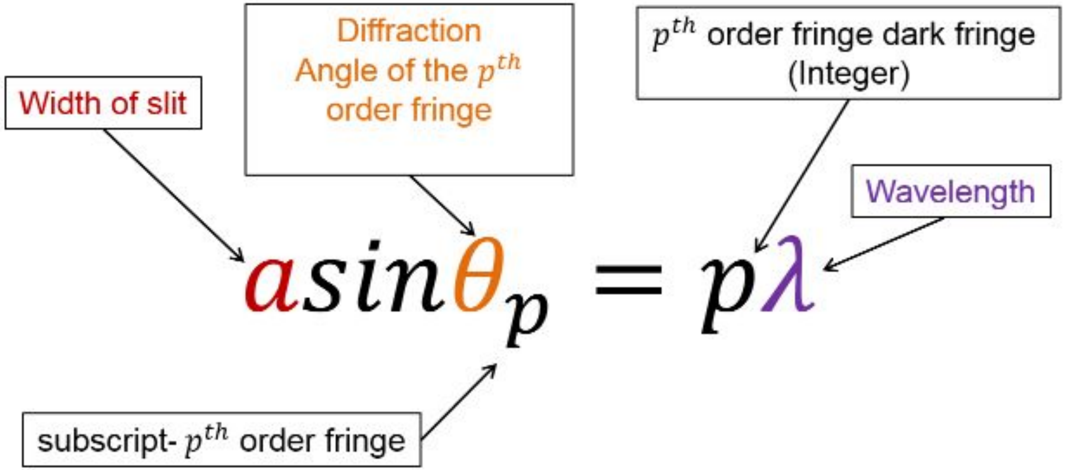
Describe in words the model for interference from a diffraction grating

$$D sin\theta = m\lambda$$

Single Slit Interference

$$a \sin \theta_p = p\lambda$$

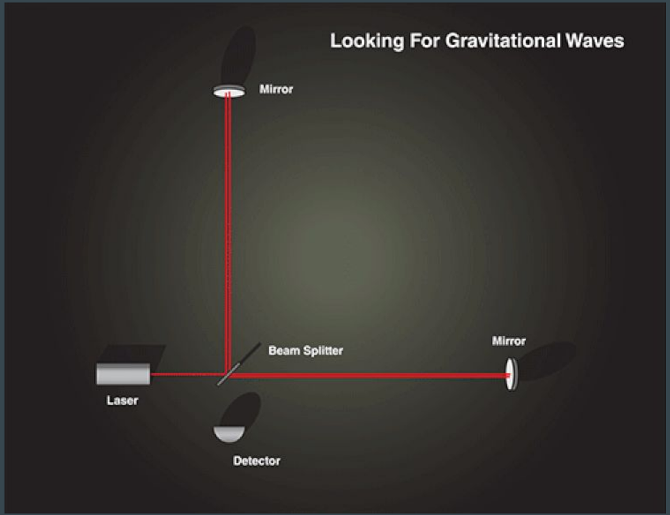
Single Slit Interference

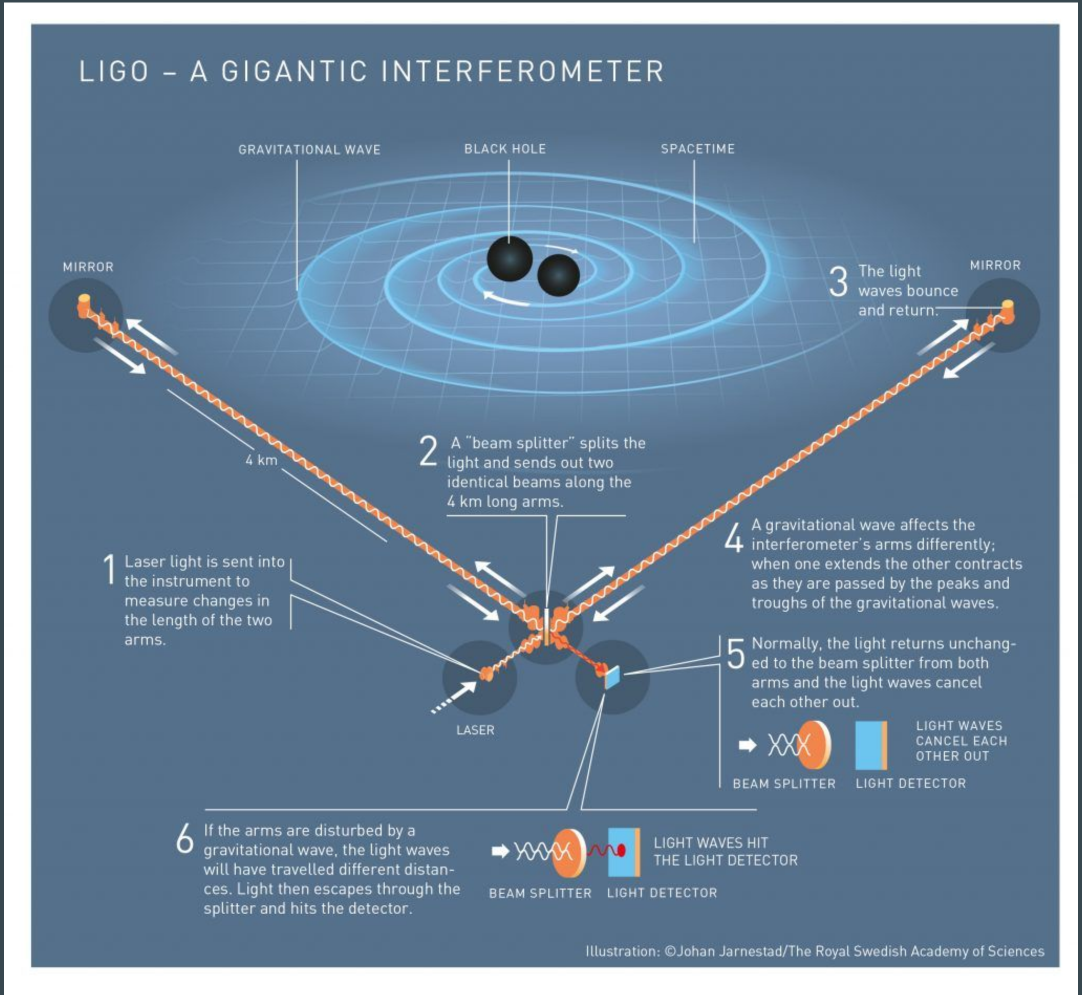


In words: The **width of the slit** multiplied by the **sine** of the **diffraction angle** of the p^{th} **order dark fringe** is equal to the product of the **order of the dark fringe** and the **wavelength**.

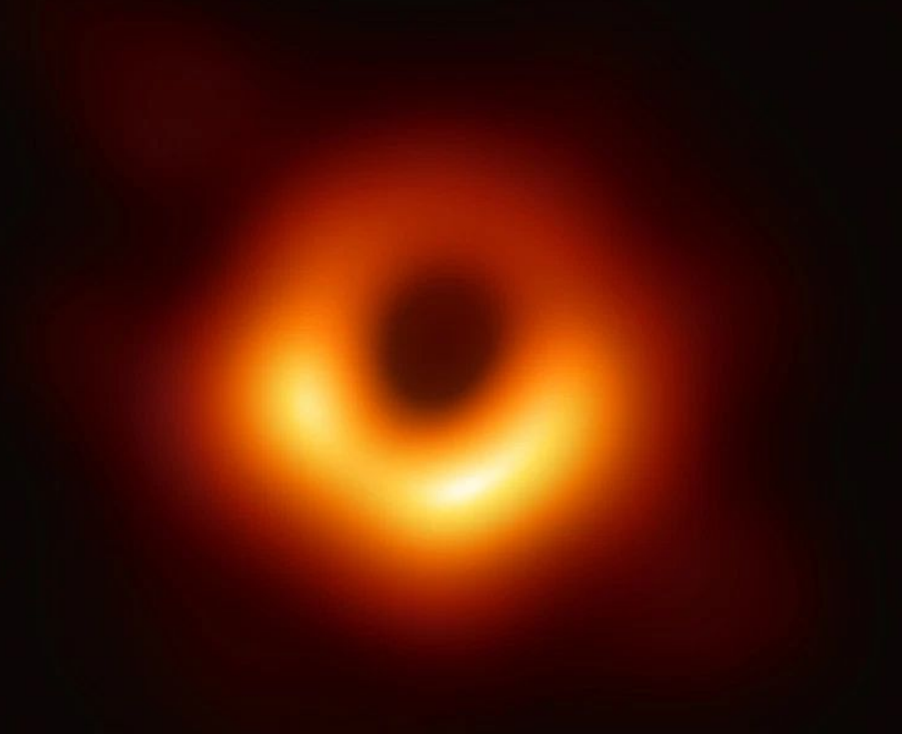
Why it’s cool

Interference can tell us about black holes!





The first image of a black hole



- Center of M87
- 55 Million lightyears away
- 6.5 Billion solar masses

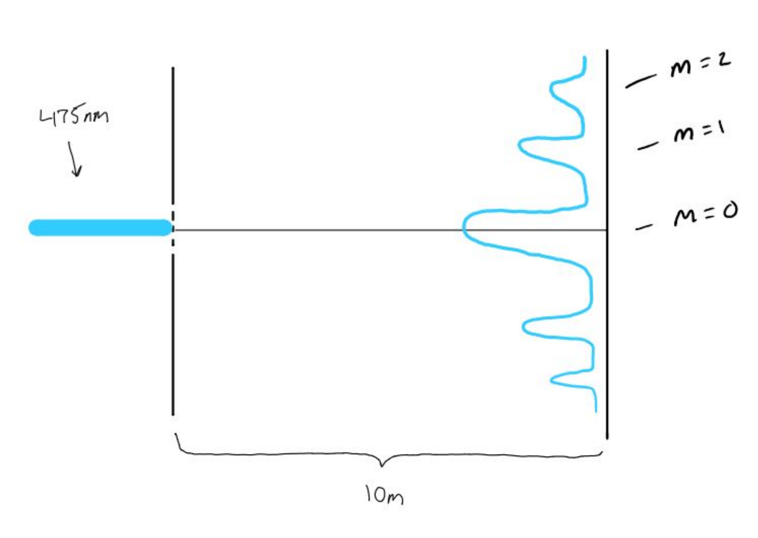
Putting it to practice

S18 Midterm 1, Question 6

A 475 nm wavelength laser produces a diffraction pattern using a **diffraction grating** of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

1. Visualize the problem

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?



2. Identify the equation(s) you need to answer the question

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

$$m\lambda = D sin\theta$$

$$\#\ \text{fringes} = 2m + 1$$

3. Identify the limiting factor

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

What limits the maximum number of fringes visible on the screen? Theta!

What is the maximum value for theta? 90 degrees

What is the order of m so that 15 fringes are visible? $m = 7$

4. Incorporating the limiting factors into the model

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

What does our model look like when we incorporate these limiting factors?

$$D sin 90^o = 7\lambda$$

5. Solve for d

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

$$Dsin90^o = 7\lambda$$

$$D = 7\lambda$$

6. Substituting values in

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

$$D = 7(475nm)$$

$$D = 3.33m$$

Did we finish the problem?

- Nope
- We found the minimum separation to get 15 total bright spots
- We are looking for the range of values d can have that will produce 15 bright spots

7. Do this again for the maximum value d can be!

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

Hint: We won't be using m=7 anymore

Hint: We will use m=8. Discuss with your neighbors why

The answer to 7

A 475 nm wavelength laser produces a diffraction pattern using a diffraction grating of slit spacing D. What is the range of values D can have that will produce exactly 15 bright spots on a screen 10.0 meters away?

$$D = 8\lambda$$

$$D = 8(475nm) = 3.80m$$

$$\boxed{3.33m < D < 3.80m}$$

How does this change if we used a single slit?

- Try it out!