Interferometry

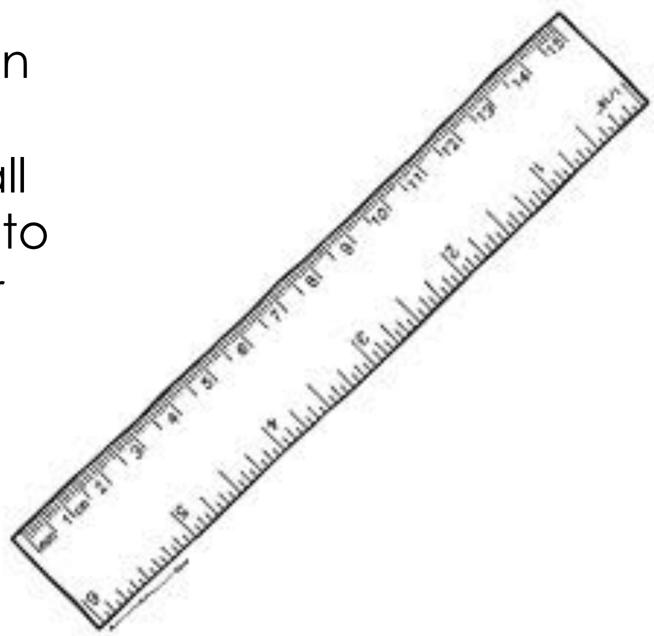
MCC Optics Sizzler

By: Kevin Kha, Brian Bullis, and Haley Emhof

Why?

To measure with high precision.

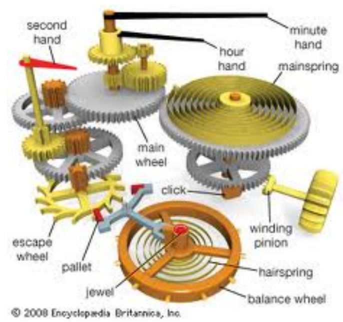
Unlike a ruler, an interferometer can measure all the way down to the nanometer scale.



What can be measured?

Lens surfaces and lenses

Watch components



How fast something is moving

EX. A Zucchini monitor or how fast a glacier moves.

LIGO (Light Interferometry Gravity Observatory)

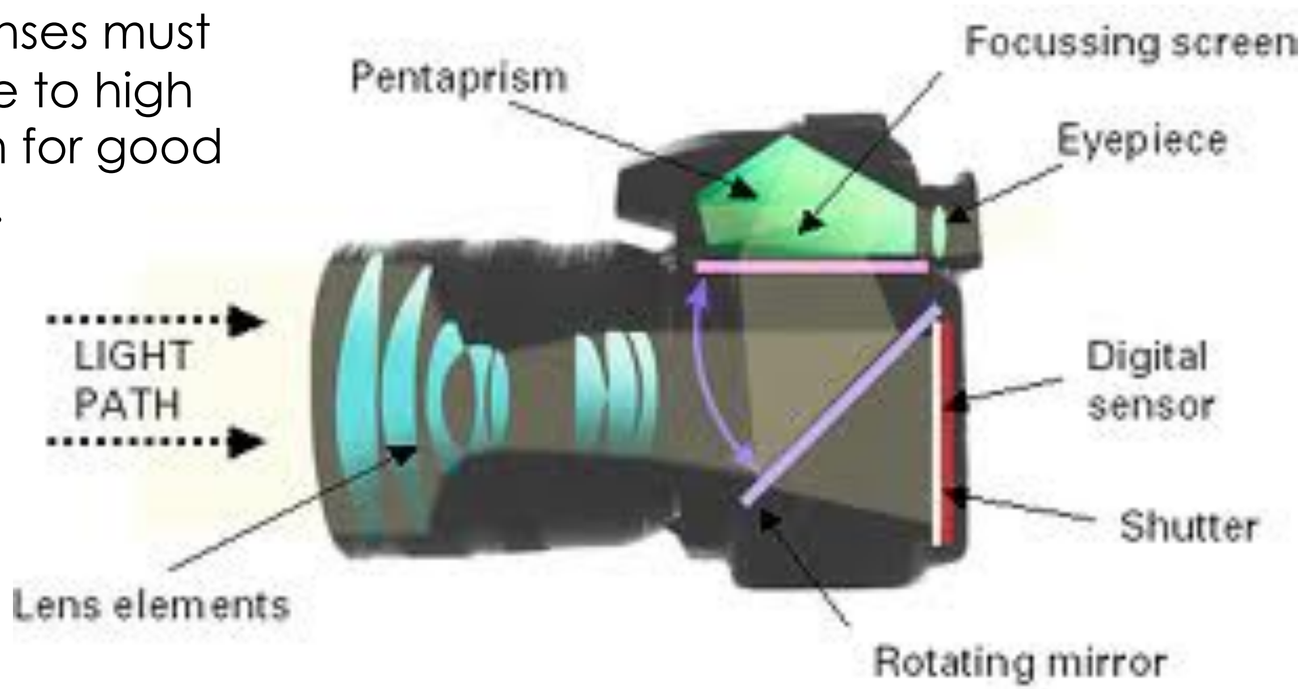
Each arm of this large interferometer is 4 kilometers long and is used to measure gravity waves.

Hanford, Washington

Livingston, Louisiana

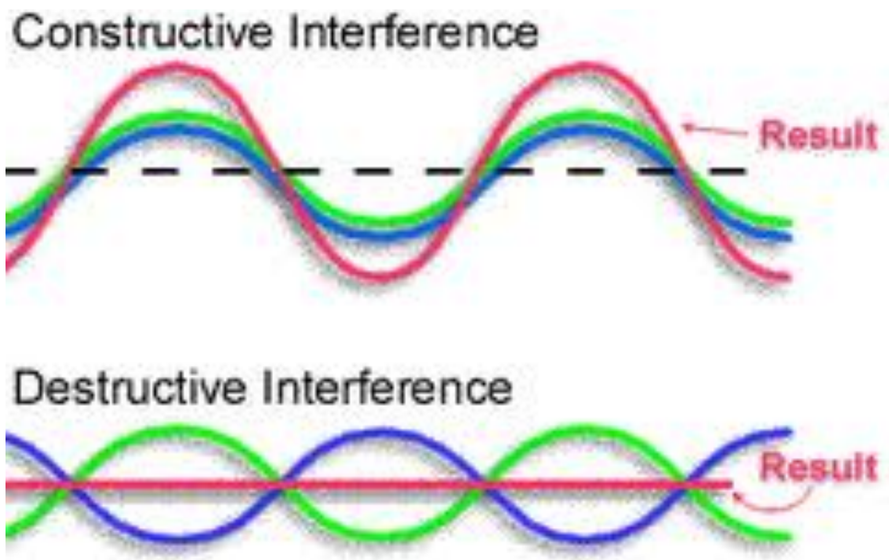
Camera Lens

In order for a camera lens to work the surfaces of the lenses must be made to high precision for good imaging.



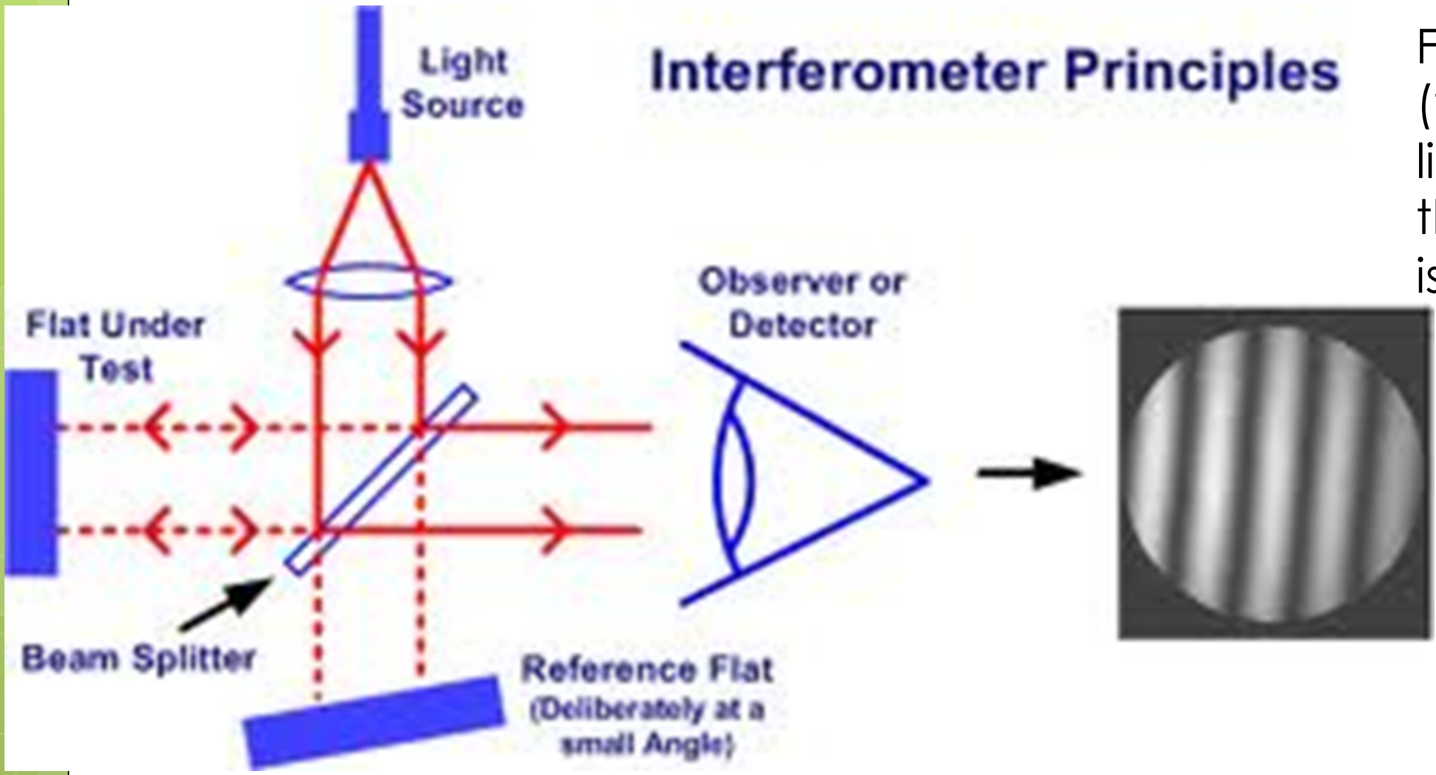
Constructive Vs. Destructive Interference

The measurement of objects is aided by constructive interference, when the crests of two waves match up perfectly and create a larger wave, and through destructive interference, when the crest and trough line up perfectly and cause the light waves to stop.



Interferometer Principles

The light source is split up into two separate beams and are later recombined together, forming fringes.

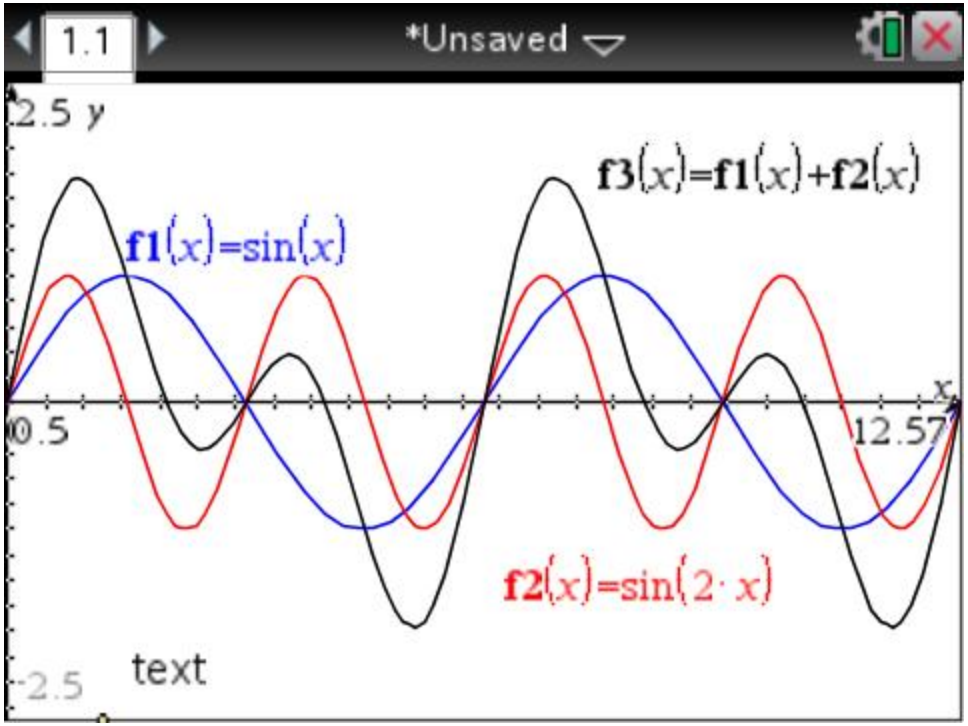


Fringe pattern (the straight lines show that the glass is very flat)

What is going on?

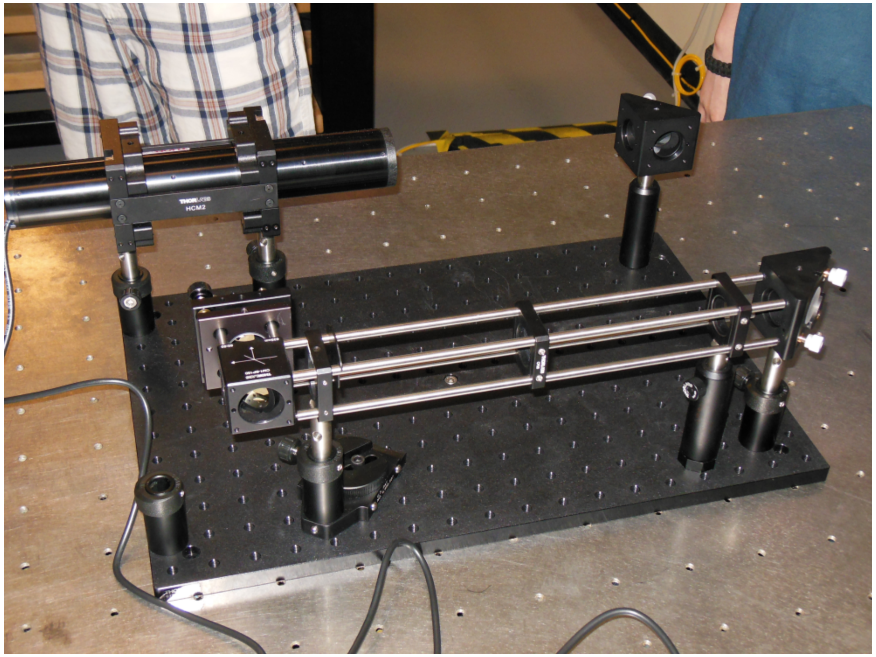
Interference: The interaction between to sin waves according to the relation various troughs and crests to create a new wave

Specific variants are constructive and destructive.



Interferometers

Newton Interferometers vs. Twyman Green Interferometers



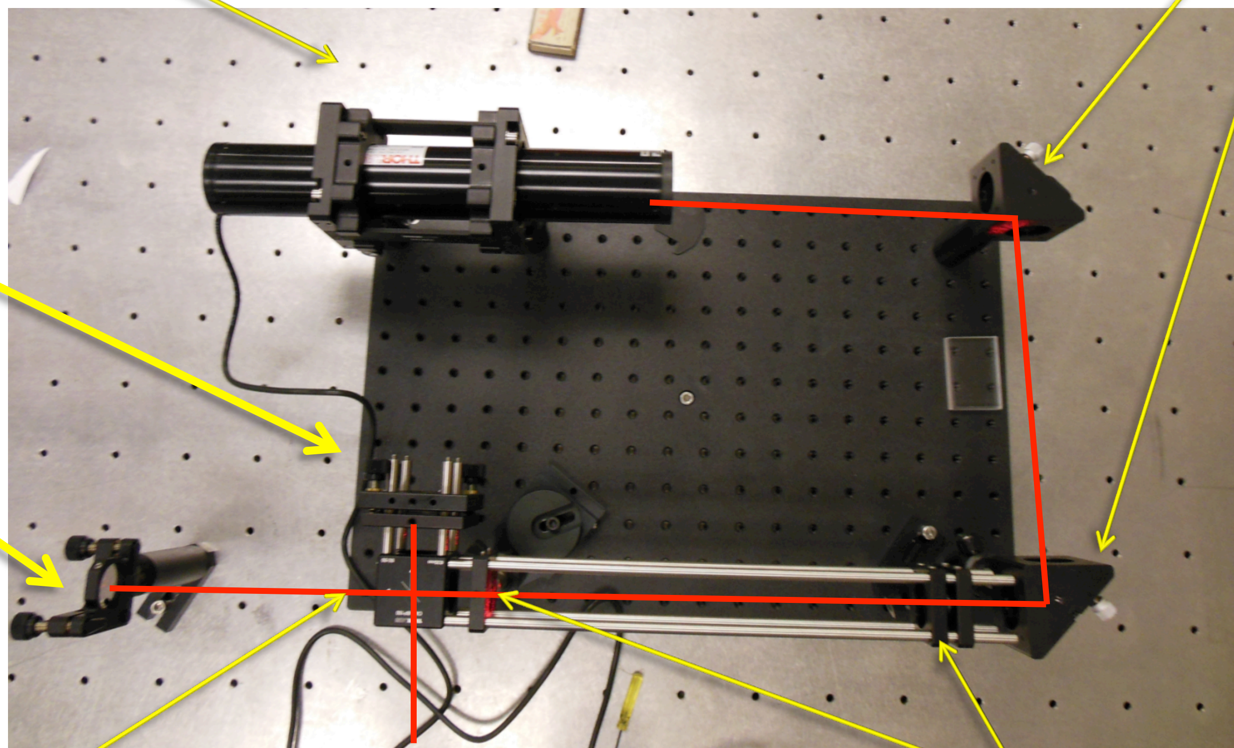
Twyman Green Set Up

Helium-Neon Laser (A HeNe)

Fold Mirror

Mirror for Reference Arm

Mirror for Test Arm

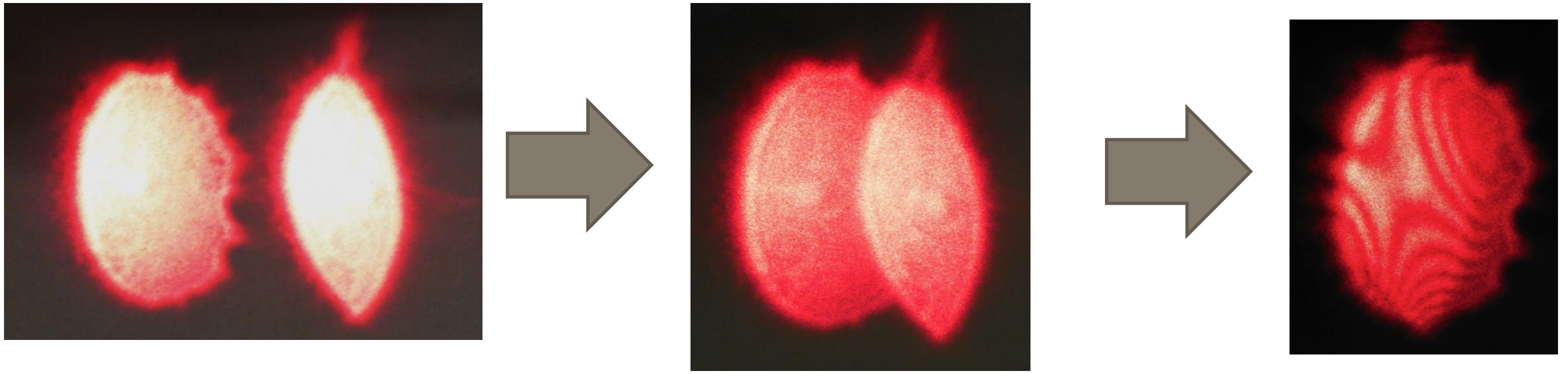


Pellicle Beam Splitter

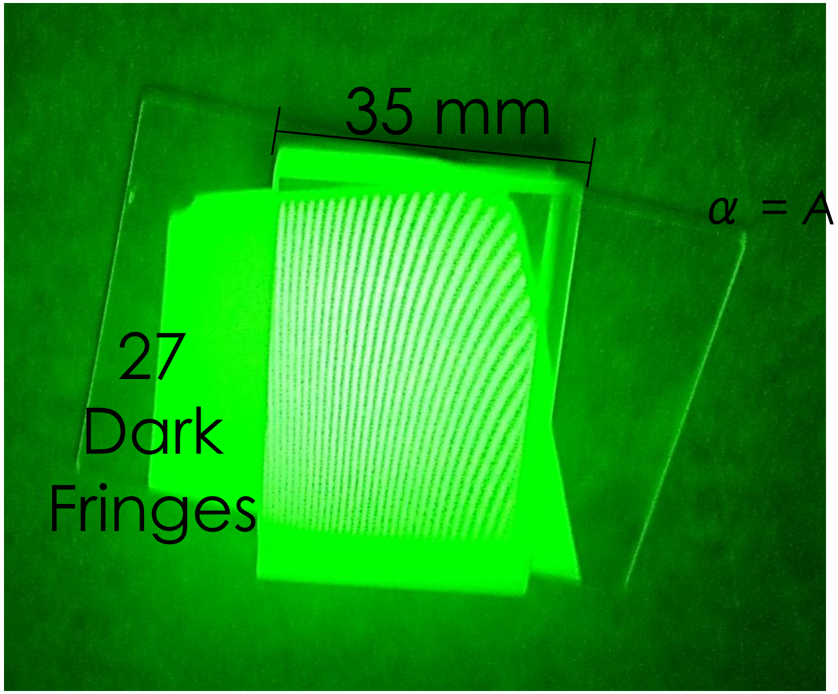
Positive Lenses- 2 create a telescope to expand the beam

Fluffing Fringes

- The alignment of two beams by adjusting two folding mirrors.
- The two beams should be together at various distances to be "fluffed."
- When correctly fluffed, the fringes show up clearly and at a low frequency.



Finding the angle between 2 plates of glass using interferometry



$$\alpha = m\lambda / 2x$$

α = *Angle between plates*

λ = Wavelength (.0005 mm)

x = Size of glass (35 mm)

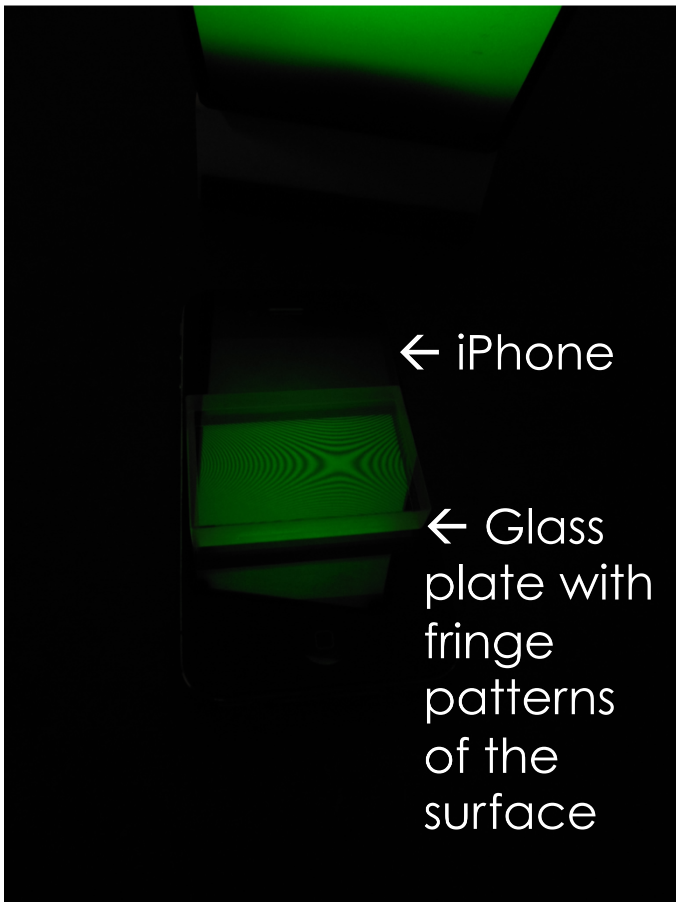
m = Number of dark fringes (27)

α = 0.011°

Using interferometry, we were able to determine the otherwise immeasurable angle created between the 2 plates of glass.

This extremely small angle subtends at 100 yards to only ¾ inch!

Determining the flatness of an iPhone screen using interferometry



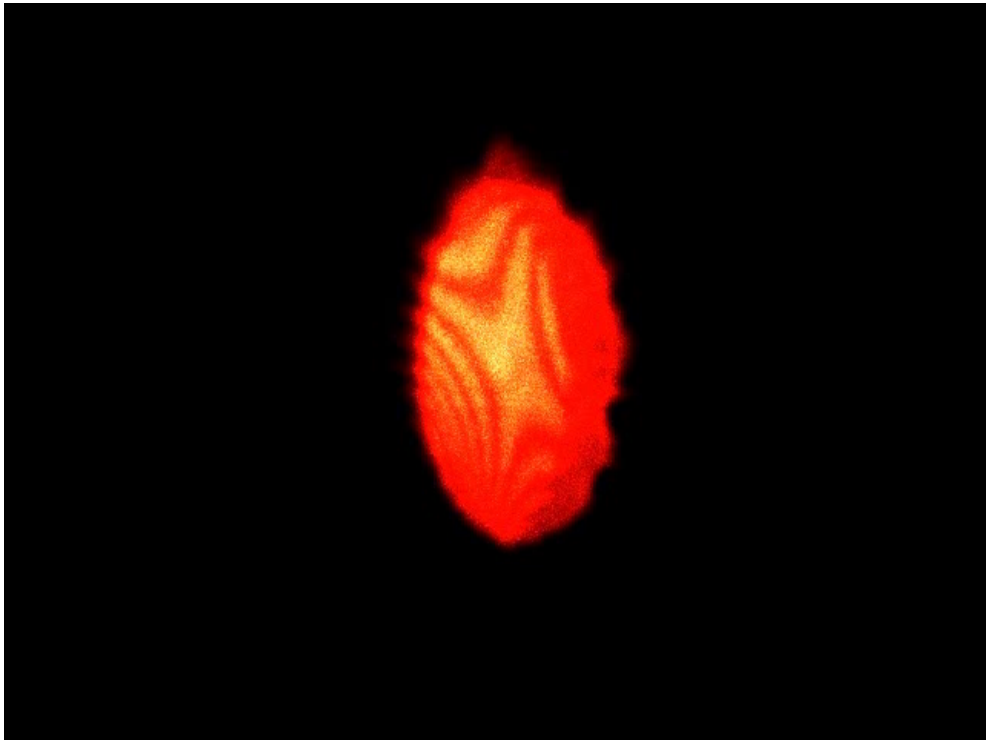
Using the same principles as the previous experiment, we used the screen of an iPhone as the second surface and determined just how flat the screen of an iPhone is.

After observing the fringe patterns, it was determined that the screen contains many imperfections.

Decollimated Telescope

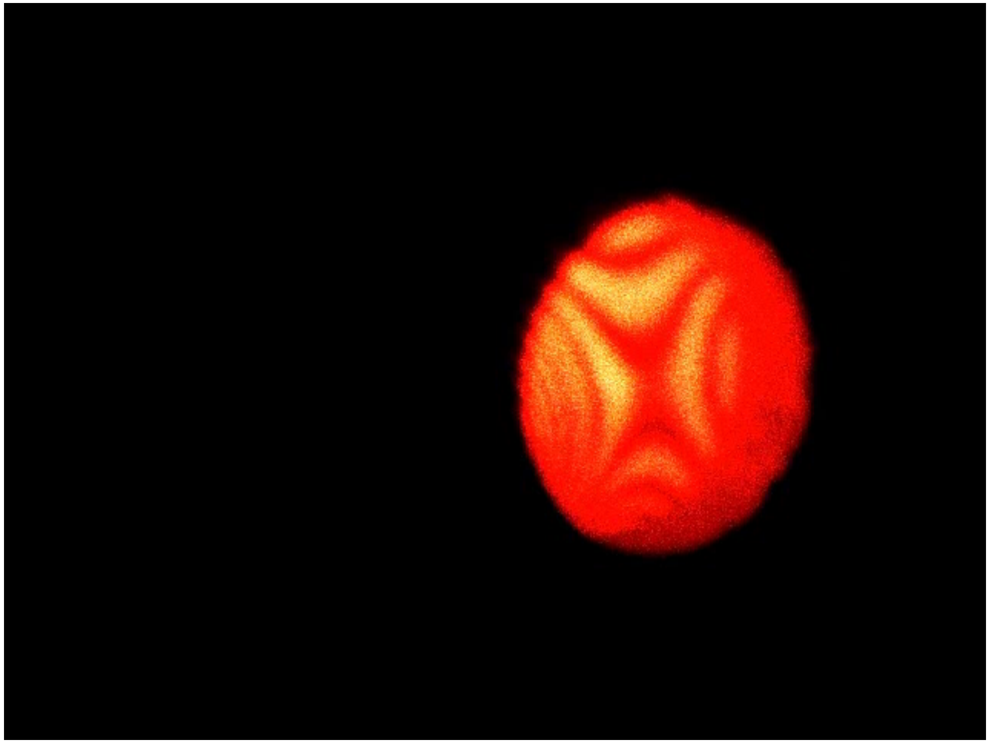
Distance from Fold Mirror to First Positive Lens	Image of Fringe
2.1mm	
6mm	

Using a Twyman-Green interferometer



When a candle is placed underneath the air the beam is traveling through, the waves travel differently and create varying fringe patterns, as seen in the video

Using a Twyman-Green interferometer (cont.)



When a sound is played near the interferometer, the pellicle beam splitter vibrates, changing the fringe patterns.

Conclusion

In this experiment we learned many things, such as:

- How to set up and use interferometers
- How to fluff a fringe
- The different factors that affect the fringes like temperature and sound waves