15. Invent Yourself: Laser Pointer

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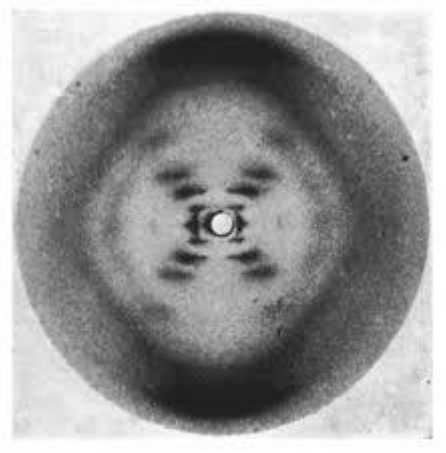
Problem

Suggest an interesting optical study involving a beam from a laser pointer.

My Problem

Rosalind Franklin confirmed the structure of DNA by taking photos of x-ray diffraction patterns directed through a crystal of DNA. Most famously Photo 51. Is the shape of a similar helical structure decipherable using a laser pointer?

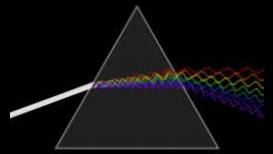


Theory

Diffraction - The bending of light around the edge of an object or aperture

Theory

Laser Basics:

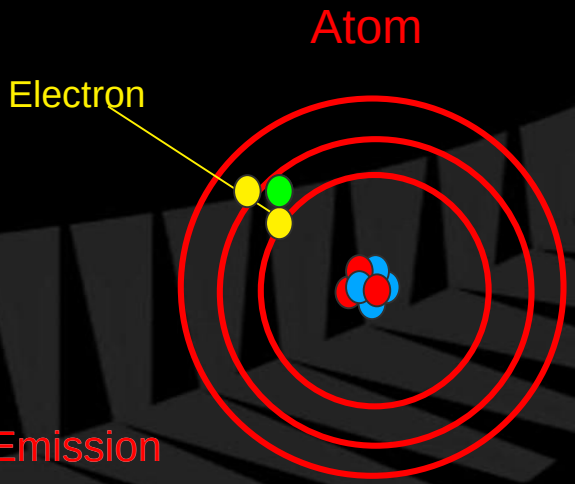
Light 

Amplification (by) 

Stimulated 

Emission (of) 

Radiation 



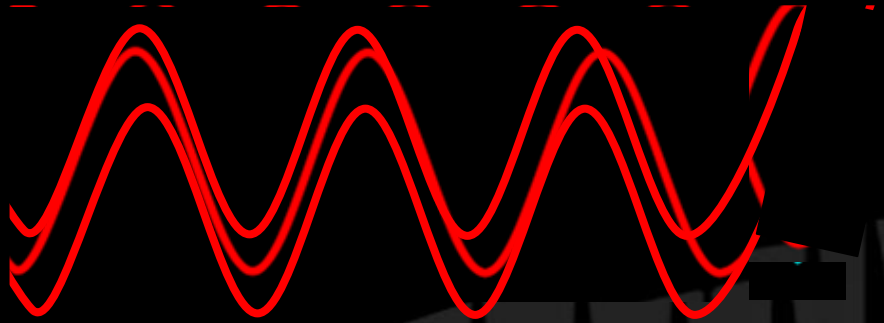
-Absorption

-Spontaneous Emission

-Stimulated Emission

Theory

Laser Basics: Coherent Light

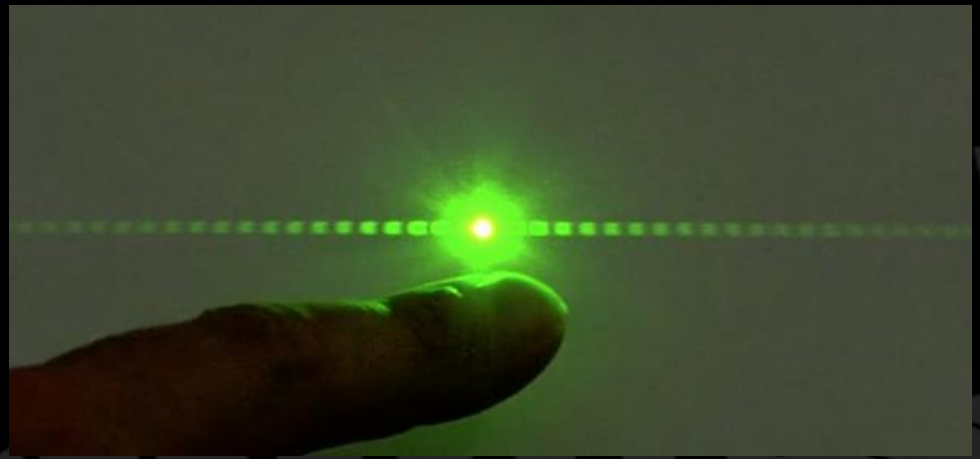


Monochromatic Light
Coherent Light

Multi-Coloured Light
Coherent Light

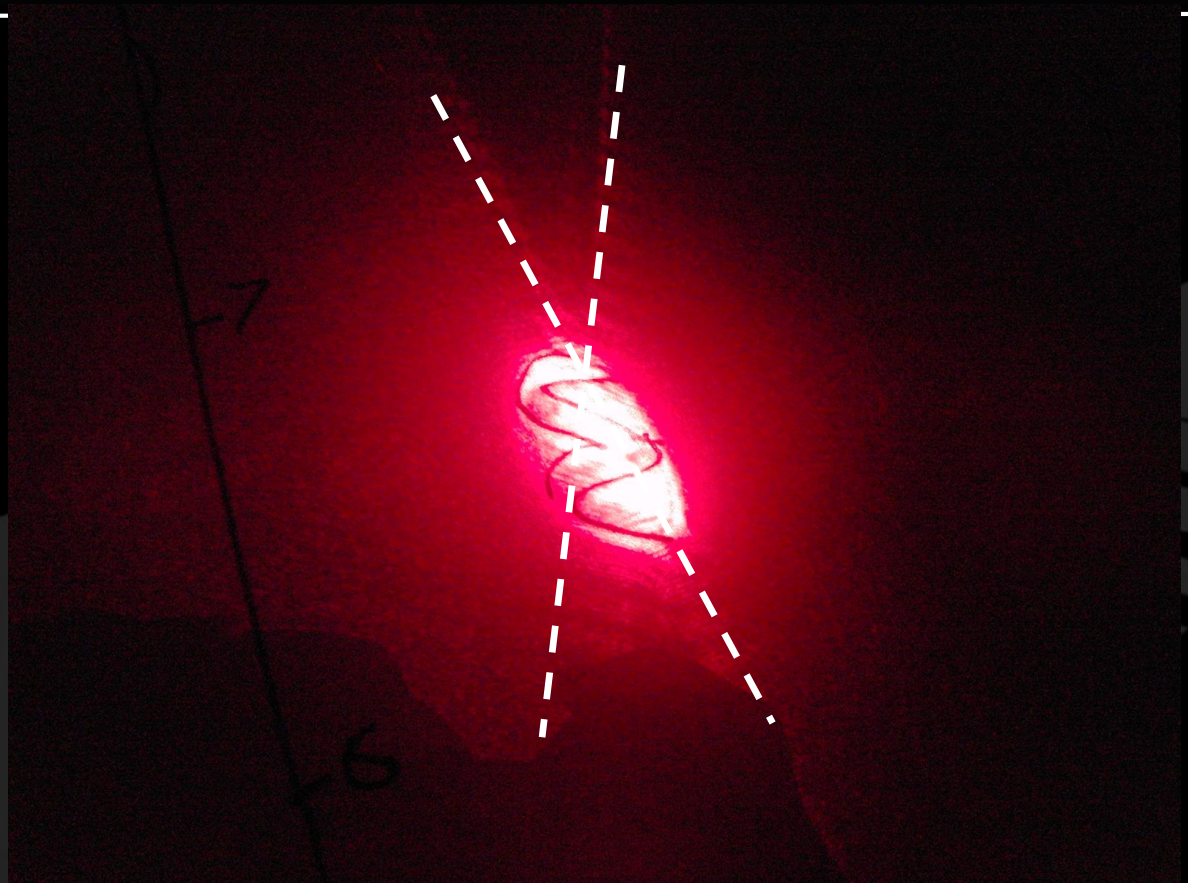
Theory

Diffraction and Interference:



Theory

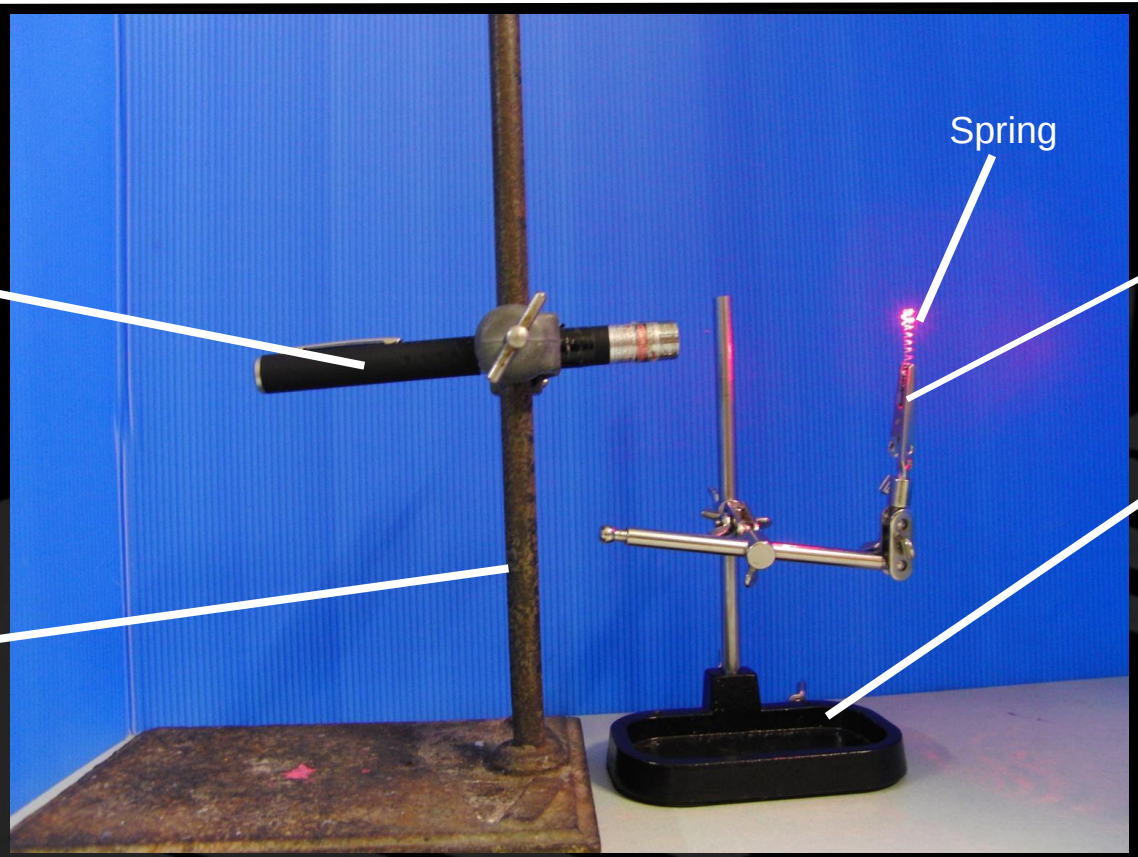
- How a cross is formed



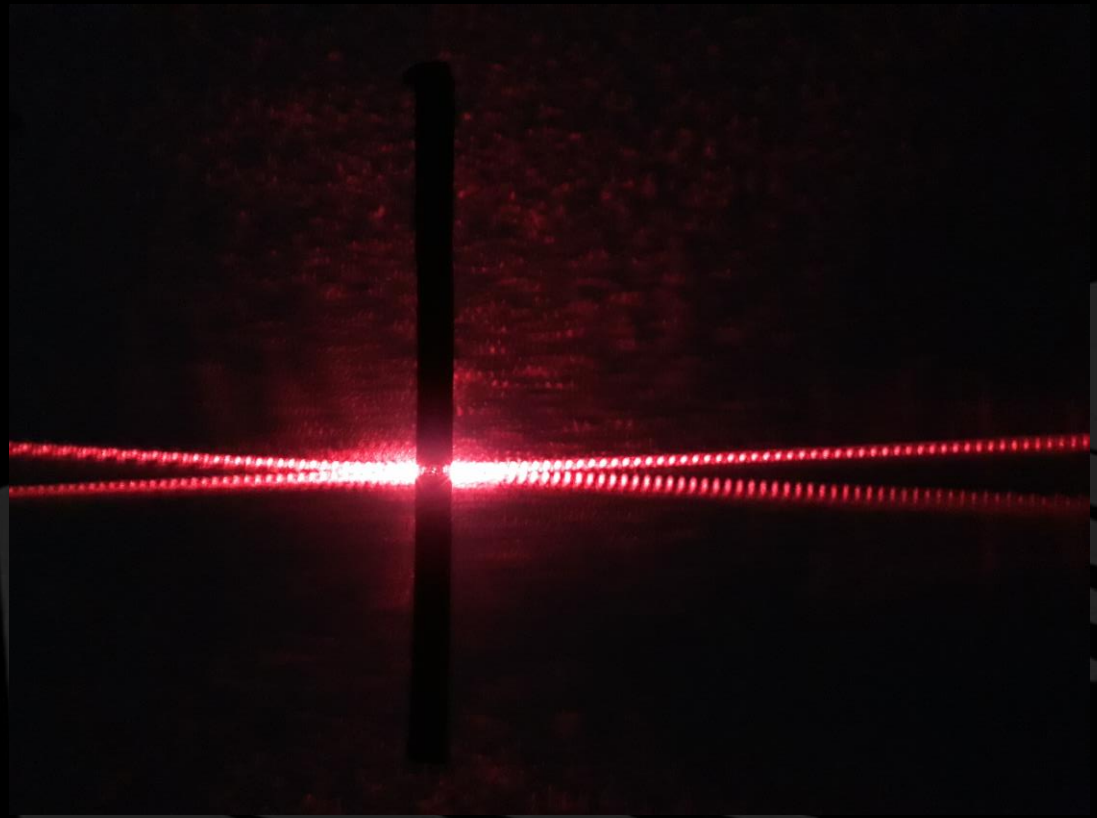
Theory

Experiment

Set Up:



Experiment



Experiment

Gathering spring information for comparison:

Information gathered:

Pitch angle

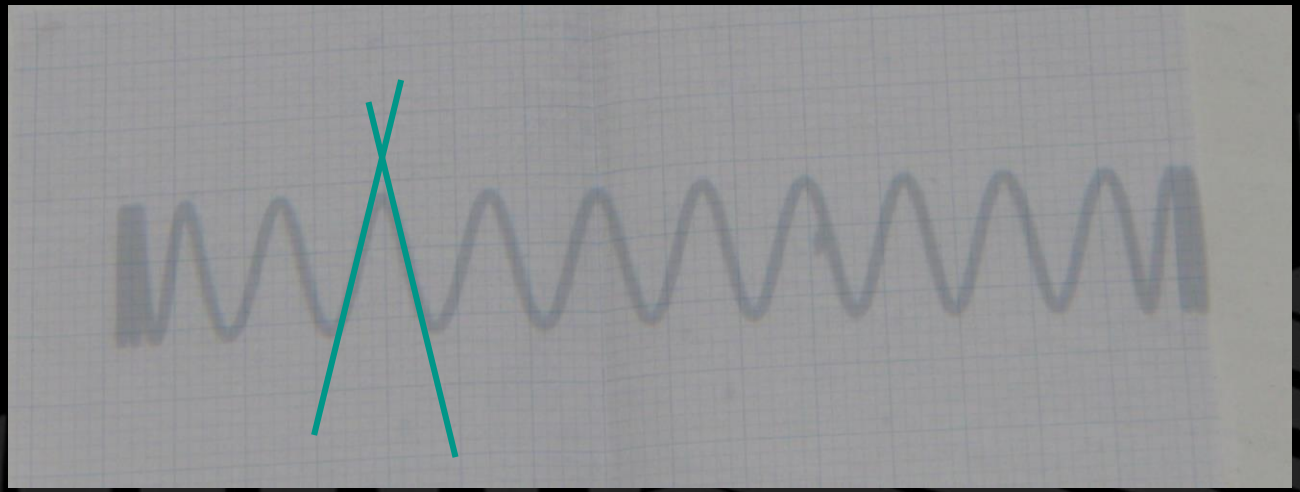
Wire thickness

Radius

Diameter

Experiment

Pitch angle



Experiment

Wire thickness

0.46mm

Experiment

Radius and Diameter

6.65mm =Diameter

3.32mm = Radius

Experiment

Interference Pattern Data Gathering Methods

Variables:

Pitch angle

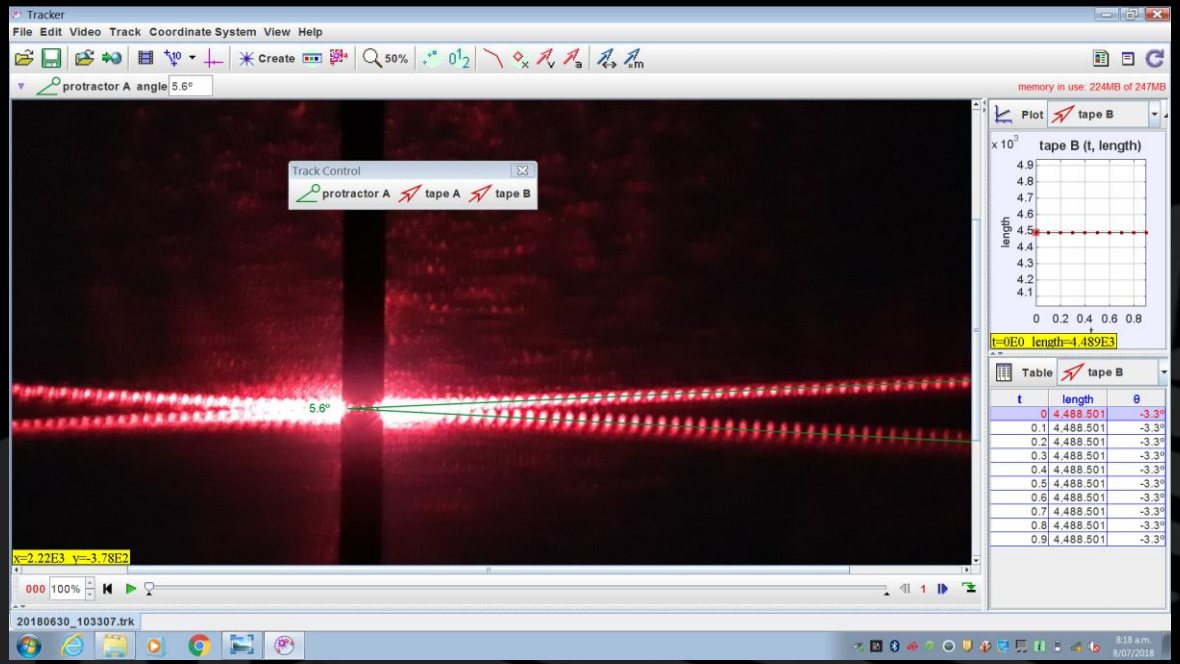
Wire thickness

Radius

Diameter

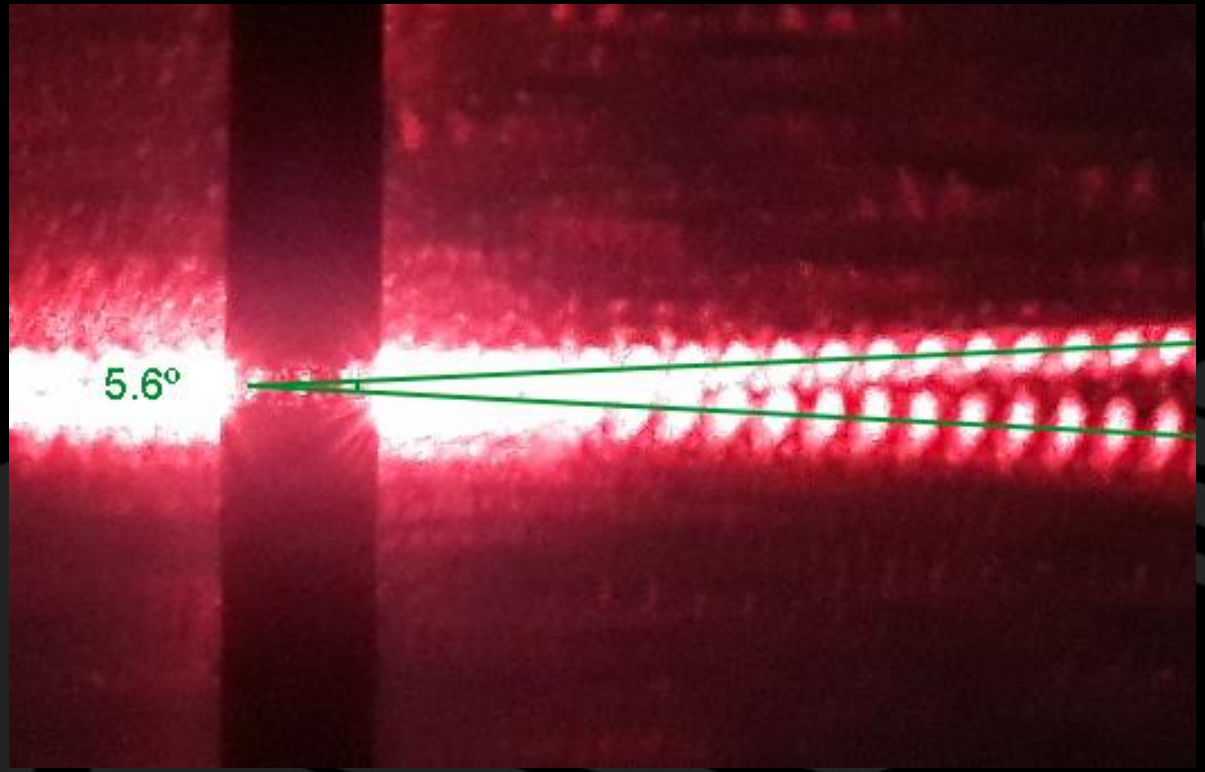
Experiment

Measuring Pitch Angle



Experiment

Measuring Pitch Angle



Experiment

Calculating Wire Thickness

$$n\lambda = \frac{dx}{L}$$

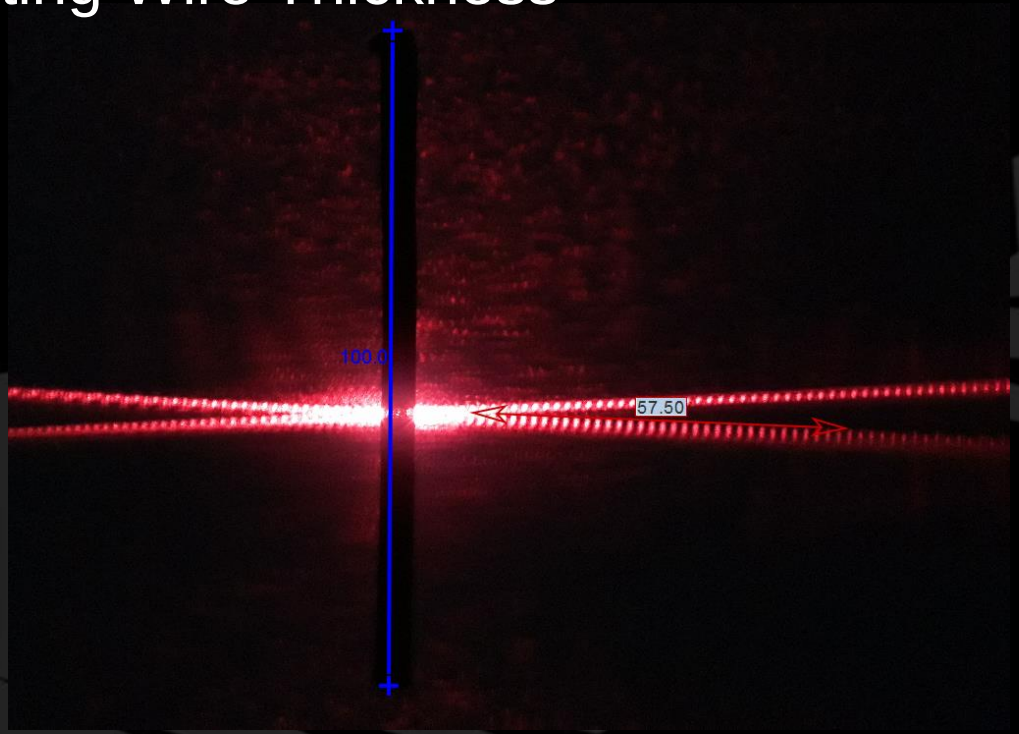
n= number of minima

λ= wave length of laser

d= thickness of the wire

x= distance between n + 1 maxima

L= distance to screen from spring

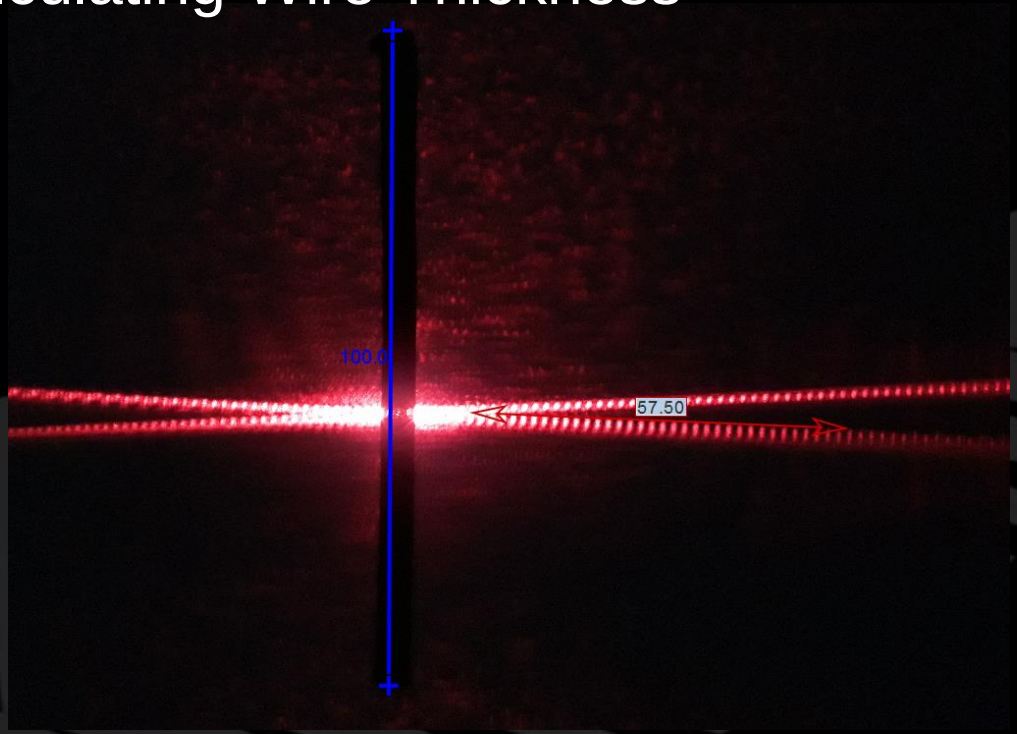


Experiment

Calculating Wire Thickness

$$\frac{Ln\lambda}{x} = d$$

1.15x36x(700 x10^{-9}) / 0.0575 = 0.000504 =0.504 mm



Experiment

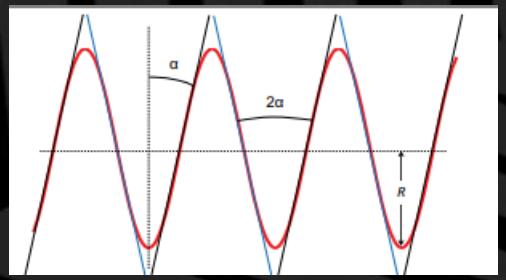
Calculating Radius and Diameter

$$\frac{P\tan(90-\alpha)}{2\pi} = R$$

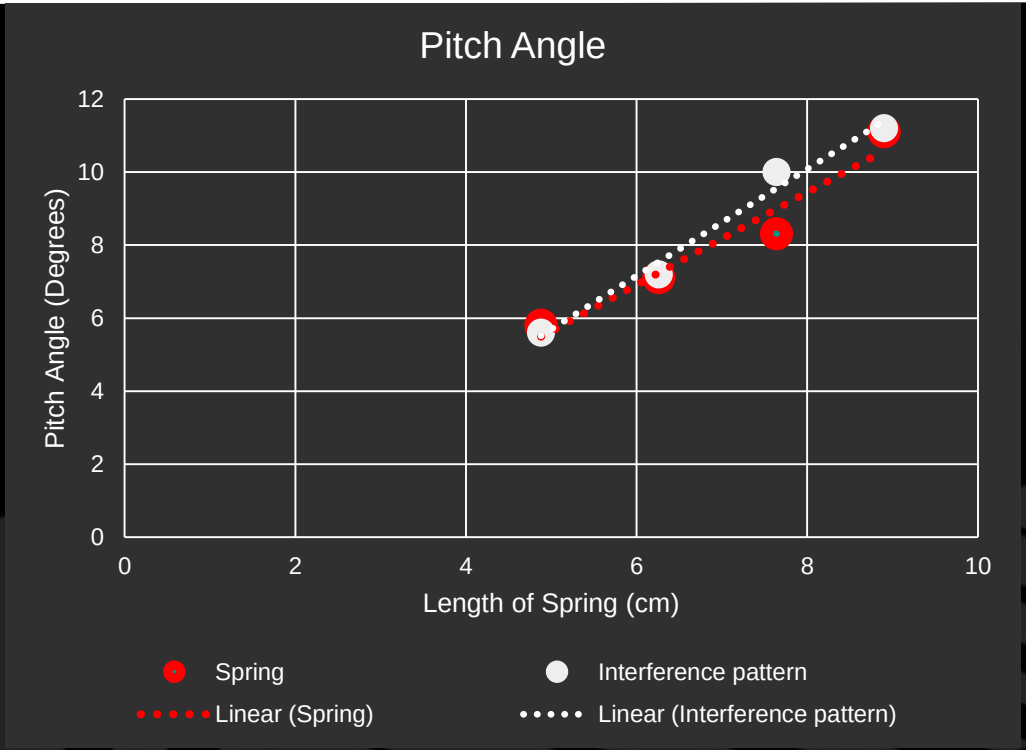
$$\frac{P\tan(90-\alpha)}{2\pi} \times 2 = D$$

$$\frac{0.106\tan(90-2.8)}{2\pi} = 0.345\text{cm}$$

$$\frac{0.106\tan(90-2.8)}{2\pi} \times 2 = 0.69\text{cm}$$



Results


Pitch Angle
Pitch Angle (Degrees)
0
2
4
6
8
10
12
0
2
4
6
8
10
Length of Spring (cm)
Spring
Interference pattern
Linear (Spring)
Linear (Interference pattern)

Results

	Wire Thickness	Spring Radius	Spring Diameter
Spring	0.46mm	3.32mm	6.65mm
Laser	0.504mm	3.45mm	6.9mm

Conclusion

The Problem Statement:
Suggest an interesting optical study involving a beam from a laser pointer.

My Problem statement:
Rosalind Franklin confirmed the structure of DNA by taking photos of x-ray diffraction patterns directed through a crystal of DNA. Most famously Photo 51. Is the shape of a similar helical structure decipherable using a laser pointer?

I looked at the interference patterns caused by diffraction of a laser shone through a helical structure (a spring) and found that yes the shape of a similarly helical structure is decipherable using a laser pointer, to a few mm off.

Bibliography

- How Rosalind franklin discovered the helical structure of DNA: Experiments in diffraction by Gregory Braun, Denis Tierney and Heidrun Schmitzer, Xavier University, Cincinnati, OH

- Optics and Lasers Edx MIT

Acknowledgements

-Murray Chisholm

-Anthea Grob

-Todd Cochrane

My Team

Bibliography

Information:

Edx MIT Optical Materials and Devices

Images:

http://www.clker.com/clipart-atmospheric-emissions.html

https://en.wikipedia.org/wiki/Ionizing_radiation#/media/File:Radioactive.svg

How Rosalind Franklin Discovered the Helical Structure of DNA: Experiments in Diffraction Gregory Braun, Dennis Tierney, and Heidrun Schmitzer, Xavier University, Cincinnati, OH