15. Invent Yourself: Laser Pointer

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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
Laser Basics:

- Light
- Amplification (by)
- Stimulated Emission (of)
- Radiation

Processes:
- Absorption
- Spontaneous Emission
- Stimulated Emission

Electron and Atom Representation in the Diagram.
Laser Basics: Coherent Light
Theory

Diffraction and Interference:
How a cross is formed
Theory
Experiment

Set Up:

- Retort Stand
- Soldering Iron Stand
- Laser Pointer
- Soldering Iron Stand
- Alligator Clip
- Spring
- Retort Stand

Image of setup with laser pointer and spring.
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

5.6°
Experiment

Calculating Wire Thickness

\[ n\lambda = \frac{dx}{L} \]

- \( n \) = number of minima
- \( \lambda \) = 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

\[ \frac{\ln \lambda}{x} = d \]

1.15 \times 36 \times (700 \times 10^{-9}) / 
0.0575 = 
0.000504 
= 0.504 \text{ mm}
Experiment

Calculating Radius and Diameter

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

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

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

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

Pitch Angle vs. Length of Spring (cm)

- Red circles: Spring
- Red dashed line: Linear (Spring)
- White circles: Interference pattern
- Black dotted line: Linear (Interference pattern)
## Results

<table>
<thead>
<tr>
<th></th>
<th>Wire Thickness</th>
<th>Spring Radius</th>
<th>Spring Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>0.46mm</td>
<td>3.32mm</td>
<td>6.65mm</td>
</tr>
<tr>
<td>Laser</td>
<td>0.504mm</td>
<td>3.45mm</td>
<td>6.9mm</td>
</tr>
</tbody>
</table>
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

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