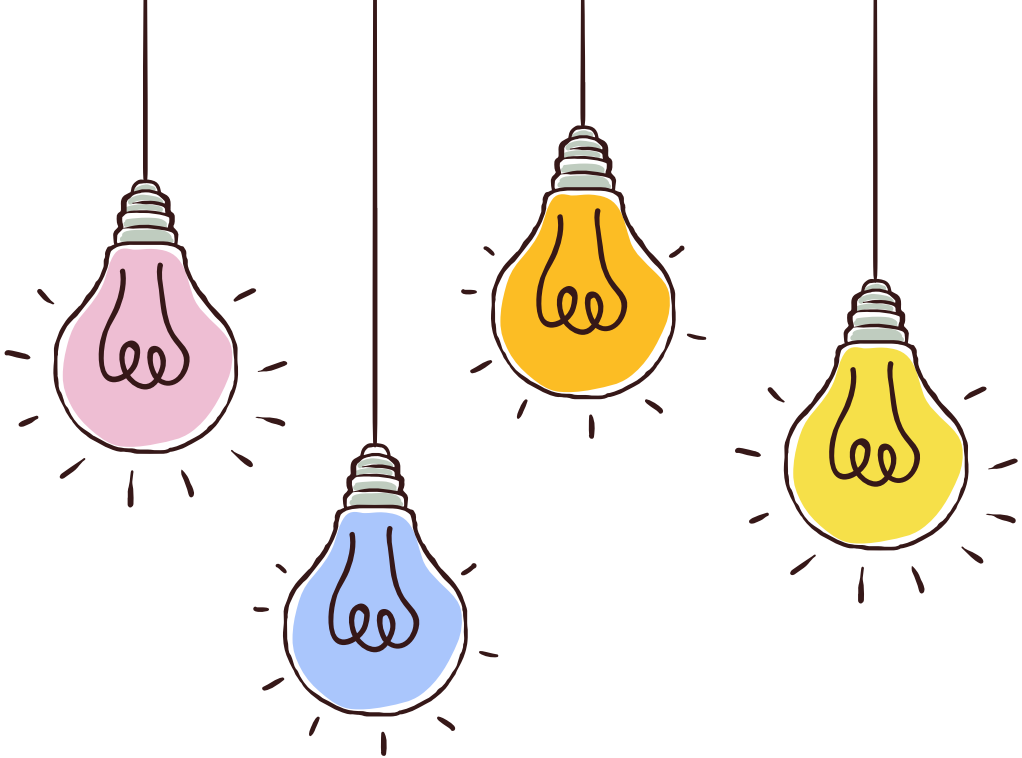

Lights Double Identity

By Adar Libin and
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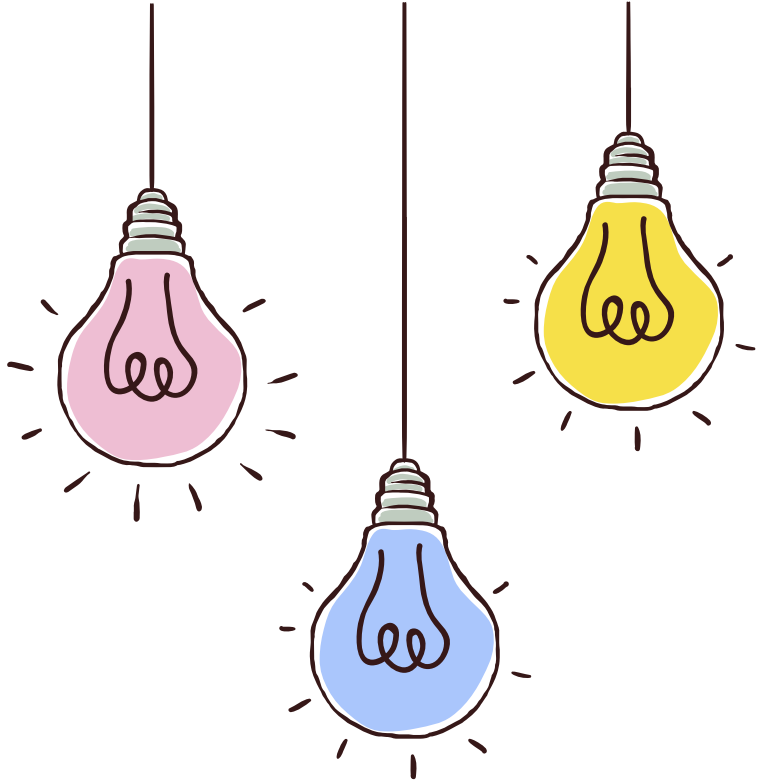
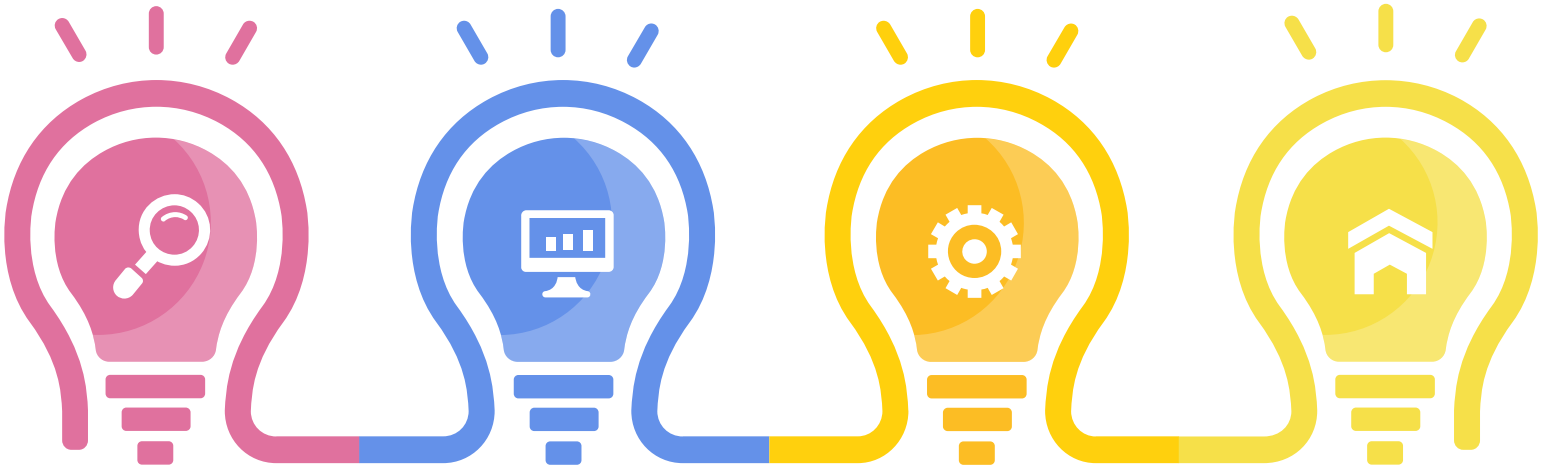
Objective

To learn about the phenomenon of photons, we hope to understand how they can be both wave and particle—two forms of existence—depending on how you look at them. We hope to understand how light Behaves and, in the process, understand some of the deepest secrets of quantum mechanics.



Hypothesis



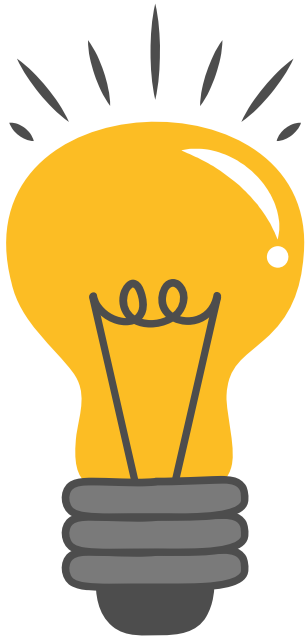
- **If a laser beam passes through two slits and is observed through a camera, then an interference pattern will be detected on the screen, because the light will behave as a wave.**
- **If we lower the brightness of the laser really low, we should be able to see each individual photon, because there won't be such a massive stream of photons coming from the laser, proving that light behaves as a particle as well.**

Materials

- WIRE (FIBER OPTIC)
- 3D PRINTED SLITS BASE

- WOOD BOARD
- HOT GLUE
- SOLDERING IRON

- COLLIMATOR
- LASER DIODE(785 NM FABRY-PEROT LASER DIODE, 250 MW, SINGLE MODE FIBER)



- COMPACT LASER DIODE DRIVER
- LAPTOP

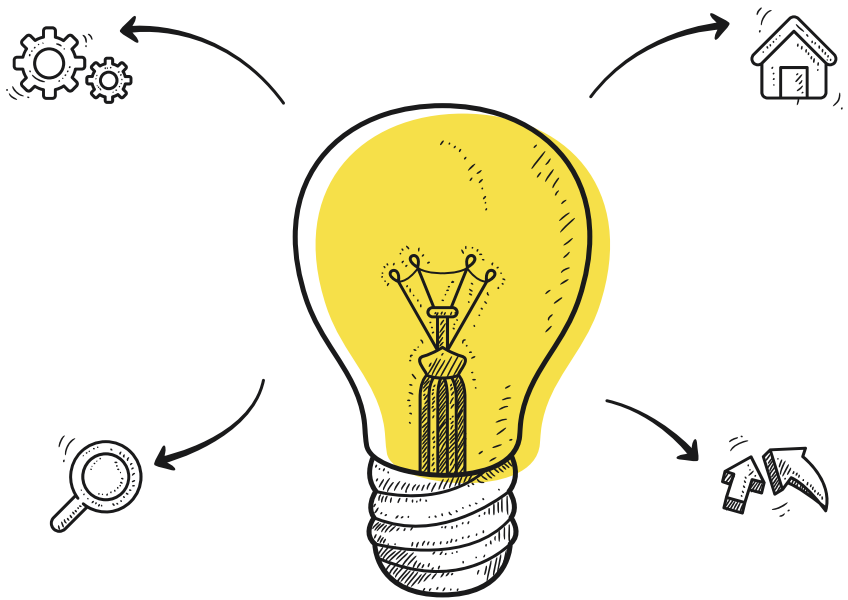
- RULER
- PAPER
- CAMERA

- DUEL SLITS FROM THORLABS
- TWEEZERS

Procedure

Setup:

- 3D print a base for the slits, laser and camera.
- Connect the collimator to the laser and connect the laser to a compact laser diode driver.
- Add slits to the 3D printed base with tweezers to not mess up the slits
- Add camera to the base and connect camera to laptop
- Add the compact laser diode driver and the 3d printed base to a wooden board.
- Use soldering and wiring to connect all the things that need wiring for.



Execution:

- Turn on TEC (Thermoelectric Cooling) to not overheat the laser
- Power on the laser.
- Look at the camera through the laptop to see the light because it barely visible with the human eye
- Lower the brightness of the laser down and observe each photon.
- Analyze the data on both the experiments

Variables

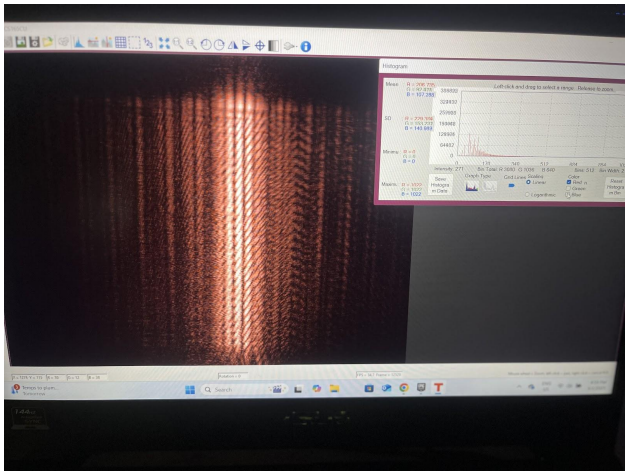
Manipulated variable: voltage of the light

Responding Variable: The light pattern was an interference and the light was more faint to the sides of the pattern.

Controlled Variable: space between the slits and the slits itself

Observation

We observed an interference pattern as a result of the laser passing through the two slits.



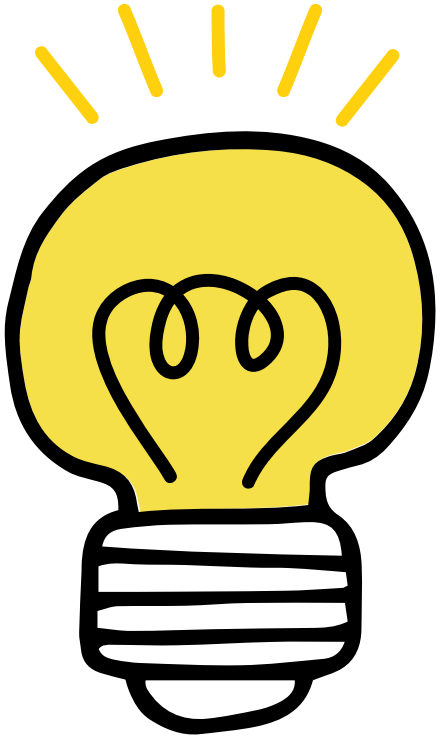
Analysis

As a result of observing the interference pattern , we can see that the photons are acting like waves, interfering with each other in turn creating an interference pattern.

Real World Applications

The double-slit experiment helped scientists discover the strange rules of quantum mechanics, which has led to amazing technologies we use today, including lasers, and barcode scanners. Barcode scanners use the property of the interference pattern to read the barcode. This experiment has also been a starting point to the development of quantum computing. Quantum computing runs on the entanglement of qubits (things that can exist as multiple states at once\ superposition). An example of this could be photons, they can exist as a wave and a particle at the same time. The entanglement of qubits means that if multiple qubits entangle, then the state of one qubit affects the state of all of them. The act of entanglement allows quantum computers to complete problems much faster than regular computers.

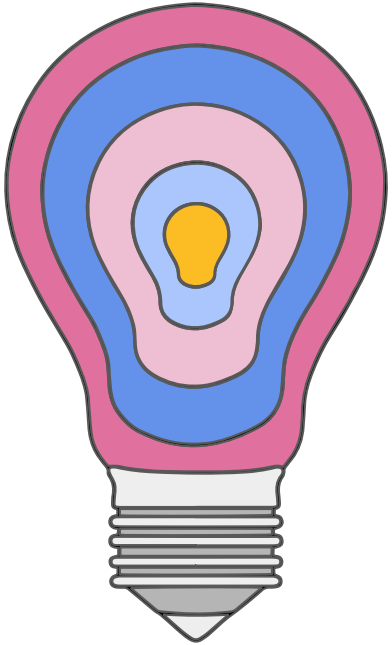
Conclusion



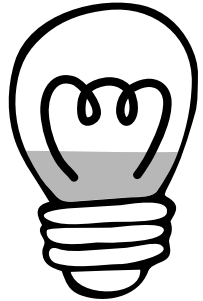
We wanted to find out if light behaves as a wave or a particle.Based on our research we created our hypothesis, “**If a laser beam passes through two slits and is observed through a camera, then an interference pattern will be detected on the screen, because the light will behave as a wave.If we lower the brightness of the laser really low, we should be able to see each individual photon, because there won't be such a massive stream of photons coming from the laser, proving that light behaves as a particle as well.”**Our hypothesis was correct, because an interference pattern occurred after the laser passed through the two slits, but we were still able to prove that if we would have turned the light down a lot we would've been able to see each individual photon hit the camera/screen and if we took that and looked at it over a period of time we would see 2 peaks. This proves that our hypothesis was correct and that light behaves as a wave and a particle.

Sources Of Error

At the start of our experiment we came to the conclusion that are slits were to big and too far apart for it to show an interface pattern, so to fix this we ordered slits of thorlabs for the experiment but then we found out that those slits are too small for a photodetector to be placed in front of them and detect which slit the photons pass through. Then later on in our experiment we met with professors from the University of Calgary and they told us that the laser we use produces a large stream of many photons passing through each slit constantly so we don't have the ability to send just a few, or one photon through the slits.



Citations



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