Summary of Key Concepts

The Double Slit Experiment

Week of October 15, 2023

Resources

- QxQ YLC Week 4 Lab [STUDENT].ipynb
- QXQ YLC Week 4 Homework Notebook [STUDENT]
- 2. Double Slit Simulator Documentation.pdf
- Feynman on the Double Slit Experiment

Key Terms

Key Term	Definition
Atom	The basic building blocks of the universe. They make up every physical thing you can interact with in the world around you. They are composed of a positively charged nucleus and negatively charged electrons.
Waves	A classification of physical objects that exist over a continuous spread of locations and can interfere with each other.
Particles	A classification of physical objects that exist at discrete locations and can interact, but not interfere with each other.
Destructive Interference	When the high point of one wave lines up with the low point of another wave and cancels out.
Constructive Interference	When the high point of one wave lines up with the high point of another wave and adds up.
Double Slit Experiment	An experiment designed by Thomas Young in 1801 involving passing a beam of light through two narrow, parallel slits onto a blank screen.
Wave-Particle Duality	The ability of quantum objects to display characteristics of waves and particles simultaneously.
Superposition	The ability of a quantum object to be in multiple states at the same time, with probabilities of being measured in each state.
Interference	The ability of waves and wavefunctions to add up or cancel each other out when they overlap.
Entanglement	Two objects are entangled when one object's state depends on the other object's state.
Measurement	The process of forcing a superposition to pick what state the object will be in. This is irreversible and destroys the superposition.

Lecture

Learning Objectives

1. *Recognize* what particles and waves are and how they differ.
2. *Recognize* what the double slit experiment is.
3. *Recognize* superposition, interference, entanglement, and measurement.
4. *Recognize* some ways that Quantum Mechanics can explain issues with Classical Mechanics.

Key Ideas

1. Classical Physics can not fully explain many natural phenomena. This made necessary the development of the theory of Quantum Mechanics.
    a. Classical Physics could not explain why electrons do not spiral into the nucleus.
    b. Classical Physics could not explain why electrons create an interference pattern in the double slit experiment.
2. Quantum Mechanics has many strange properties, including superposition, interference, measurement, and entanglement.
3. Quantum Computing takes advantage of the properties of Quantum Mechanics to solve problems more efficiently than classical computers.
    a. Qubits can be in a superposition of the 0 and 1 states.
    b. Quantum computers can solve complex problems, such as the maze problem, faster than classical computers by exploring all possible solutions simultaneously.

Lab

Learning Objectives

1. *Apply* python basics to use a simulator object to run double slit experiments.
2. *Recognize* how the double slit experiment demonstrates quantum effects.

Key Ideas

1. By modifying the attributes of the doubleSlit object, students can get many different results in the double slit experiment.
    a. Increasing slit difference will increase bands in the interference pattern.
    b. Increasing the distance to the screen increases the width of the interference bands.
    c. Allowing electrons to be measured passing through the slits destroys the interference pattern.