CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35380

Project Title
Proving the Heisenberg Uncertainty Principle

Abstract

Objectives/Goals
To demonstrate, explain, and prove the Heisenberg Uncertainty Principle.

Methods/Materials
Layered shelves or table and a chair; tape; Quick Grip#; caliper; black paint; laser pointer; a laser absorbing board. Paint caliper with black paint. Fit laser pointer into the Quick Grip. Tape the Quick Grip and laser to high shelf or table. Tape black caliper to lower shelf than the Quick Grip or on a chair 31 centimeters below the Quick Grip. Place laser-absorbing board on floor under caliper so board is 110 centimeters away from caliper. Turn laser pointer on. Open caliper to a 5 millimeter length. Calibrate position of caliper so laser pointer is passing through opening in the caliper. Record results at 5 millimeters by examining laser dot on board. Close caliper to a 2 millimeter length. Record results at 2 millimeters. Close caliper to a 1 millimeter length. Record results at 1 millimeter. Close caliper to a 0.25 millimeter length. Record results at 0.25 millimeters. Repeat steps 7-13 twice more.

Results
At a measurement where the caliper was opened to 5 millimeters, the dot had a normal diameter of 8 millimeters. When the caliper was closed to 2 millimeters, the diameter was still 8 millimeters. When the caliper was closed to 1 millimeter, the width of the dot was 4 millimeters. For a width of 0.25 millimeters, Test A had a width of 16 millimeters, Test B had a width of 28 millimeters, Test C had a width of 23 millimeters.

Conclusions/Discussion
When the caliper was closing, specific measurements were known, and therefore the caliper was set to those measurements. That means that the caliper was localizing the photons so that the photons are going to a more precise location and therefore a more certain position. And in the Heisenberg Uncertainty Formula, when the uncertainty of the position decreases, than the uncertainty in momentum must increase in order to make the formula correct. But because of wave/particle-duality (how light acts like a particle and a wave), the momentum of a photon can not be be precisely determined. This is because of how you need to measure the wavelength of the light in order to measure the momentum. And if you want to measure the position, you need to think in terms of photons, but a photon does not have a wave and therefore no momentum. In this experiment the ways of nature and quantum physics will only allow us to observe the effects of the Heisenberg Uncertainty Principle.

Summary Statement
Explaining that when light is passed through a aperture, why does the final product of the light begin to widen instead of normally narrowing based on the quantum level of the Heisenberg Uncertainty Principle.

Help Received
Zach Bjornson and Goeff Krampitz helped to try to set up the biology experiment in which was changed to the present experiment; Dr. David Wineland helped my understand the deepest parts of quantum physics and lasers by inviting me to his lab at NIST; my parents and my uncle for helping me purchase the