Double-Slit Experiment LaTeX

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Abstract

In this experiment we use a laser of wavelength 670nm to re-perform Young's Double-Slit Experiment which demonstrates the wave nature of light. The observed interference pattern is fitted using Fraunhofer model with a detailed calculating of Chi-Squared as an indication of the goodness of the fit, and is found to be consistent with the theory.

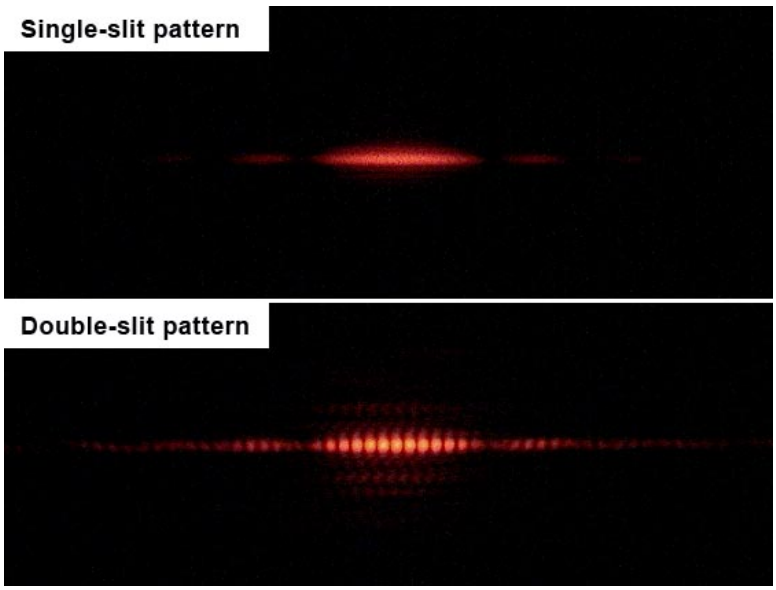

FIG. 1. Single and double-slit interference patterns[1].

I. INTRODUCTION

The double-slit experiment, also know known as the Young′s experiment, explores the wave-like nature of light. It is important in this experiment for the two sources of light are coherent and have the same phase. Back in 1801, Thomas Young had difficulty with using common light sources, such as candles and lanterns, to be served as coherent sources of light. Thus instead, Young performed the experiment by filtering sunlight through a pinhole in a window shutter split by a piece of card and projecting it horizontally across the room. Light waves from either side of the card coming through the pinhole can be thus considered coherent sources and the interference pattern was then projected onto a screen from which the wavelength of the light source could be determined using Young′s Equation:

$$\lambda = \frac{y * d}{m * L}$$

Today, we can do the experiment by using the TWS apparatus that includes a monochromatic laser beam at one end (with a wavelength of 670 nm) passing through a double slit all encapsulated in a tightly sealed u-channel. Adjusting the micrometer attached to the detector-slit allows you to gather information regarding the interference pattern that is projected to a photodiode at the other end of the u-channel.

II. EXPERIMENT

In this experiment, the apparatus is set up as shown in Fig. 2. After precise alignment of the laser, the double-slit, the slit-blocker, and the detector-slit, the photodiode is connected to a multimeter which is ultimately connected to the computer. LabView is used to collect data first for the double-slit experiment and for the single-slit experiment.

All parts are carefully aligned and key positions of the slit-blocker are recorded, so that light from one or two slits could be blocked and form both double-slit and single-slit interference patterns. The shutter at the end of the U-channel was kept closed, because only the photodiode on the surface of the shutter is used. After the preparation work, the double-slit experiment is first performed. A double-slit of slit width approximately 0.1 mm and slit separation 0.406 mm is used.

The slit-blocker is set at the position where light from both slits are allowed to pass, and the detector-slit is set at the position of the central maximum. The photodiode outputs a

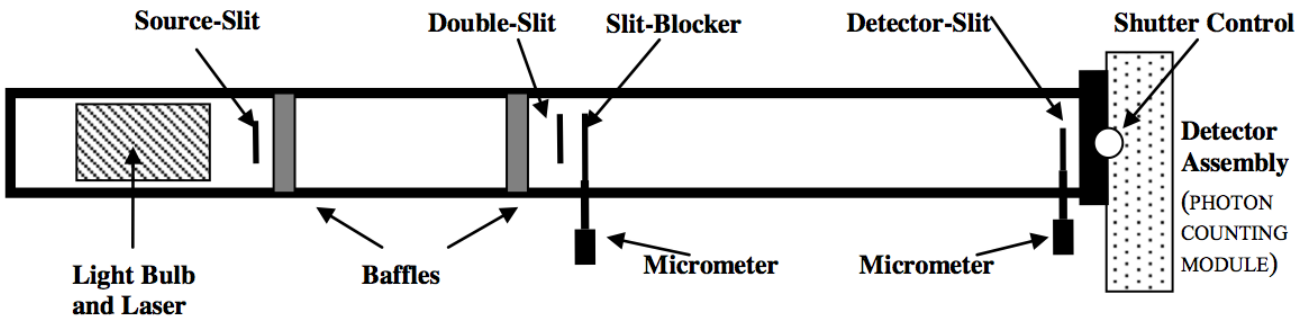

FIG. 2. Schematic of TWS apparatus - not to scale[2].

voltage that is proportional to the intensity of the laser beam.

By changing the position of the detector-slit, intensity of the laser light is recorded by LabView as a function of location. Then the experiment is repeated for single-slit when the slit-blocker blocks light from one of the two slits.

III. RESULTS

Double slit intensity under Fraunhofer conditions:

$$I = I_0 sinc^2(\frac{\pi a}{\lambda} sin\theta) cos^2(\frac{\pi d}{\lambda} sin\theta)$$

Single slit under Fraunhofer conditions:

$$I = I_0 sinc^2(\frac{\pi a}{\lambda} sin\theta)$$

IV. DISCUSSION

V. CONCLUSION

VI. FIGURES

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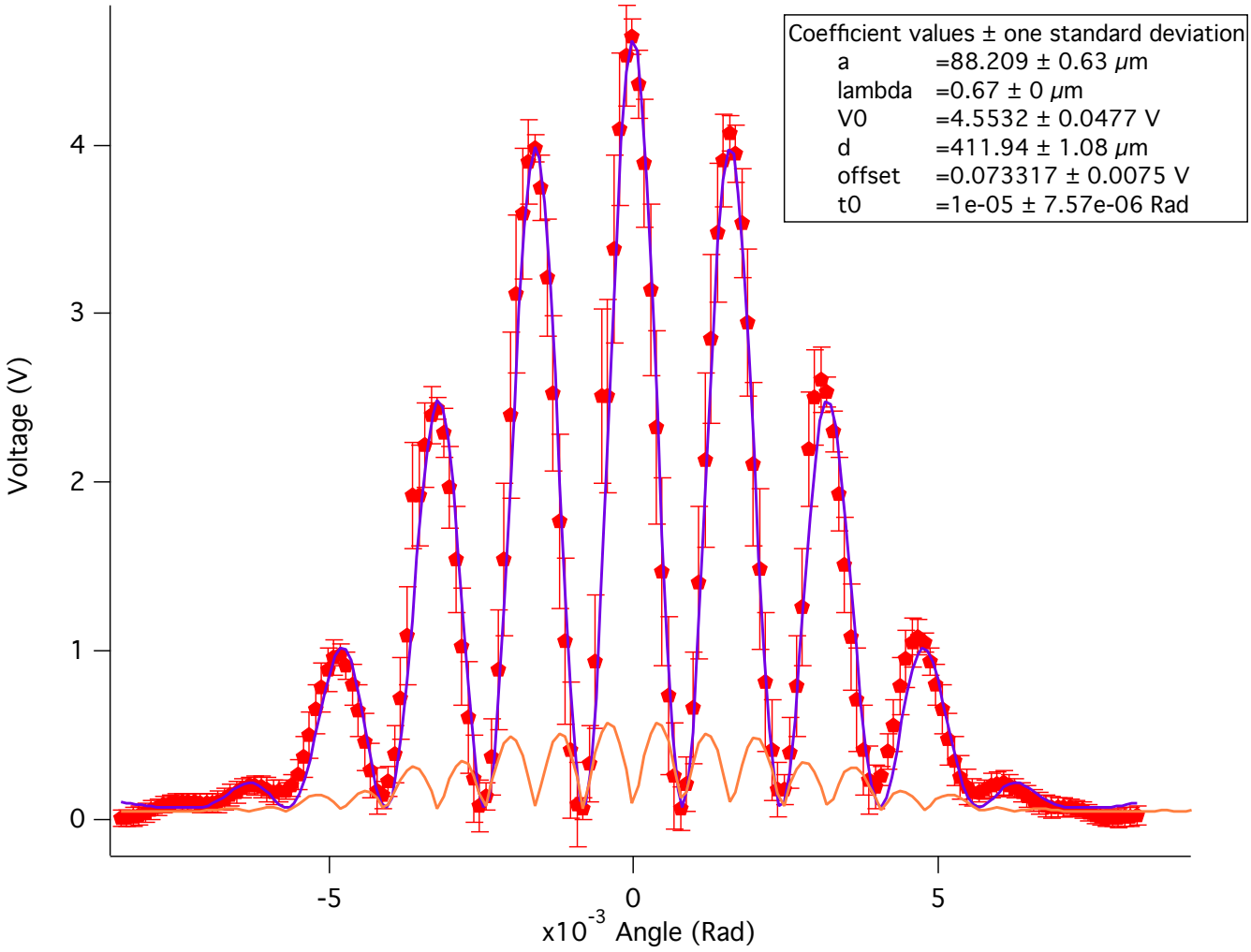

FIG. 3. Plot of double slit interference.

VII. TABLES

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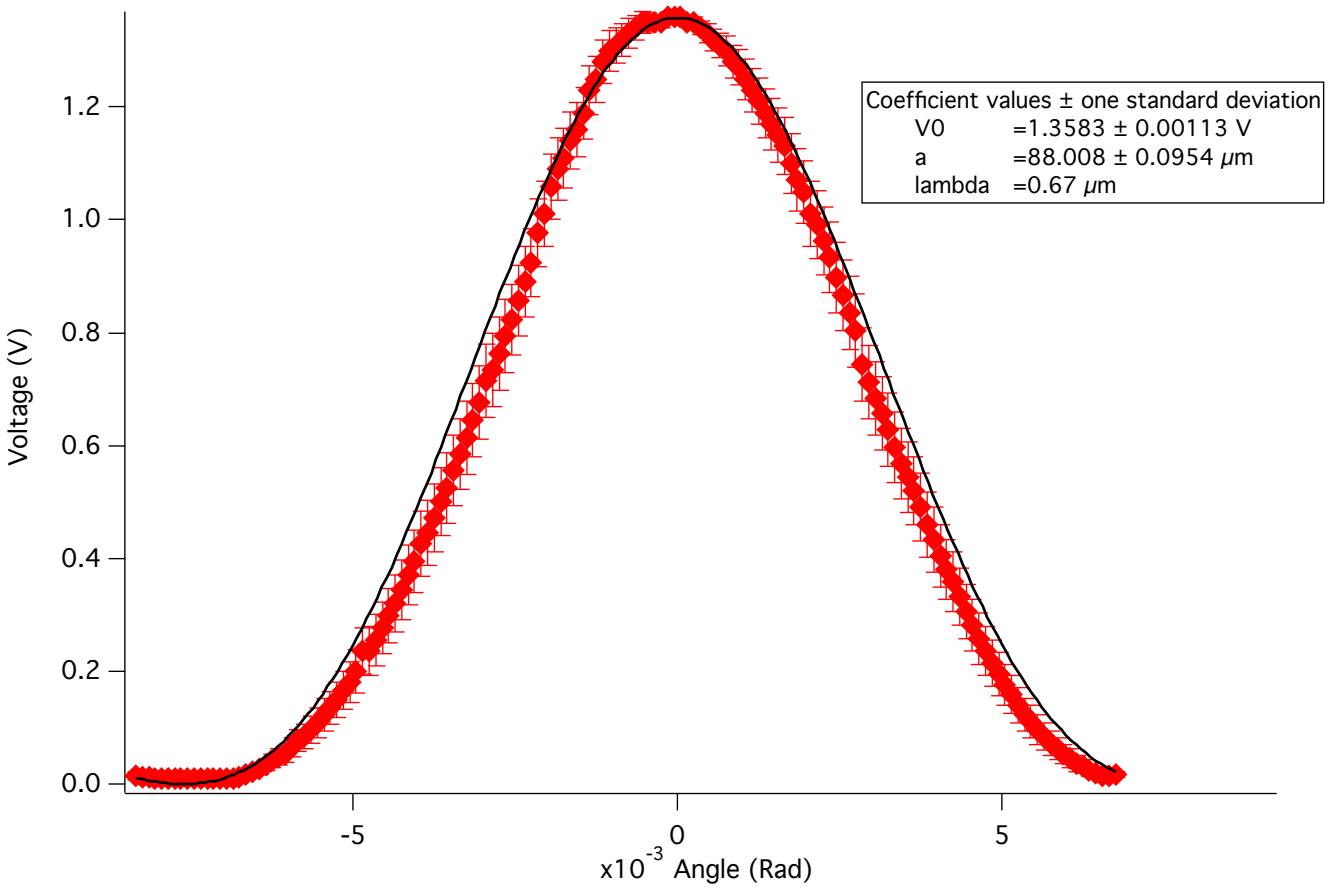

FIG. 4. Plot of single slit interference.

TABLE I. Elementary bosons

Name	Symbol	Mass (GeV/c^2)	Spin	Discovered	Interacts with
Photon	γ	0	1	1905	Electrically charged particles
Gluons	g	0	1	1978	Strongly interacting particles (quarks and gluons)
Weak charged bosons	$W^{\pm}$	82	1	1983	Quarks, leptons, $W^{\pm}$, Z^0, γ
Weak neutral boson	Z^0	91	1	1983	Quarks, leptons, $W^{\pm}$, Z^0
Higgs boson	H	126	0	2012	Massive particles (according to theory)

[1] LaTeX Double Slit Experiment, <http://upload.wikimedia.org/wikipedia/commons/c/c2/Single_slit_and_double_slit2.jpg/>.

[2] LaTeX TeachSpin Instructions Manual, *Two-Slit interference, One Photon at a Time (TWS1-B), Pulse Counter/Interval Timer (PCIT1)*, 6/2013.

[3] LaTeX Project Web Site, <http://www.latex-project.org/>.

[4] *LaTeX* (Wikibook), <http://en.wikibooks.org/wiki/LaTeX/>.

[5] Helmut Kopka and Patrick W. Daly, *A Guide to LaTeX*, 4th edition (Addison-Wesley, Boston, 2004).

[6] REVTeX 4 Home Page, <https://authors.aps.org/revtex4/>.

[7] On the other hand, you can avoid the installation process entirely by using a cloud-based LaTeX processor such as ShareLaTeX, <https://www.sharelatex.com/>, or writeLaTeX, <https://www.writelatex.com/>.

[8] In typography, aesthetics often takes precedence over logic.

[9] Please don't try to handle foreign characters and accents with the `inputenc` and `fontenc` packages, which are incompatible with AJP's editing process.

[10] See the Mathematics chapter of Ref. 4 for an excellent overview of math symbols and equations, with examples.

[11] Thinking up a good label name takes a moment, but it's worth the trouble; we strongly advise against using labels like `eq2`, which become extremely confusing after you decide to add another equation before Eq. (**??**).

[12] You need to process a file twice to get the counters correct.

[13] N. David Mermin, "What's wrong with these equations?," Phys. Today **42** (10), 9–11 (1989).

[14] American Journal of Physics Editor's Web Site, <http://ajp.dickinson.edu>.

[15] Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics, Vol. 1* (Addison-Wesley, 1964), p. 3-10.

[16] Many LaTeX users manage their bibliographic data with a tool called BIBTeX. Unfortunately, AJP cannot accept BIBTeX files; all bibliographic references must be incorporated into the manuscript file as shown here, at least when you send an editable file for production.

[17] Freeman J. Dyson, "Feynman's proof of the Maxwell equations," Am. J. Phys. **58** (3), 209–211.

[18] M. R. Flannery, "Elastic scattering," in *Atomic, Molecular, and Optical Physics Handbook*, edited by G. W. F. Drake (AIP Press, New York, 1996), p. 520.

[19] *AIP Style Manual*, 4th edition (American Institute of Physics, New York, 1990). Available online at <http://www.aip.org/pubservs/style/4thed/toc.html>. Although parts of it have been

made out of date by advancing technology, most of this manual is still as useful as ever. Just be sure to follow AJP's specific rules whenever they conflict with those in the manual.