Writing Scientific Papers

Dr. Forrest

Phys 3110

UNIVERSITY OF HOUSTON

Structure of paper

- Title
- Abstract
- Introduction (& Theory)
- Experimental method
- Results, Analysis, and Discussion
- Conclusion
- References

Title

- Identifies experiment adequately and briefly, not more than ten words
- Put keywords identifying the work in the title
- Title will be used to classify your work
- Cites author first, lab partner(s) second, course, and date

UNIVERSITY OF HOUSTON
Learning. Leading.

Abstract

- Briefly summarizes the full report concisely and effectively, $\leq$ 100 words
  - Enables those who work in the subject to decide whether they want to read the paper
  - Provides a summary for those who have only a general interest in the subject
- Should indicate the general scope, final result with uncertainty, and main conclusion
- Self contained. No references.

UNIVERSITY OF HOUSTON
Learning. Leading.

Introduction

- Establishes concept of experiment (what)
- Establishes context of experiment; Relation of the experiment to any previous work (why)
- States purpose, and hypothesis if appropriate; What is the objective?
- (must include specific, may include general)
- Theory: Includes all equations used, defines all variables. Derives (or at least motivates) equations.
- Introduction should bring reader to the point where he is ready to hear about your experiment
- Aim at a general physicist, not an expert

UNIVERSITY OF HOUSTON
Learning. Leading.

Constraint on the post-Newtonian parameter γ on galactic size scales

Adam S. Bolton, Saul Rappaport, and Scott Burles, Phys. Rev. D, 061501(R), **74**, (2006).

…"post-Newtonian gravity parameter γ (e.g. [4,5])"…

Fermat time delay surfaces [10,11]. By extremizing the sum of the Shapiro and geometric time delays, one obtains the "lens equation" that relates position in the observed image plane to location in the unobserved and unlensed source plane:

$$\vec{\theta}_s = \vec{\theta} - \frac{(1+\gamma)}{2}\vec{\nabla}\psi(\vec{\theta}). \qquad (2)$$

Here, $\vec{\theta}_s$ is the angular source location, $\vec{\theta}$ is the angular location of the image, and $\psi(\vec{\theta})$ is a scaled line-of-sight integral of the Newtonian gravitational potential of the lensing object (see Eq. 48 of [12] for the explicit definition of ψ in this context). The Einstein radius, defined by $\vec{\theta}_s =$

Experimental Method

- Describes materials & equipment used (in paragraphs, not lists)
- Might show a diagram of the apparatus
- Describes procedures (in paragraphs, not lists)
- Briefly gives enough detail to allow replication of the experiment
- Uses own words, not a copy of the manual
- What you did, not instructions for others
- Amount of detail depends on scope of journal
- Do not aim the paper at other experts using the same apparatus, aim at a general physicist

Results: Measurements

- All necessary results reported, with errors – Instructor should be able to confirm analysis using the data presented
- Do not reproduce the second best data set with the caption "typical set"
- Uses text to describe data shown in table or graph.
- When appropriate, use tables or graphs.
- Refer to any tables and/or graphs in text, by number.
- Any tables have titles/figures have captions, appear in order mentioned in text, and are correctly labeled

UNIVERSITY OF HOUSTON
Learning. Leading.

Diagrams, graphs and tables

- Graphs should be bold and clear, with large axis labels, and units.
- Tables stand out, so the reader can find the results easily. Include units.
- Figures get a caption below. Tables get a title above.
- Must be referred to in the text, number in order of reference.

Results

"…we normalize the load by the critical energy release rate at the Griffith criterion *Gc* tabulated in Table I."

TABLE I. Griffith critical load, measured lattice trapping, and lattice-trapping-model parameters for Si (111) fracture.

	TB	SW	IMSW	EDIP
G_c (J/m^2)	2.0	2.8	2.8	2.2
R	1.09–1.16	1.44–1.56	1.39–1.52	1.65–1.73
s_{bb} (Å)	2.70	1.40	1.40	0.77
s_{eq} (Å)	1.38	2.31	2.00	2.34

"Lattice Trapping Barriers to Brittle Fracture", N. Bernstein and D.W. Hess, Phys. Rev. Lett., 025501, **91**, 2003.

UNIVERSITY OF HOUSTON
Learning. Leading.

Results

"…Taking account of the nondegeneracy for $n \leq 2$ gives the solid curve in Fig. 1, which includes prominent well known resonances. Including nondegeneracy for $n \leq 4$ [26] gives the dotted curve in Fig. 1."

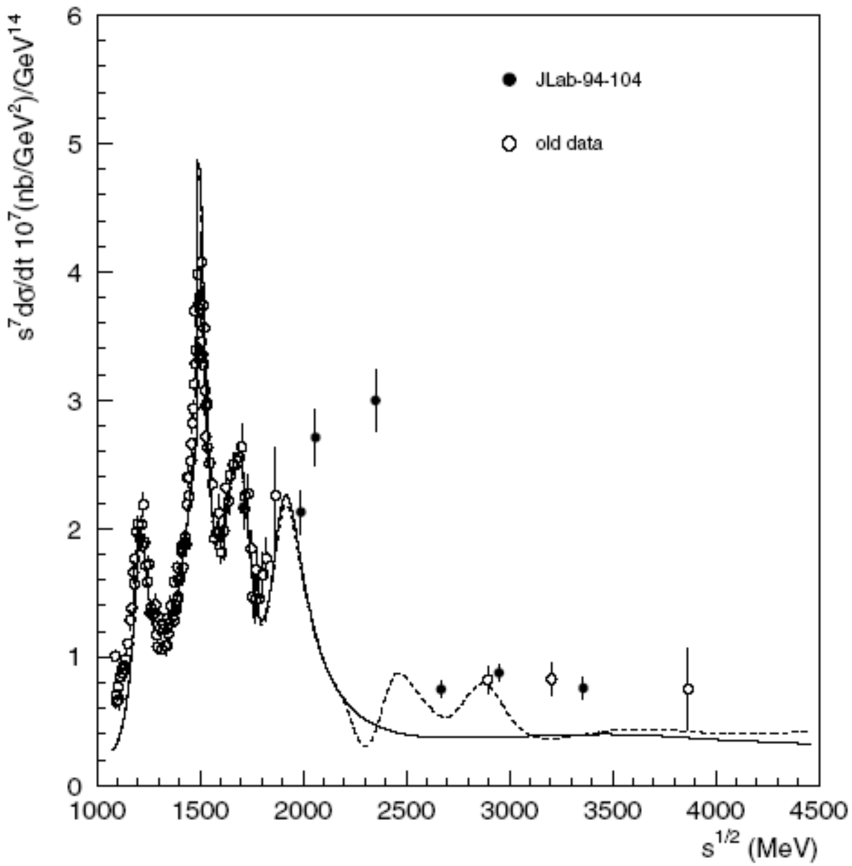

FIG. 1. Energy dependence of the differential cross section for π^+ photoproduction at $\theta = 90°$. The solid curve denotes degeneracy breaking for $n \leq 2$, while the dotted for $n \leq 4$. The empty circles are old data from Ref. [20], and the solid dots are new data from JLab [21].

"Locality of Quark-Hadron Duality and Deviations from Quark Counting Rules Above the Resonance Region", Qiang Zhao1 and Frank E. Close ,Phys. Rev. Lett., 022004, **91**, 2003.

Analysis: Calculations

- Explain all necessary calculations– instructor should be able to confirm calculations based on what is discussed
- For complicated work, give an example to clarify
- Refer to equations given in Introduction
- Use text to describe analysis, refer to any tables and/or graphs
- Include error analysis! Explain what errors you are using
- Give final result, with error

Discussion

- Discusses scientific content & context of results, and relates them to the objective and/or hypothesis
  - Comparison with other similar measurements
  - Comparison with relevant theories
  - Discussion of the state of the problem in the light of your results
  - Did you get what you expected, within error bars? Why / why not?
  - What did you learn?
  - What could be improved upon?

UNIVERSITY OF HOUSTON
Learning. Leading.

Organization

- Results, Analysis, and Discussion: 1 section

Conclusion: Summary

- The *conclusion* is the counterpart of the *objective* in the introduction – did you achieve it?
- Summarize the report
  - What you did
  - Repeat final numerical results, with error
  - Main points of discussion

UNIVERSITY OF HOUSTON
Learning. Leading.

References

- Every report will have at least one, the lab manual
- Reference for equations, figures, background info…
- Number in order referred to in text
- Refer to the reference in text where it was used.[1][1]
- Use a standard format
- See Sample MS Word report on my web page
- see library course page: http://guides.lib.uh.edu/phys3313
- LabWrite, link from my web page
- UH Writing Center

UNIVERSITY OF HOUSTON
Learning. Leading.

Examples

- What is good?
- What is not good?

I. Introduction

The goal of the experiment is to obtain a value for Planck's constant (h), and it will be achieved through five different LED's of different wavelengths. The LED's are set up in a circuit and connected to an oscilloscope, the data from the voltage across the circuit and the resistor will be used to find the resistance of the diode. The following equation is for the voltage across the diode (V),

$$V = V_c - V_R \quad (1)$$

In which V_c is the value from CH1 of the oscilloscope or the voltage of the circuit, V_R is the value obtained in CH2 or the voltage across the resistor.

UNIVERSITY OF HOUSTON
Learning. Leading.

I. Introduction

The goal of the experiment is to obtain a value for Planck's constant (h), and it will be achieved through five different LED's of different wavelengths. The LED's are set up in a circuit and connected to an oscilloscope, the data from the voltage across the circuit and the resistor will be used to find the resistance of the diode. The following equation is for the voltage across the diode (V),

$$V = V_c - V_R \qquad (1)$$

In which V_c is the value from CH1 of the oscilloscope or the voltage of the circuit, V_R is the value obtained in CH2 or the voltage across the resistor.

<u>Good</u>

Section Heading
Specific purpose.
Brief overview of experiment.
Defined all variables in equation.

<u>Bad</u>

No context (why).
Didn't define "LED".

UNIVERSITY OF HOUSTON
Learning. Leading.

II. Experimental Procedure

Use the caliper with an error of $\pm .02\ mm$ to measure the length of the aluminum bar, along its longest side. Then used the micrometer with an error of $\pm .01\ mm$ to measure both the height and width of the aluminum bar. Then go to the mass scale with an error of $\pm .01\ g$ to measure the mass. After that use equation (1) to find the density, and then use equation (2) to find the error in the calculations. Next, attach a DC power supply with two different multimeters, the BK Precision 2407A and the Protek 608, with errors of $\pm .02\ V$ and $\pm$ $.005\ V$, respectively, were used for this

UNIVERSITY OF HOUSTON
Learning. Leading.

II. Experimental Procedure

Use the caliper with an error of $\pm .02\ mm$ to measure the length of the aluminum bar, along its longest side. Then used the micrometer with an error of $\pm .01\ mm$ to measure both the height and width of the aluminum bar. Then go to the mass scale with an error of $\pm .01\ g$ to measure the mass. After that use equation (1) to find the density, and then use equation (2) to find the error in the calculations. Next, attach a DC power supply with two different multimeters, the BK Precision 2407A and the Protek 608, with errors of $\pm .02\ V$ and $\pm$ .005 V respectively, were used for this

<u>Good</u>

Section Heading

Gave model of equipment

<u>Bad</u>

Instructions, not a description of what they did.

III. Results, Analysis, and Discussion

Table 1. Aluminum bar mass and dimensions.

Run	*m* (g)	*l* (mm)	*w* (mm)	*h* (mm)
1	63.35	79.70	22.680	12.745
2	63.37	79.72	22.620	12.810
3	63.38	79.72	22.680	12.780
σ_m	0.01	0.01	0.020	0.02
δ	0.01	0.001	0.001	0.01

From eq. 2, all σ_m were computed. (Reminder: δ is instrumental precision and if $\sigma_m < \delta$, $\delta = \Delta x$ for more conservative error estimates). Following the $\mu \pm \Delta x$ convention, final reported bar quantities are (based on Table 1): $m = 63.37 \pm 0.01$ g, $l = 79.71 \pm 0.01$ mm, $w = 22.660 \pm 0.020$ mm, and $h = 12.778 \pm 0.001$ mm. From eqs. 1 & 4, final bar density is 2.745 ± 0.005 g/cm^3 with precision 0.17%.

UNIVERSITY OF HOUSTON
Learning. Leading.

III. Results, Analysis, and Discussion

Table 1. Aluminum bar mass and dimensions.

Run	*m* (g)	*l* (mm)	*w* (mm)	*h* (mm)
1	63.35	79.70	22.680	12.745
2	63.37	79.72	22.620	12.810
3	63.38	79.72	22.680	12.780
σ_m	0.01	0.01	0.020	0.02
δ	0.01	0.001	0.001	0.01

From eq. 2, all σ_m were computed. (Reminder: δ is instrumental precision and if $\sigma_m < \delta$, $\delta = \Delta x$ for more conservative error estimates). Following the $\mu \pm \Delta x$ convention, final reported bar quantities are (based on Table 1): $m = 63.37 \pm 0.01$ g, $l = 79.71 \pm 0.01$ mm, $w = 22.660 \pm 0.020$ mm, and $h = 12.778 \pm 0.001$ mm. From eqs. 1 & 4, final bar density is 2.745 ± 0.005 g/cm^3 with precision 0.17%.

<u>Good</u>

Section Heading.

Table title above.

Good table layout.

Included standard deviation and tool precision in table.

<u>Bad</u>

Put table as first thing under heading.

References

R. L. Forrest, “Measurement and Error Analysis”, in Advanced Laboratory I Manual, University of Houston, 8/9/2018.

R. L. Forrest. “Error Analysis”, http://nsmn1.uh.edu/rforrest/Error%20Analysis%20lecture.pdf.

UNIVERSITY OF HOUSTON

Learning. Leading.

References

R. L. Forrest, “Measurement and Error Analysis”, in Advanced Laboratory I Manual, University of Houston, 8/9/2018.

R. L. Forrest. “Error Analysis”, http://nsmn1.uh.edu/rforrest/Error%20Analysis%20lecture.pdf.

Good

Section Heading

First reference has correct content.

Bad

Not numbered.

Second reference needs an “accessed on” date.

Resources

- Lab Manual
- My web page: Lab Report Resources & Links
  - Sample MS Word report & .tex file
  - library Research Guide: http://guides.lib.uh.edu/phys3313
  - Report Rubric
  - LabWrite
- UH Writing Center

UNIVERSITY OF HOUSTON
Learning. Leading.

My References

Daryl W. Preston, The Art of Experimental Physics, (Wiley, New York, 1991), pp. 29-33.

UNIVERSITY OF HOUSTON

Learning. Leading.

Homework

- Grade the provided lab report, using the course rubric. Give numerical grades for each section of the rubric.