Thursday, December 5, 2:30 – 5:20 poster presentations, 1st floor hallway

Thursday, December 12, 2:30 – 5:20 talks, room 105

Both open to department

# Same project for poster and talk

If you are waiting on your grades to decide which project you want to pick for the poster and talk, let me know and I'll try to get to yours quicker. Many of you have already decided.

# Your poster abstract should be like a paper abstract Abstracts due Thursday

It should include: (not necessarily in this order)

What you found? All main outcomes found with values and uncertainty

Briefly how you found it?

Briefly why is what you found interesting and/or useful. (Which should be elaborated upon, typically in the introduction.) <u>This typically goes first</u>.

Sometimes: limitations of or possible improvements to work, <u>particularly if your answer is off from expected</u> (more common in conclusions/discussion)

Goal: concisely communicate the key findings of a project in a visually engaging way, allowing viewers to quickly grasp the main points of the study while also generating interest and discussion about the research

# What a poster is not

- It’s not a paper. You won’t write long details about anything. Focus on the key points
- It’s not a lab notebook. You don’t need tables of data
- Other things we don’t need: equipment list or detailed procedure (brief is ok, example: in charge to mass, talk about 4 experiment parts)
- Other the other hand, you might include references or a link to them, some use a qr code
- You do want error bars and the expected values.

# Key metrics

- **Clear and concise information delivery:** Present complex research data in a simplified format that is easy to understand for a diverse audience, even those not experts in the field.
- **Visual appeal:** Utilize graphics, images, charts, and diagrams to effectively convey information and grab attention.
- **Stimulate discussion:** Encourage interaction with the poster presenter by providing enough detail to spark questions and further conversation about the research.
- **Highlight key findings:** Emphasize the most important results of the study, making them readily apparent to viewers.

https://undergradcollege.utexas.edu/academics/undergraduate-research/guide-creating-research-posters/poster-samples

# Effect of Microbial Legacy on Nitrogen Cycle and Restoration Success

[redacted]

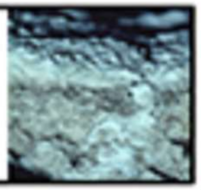
University of Texas at Austin

## Introduction

- Nitrogen(N) cycle plays a key role in ecosystem and every transformation of the N cycle driven by microbes.
- Restoration attempts on converting abandon rangelands in south Florida back to the native scrub ecosystems allow a unique opportunity to study persistent effects of previous vegetation left on the microbial community and ecological processes.
- Biological crust is essential for native ecosystem.

## What is Crust?

- A surface layer of "Living Soil", consisting primarily of cyanobacteria, algae, fungi and their byproducts.
- Supports many biological functions like N fixation and water infiltration control.



## Questions

- How does native crust affect microbial legacy?
- Which impacts the N-cycle more? Microbial abundance or composition?

## Field Site: Native scrub lands and abandoned pastures at Archbold Biological Station.

- Sites are abandoned pastures and native scrub lands subjected to pasture removal treatments and crust addition treatment(Fig 2).

Fig 1. Archbold Biological Station is located at the souther end of the Lake Wales Ridge in central FL.

Fig 2. Plot design


Heavily pastured

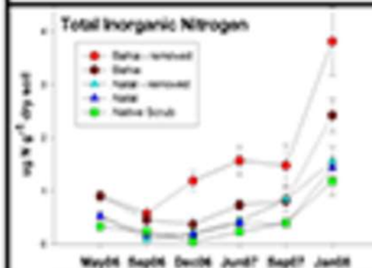
Lightly pastured

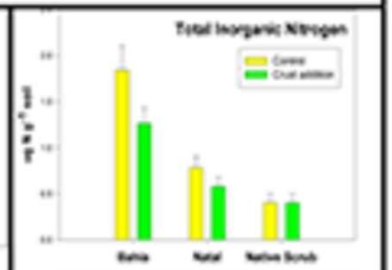
Native scrub

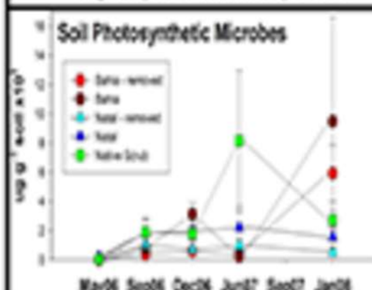
## Method

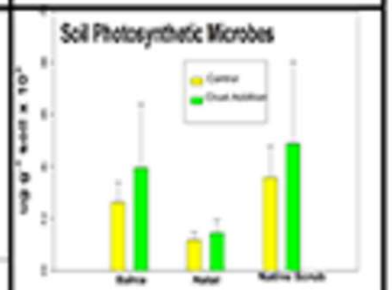
- Biogeohemical
  - KCl extraction
  - Photosynthetic activity determine by fluorometry.
- Molecular approach
  - PCR
  - RFLP
  - Direct sequence analysis

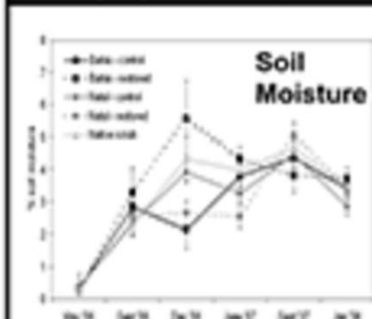
## Soil Nitrogen, Photosynthetic Microbes Abundance, and Moisture changes over time and treatment




- Crust addition decrease inorganic N, but does not affect microbial abundance.
- Native soil respond and tracks moisture.
- Inorganic N is not tracked by any site.
- Pastures site response to moisture unknown.

## Possible mechanisms

- Pasture vegetation has caused a shift in soil microbe community and chemistry.
- Frequent disturbance favor more resilient microbes and changes community composition.

## Sample restriction fingerprint


- DNA based fingerprints allow characterization of community difference.
- Couple with clone library will allow identification of species.

## Conclusion

- Inorganic nitrogen increases over time, and pasture sites both have higher inorganic nitrogen than the native.
- Crust treatment helps increase nitrogen fixation, but does not increase microbial abundance significantly.
- The microbial abundance does not track N, but does track moisture.
- Composition may be the more important factor in N-cycling.

## Acknowledgment

References or remove

**Strengths**

- Clearly defined research questions
- Effective use of visual aids
- Clear organizational structure
- Bullets break up text

**Room for improvement**

- Technical language/undefined acronyms (accessible to limited audience)
- Narrow margins within text boxes
- Too many thick borders around boxes

# The Impact of African American Academic-Professional Student Organizations on African American College Students' Adjustment & Career Goals

[redacted] Psychology Major, McNair Scholars Summer Research Institute Project
*Supervised By:* [redacted]

## Introduction

African Americans have only been lawfully granted equal educational opportunity for 58 years[2, 10]. Research has shown that only 40% of Black undergraduates graduate, in which some believe is due to lack of academic preparation[3, 7].

However, several researchers have found various reasons that contribute to African Americans not finishing: financial difficulties, campus climate, feeling disconnected from White faculty & classmates, and not fully adjusting to new environment[1,4, 8, 9, 11].

Furthermore, research has shown being involved in an ethnic-specific student organization greatly increases African American students college adjustment and development[5,6].

[1]Astin (1993)
[2]Brown v. Board of Education (1954)
[3]Cross & Slater (2004)
[4]Delpit (2012)
[5]Guiffrida & Douthit, (2010)
[6]Harper & Quaye (2007)
[7]Levin & Levein (1991)
[8]Museus (2008a)
[9]Strayhorn & Terrell (2007)
[10]Sweatt v. Painter (1950)
[11]Tinto (1993)

## Research Question

How does involvement in student organizations, that are discipline-specific and ethnic-specific, impact African American college students' adjustment and career goals?

## Methods

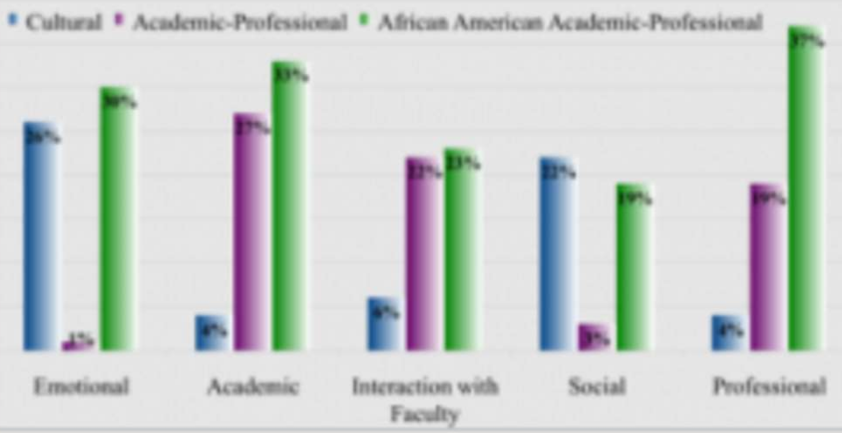
| Participant Inclusion Criteria | Participant Demographics |
|---|---|
| Undergraduate or graduate student, post-baccalaureate in the work force | Total n = 72<br><br>16 males; 56 females |
| Attending or attended a predominantly White institution | 4 underclassmen; 32 upperclassmen; 14 graduate students; 18 in the workforce; 4 unemployed<br><br>9 between ages 18-20; 44 between ages 21-23; 19 were 24 or older |
| Identify as Black/African/African American or Biracial | 65 self-identified as Black/African American; 7 as Biracial |

**Materials and Procedure**

Voluntary online survey assessed participants' involvement in student organizations, interactions with faculty, and how student organizations impacted adjustment to college.

## Results

3 types of student organizations assessed to determine the impact on five areas of college adjustment.




## Discussion

**Cultural Organizations**

- Provide students with high social and emotional support

**Academic-Professional Organizations**

- Provide students with academic and professional support

**Black/African American Academic-Professional Organizations**

- Provide students ALL forms of support
- Help students the most with emotional, professional, academic, and interaction with faculty college adjustment
- Significantly impact students in coping with feeling as the Black spokesperson

**Implications**

- Colleges and universities should fully utilize and support Black/African American Professional Organizations as a tool to improve Black student success.

## Future Research

- Larger sample size → equalize gender representation
- Test-retest survey → validity and reliability
- Assess how discipline-specific and ethnic specific student organizations impact on other students of color.

## Acknowledgements

Thank you to the UT McNair Scholars Program, my advisor, and all those who have supported me furthering my research experience through feedback and presentations opportunities.

**Strengths**

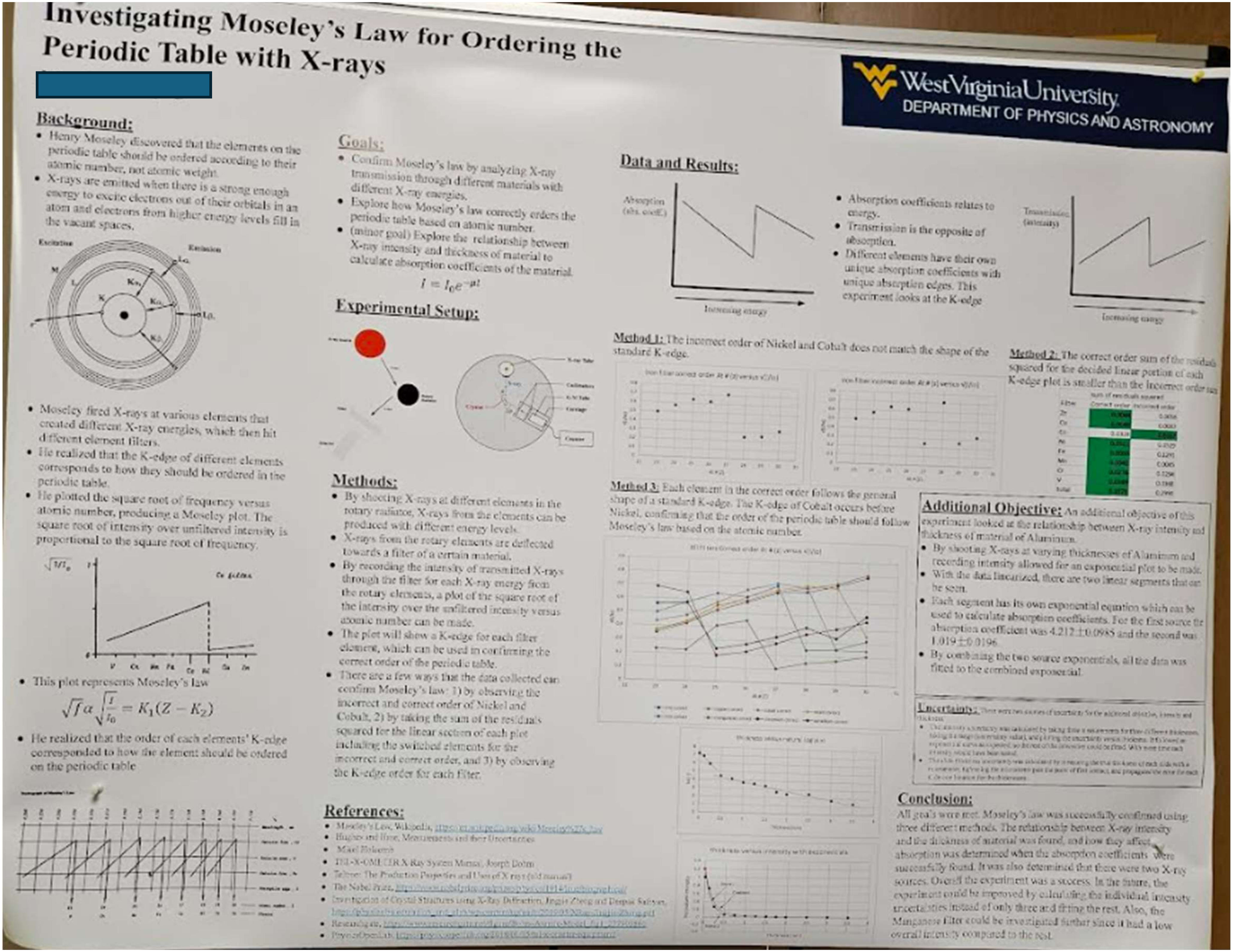
- Parameters of study well defined
- Clearly defined research question
- Simple color scheme
- Clear sections
- Use of white space

**Room for improvement**

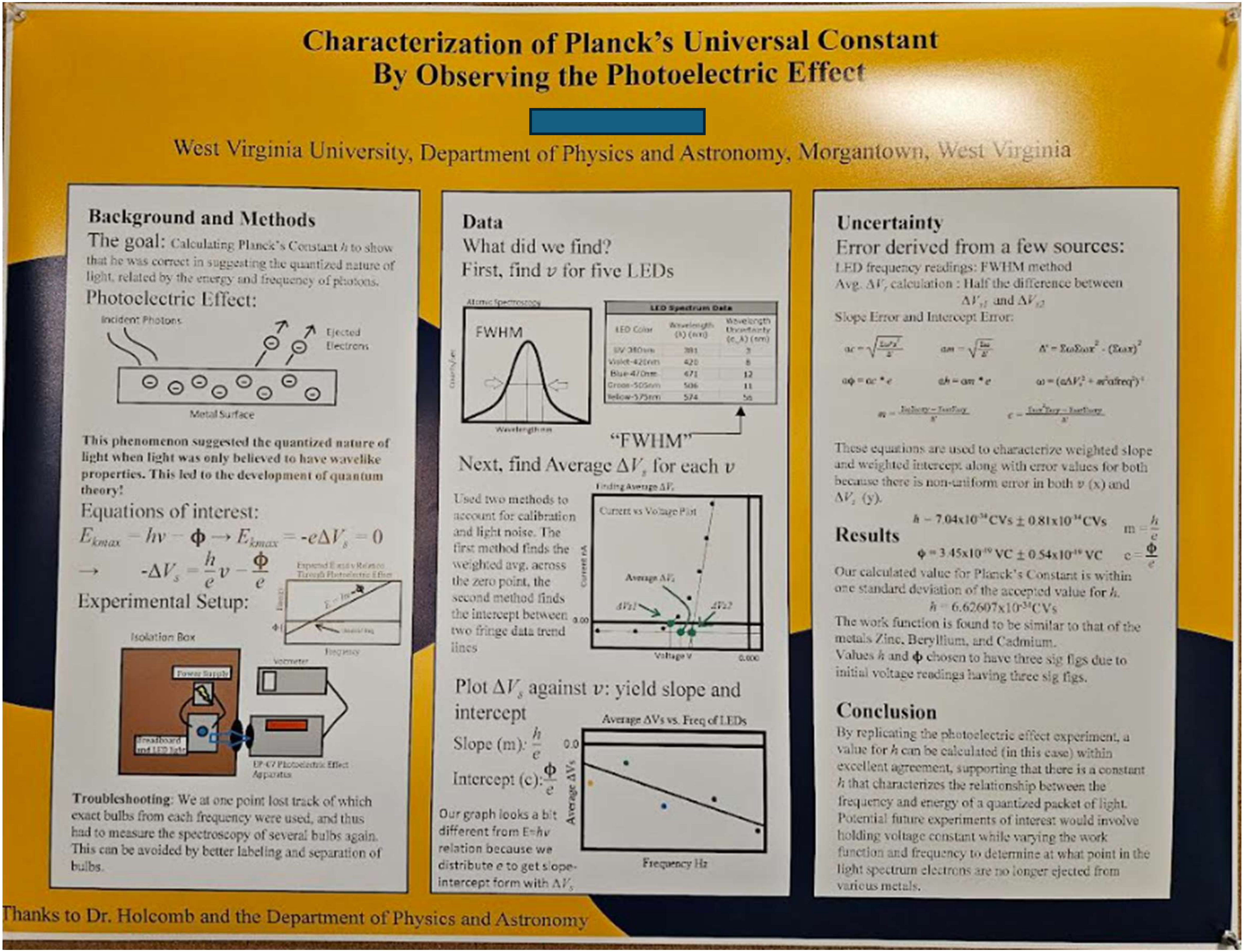
- Discussion of Results
- Minor formatting misalignments
- Long title

# Past Advanced Lab Examples

- I do not expect you to look exactly like any of these, but it should give you some ideas
- The lowest grades among these examples were still a B


Investigating Moseley's Law for Ordering the Periodic Table with X-rays
[redacted]
West Virginia University
DEPARTMENT OF PHYSICS AND ASTRONOMY
Background:
Henry Moseley discovered that the elements on the periodic table should be ordered according to their atomic number, not atomic weight.
X-rays are emitted when there is a strong enough energy to excite electrons out of their orbitals in an atom and electrons from higher energy levels fill in the vacant spaces.
Excitation
Emission
Moseley fired X-rays at various elements that created different X-ray energies, which then hit different element filters.
He realized that the K-edge of different elements corresponds to how they should be ordered in the periodic table.
He plotted the square root of frequency versus atomic number, producing a Moseley plot. The square root of intensity over unfiltered intensity is proportional to the square root of frequency.
This plot represents Moseley's law
$\sqrt{f}\,\alpha\sqrt{\frac{I}{I_0}} = K_1(Z - K_2)$
He realized that the order of each elements' K-edge corresponded to how the element should be ordered on the periodic table
Goals:
Confirm Moseley's law by analyzing X-ray transmission through different materials with different X-ray energies.
Explore how Moseley's law correctly orders the periodic table based on atomic number.
(minor goal) Explore the relationship between X-ray intensity and thickness of material to calculate absorption coefficients of the material.
$I = I_0 e^{-\mu t}$
Experimental Setup:
Methods:
By shooting X-rays at different elements in the rotary radiator, X-rays from the elements can be produced with different energy levels.
X-rays from the rotary elements are deflected towards a filter of a certain material.
By recording the intensity of transmitted X-rays through the filter for each X-ray energy from the rotary elements, a plot of the square root of the intensity over the unfiltered intensity versus atomic number can be made.
The plot will show a K-edge for each filter element, which can be used in confirming the correct order of the periodic table.
There are a few ways that the data collected can confirm Moseley's law: 1) by observing the incorrect and correct order of Nickel and Cobalt, 2) by taking the sum of the residuals squared for the linear section of each plot including the switched elements for the incorrect and correct order, and 3) by observing the K-edge order for each filter.
References:
Moseley's Law, Wikipedia
Hughes and Hase, Measurements and their Uncertainties
TEL-X-OMETER X-Ray System Manual
The Nobel Prize
Data and Results:
Absorption (abs. coeff.)
Increasing energy
Absorption coefficients relates to energy.
Transmission is the opposite of absorption.
Different elements have their own unique absorption coefficients with unique absorption edges. This experiment looks at the K-edge
Transmission (intensity)
Increasing energy
Method 1: The incorrect order of Nickel and Cobalt does not match the shape of the standard K-edge.
Method 2: The correct order sum of the residuals squared for the decided linear portion of each K-edge plot is smaller than the incorrect order sum.
Method 3: Each element in the correct order follows the general shape of a standard K-edge. The K-edge of Cobalt occurs before Nickel, confirming that the order of the periodic table should follow Moseley's law based on the atomic number.
Additional Objective: An additional objective of this experiment looked at the relationship between X-ray intensity and thickness of material of Aluminum.
By shooting X-rays at varying thicknesses of Aluminum and recording intensity allowed for an exponential plot to be made.
With the data linearized, there are two linear segments that can be seen.
Each segment has its own exponential equation which can be used to calculate absorption coefficients. For the first source the absorption coefficient was 4.212±0.0985 and the second was 1.019±0.0196.
By combining the two source exponentials, all the data was fitted to the combined exponential.
Uncertainty:
Conclusion:
All goals were met. Moseley's law was successfully confirmed using three different methods. The relationship between X-ray intensity and the thickness of material was found, and how they affect absorption was determined when the absorption coefficients were successfully found. It was also determined that there were two X-ray sources. Overall the experiment was a success. In the future, the experiment could be improved by calculating the individual intensity uncertainties instead of only three and fitting the rest. Also, the Manganese filter could be investigated further since it had a low overall intensity compared to the rest.

- It looks a bit disorganized – inconsistent formatting (lost points in visual presentation)
- There's a bit too much background (about 1/3!)
- Less methods, more results discussion
- Did not discuss experimental improvements/troubleshooting
- While the rubric asks for "a clear discussion of error and uncertainty", you don't need a separate section for this. A sentence about how uncertainty is determined may be sufficient.
- You may need slightly more discussion of uncertainty in the following labs: photoelectric, charge to mass, and ESR. Anyone know why? A figure is likely helpful for these labs.


Characterization of Planck's Universal Constant
By Observing the Photoelectric Effect
[redacted]
West Virginia University, Department of Physics and Astronomy, Morgantown, West Virginia
Background and Methods
The goal: Calculating Planck's Constant h to show that he was correct in suggesting the quantized nature of light, related by the energy and frequency of photons.
Photoelectric Effect:
Incident Photons
Ejected Electrons
Metal Surface
This phenomenon suggested the quantized nature of light when light was only believed to have wavelike properties. This led to the development of quantum theory!
Equations of interest:
$E_{kmax} = hv - \phi \rightarrow E_{kmax} = -e\Delta V_s = 0$
$\rightarrow -\Delta V_s = \frac{h}{e}v - \frac{\phi}{e}$
Experimental Setup:
Isolation Box
Power Supply
Breadboard and LED light
Voltmeter
EP-47 Photoelectric Effect Apparatus
Troubleshooting: We at one point lost track of which exact bulbs from each frequency were used, and thus had to measure the spectroscopy of several bulbs again. This can be avoided by better labeling and separation of bulbs.
Data
What did we find?
First, find $v$ for five LEDs
Atomic Spectroscopy
FWHM
Wavelength nm
LED Spectrum Data
LED Color | Wavelength (λ) (nm) | Wavelength Uncertainty (σ_λ) (nm)
UV-380nm | 381 | 3
Violet-420nm | 420 | 8
Blue-470nm | 471 | 12
Green-505nm | 506 | 11
Yellow-575nm | 574 | 56
"FWHM"
Next, find Average $\Delta V_s$ for each $v$
Finding Average $\Delta V_s$
Used two methods to account for calibration and light noise. The first method finds the weighted avg. across the zero point, the second method finds the intercept between two fringe data trend lines
Current vs Voltage Plot
Current nA
Average $\Delta V_s$
ΔVs1
ΔVs2
0.00
Voltage V
0.000
Plot $\Delta V_s$ against $v$: yield slope and intercept
Slope (m): $\frac{h}{e}$
Intercept (c): $\frac{\phi}{e}$
Average ΔVs vs. Freq of LEDs
0.0
Average ΔVs
Frequency Hz
Our graph looks a bit different from E=hv relation because we distribute e to get slope-intercept form with $\Delta V_s$
Uncertainty
Error derived from a few sources:
LED frequency readings: FWHM method
Avg. $\Delta V_s$ calculation : Half the difference between $\Delta V_{s1}$ and $\Delta V_{s2}$
Slope Error and Intercept Error:
These equations are used to characterize weighted slope and weighted intercept along with error values for both because there is non-uniform error in both $v$ (x) and $\Delta V_s$ (y).
Results
$h = 7.04\times10^{-34}$ CVs ± $0.81\times10^{-34}$ CVs
$\phi = 3.45\times10^{-19}$ VC ± $0.54\times10^{-19}$ VC
$m = \frac{h}{e}$
$c = \frac{\phi}{e}$
Our calculated value for Planck's Constant is within one standard deviation of the accepted value for h.
$h = 6.62607\times10^{-34}$CVs
The work function is found to be similar to that of the metals Zinc, Beryllium, and Cadmium.
Values h and φ chosen to have three sig figs due to initial voltage readings having three sig figs.
Conclusion
By replicating the photoelectric effect experiment, a value for h can be calculated (in this case) within excellent agreement, supporting that there is a constant h that characterizes the relationship between the frequency and energy of a quantized packet of light.
Potential future experiments of interest would involve holding voltage constant while varying the work function and frequency to determine at what point in the light spectrum electrons are no longer ejected from various metals.
Thanks to Dr. Holcomb and the Department of Physics and Astronomy

- Shiny!
- Inconsistent fonts really make this look rough (lost points in visual presentation)
- Experimental setup could have been better.
- While uncertainty discussion in your lab notebooks and more briefly in your papers is important, you'll want to be even more brief here. We just need to know how you determined your errors. We don't need all of the formulas. But, be ready to discuss is if anyone asks. 1/6 of this poster is about uncertainty and that's too much.

# Atomic Spectroscopy

[redacted]

Physics 341L: Advanced Physics Laboratory I

## Abstract

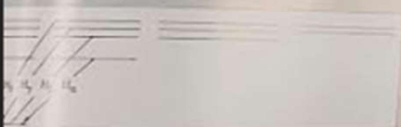
...spectroscopy is the field of study of the ...etic radiation absorbed and/or emitted by ...le atomic spectroscopy is used widely in ...and astronomy to determine what elements are ...an object, it can also be used to analyze the ...of the atoms themselves. This experiment is to ...ater statement, where we will determine the ...onstant and the ratio of hydrogen-deuterium ...ss using the Balmer spectral series of hydrogen ...ium. In order to do this accurately, we also ...independent calibration of the spectrometer with ...gas, and in this case, mercury. After completion ...eriment, we determined the Rydberg constant to ...nm^-1 with an uncertainty of 0.000785nm^-1, ...ss ratio to be 1.729 with an uncertainty of 1.692.

## Background

...ner series is characterized by an electron making ...from state $n \geq 3$ to state $n = 2$, where n is the ...antum number of the electron. For this ..., we will be looking at three Balmer lines: $H_\alpha$, ...the transition from state 3-2, $H_\beta$, where β is the ...from 4-2, and $H_\gamma$, where γ is the transition from ...avelength of these transitions can be calculated ...ydberg formula

$$R_\infty = \frac{1}{\lambda_n}\left(\frac{4n^2}{n^2-4}\right)$$

...$1.0973731 \times 10^7 m^{-1}$ is the infinite-mass ...stant and $\lambda_n$ is the wavelength for the transition ...level to $n = 2$.



...ansitions for the Balmer series.

...-proton mass ratio for a single Balmer ... by

$$\frac{m_d}{m_p} = \frac{A_{air}}{A_{air} - \Delta\lambda_{air}}$$

...theoretical separation for air between the ...hypothetical infinitely heavy nucleus ...experimentally measured wavelength

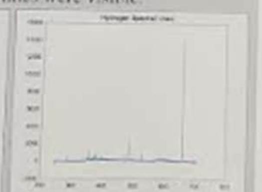
## Apparatus and Procedure

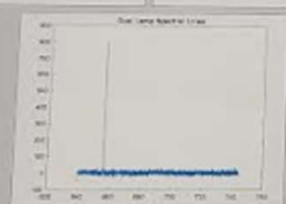
Equipment List:

- Ocean Optics HR4000 monochromator and controller (#HR4C6188, Order #647877, for 249-702nm spectral scan (low-resolution); #HR4C6189, Order #647878, for 640-741nm spectral scan (high-resolution)).
- Ocean Optics HR4-CBL-DB15 multiwire flat-cable bundle.
- Beige USB cable.
- Ocean Optics spectral scanning software.
- Fiber optic cable.
- Mercury Lamp.
- Hydrogen Lamp.
- Hydrogen-Deuterium Dual Lamp.

**Figure 2:** Image of the lab setup.

To get the spectroscopy of each element, we used the application OceanView's live capture feature, and we set the integration time to one second. We placed the fiber-optic cable close to the lamp for the element we were currently measuring until the spectral lines were visible.





**Figures 3-5:** Spectroscopy of hydrogen, mercury, and deuterium-hydrogen. Hydrogen and mercury is low-resolution, and the dual-lamp is high-resolution.

## Results

To get the Rydberg constant for hydrogen, we need to change our observed data into calibrated data, which we can do using mercury.

**Figure 6:** Accepted vs observed wavelength for mercury

Now we can create a calibration equation using the line of best fit for the graph above:

$$\lambda_{cal} = 1.0013553\lambda_{obs} - 0.688616$$

Figure 7: [illegible] for hydrogen

The Rydberg [illegible] by the slope of the graph above:

$$[illegible] 0.010861 \ nm^{-1}$$

For the mass [illegible] spectral lines from the dual-lamp mixture [illegible]

$$\frac{m_d}{m_p} = 1.7288$$

Uncertainty:

Using a linear regressio[illegible] analysis, we were able to find the uncertainty in the [illegible] constant and the deuterium-proton mass [illegible]

$$\delta R_H = 0.000[illegible] nm^{-1}$$

$$\delta\left(\frac{m_d}{m_p}\right) = [illegible]$$

## Discussion and Conclusion

The accepted value for the Rydberg constant is $R_H = 0.010901 nm^{-1}$, and our experiment found the Rydberg constant to be $R_H = 0.010861 nm^{-1}$ with an uncertainty of $\delta R_H = 0.000785 nm^{-1}$. Comparing this to the accepted value gives us a 0.2% error. The difference between the accepted value and the value we found through the experiment could be attributed to several aspects of the experiment, which include light pollution from the computer and lamps, scratches on the surface of the fiber optic cable, the dimness of the hydrogen sample, and human error in determining the FWHM values for the hydrogen-deuterium dual lamp.

The accepted value for the mass ratio is $\frac{m_d}{m_p} = 1.999$, and our experiment found the mass ratio to be $\frac{m_d}{m_p} = 1.729$ with an uncertainty of $\delta\left(\frac{m_d}{m_p}\right) = 1.692$. Comparing this to the accepted value gives us a 13% error. The difference between the accepted value and the value we found through the experiment can be attributed to the experimental aspects listed above for the Rydberg constant.

Our determined Rydberg constant and mass ratio were consistent with accepted results. In order to minimize the effects these aspects had on our results, I could reduce the light pollution by manually reducing the computer brightness and adjusting the computer's location and ensuring all lamps are faced away from the fiber optic cable, cleaning the fiber optic cable, and write code to determine the FWHM with more precision for the dual lamp.

## References


- Hughes, I., Hase, T. (n.d.). *Measurements and their Uncertainties: A practical guide to modern error analysis.* Oxford University Press.
- Jenkins, F. A., White, H. E. (1937). *Fundamentals of Optics.*
- Koepke, D. (n.d.). *Atomic Spectroscopy 2020.*
- Melissinos, A. C., & Napolitano, J. (1966). *Experiments in Modern Physics.*
- Moses, C. J., Moyer, C. A., & Serway, R. A. (1989). *Modern Physics.*
- National Institute of Standards and Technology. (n.d.).


## Summary

...that the Rydberg constant can be derived from the spectral lines of hydrogen using mercury as a calibration element, and the deuterium-proton mass ratio can be found from a sample ...troscopy, we were able to show ...of hydrogen and deuterium. While this experiment proved these values can be found, this is not the usual use of atomic spectroscopy. Atomic spectroscopy is usually used for other scientific fields, such as chemistry and ...oves that atomic spectroscopy is a versatile tool that can also be used to show properties of atoms.

- Please don’t include poster abstract
- I can’t see the peaks, nor how wide they are
- Heavy on the amount of words
- How do you feel about the grey background?
- Unlike in papers, you don’t need figure numbers. Captions are optional, but can be a good place to discuss how error bars are defined.

# Using Atomic Spectroscopy to Explore the Properties of Hydrogen and Deuterium

[redacted]
West Virginia University

## Atomic Spectroscopy

- Electrons transitioning between energy states release or absorb photons
- The energy of the photon depends on the properties of the atom [1]

$$E = -\frac{1}{2n^2} Z^2 \alpha^2 c^2 \mu$$

- Photons of specific wavelengths correspond to specific energies [2]

$$E = \frac{hc}{\lambda}$$

- The wavelengths emitted by a substance can be used to identify its properties
- Applications in medicine, astronomy, ect. [4]

## Introduction

- Rydberg Constant - a physical constant that depends on the reduced mass of an electron that relates transitions between energy states to the wavelength emitted [7]

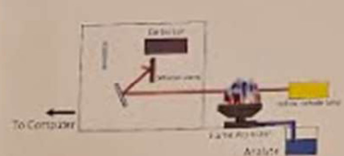
$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

- Hydrogen and Deuterium – Isotopes of the same element; deuterium has one neutron

Goals:
- Use atomic spectroscopy to identify the Rydberg constants of hydrogen and deuterium within a margin of uncertainty
- Calculate the mass ratio between hydrogen and deuterium

Learning Outcomes:
- Learn how to use spectrometer
- Better understand atomic spectroscopy
- Learn how to calculate error

Atomic Spectroscopy can be used in astronomy to identify elements in clouds of gas [3]




Flame Atomic Absorption Spectroscopy can be used to find trace metals in samples [5] [image: 4]

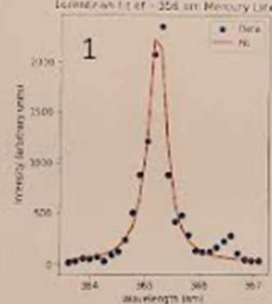
## Methods

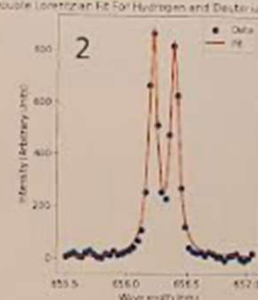
- Take mercury spectra to use for calibrations
- Take wide spectra of hydrogen and deuterium mixture for Rydberg constant calculation
- Take high resolution spectra of hydrogen and deuterium mixture for mass ratio calculation

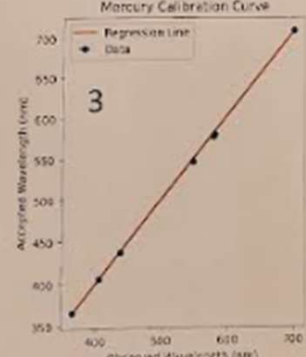
$$\frac{m_2}{m_1} = \frac{\lambda_1 - \ldots}{\lambda_2 - \lambda\ldots}$$

- Use raw spectrum data to perform Lorentzian fit and calibrate using mercury data
- FWHM from Lorentzian fits used as error – propagated forward through calculation and linear regressions

## Results




| Observed Mercury Wavelength (nm) | Error |
| --- | --- |
| 365.21 | 0.19 |
| 404.85 | 0.19 |
| 435.94 | 0.21 |
| 545.89 | 0.26 |
| 576.97 | 0.49 |
| 567.10 | 0.48 |
| 700.06 | 0.18 |

## Discussion

1. Example Lorentzian fit from raw data used to find true center wavelength
2. Double Lorentzian fit from high resolution spectra of hydrogen and deuterium mixture used to find wavelengths for mass ratio calculation.

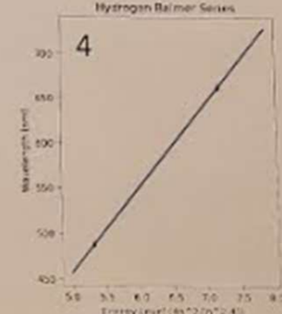
$$\frac{m_D}{m_H} = 1.521 \pm 0.001$$

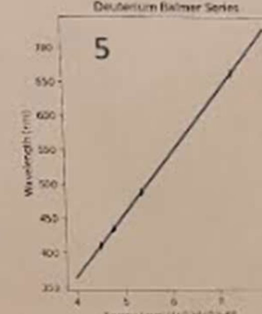
3. Mercury calibration curve used to calibrate hydrogen and deuterium data – errors shown in adjacent table
4. Hydrogen Balmer series linear regression – slope is reciprocal of Rydberg constant.

$$R_H = 1.09520 \pm 0.00360 \times 10^7\ m^{-1}$$

5. Deuterium Balmer series linear regression – slope is reciprocal of Rydberg constant.

$$R_D = 1.09507 \pm 0.00223 \times 10^7\ m^{-1}$$




## Conclusions

- Hydrogen and Deuterium Rydberg constants match accepted values within margin of error (1.09677 and 1.0970) [6]
- Mass ratio does not match accepted value (2)

Potential Improvements:
- Check ~700nm mercury value using high resolution spectrometer
- Take multiple spectra and combine the raw data to get more accurate observed wavelengths

Future work – Analyze other elements to determine Rydberg constants

## References

1. [illegible] (2012). Quantum Mechanics. Pearson.
2. [illegible]
3. [illegible]

- Spectra easier to see
- Light on why we should care. “applications in astronomy, medicine, etc.”
- The graphs are numbered, but unclear why
- Good: fit lines include, bad: fit lines not mentioned in 4 and 5