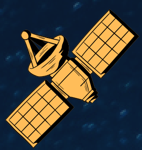
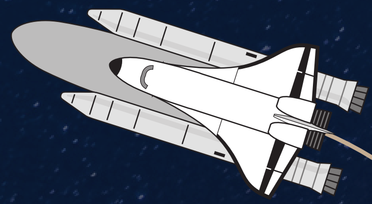


THE QUARK

MAY 2024



A SPECIAL THANKS TO THE PHYSICS AND ASTRONOMY DEPARTMENT FOR HELPING US CHASE OUR DREAMS IN THE LAB AND THROUGH THE STARS.

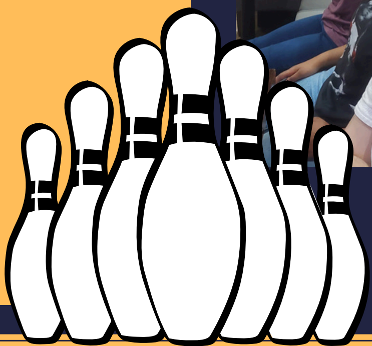
TABLE OF CONTENTS

PHAS Welcome BBQ

On September 7, 2023, the Department of Physics & Astronomy held its annual welcome barbeque! Over sixty people, students and faculty alike, attended for good conversation and delicious food catered by H-E-B's True Texas BBQ.

Game Night

In Fall of 2023, SPS had our first Game Night of the year! Filled with bowling, lasertag, and overall good times, this was definitely a night to remember!



“Put a ring on it”: The Cartwheel Galaxy and Other Mysterious Ring Galaxies

Elliott Walker

When we think of rings in space, the first object that comes to mind is often the magnificent planet Saturn. However, our universe is also host to rings much grander than anything found in our own solar system: ring galaxies. Ring galaxies are a rare subclass of galaxies defined by a ring-like morphology (appearance), consisting of a round band of material encircling an inner galactic nucleus at a distance. There are several processes through which they can form and evolve, although it is sometimes unclear which model best describes the ring galaxies that we observe. It is thought that the most common of these methods is via galactic collision.

In August 2022, James Webb Space Telescope (JWST) images of ESO 350-40, better known as the Cartwheel Galaxy, were released. The main image [top right] is a composite of images taken with JWST’s Near-Infrared Camera and Mid-Infrared Instrument. Since these instruments only image in the infrared - wavelengths of electromagnetic radiation longer than those of visible light - the colors seen are not “true color”; instead, redder colors are assigned to longer wavelengths, highlighting regions with lots of dust, and bluer colors represent shorter wavelengths, showing us pockets of star formation within the galaxy.

As a ring galaxy, the Cartwheel Galaxy is very interesting. It was discovered in 1941 by Fritz Zwicky, who called it “one of the most complicated structures awaiting its explanation on the basis of stellar dynamics”. Astrophysicists have determined that its current form is a result of an interaction that occurred between 200-400 million years ago, in which a smaller galaxy - possibly one of those seen to its left in the above image - struck the large progenitor spiral galaxy in a dramatic face-on collision. This produced shockwaves, sending galactic material outwards along the disk from the point of collision and creating the galaxy’s wide outer ring. Some remaining material then coalesced at the center to reform the core and inner ring of the galaxy. Since then, the continuing rotation of the Cartwheel Galaxy has caused the spiral-like structure to begin reforming within its disk, in the form of the galaxy’s characteristic “spokes”. With JWST’s mid-infrared imaging allowing us to see concentrations of gas and dust in the galaxy, astrophysicists can update their models - which originally only had accurate data regarding stars glowing in the visible spectrum - to better understand how interactions within the galaxy are allowing these arms to reform so quickly.

Furthermore, observations of the objects Arp 148 (Mayall's Object, left) and Arp 147 (right) support models of galactic collisions causing the formation of ring galaxies. As pictured in this Hubble Space Telescope image, Mayall's Object consists of two galaxies undergoing a violent collision. The result of this interaction will likely be a ring galaxy similar to the Cartwheel Galaxy, or potentially something more like the galaxy pair Arp 147, where we see two galaxies that are thought to have collided about 40 million years ago, shaping them into their current ringed forms.

Not all ring galaxies are thought to have resulted from such collisions. Hoag's Object is a prime example. Originally thought to be a phenomenon of gravitational lensing, it is now known that this object is a ring galaxy, with a large ring of young blue stars encircling the older yellow nucleus. No collision model has been able to accurately describe what we see in Hoag's Object, and so multiple alternative models have been put forward. One such model is Noah Brosch's "bar instability" model, which describes a barred spiral galaxy whose inner bar becomes unstable and rotates at a rate so high that it creates density waves that send galactic material outwards to form a ring. There is still not enough evidence to conclude which model is correct, leaving the question of how exactly it formed unresolved.

Unfortunately, nothing is forever. Within a few hundred million years, the rings of most of these galaxies are expected to disintegrate, as either the material falls back into the galaxy and potentially reforms a more typical spiral structure (this is expected of the Cartwheel Galaxy), or the gas and dust become too diffuse to allow for continued star formation in the rings.

Ultimately, the formation and evolution of ring galaxies remains somewhat of a mystery to astronomers. Research in this field continues to tell us more about the dynamics of galaxies, from interactions of rings with interstellar media to certain gravitational phenomena.

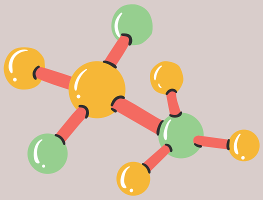
The Fall Trip

The TTU Chapter of the Society of Physics Students attended the TSAPS Conference in San Angelo Texas at Angelo State University. There, we had multiple students present including Amaris McCarver, who won an award in Undergraduate Research from the American Physical Society.

The SPS students attended various lectures throughout the conference and got to hear from speakers, such as Ginger Kerrick, a Texas Tech alumni, who gave a talk called “Leadership Lessons from NASA's Mission Control Room.” At the end of the conference, the students stayed to view the Annular eclipse and join in on the festivities held during it.


2333


Solar S



The Interplay of Chemistry and Physics: A Symbiotic Relationship

Mikaela J. D'Onofrio-Cantu

Chemistry and physics are two distinct yet deeply intertwined scientific disciplines that form the foundation of our understanding of the natural world. These disciplines, often regarded as separate entities, are in fact closely interlinked, sharing fundamental principles that have led to groundbreaking discoveries and technological advancements. This article explores how chemistry and physics are essential to each other, shaping our understanding of matter, energy, and the universe itself.

1. Fundamental Concepts

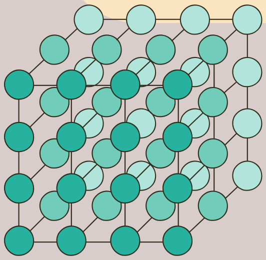
At their core, chemistry and physics are built upon shared fundamental concepts. The study of atoms, molecules, and the interactions between them lies at the heart of both disciplines. Physics provides the underlying laws governing the behavior of particles, while chemistry focuses on how these particles combine to form compounds and reactions. The periodic table, a cornerstone of chemistry, finds its roots in understanding atomic structure, which is deeply rooted in quantum physics.

2. Quantum Mechanics and Molecular Structure

Quantum mechanics, a branch of physics, plays a pivotal role in understanding the behavior of matter at the atomic and molecular levels. The behavior of electrons, which dictate chemical reactions, is governed by quantum mechanics. Quantum models such as the Schrödinger equation help predict molecular structures, energy levels, and reaction mechanisms. This knowledge is crucial in designing new materials, pharmaceuticals, and understanding biochemical processes.

3. Spectroscopy and Atomic Interactions

Spectroscopic techniques, rooted in both physics and chemistry, enable scientists to study matter by analyzing the interaction of light with atoms and molecules. These techniques provide insights into molecular composition, electronic states, and even the behavior of materials under extreme conditions. Nuclear magnetic resonance (NMR) and infrared (IR) spectroscopy, for instance, rely on quantum principles to probe molecular structures.



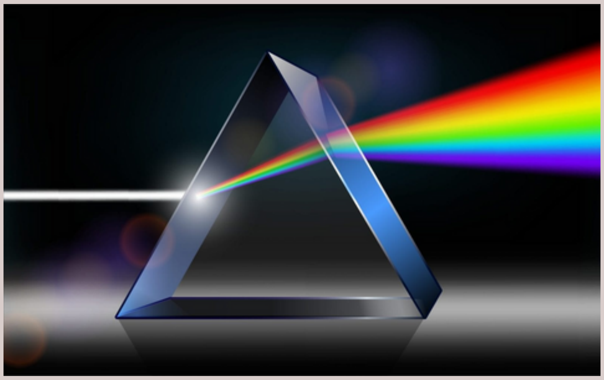
4. Thermodynamics and Energy Exchange

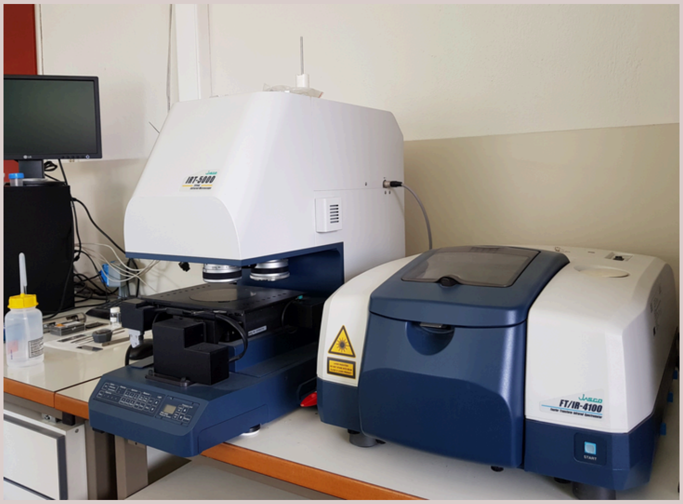
Thermodynamics, a branch of physics, forms the basis for understanding energy transfer and conversion. In chemistry, thermodynamic principles guide reactions, determining whether they proceed spontaneously and predicting equilibrium compositions. The concept of entropy, central to thermodynamics, also has profound implications for chemical processes, influencing reaction spontaneity and feasibility.

5. Material Science and Cross-Disciplinary Advances

The convergence of chemistry and physics has led to remarkable cross-disciplinary advancements, particularly in material science. Understanding the structure-property relationships of materials requires insights from both disciplines. Nanotechnology, for example, has emerged from this synergy, enabling the design of materials with tailored properties for applications ranging from electronics to medicine.

In conclusion, chemistry and physics are symbiotic, with each discipline enriching the other in a harmonious exchange of knowledge and principles. From the microscopic world of atoms and molecules to the macroscopic behavior of matter, the interplay between these disciplines has resulted in profound insights that have shaped our understanding of the natural world and paved the way for technological innovations. As we continue to unravel the mysteries of matter and energy, the collaboration between chemistry and physics remains essential, driving the progress of science and benefiting humanity as a whole.





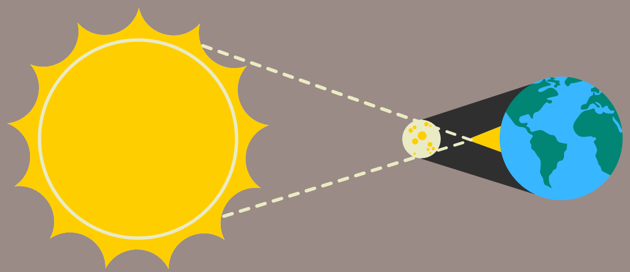
THE ANNULAR ECLIPSE

OCTOBER 14TH, 2023

The Department of Physics and Astronomy held a public viewing for the eclipse, with eclipse glasses and solar telescopes available to anyone who came by! Lubbock experienced a partial eclipse of roughly 90% coverage.

In the maximum path, an annular eclipse could be seen, in which the sun appeared as a “ring of fire” behind the moon in the sky. This phenomenon is due in part to the moon’s variable distance from the Earth.

Photo credit: Andrew



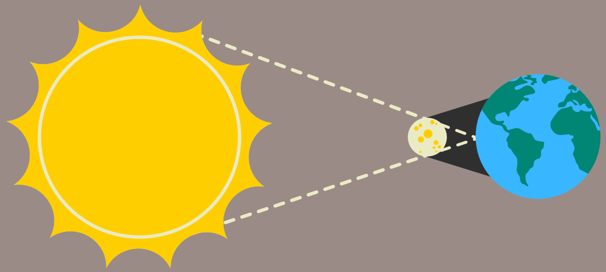
THE TOTAL ECLIPSE

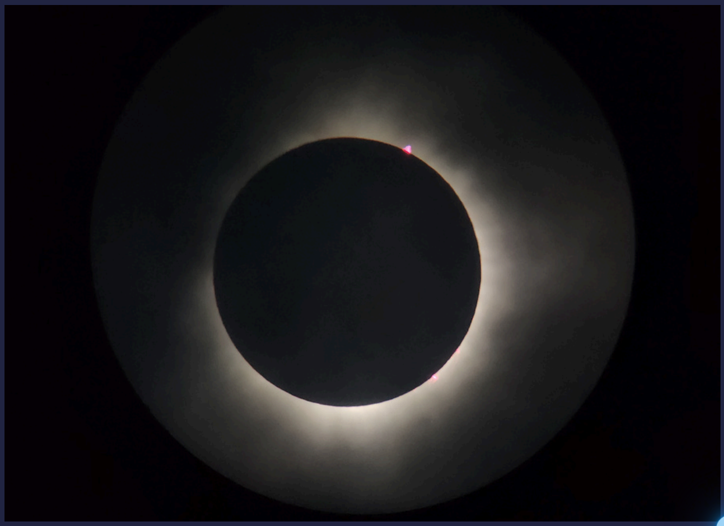
APRIL 8TH, 2024

Just as with the annular eclipse months before, the Department conducted a public viewing. Lubbock experienced a partial eclipse of about 88% coverage.

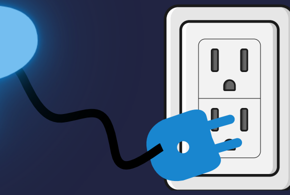
Some of our students traveled elsewhere in Texas and beyond to witness the exciting moment of totality, during which the solar corona became visible to the naked eye!

Photo credit: Elliott Walker





puzzled?



by elliott walker

Across

2. highly penetrative radiation of cosmic origin; a common astronomical image artifact
4. neutral and rarely interact, trillions pass through your body each second
5. quantum particle in a ___; may be seen sliding on a ramp; #17 across's cat is inside
8. type of integral extending integration to a wider class of functions; L^p; Henri ___ (French)
9. Maxwell famously modified this person's equation; unit of charge flow
14. famous equations governing fluid flow; one of seven Millennium problems
15. the strong interaction acts on; L***H***C
16. degenerate remnant of most dead stars; center of a planetary nebula
17. hard-to-spell equation important to quantum mechanics
19. particle of integer spin; Higgs ___
20. a key spectral line in astronomy, emitted by hydrogen
21. effect central to the function of CCDs and solar panels

Down

1. as far as we know, there are no magnetic ________s
3. amount of air along observer's line of sight, related to zenith angle
6. in astronomy, any element that isn't hydrogen or helium
7. electrical resistance vanishes below a critical temperature
10. proportion of incident radiation reflected by a surface
11. tendency of a conductor to oppose a *change* in electric current
12. I prefer strawberry; in physics, refers to the species of an elementary particle: 6 for quarks and 6 for leptons
13. prefix for certain "characteristic" functions, values, vectors, and spaces
16. weakly interact; particles hypothesized as one explanation for dark matter; a coward
18. Doppler shift towards longer wavelengths

Stuck? See the next page for solutions! Note: no spaces!

Theoretical Physics: Creativity over Capability

Michael O'Donnell

At its core, theoretical physics is a quest to decipher the underlying principles that govern the cosmos. It is a continuous dialogue with the unknown, a dance with the enigmatic forces that shape our reality. Creativity becomes the torchbearer in this journey, illuminating unexplored paths and revealing hidden connections. Theoretical physicists are akin to artists, crafting narratives of the universe with the elegant strokes of mathematical equations.

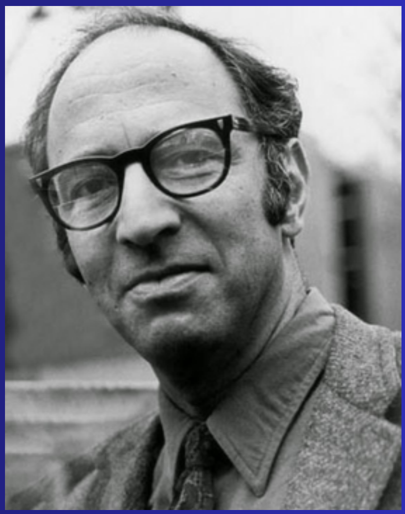
One of the primary ways in which creativity manifests in theoretical physics is through the formulation of new theories. Visionaries like Albert Einstein, Richard Feynman, and Isaac Newton didn't merely crunch numbers; they envisioned alternate realities and dared to challenge the established norms. Einstein's theory of relativity, for instance, was a stroke of creative genius that transformed our understanding of space, time, and gravity. It was an audacious departure from classical physics, an imaginative leap that redefined the very framework of our understanding of the universe.

Creativity is also the driving force behind the development of mathematical tools and frameworks. Theoretical physicists often find themselves grappling with complex mathematical structures that defy conventional intuition. In these moments, creativity becomes the bridge between the abstract and the tangible. Mathematicians like Emmy Noether, whose groundbreaking work laid the foundation for modern theoretical physics, exemplify how creativity can be the key to unlocking the language of the universe.

Emmy Noether, 1882-1935

Moreover, creativity is the catalyst for paradigm shifts in theoretical physics. Thomas Kuhn, in his seminal work "The Structure of Scientific Revolutions," emphasized the role of creative thinking in scientific breakthroughs. The history of physics is punctuated by moments when prevailing paradigms crumbled under the weight of creative innovations. Quantum mechanics, with its probabilistic nature and wave-particle duality, emerged as a creative response to the limitations of classical physics. It was a departure from the deterministic worldview, ushering in a new era of uncertainty and fascination.

Thomas Kuhn, 1922-1996



In conclusion, creativity is not a mere embellishment in theoretical physics; it is its heartbeat. It is the force that breathes life into equations, transforms abstract concepts into tangible realities, and pushes the boundaries of human understanding. Theoretical physics, with its reliance on imagination, innovation, and daring leaps of thought, stands as a testament to the profound impact of creativity on the scientific endeavor. As we continue to unravel the mysteries of the universe, let creativity be our guiding light, illuminating the unexplored corners of the cosmos and inspiring the next generation of theoretical physicists to dream beyond the limits of the known.

Women in Physics (WiP) is a trailblazing student organization that exists to provide professional development opportunities to students from traditionally marginalized communities.

✨**Conferences for Undergraduate Women in Physics (CUWiP) trips**

✨**WOmentorship program!**

✨**CV workshops**

✨**Graduate student panels**

✨**Guest speakers**

Students of all majors and gender identities are encouraged to join us as we build a community geared toward promoting the educational and professional success of our students!

For more details, contact us at ttuwomeninphysics@gmail.com and check out our website here: https://sites.google.com/view/ttuwip/home

Solutions to Crossword

Across:

2) cosmicray; 4) neutrino; 5) box; 8) lebesgue; 9) ampere; 14) navierstokes; 15) hadrons; 16) whitedwarf; 17) schrödinger; 19) boson; 20) halpha; 21) photoelectric

Down:

1) monopole; 3) airmass; 6) metal; 7) superconductor; 10) albedo; 11) inductance; 12) flavor; 13) eigen; 16) wimp; 18) redshift

The Dark Side of Lightning: Gamma Radiation and Its Effect on Humans

Mikaela D'Onofrio-Cantu

Dark lightning is an intense effect of electrical discharge that occurs during thunderstorms. It is also known as gamma radiation and is believed to be caused by cosmic rays interacting with the atmosphere. While dark lightning is a fascinating and powerful phenomenon, it might have dire consequences for humans.

What is dark lightning?

Thunderstorms are characterized by their electrical activity in the form of lightning and thunder. Dark lightning, or Terrestrial Gamma-ray flashes (TGFs), are bursts of gamma rays produced by the collision of extremely fast-moving electrons and air molecules during thunderstorms.

Dark lightning was first detected in 1991 and was named 'dark lightning' due to its emissions being initially undetectable with the human eye. Lightning discharges this type of radiation during thunderstorms and it is one of the most energetic radiations produced by nature.

Researchers used satellite and radio waves to reconstruct the ethereal electrical event that was dark lightning, discovered as two satellites passed right above the same thunderstorm just as the pulse occurred. To study upper-atmospheric lightning and terrestrial gamma-ray flashes (TGF), researchers are trying to gather data from the Atmosphere-Space Interactions Monitor (ASIM).

What are the dangers of gamma radiation?

As lightning expert Joseph Dwyer said, “We know a lot about black holes in galaxies that are very far away, but we still don't really understand what's happening in the clouds a few miles above our heads.” This phenomenon is most often experienced when traveling through thunderstorms and can be very damaging to the human body. At the top of a lightning storm, the average radiation exposure at 39,370 ft (12,000 meters) is the same as 10 chest X-rays, while at 16,076 ft (4,900 meters) it is 10x stronger, or the equivalent of a full-body CT scan. Getting in contact with one of these dark bursts would be the amount of radiation safe for human health for a year. The chance of you getting hit by dark lightning is low, but it's important to be aware of the potential dangers associated with this.

How can we protect ourselves from gamma radiation?

As mentioned, the risks associated with dark lightning are serious, and it is important to take steps to protect ourselves. Pilots and air traffic controllers should avoid flying into or near thunderstorms, as this increases the chances of being struck by dark lightning. The best practice is to fly around thunderstorms and other areas of severe weather.

In addition, it is important to be aware that dark lightning only strikes once in every 1000 lightning strikes and even if a person were struck by dark lightning in the air, they would not necessarily be aware of it at the time. The effects of gamma radiation from dark lightning could show up later, in the form of genetic damage or cancer.

Finally, it is important to remember that gamma radiation from a Terrestrial Gamma-ray flash (TGF) can be dangerous even if it does not affect an individual immediately. For this reason, it is important to take precautions to reduce exposure to TGFs and other forms of gamma radiation, such as using shielding and avoiding unnecessary travel in areas of severe weather.

2023-2024 SPS OFFICERS!

[President]
Sabrina Debreau

"I am currently pursuing a dual degree in a B.A. in Philosophy paired with a B.S. in Physics. Outside of studies, I possess a unique background and experience with youth homelessness and the foster care system, and I plan to continue my passion in advocacy for youth with similar experiences by representing us in the areas of policy work and mentorship."

[Vice President]
Alex Droemer

"Certified cat enthusiast. I enjoy spending time with my cat, Willow (pictured) (she is very silly) and I follow at least 20 cat accounts on Instagram. When I'm not looking at cats, I'm studying with my friends or playing video games. I also enjoy hiking!"

[Secretary]
Alexandria Prather

"Sorry I missed your text; I was too busy answering my emails. If I'm not scheduling emails, I'm probably writing in my planner. If I'm not writing in my planner, I'm probably playing Mario Kart. You'll never catch me without a rubber duck in my bag, and I accept pet photos as a form of currency."

[Treasurer]
Andrew Brokovich

"I am Andrew Brokovich, and I am an applied physics major. My interests are condensed matter physics and science communication. I am an Eagle Scout."

2023-2024 SPS OFFICERS!

[Historian]
Patrick Watts

[Webmaster]
Amaris McCarver

"I am an undergraduate researcher, and I have served as an SPS officer for two years. I like finding pulsars, long coding sessions, and playing Pokemon. As my final semester at Texas Tech comes to an end, I know I will miss being a part of SPS."

[Head of Public Relations]
Mikaela D'Onofrio-Cantu

"My name is Mikaela and I am the head of Public Relations! I run the PR Committee and am Editor-In-Chief of the Quark. I also work for the Former Foster Youth Program on campus as a student assistant. In my free time, I enjoy entering photography contests."

[Bonus Officer]
Darby Hanes

"Hi! My name is Darby. I'm currently a junior, and have been involved with SPS since my first semester. Last year, I served as secretary of the organization. SPS has been an amazing experience, from trips, to volunteering, to the friends I've made along the way."

INTRODUCING: 2024-2025 SPS OFFICERS!

[President]
Darby Hanes

[Vice President]
Sabrina DeBreau

[PR Head]
Mikaela D'Onofrio-Cantu

[Secretary]
Andrew Brokovich

[Historian]
Luis Ayerdi-Morales

[Treasurer]
Elizabeth Veraa

[Webmaster]
Elliott Walker

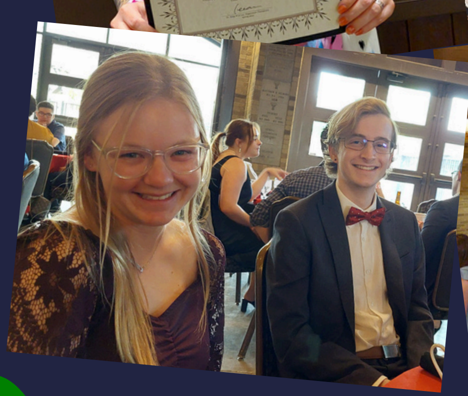
Spring Banquet & ΣΠΣ Induction 2024

On April 12, 2024, the Department of Physics and Astronomy held its annual banquet, hosted at the Frazier Alumni Pavilion! Before the banquet, the Sigma Pi Sigma physics & astronomy honor society had their induction ceremony. At the banquet, guests were provided an enjoyable full-service meal. Throughout the night, various awards and honors were presented, including the student-chosen Professor of the Year, which was awarded to Professor Yun Suk Eo! The new GRASP, SPS, and ΣΠΣ leadership for the 2024-2025 year were also announced. Dr. Ceren Uzun, a graduate alumnus of TTU PHAS and a researcher at Los Alamos National Laboratory, gave a terrific talk about her work and her experiences working at a national lab in contrast to traditional academia. Overall, it was a night filled with good food and great company.


Texas Tech University
Texas Tech University


Texas Tech University


Texas Tech University



CITATIONS

“Put a Ring on It”, p. 2-3:
https://arxiv.org/pdf/1003.4691.pdf
https://youtube.com/playlist?list=PLGZ0qOS86P51xBs5i8aNlX-bIVPWy9jyM
https://en.wikipedia.org/wiki/Ring_galaxy
(See also: Hoag’s Object, Mayall’s Object, Arp 147, Cartwheel Galaxy)
https://webbtelescope.org/contents/media/images/2022/039/01G8JXN0K2VBQP112RNSQWTCTH
Other images: credit NASA

“Unveiling the Creative Cosmos”, p. 13-14:
Feynman, R. P., Leighton, R. B., & Sands, M. (1965). The Feynman Lectures on Physics.
Atkins, P. W., & de Paula, J. (2010). Physical Chemistry.
McQuarrie, D. A., & Simon, J. D. (1997). Physical Chemistry: A Molecular Approach.
Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of Analytical Chemistry.
Ball, P. (2009). Made to Measure: New Materials for the 21st Century.

“The Dark Side of Lightning”, p. 16-17:
https://science.nasa.gov/dark-lightning-0
https://interestingengineering.com/science/dark-lightning-uncovering-the-strongest-energy-discharge-on-earth
https://futurism.com/dark-lightning-fact-or-fiction
https://www.livescience.com/28594-dark-lightning-zaps-airline-passengers.html
https://www.advancedsciencenews.com/wp-content/uploads/2020/12/Untitled-14.jpg

“The Interplay of Chemistry and Physics”, p. 9-10:
Feynman, R. P., Leighton, R. B., & Sands, M. (1965). The Feynman Lectures on Physics.
Atkins, P. W., & de Paula, J. (2010). Physical Chemistry.
McQuarrie, D. A., & Simon, J. D. (1997). Physical Chemistry: A Molecular Approach.
Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of Analytical Chemistry.
Ball, P. (2009). Made to Measure: New Materials for the 21st Century.

Why SPS?

I joined SPS because I love donuts!
I wanted to find people who had similar interests and wanted to do the same things I did. I found a community that I related to.
-Gabby Prime ‘24

It can be difficult to connect with people in your major, but SPS provides a great way for Physics undergrads to foster a sense of community.
-Alex Droemer ‘24

SPS is a great place to find good people who are passionate about all things STEM - even as a math major, I’ve found my place here!
-Elliott Walker ‘26

When I started out as a Physics major, the people of SPS helped me through my first year. Even though I’m no longer in Physics, I love being able to continue supporting others, through SPS.
-Mikaela D‘onofrio-Cantu ‘26

I met my first TTU friends through SPS on my first day of class. It’s been a big part of my life ever since.
-Darby Hanes ‘25

~meet the team~

Mikaela D'Onofrio-Cantu
Editor-In-Chief

Mikaela is a Sophomore physics major, with a professional concentration and a math minor. Mikaela is from Tahoka, Texas where she won second place for UIL Regional Editorial Writing. She loves photography, art, and creative writing, as well as physics.

Elliott Walker
Writer, Editor

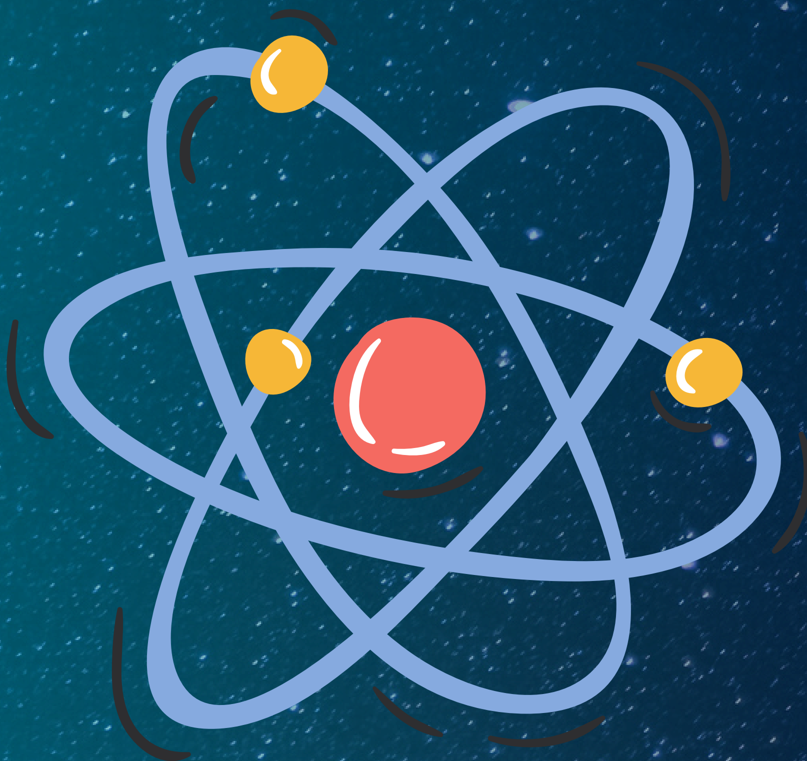
Elliott is a second-year Mathematics major and Physics minor. Though he's moved around the country multiple times, he will say he is "from" The Woodlands, Texas, just north of Houston. Elliott loves reading sci-fi, playing the piano, and stargazing with friends.

NOT PICTURED:

Darby Hanes
Quote Collector

Michael O'Donnell
Writer

Elizabeth Veraa
Moral Support



TEXAS TECH UNIVERSITY CHAPTER OF THE SOCIETY OF PHYSICS STUDENTS

@ttusps

@sps_at_TTU

@ttusps

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Department *of* Physics & Astronomy™