October 2022

THE QUARK

Brought to you by The Society of Physics Students

SpOoKy Contents

About The Quark

The Quark is a monthly newsletter produced by the Public Relations Committee of the Texas Tech chapter of the Society of Physics Students (SPS). Our goal is to help new students become more familiar with the Physics Department and provide returning students more insight on aspects of the department they might not have been aware about.

If you have any questions about The Quark or SPS, you can email our Public Relations Officer Sabrina DeBreau at sdebreau@ttu.edu .

The Physics of a Doorbell

By Milan Maheshwari

Have you ever wondered how a doorbell works? What actually happens when you click the doorbell button? How is the sound from the doorbell produced? In this article, I will explain how exactly a doorbell functions and the physics behind this process. First, let's understand that the doorbell is connected in a series circuit. In a series circuit, the current is the same throughout the circuit while the voltage varies as you move along the circuit, but the total voltage entering the circuit and exiting the circuit stays the same. The total resistance (Req) of a series circuit is equal to the sum of all the resistors in the circuit. There are multiple components that are connected in the series circuit. The doorbell button acts as a switch to the circuit, allowing current to flow through the circuit when someone pushes the doorbell button. There is also a step-down transformer connected to the circuit that serves to reduce the voltage coming out of plugs (120 volts) to a much lower voltage that is safe for both the wires and the doorbell system. A transformer is based upon Nikola Tesla's idea of alternating current (ac current) and faradays law of induction. By looping around a coil in a circular fashion multiple times, a solenoid is formed. When current runs through a wire, it generates a magnetic field. In a solenoid, current is sent through several circular loops of coil, and the magnetic field is directly proportional to the number of loops there are. The greater the number of turns of coil, the stronger the magnetic field is. The formula for a solenoid is $B = \mu_o nI$ where I is the current passing through the coil, n is the number of turns that the coil makes per unit length of the solenoid, B is the magnetic field strength, and mu is the magnetic constant, also known as the permeability of free space. A transformer consists of two solenoids both wrapped around an iron core. The solenoid where the voltage is inputted is known as the primary coil and the solenoid where voltage is outputted is

known as the secondary coil. A transformer operates only on an ac power source, and it is used to either increase or decrease an ac voltage. The alternating current in the primary coil creates an alternating magnetic field, which then comes into contact with the secondary coil, generating an induced alternating electromotive force (the output voltage) in the secondary coil (based on faradays law of induction). Based on the number of turns in each coil, the voltage can be decreased by passing through the transformer if there is a greater number of turns in the primary coil than the secondary coil (if $N_s<N_p$ step-down transformer) or increased by passing through the transformer if there is a greater number of turns in the secondary coil than the primary coil ($N_s>N_p$ step-up). One part of the circuit is also wound up in a circular fashion to generate a solenoid. There is an iron rod that is located near the solenoid and has a spring attached to it. Before you press the doorbell, the spring is relaxed (no potential energy). When you press the doorbell (the switch), current is allowed to flow through the solenoid, allowing the solenoid to generate a strong magnetic field which can then exhibit a strong magnetic force on the iron rod pulling it towards the bell/chime and causing it to strike the bell/chime. As the iron rod strikes the bell due to the solenoid's magnetic force on the rod, the iron rod compresses the spring and generates potential energy in the spring so that when you release the doorbell button, the potential energy in the spring will convert into kinetic energy and the spring will exert a force on the iron rod pulling it back to its resting position that it was in prior to pushing the doorbell button.

News, Events, & More!

SPS General Meeting Dates:

11/2 at 6pm, and 11/23 at 6pm

Upcoming Events:

- Special Seminar on the Nobel Prize in Physics on 11/4 at 5:30pm in SCI 234
- Family STEM Night on 11/7 at 4:30pm in the TTU SUB Ballroom
- SPS Game Night at Main Event on 11/9 at 6:00pm
- Astronight at the YWCA on 11/18 from 6:30pm to 9:00pm

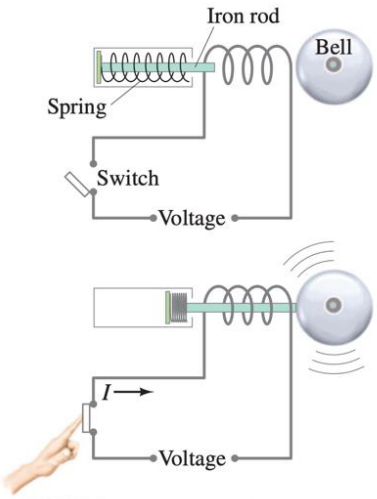

FIGURE 20–29 Solenoid used as a doorbell.

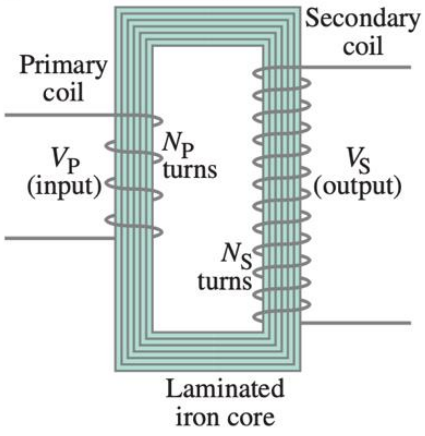

FIGURE 21–23 Step-up transformer ($N_P = 4$, $N_S = 12$).

Student Spotlight: Amaris McCarver

By John Lawhon

Following the success of Amaris McCarver's research presentation at the annual departmental poster competition, Amaris talks about her research, the process, and how a student can get involved in research at Texas Tech University.

Amaris McCarver is a third-year physics major with a concentration in astronomy, the historian of the Society of Physics Students, and a member of the Woman in Physics student organization. Amaris began her research involvement before she attended Texas Tech University. When asked how she first got involved, she responded “During first-year student orientation, I asked Dr. Ungar, the physics department advisor, how to get involved with research as an undergraduate. She pointed me in the direction of Dr. Maccarone and after reading about his research, I soon got in contact with him, and am now happy to do research with him.” Amaris has been doing research in astrophysics for a little over two years now, recently she presented at the Texas Tech annual departmental poster competition. Her research was about the discovery of a millisecond pulsar in transient emission in the cluster Glimpse-C01. The poster was a product of over two summers of research and development. Amaris goes on to say, “most of my research took place during the summer with the Naval Research Internship Enterprise programs at the Naval Research Laboratory.” During this time Amaris was guided by Dr. Tracy Clark and Dr. Maccarone. When asked about her preparation for the poster competition, Amaris said “the biggest preparation for me was presenting at other conferences such as the New Mexico symposium, the VLAS conference, and the WAS conference.”

Amaris is currently in the process of writing the paper for her research. Amaris has dedicated a lot of time to research, when asked what draws her to it she responded “my original motivation to begin research was curiosity and excitement. I did not know how beneficial it would be.” Amaris plans on beginning more research in the near future. When asked for advice to undergraduates interested in research she replied “to any undergraduates who want to get involved in research, as you take physics and astronomy classes, use the opportunity to develop your interest and connect with your professors. Find someone in the department whose area of research aligns with your interests.”

News, Events, & More!

NEWS:

- Congratulations to Dr. Maik Reddiger for a successful defense of his Ph.D. dissertation, "Towards a Probabilistic Foundation for Non-Relativistic and Relativistic Quantum Theory"!
- Congratulations to Dr. Duncan and the PHAS-CEES group for winning the *2022 TechConnect Defense Innovation Award*!
- Congrats to Amaris McCarver & Shelby Courreges for winning 1st & 2nd Place at the departmental poster competition!
- Congratulations to Dr. Kupfer and his research group for taking part in the City of Lubbock Pumpkin Carving Competition under the team name "Galactic Gourds". They also won the 'BEST' and 'FUNNIEST' pumpkin. Check it out here:

  https://flic.kr/s/aHBqjAcJMG

Triple P Night

By George Collier

Last month the physics department held a new event, the first of its kind, dubbed "Triple P Night." Triple P stands for "physics, philosophy, pizza" in that order. The event consisted of a talk by Dr. Joel Velasco on the nature of infinities and how they intersect with physics. Free drinks and pizza were provided courtesy of the father of one of the event organizers.

The event was organized by Sabrina DeBreau and Lavonne Mack with the help of both the department of Physics and astronomy as well as the department of Philosophy. The discussion led by Dr. Velasco was on the nature of infinity and how it relates to physics. Among the topic discussed were Zeno's paradox, the idea that to move between any two points an infinite number of incremental steps must be taken along that path. This idea also lead into the discussion of supertasks, the idea of a task that involves completing an infinite number of steps in a finite amount of time, and the logical paradoxes that arise from this possibility. The usefulness of infinities was also discussed, in mathematics operations such as integrals and derivatives are accurately described with infinite series. In fact, mathematics often uses the idea of convergence to define the finite result of an infinitely long process, such as a Reimann sum. In physics these same concepts have proven extremely useful, for example derivatives and differential equations are used in every branch of physics and have repeatedly yielded accurate descriptions of reality despite relying on the idea of analyzing infinitely small increments of a function.

The discussion may have been led by Dr. Velasco, but many individuals in attendance including undergraduates (from both the physics and philosophy departments), graduate students, and professors gave their input and personal theories on how to resolve these philosophical issues. The discussion highlighted the different ways that physicists and philosophers view these problems while also highlighting the inescapable reality that even physics relies on philosophy in order to understand the

world. The reception to the event was overwhelmingly positive, those in attendance felt that the event broadened their understanding of the philosophy that underlies physics while also simply being an entertaining even overall. The participation of the audience and the discussion that followed made the event more than a talk, but rather an educational discussion among an entire group. It's also worth mentioning that free pizza is always a crowd pleaser.

The event was both a unique way of connecting both the department of physics and philosophy and involving the students and faculty of both departments. It was truly a one-of-a-kind event that you won't find at another university. It is also just the first of more. Another similar event is planned for the upcoming spring semester. A date hasn't been decided upon, but I urge the readers of this article to attend the even when it does transpire next semester. If you have any interest in philosophy, physics, or even pizza, then you wont regret coming!

Thanks again to Sabrina DeBreau, Lavonne Mack and her father, The Society of Physics Students, The Department of Physics, and The Department of Philosophy for working to make this amazing event a reality.

Professor Spotlight: Dr. Joel Velasco

By Matthew Pinson

Dr. Joel Velasco is an Associate Professor and Chair for the Department of Philosophy here at Texas Tech University. He received his Ph.D. at the University of Wisconsin-Madison, and specializes in the philosophy of biology, general philosophy of science, and epistemology. Dr. Velasco started working for Texas Tech in 2013, but before Tech he had worked at Stanford for his post doc., Cornell, and California Institute of Technology.

When asked what made him pursue the philosophy of science he replied, "If you asked me when I was 18 going into college what I was going to major in, I would have said physics… Actually I was interested in astrophysics." He talks about how he had read the Popular Science magazine and was interested in Cosmos by Carl Sagan. "What really happened was that I just took Philosophy… and I realized that was exactly what I wanted to do. I just sort of discovered it by accident." Dr. Velasco then goes to explain in his first graduate seminar, the class was over probability and he loved it. He says that he partly got into the philosophy of science through the more technical uses, like doing a lot of logic and math, "But mostly, these are just the questions that I find fascinating."

In regards to the relationship between philosophy and science Dr. Velasco says, "Well this is a great question you know, if you ask what is philosophy there's some sort of central areas… For example, metaphysics. What is the world like? what kinds of things exist? Epistemology, what do we know and

how do we know it… You know science is a really effective, cumulative, knowledge producing machine so if you can understand how that works, that is what philosophers have been after all along." Dr. Velasco brings up how Dennett makes a comment on how it's impossible to do anything without doing philosophy, and so it's impossible to do science without philosophy. "Really you're just sort of doing bad philosophy. So, you aren't really aware that you're doing it and that's just kind of a risky thing… You know, the greatest philosophers of physics are probably Newton and Einstein and Maxwell." He then brings up a very interesting point, where people are often dismissive of philosophy and how he believes they are mistaken in the importance of thinking about these foundational questions. When asked what advice he would give to a student who wants to look into the philosophy of science but doesn't know where to start he says, "You know, I recommend what I would recommend any educated person—they should read." He also recommends taking Tech's intro classes to philosophy, more specifically looking at intro to ethics or a logic class.

Dr. Velasco also spoke at "Triple P Night" hosted by The Department of Physics & Astronomy in affiliation with SPS (Society of Physics Students,) in where he spoke of Zeno's paradox and the paradoxical nature of infinity. When asked about paradoxes relevant to the conversation of philosophy and physics he says "I think in general, the interesting questions about philosophy and physics are not really about paradoxes." He goes further to explain when you take a question like the nature of time or causation you would need to know some physics, but in knowing all physics you would still be left with a question, so in that it is also a philosophical question. "It would be absurd to talk about the nature of time without knowing physics, but actually knowing all the physics there is to know still leaves open questions… and that's where physics and philosophy work really well together."

When asked what message he'd like to give to the people reading this he comments, "I think that a lot of people don't really understand what philosophy is because their not, sort of, exposed to it… so I think you should try to check it out, because it's going to turn out ---for some portion of people, that they might love philosophy."

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Giancoli, D. C. (2014). *Physics: Principles with applications*. Boston: Pearson.

Acknowledgements

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