THE QUARK

Brought to you by the Society of Physics Students

Upcoming Events

- Dead Day Social 05/09, 1pm at Frank Higinbotham Park

About the Quark

The Quark is a monthly newsletter written by the members of the Public Relations Committee of the Society of Physics Students at Texas Tech University.

All questions, comments, concerns, or suggestions may be directed towards the current SPS Public Relations officer, Sadman Ahmed Shanto, at sadman-ahmed.shanto@ttu.edu.

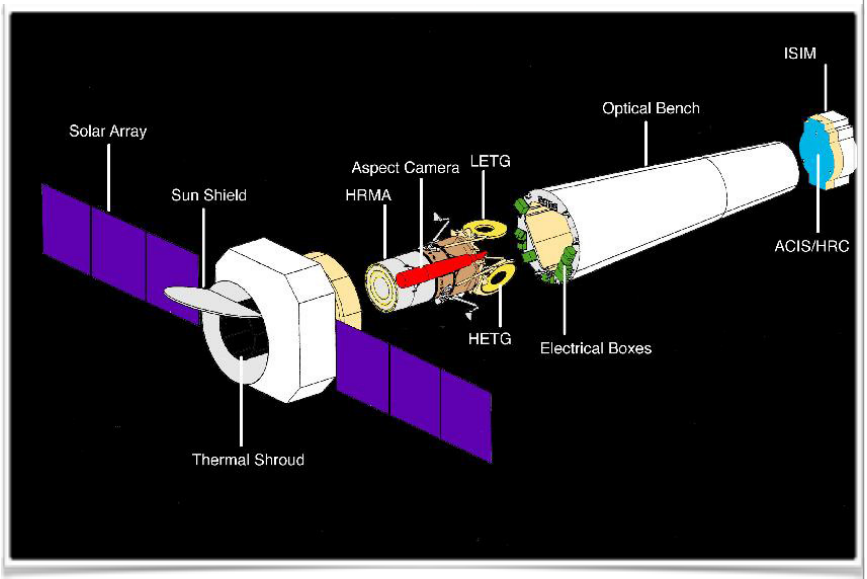
The Black Holes at the Center of Our Galaxy

By Priyadarshini Rajkumar & Edith Gallegos

Scientists have long predicted that thousands of smaller stellar-mass black holes should exist in the area surrounding the supermassive black holes at the center of large galaxies, forming density cusps. Finally, after almost two decades of extensive searching, researchers from Columbia University, using the data from Nasa's Chandra X-ray observatory, collected evidence for hundreds, perhaps thousands, of black holes in the region stretching about three light years out from Sagittarius A*, the supermassive black hole of our own galaxy [1]. Other discoveries have shown that as distance to the center of the galaxy decreases, this region gets more crowded with black holes.

Isolated black holes are nearly impossible to detect due to their extremely strong gravitational pulls which do not even allow light to escape from them. Although most of the black holes are isolated, some capture and hold on to passing low mass stars,

forming a stellar binary. [2] This mating process emits x-ray bursts that are weaker but consistent and detectable. NASA's Chandra X-ray telescope, which is 86,500 mi. above Earth's atmosphere uses an advanced CCD imaging spectrometer to capture X-rays and measure their energy. Its high-resolution camera has eight mirrors and focuses X-rays in a way that is "equivalent to the ability to read a newspaper at a distance of half a mile" [3]. However, the galactic center is so crowded with X-ray emitting objects and X-ray glowing gas that it is hard to find the black hole binaries that emit X-rays. Despite the difficulties, the team identified 12 black holes and with that data they were able to calculate the population of isolated black holes around Sagittarius A*.[1]

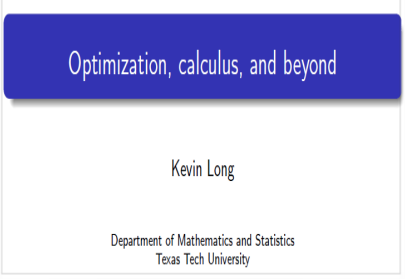


The Chandra X-ray Observatory

The team of researchers have found just a small number of X-ray sources; according to the calculations made, there must exist several hundred more black holes lurking in our galactic center. In the future, finding more precise estimates of the number of black holes at the center of our galaxy could help us create models for other galaxies. Furthermore, gravitational wave patterns around large clusters of black matters can now be better understood [4].

The Math Function

By Colin Brown



On Thursday, April 26, the SPS Public Relations Committee hosted an event with Dr. Long in order to provide insight into the concepts of calculus and its applications.

At the event Dr. Long gave a presentation discussing the concept of optimization and it's various applications. He discussed how optimization problems relate to Fermat's Principle of least time for light. Showing that light follows the most optimal path. He also shared his favorite optimization problem, one that results in the time independent Schrödinger equation.

He recommended for further reading: Volume 2, Lecture 19 of *The Feynman Lectures on Physics* which can be found online here: http://www.feynmanlectures.caltech.edu/II_19.html

Spring '18 Star Party

By Colin Brown
Pictures by Zoe Smith & Shanmuga Shivakumar

On Saturday, May 5th, SPS and the South Plains Astronomy Club went out to the TTU Skyview Observatory for a night of looking at the stars. Catering was provided by SPS.

While there, SPS Historian, Zoe, and SPS Secretary, Shanmuga, captured pictures of the event as well as the stars, planets, and the sunset.

Professor Spotlight: Dr. Thomas Gibson

By Cristobal Moreno & Carlos Perez

Dr. Thomas Gibson is an associate professor at Texas Tech University. He came to Tech in 1985 after finishing his post-doctoral research at The California Institute of Technology. Dr. Gibson primarily teaches introductory level physics at Tech, including Physics 1401, physics for non-science majors, and the Physics 1408 major's section. When he first came to Tech, he became the Society of Physics Students (SPS) faculty advisor and joined them on all of the organization's semester trips. He also started the Physics Circus with former faculty member Ranald Peters. Dr. David Lamp and Dr. Wallace Glab would eventually join the group. The Physics Circus consisted of physics demonstrations directed towards elementary, middle, and high students, but this demonstration also happened to be based on the labs that introductory physics students are assigned do at the university level. Consequently, they would have to use the same equipment that the students would use in lab.

Dr. Gibson has always been interested in the why and how, which led him to study subjects that involved science. When Dr. Gibson first went to college at Cameron College, he was a math major. It wasn't until he took physics courses that he became "hooked", and decided to change his major to physics. As an undergraduate he was involved in a project that consisted of a group of students who built a solar pool heater on top of a faculty member's house. Dr. Gibson remembers to this day that the faculty member's wife was "very pregnant" at the time, and she thought that they going to destroy their roof. It eventually did break down due the cheap materials used to construct it. His first experience at a large university was during a sectional APS meeting, in which he got see early attempts at detecting Gravitational Waves. After he got his B.S. in physics at Cameron University, he went to the University of Oklahoma to obtain his PhD. Dr. Gibson chose this university because it was a large university in his state, he could pay in-state tuition, and it was close to home. He had a fantastic experience in that university and it was there that he met his wife.

While there, Dr. Gibson got a job as a TA to pay off some of his tuition, but also got involved with the research his employer was conducting. He started studying quantum collision theory of charged particles, atoms, and molecules. He got to learn how to work with programs, quantum collision theory, and the ins-and-outs of doing scientific research. After finishing his PhD, Dr. Gibson went to California Institution of Technology to pursue post-doctoral research for three years. He conducted the same kind of research that he did at University of Oklahoma, quantum collision theory. He worked with a variety of methods to calculate the cross-section for charged particle collisions, but no one way had a general method. At Caltech, physicists were using methods that quantum chemists used that were "sought of general" within a certain approximation. This method was mostly representative of reality. Dr. Gibson and his group were able to solve the electron exchange problem using the quantum chemistry method. After his post-doc research, Dr. Gibson got multiple job offers from laboratories and universities including Texas Tech University, Los Alamos National Laboratory, and Mississippi State University. In the end he decided work at Texas Tech because he thought it was better than Mississippi. In addition, he did not want to work "behind a fence" at Los Alamos and wanted to help students.

When Dr. Gibson got to Texas Tech University, he continued to conduct research on charged particle collision. However, he became interested in positron collision because he ran into some experimentalist from Wayne State University who were doing measurements of these specific collisions, but these measurements also contradicted the result from other experimentalists. This led them to ask theoretical physicist like Dr. Gibson about their opinions on this matter. When a positron gets close to an atom, it starts to interact very strongly. An electron behaves in the exact opposite manner to an electron. This type of collision also initiates a phenomenon known as positronium formation in which an electron

'18 Spring Banquet

By Colin Brown

Pictures by Zoe Smith

On April 20th the Physics Department hosted the annual Spring Banquet for all members of the department. It was there that next years scholarships were awarded to the outstanding students of the department. We also had the pleasure of seeing the presentations of Dr. Laity

The Society of Physics Students organized the banquet

Dr. Laity giving his presentation

Women in Physics Presents: Impostor Syndrome & What You Can Do

By Diane Ha

Imposter syndrome is the phenomenon described by Scientific American as "pervasive feeling[s] of self-doubt, insecurity, or fraudulence" despite evidence of competence and success. Wikipedia states that people with imposter syndrome credit their success to "luck, timing, or as a result of deceiving others into thinking they are more intelligent and competent than they believe themselves to be."

What can you do?
- Don't compare yourself to others
- Remind yourself of your achievements
- Focus on the value you bring, not on attaining perfection
- Break the cycle of continually seeking and then dismissing validation outside of yourself by learning to pat yourself on the back
- Take solace in the truth that imposter syndrome is a symptom of success!

Do you have imposter syndrome? Find out here: http://paulineroseclance.com/pdf/IPTestandscoring.pdf

and a positron orbit each other.

Currently, Dr. Gibson is interested in developments in the world of astrophysics because some of it involves charged particle collisions. Consequently, Dr. Gibson is currently not taking in new student for his research. However, he is willing to mentor and advise students depending on their academic backgrounds and what they want to do in the future.

Dr. Gibson's favorite physics problem involves dark matter and dark energy. He also has a strong interest in the history of astrophysics. Dr. Gibson's favorite physicist is Richard Feymann because "he was such a character and because he emphasized developing your physical intuition about processes and making a mental model of what's going on in such a way that you can more or less determine what the important physics of it is". Dr. Gibson met him at Caltech and worked on his lectures. He also met Freeman Dyson and Hans Bethe. Interestingly, Dr. Gibson used to park in Hans Bethe's parking stop at Caltech to pick up his wife.

Dr. Gibson's hobbies consist of trains and learning German. He belongs to a train club in Los Angeles, California. They have about a mile and half of track at the club area, which is located next to the LA Zoo. This was started by Walt and his friends. On Sunday's, the club trains haul the public around the track. Some of the club engine even are able to haul about 30 adults.

Dark Matter: Detecting the Undetectable

By: Carlos Perez

For many decades now, dark matter has been subject to many speculations as to what it really is. Although physicists currently do not exactly know what dark matter is, they do know what it is not. Dark matter exhibits properties which greatly differ from those found in ordinary matter. An elementary understanding of dark matter can be found in the following video: "What is Dark Matter and Dark Energy" from youtube channel *Kurzgesagt*.

https://www.youtube.com/watch?v=QAa2O_8wBUQ.

Astronomer Vera Rubin is the woman credited with the discovery of dark matter. Rubin stumbled upon the effects of dark matter when studying the galactic dynamics of galaxies during the 1960s and 1970s. She was particularly interested in galaxy rotation rates and patterns. By calculating these, one could calculate the entire mass of any galaxy. More about this can be found in the following page from The University of Michigan's Astronomy Department.

https://dept.astro.lsa.umich.edu/resources/ugactivities/Labs/tully_fisher/tf_intro.html

Rubin figured that the farther away gas clouds were from the center of a galaxy, the slower they would be moving. However, when she calculated the velocity, her results wound up differing significantly from those originally expected. In fact, her results showed that for many galaxies, the further away from the center one is, the faster the clouds seemed to be moving. The only way these rapid rotations rates could be accounted for would be if some undetectable mass were present. Rubin calculated that the amount of undetectable matter would be five to ten times that of the ordinary matter already present in the galaxy. Thus, the theory of dark matter was born. Vera Rubin died in 2016, but more about her life and death can be read in this article from Carnegie science.

https://carnegiescience.edu/news/vera-rubin-who-confirmed-%E2%80%9Cdark-matter%E2%80%9D-dies

So how exactly do you detect something which does not emit, absorb, or reflect light? Dark matter is theorized to be non-baryonic, meaning that it is not composed of protons, neutrons, or electrons. It is currently believed dark matter is composed of hypothetical particles such as sterile neutrinos, axioms, and WIMPs (weakly-interactive massive particles). Current experiments to detect any sort of interaction between dark matter particles and ordinary matter use scintillator materials. Scintillator materials exhibit scintillation, meaning that an object emits light when hit by some form of ionizing radiation.

Is there any way to detect dark matter? As a matter of fact, researchers from Brown University have proposed a new method of detecting dark matter. The method is designed to detect any interaction between dark matter particles and a tub of superfluid Helium. The Helium would be sensitive to particles in a much lower mass range than is possible with any of the large-scale experiments run so far, the researchers say. The use of Helium provides more of an advantage than the use of the noble gas Xenon. In order for a collision to be detected, the incoming particle must be of equal masses to the atomic nuclei. If this is not the case, then the particle would just bounce off without being detected. This stems from the fact that Xenon has an atomic mass of around 100 protons compared to just 4 protons of Helium, making it a more compatible target for particles with much less mass. Researchers are then able to detect the evaporation of a single atom from the Helium surface. This sensitivity can allow researchers to detect any small change of energy within particles of very low masses. Brown researchers believe this method is capable of sensing masses that are twice the mass of electrons, roughly 1000 to 10,000 times lighter than particles in the large dark matter scale. "From those fundamental experiments," Stein says, "we would craft designs for a bigger and more complete dark matter experiment." You can read more at:

https://phys.org/news/2017-11-physicists-dark-strategy.html#jCp

So you may be wondering what all the hoopla is about dark matter. How could a "matter" that has no neutrons or protons doesn't absorb lights has little to mass have any effect on my day to day life? Turns out the answer is quite surprising. You see the 2nd law of thermodynamics states that entropy increases in the universe leading to a state of disorder. As the universe continues to expand it should be tearing apart how ever a force it preventing this from happening. Something is preventing the galaxy from tearing apart, one would assume it is gravity keeping the universe intact however the gravity required is enormous and can not be generated from the mass from all known masses in the universe. That's force that is possibly keeping the universe intact and keeping you cozy in your room is none other than dark matter. While not much is know about dark matter, hopefully further research from Brown University may unlock the secrets of dark matter. You can read more at:

https://www.nasa.gov/multimedia/imagegallery/image_feature_827.html

Student Spotlight: Sadman Ahmed Shanto

By Priyadarshini Rajkumar & Edith Gallegos Ramos

Sadman Ahmed Shanto is a freshman majoring in applied physics and minoring in mathematics and management at Texas Tech University. He was born in Dhaka, Bangladesh and graduated from Maple Leaf International High School (MLIS). He developed an early fascination for science as a toddler, when he became perplexed by the flow of water from his shower faucet. He fully developed his interest in physics after he read "The Grand Design" by Steven Hawking. Shanto has always been curious to learn more about the

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- Diane Ha
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- Victoria Blackmon

way that things work. During his schooling, he was the senior executive for MLIS science club and participated in many competitions, including the MLIS science competition, in which he built a robot using the Arduino kit, that could draw basic shapes.

Shanto is the current Public Relations Officer for the Society of Physics Students (SPS). His main goal is to make SPS one of the most active clubs on campus. As an officer, he pitched the idea for "The Quark" and made efforts to influence SPS members to participate in the University Physics Competition. More recently, he arranged a workshop: “The Math Function”. in which Dr. Katharine Long explained the underlying concepts of calculus. Some other positions Shanto holds include: Vice President for SACNAS and the Executive Officer of Social Events for Alpha Lambda Delta. He also works at the TECHniques center as a science tutor for students with learning disabilities. He further challenges himself by attempting to understand real-time problems along with a few of his friends at Tech. Currently his team is working on an algorithm that converts sign language into text in real time, using technology to bridge the gap that lies between disabled people and the rest of the world

When asked what tip he would give to his fellow students, without any hesitation, he said, “If you are not passionate about physics and lack motivation, just drop the subject.” In the future, Shanto wishes to obtain a doctorate in theoretical physics and work on unifying gravity and quantum mechanics. Apart from science, Shanto is deeply involved with business. He has founded Eloomy.com along with a friend, when they noticed little to no advancement of e-commerce in Bangladesh. Currently, he is working to create Bangladesh's first ever online payment platform. In his free time, Shanto reads books and hangs out with his friends.

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[3] http://chandra.harvard.edu/about/

[4] https://www.sciencedaily.com/releases/2018/04/180404133532.htm

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[7] https://phys.org/news/2017-11-physicists-dark-strategy.html#jCp

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