DEPARTMENT OF PHYSICS

MCMURRY UNIVERSITY

Dear Friend:

We hope that you and your family are healthy and doing well in these unusual and challenging times. The last three months certainly brought some very unusual and challenging experiences for all of us at the McMurry Physics Department. However, as we look back at this experience, we are certain that the lessons we have learned will help us to make our Physics Program more adaptable and even better suited for the diverse interests of our students. As usual, we would like to tell you about the successes of our students and faculty through this academic year and bring you the latest news from McMurry Physics Program.

We were expecting to have nine graduates this year. However, several students had to delay their graduation because they were not able to finish some of their classes and senior research projects in May, due to the COVID-19 pandemic. We expect that they will be able to finish their projects through the summer and graduate in August.

We are especially proud of the students who did finish on time despite all the difficulties of this spring.

Tikhon Bykov - Wayne Keith - Timothy Renfro

The McMurry Physics Department

Senior Research Projects

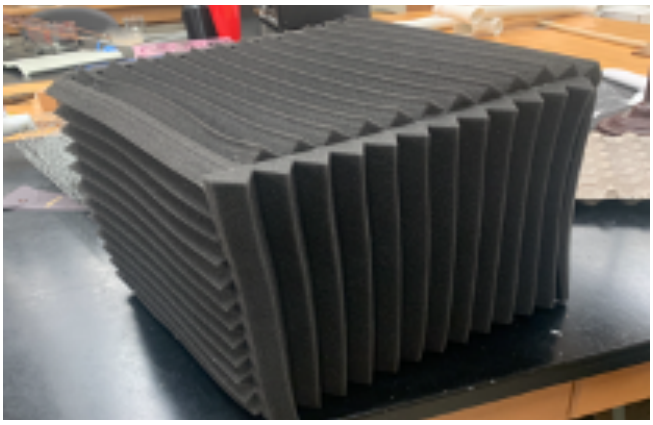
Jerett Bell

(HOMETOWN: FRIENDSWOOD, TX)

Jerett Bell (Hometown: Friendswood, TX), working with Dr. Bykov, completed his project to design and build a diver propulsion vehicle (DPV) or a dive scooter. The question of cost efficiency versus performance of the product was studied. Jerett's DPV was compared to many professionally made diver propulsion vehicles. Some variables tested include maximum speed, maximum battery life, estimated maximum power output, weight, usability, and depth rating. These values determined for the homemade diver propulsion vehicle closely match similarly priced professional designs. Jerett hopes that his project would inspire other students to use easy accessible materials and devise a way to create their own versions of the product that is cost-efficient and functions in the intended way. The underwater picture shows Jerett testing his DPV. This test was performed during spring break. Unfortunately, we were not able to run the additional tests we were planning, since the University swimming pool closed because of COVID-19 restrictions. The project was finished and presented to the public at the end of April. Jerett also presented this work at the McMurry Virtual Undergraduate Research Festival on May 2nd. After graduation, Jerett will continue his education by pursuing an MBA at the University of Houston in Clear Lake starting in the fall.

Casey Grove

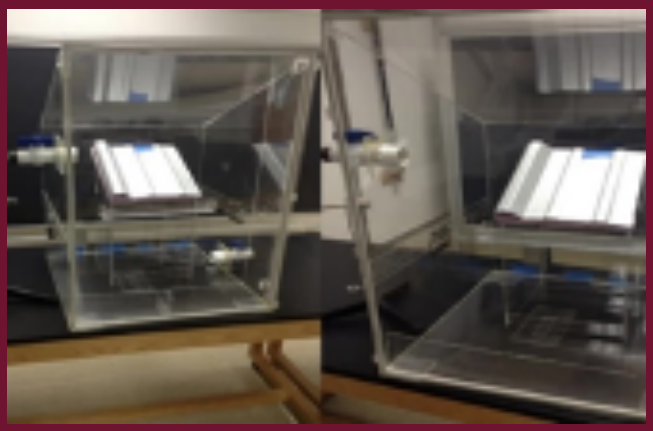
(HOMETOWN: AUSTIN, TX)



Casey Grove (Hometown: Austin, TX), working with Dr. Keith, completed his project to study sound damping. Sound damping has been a large industry since the boom of music in the late 40's. The purpose of the sound damping project was to design a small mesh box that will hold place as a mini-room version of a sound studio that will record a constant sound coming from outside the box (see picture). The goal was to find which material has the best absorption and to find if there is a significant difference between the materials used in the earlier years compared to the current technology. A cost benefit analysis for the different materials was performed as well. After the University went into remote instruction mode in late March, Casey was able to complete the majority of his project in Austin, but he did travel to Abilene for a short time to collect some materials from the physics lab. The project was presented to the public in early May. Currently Casey is working for a construction company in Austin and applying to Master level graduate programs in engineering.

Aaron Herring

(HOMETOWN: ABILENE, TX)



Aaron Herring (Hometown: Abilene, TX), working with Dr. Renfro, tested roofing material for use as passive dew water collector. A special steam chamber was constructed (see the picture). However, it was discovered that the only way to get any results in an indoor laboratory environment was to apply steam directly to the sample. Due to the amount of time and money spent building and redesigning the chamber, only R-panel commercial grade steel roofing panels were tested. The results show a natural logarithmic relationship between the amount of steam that came in contact with the sample and the amount of water that was harvested. When a cooling coil was added, the amount of water collected would substantially increase. Aaron finished and presented his project in late April. He also presented his work at the McMurry Virtual Undergraduate Research Festival on May 2nd. After graduation, Aaron is planning to find an entry-level engineering job.

Mason Mireles

(HOMETOWN: AMARILLO, TX)

Mason Mireles (Hometown: Amarillo, TX), working with Dr. Bykov, designed and built an affordable and efficient fishing bait cannon (presented in the picture below). The goal was to be able to design a bait cannon that uses compressed air to shoot the bait and can be easily stored, easily transported, and cost effective. The simplest and most reliable design was selected. It was then tested by shooting different sized bait with different amounts of pressure. When testing the cannon, three different tests were performed in order to see how the angle, pressure, and barrel lengths affects the range of the bait. It was confirmed that with constant mass and pressure, the furthest distance would be reached with a 45o angle. It was also found that the length of the barrel did have an effect on the distance. For a barrel with a 2-inch diameter, the 4-foot long barrel launched the bait the furthest. For the 1.5-inch diameter barrel, the 5ft barrel had the furthest distances. Dependence of the range on the pressure was studied It was found that around 80psi the rage reaches its maximum value. Mason finished and presented his project in the early December. He graduated in December and currently is working for Consolidated Nuclear Security (Pantex) in Amarillo, TX.

Desmond Turner

(HOMETOWN: SPEARSVILLE, LA)

Desmond Turner (Hometown: Spearsville, LA), working with Dr. Bykov, completed his project "Use of Neodymium Magnets in Football Helmets to Help Reduce Chances of a Concussion". Concussions are unfortunately a common injury in the sport of football and approximately 60 percent of football concussions are caused by helmet-to-helmet hits. The aim of the project was to reduce the risks of these concussions. Strong neodymium magnets were placed inside the football helmets. The goal was to reduce the force by slowing the impact due to the magnets repelling in close contact. The neodymium magnets were placed in the front, back, top and both sides of the football helmet. The force that helmets would exert on each other during a collusion was measured with magnets inside the helmet and without magnets in order to compare the results. The data show that the magnets did reduce the force of collision by a substantial fraction. The picture shows the helmet collision test designed by Desmond. We are grateful to the McMurry University Science and Math Advisory Board (SMAB) for funding Desmond's project through the Bloomer's Student Research Stipend. Desmond presented preliminary results of his project at the virtual SMAB meeting on April 18th. His final public presentation took place in late April. He also presented his work at the McMurry Virtual Undergraduate Research Festival on May 2nd. After graduation, Desmond will be looking for an engineering job or wants to attend a Master level engineering graduate program.

Francis Narvaez

(HOMETOWN: STAFFORD, TX)

Francis Narvaez (Hometown: Stafford, TX), working with Dr. Renfro, continued her project on making plant fiber infused plastic as a possible building material. Her goal is to make building materials from recycled plastic that can be used as a substitute for current commonplace materials such as wood or ceramics. Currently Francis is working with Dr. Renfro and Colton Hunt on the filastruder in order to make her product usable in a 3D printer. From this stage, she plans to make samples to be tested in a Young's Modulus device to learn the materials tensile and compressive properties. Depending on time and availability, Francis may also be imaging her materials using a scanning electron microscope. She will continue working through the summer.

Colton Hunt

(HOMETOWN: SAN ANGELO, TX)

Colton Hunt (Hometown: San Angelo, TX), working with Dr. Renfro, continued with his project for developing conducting graphite infused plastic fiber capable of conducting electricity to be used in 3D printing. Thus far, in the project Colton has assembled a filastruder fiber maker (see the picture) and has started making test samples. He will continue his work through the summer. If time allows and he can get an access, Colton will also be imaging the materials using a scanning electron microscope.

We are expecting that additional senior research projects will be completed during the summer and will talk about those in next year's physics newsletter.

In addition to these graduates, we also have a strong group of juniors who will be working on their projects next year. There were four proposals presented this year. We also hope that two more proposals will be presented at the beginning of the fall.

Senior Research Proposals

Andreas Rivera

(HOMETOWN: AUSTIN, TX)

Andreas Rivera (Hometown: Austin, TX), working with Dr. Renfro, presented his proposal to build a Robotic Rover. The goal of this project is to design and build a robot rover that runs autonomously as well as with a wireless controller. Andreas is interested in a career in the Robotics field. With this project, he wants to show his understanding of how physics applies in robotics and to get a better understanding of the electronics behind robotics applications. Andreas presented his proposal in January, but he will be working on this project during the next academic year.

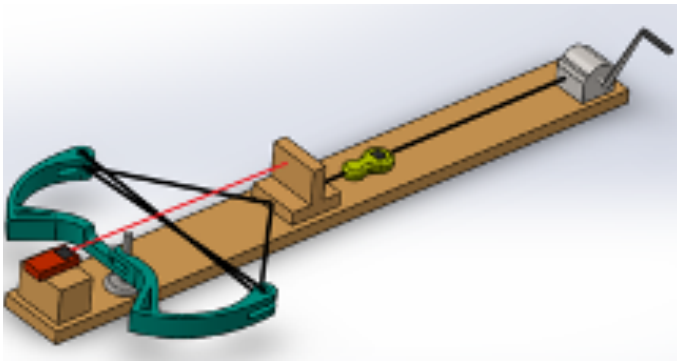
Jacob Williams

(HOMETOWN: GOLDTHWAITE, TX)

Jacob Williams (Hometown: Goldthwaite, TX), working with Dr. Keith, presented his proposal to design and build an electromagnetic suspended bike. The bike should be able to use electromagnetic suspension instead of a physical axle. The goal is to achieve that with the right arrangement of permanent magnets and electromagnets. The project will start with a small prototype model. Jacob's presentation took place in early May and he will be working on the project through the next academic year.

Joseph Watson

(HOMETOWN: HASKELL, TX)



Joseph Watson (Hometown: Haskell, TX), working with Dr. Keith, defended his honors project proposal "Compound Bow Efficiency". The goal of this project is to determine what affects the efficiency of a compound bow. Some general factors might be draw weight, draw length, cam shape, let-off percentage, arrow weight, arrow spine, and string silencers. The efficiency of a compound bow will be measured using several sets of variables and constants to determine relationships for efficiency factors. This project's initial goal is to measure dependencies of draw weight, draw length, and arrow weight on efficiency. The picture shows Joseph's design for testing a bow. Joseph presented his proposal in late April and will be working on his project during next academic year. We are grateful to the Science and Math Advisory Board for supporting this project and awarding Joseph with a 2020-2021 academic year Bloomer's Student Research Stipend.

Jonathan Samudio

(HOMETOWN: FORT WORTH, TX)

Jonathan Samudio (Hometown: Fort Worth, TX), working with Dr. Keith, defended his honors project proposal "Low-Cost Gamma Ray Spectrometry". Typically, gamma ray spectrometry is performed using professional grade equipment with expensive scintillation detectors. Jonathan's project aims to construct a much lower cost detector, which will provide a gamma spectrum, generally matching the accepted spectrum energies for a specific radionuclide. A custom high voltage power supply will be constructed to drive a photomultiplier tube with an attached thallium-doped sodium iodide crystal. This detector will then be wired with an Arduino microcontroller for which a program will be written to interpret the readings of the detector. The spectrum results will then be compared to theoretical values and values obtained on professional equipment within the Physics department. Jonathan presented this proposal in early May and he will be working on his honors research through the next academic year.

Other Student Projects & Events

A majority of the design projects described here might not be possible to complete without extensive use of 3D printers. Our oldest 3D printers are now at the end of their lifespan. With this in mind, the Physics department purchased two new Ultimaker 2+ printers. The printers came in just before we left for spring break and did not get much chance to be used because of the remote instruction mode after spring break. We are looking forward to the next academic year for a wider use of this new equipment. We are grateful to the Ward-Bottom Science Fund for making this purchase possible.

There are several other student projects that were performed as parts of regular courses that are worthy of mentioning.

In the **"Automated Experiments"** course offered by **Dr. Renfro** in the fall, students worked on a group project to write a program controlling a robot with a 900MHz sensor to create a radio heat map.

In the **"Digital Electronics"** course offered by **Dr. Renfro**, the group project was to design a method for delivering a Christmas light show using readily available components on an affordable scale. Students worked with the "Student Life" Office to demonstrate their results for possible solutions to replace the Christmas light display used on campus that has now seen the end of life. One student was the team leader while three other students were in supporting roles making measurements, research, and design. Although students did manage to make an equipment list and basic design to implement, supply chains from China closed due to COVID-19. We still hope that this project will be completed next fall.

In **"Thermodynamics II"** offered by **Dr. Bykov** in the fall, the group project was to perform numerical simulation of a critical droplet in 2D Lattice Fluid. The group members subdivided their duties where one student was responsible for the theory while the other two students were responsible for the programming aspect of the project. The results of that project were present at the Abilene Christian University (ACU) Virtual Undergraduate Research Festival *(https://blogs.acu.edu/researchfest/virtual-undergraduate-research-festival/)* that took place during a week of April 13-17. At the festival, Joseph Watson presented a poster on behalf of the entire student group including Joseph Watson, Aaron Herring, and Mason Mireles. The poster was entitled "Numerical Study of Liquid Droplets inside Supersaturated Vapor using Density Functional Theory for 2D Lattice Gas with Short Range Interactions". Joseph has also made a second presentation on the same subject at the McMurry Virtual Undergraduate Research Festival on May 2nd. He also submitted a paper to the Journal of Undergraduate Reports in Physics and it is currently being considered for publication.
Despite the remote learning mode, a programming group project was still incorporated into **"Classical Mechanics II"** offered by Dr. Bykov in the spring. The original intent of the project was to perform both numerical simulation and experimental study for nonlinear vibrations of a piano/guitar string. Even though experimental part was cancelled, students were successful in conducting numerical simulation. Precession of the elliptical trajectory of a point on a string was observed. RK4 numerical method was used to simulate and record this motion over time. Nonlinear stretched string driven with a sinusoidal function of time was used to illustrate the types of possible resonance. Finally, it was observed how damping would change the trajectory. Responsibilities were divided between the group members with one student being responsible for setup of homogeneous problem, while the other student addressed inhomogeneous problem with driven oscillations. The third student was responsible for adding damping contribution to simulations of both problems.

In **"Electronics"**, students proposed before spring break to complete a group project comparing an AC vs. DC household. Since most items in a modern home (excluding major appliances) are natively DC, each item such as an LED lightbulb, cell phone charger, or alarm clock has to have its own AC to DC converter. Alternatively, one converter can be used for the entire house, with 12V and/or 5V DC outlets available throughout. Although the project was not able to be completed as planned, the students were able to independently address various aspects of the project (power converter design, efficiency of devices etc.) from their homes.

As mentioned above, several physics students participated in the McMurry Virtual Undergraduate Research Festival, which replaced the McMurry Academic Conference that could not be conducted in its traditional format due to the COVID-19 pandemic. You can learn more about the festival and even see some of the student presentations by going to *https://blogs.mcm.edu/STEMsuccess/partnering-for-stem-success-2/spring-2020-title-v-virtual-research-festival/.*

The overall experience of transitioning to remote teaching/learning mode for the last two months of the spring semester went relatively well. Even though both students and faculty have missed opportunities for face-to-face interactions and are looking for returning to a more normal mode in the future, we were able to transition all of our classes online with a minimal loss of content. The majority of physics classes were still meeting in synchronous mode using the Microsoft-Teams software platform. Many of the lessons we have learned about this software will allow us to enhance our face-to-face instruction in the future as well. The only major adjustments to the content we had to make was in the lab. In University Physics Dr. Bykov would perform laboratory experiments through the live stream with students still taking all the readings (where it was possible to do through video) from the measuring devices.

In General Physics and Astronomy, a combination of live-stream and pre-recorded videos for the experiments was

used. In Advanced Physics Lab and Electronics, the majority of the experiments were finished before spring break. Dr. Renfro and Dr. Keith had to make video recordings of some final experiments. Unfortunately, major adjustments had to be made for final projects in these two courses since experimental teamwork was not possible at that point, but virtual interactions of student teams during certain extended meeting times worked even better. Students were able to meet online outside of the regular class hours during the times that worked for their busy schedules. Collaborations on problem solving, numerical, and computational projects worked especially well.

We had a large and strong freshman class this year. Many of these students are coming back in the fall, however, probably not all the students will due to current uncertainty with the COVID-19 situation. It appears that we should retain all of our upper classman. At the same time, we do not have a clear picture of how many freshman we will get this year in physics. Therefore, if you know of any prospective students who might be interested in a physics or engineering degree, please direct those students' attention towards the McMurry Physics Program.

There were many other notable events during this academic year.

In the fall of 2019, the National SPS office recognized the McMurry University Chapter of the Society of Physics Students as one of the outstanding chapters for the 2018-2019 academic year. Nationally, only about 15% of SPS chapters are recognized. We are truly grateful and honored to be the recipients of this award. The picture of our Chapter in front of the McMurry Science Christmas tree was taken on the day when the award was announced. The SPS Chapter puts up the tree every year.

The National SPS Office has also awarded our Chapter's president, Joseph Watson, with the Peggy Dixon Two-Year Scholarship. This is a great honor and privilege for Joseph to receive this award. Joseph was also recognized by the University as this year's **"Outstanding Student Leader in an Honorary/Professional/Academic Organization"**. He will continue to serve as SPS president next year.

In the early fall several SPS members gave presentations on what they did during the previous summer.

Physics student Jonathan Samudio talked about his participation in the REU program at Texas Christian University where he worked with Dr. Mia Bovill on the computational astrophysics project **"Modeling the Properties of the Satellites of the Magellanic Clouds"**. The Magellanic Clouds are dwarf galaxies merging with the Milky Way and they carry with them additional dwarf satellites. Unless these satellites can be identified by unique properties, they will be lost among countless other Milky Way dwarves. The primary concern of the project was to identify the number of these satellites. It was found that there was a linear relationship with some scatter between the mass of the host dark matter halo and the number of satellites predicted.

Another two physics students, Carlos Martinez Hamdan and Gabriela Martell, talked about their internship with **"Elgin Power Solutions"**. Carlos participated in the internship during the early summer and Gabriela worked there during late summer and in the fall. The company specializes in the design and manufacture of electrical products for surface and underground mining, mine lighting, camera systems, electrical power-distribution equipment and controls. The project that Carlos, Gabriela and another McMurry physics student, Colton Hunt, worked on was the "Mesquite Star" electric power substation for the new wind turbine farm being built in Roscoe, TX. When finished, it will be one of the biggest substations in Texas. All students pointed out that working on this project was a valuable experience in preparing for their future careers in an engineering field.
Unfortunately, this summer many research experience programs and internships were cancelled due to COVID-19. We hope that these opportunities will become available again next summer.

Throughout the academic year, we hosted several presentations by the physics alumni in the series of talks **"What I did with my physics degree"** as well as a panel discussion conducted by the members of the Science and Math Alumni Advisory Board (SMAB). During the panel discussion, SMAB members were able to answer student questions about what aspects of their education at McMurry were important for their future careers. Students have also received some useful advice on how to navigate through the process of finding a job and how to prepare for job interviews.

In February, McMurry physics alumnus Kent Grimes gave a talk about his experience in graduate school while working on his Master's degree in Civil Engineering at Texas Tech University. He then talked about different skills, such as communication, teamwork, project management and most of all, the ability to think critically and solve open-ended problems that he found essential when working in industry. Currently Kent is working as an aeronautical engineer at Lockheed Martin airspace corporation, Fort Worth TX.

After going into a virtual mode in the late spring, we were still able to continue our talk series on the MS-Teams platform. McMurry physics alumnus, Dr. Tyler McCracken, talked about his career path starting with a McMurry physics degree to a

PhD in astrophysics from New Mexico Tech University to his work as a postdoctoral research associate at Yale University, and finally to his move from academia to industry as a Senior Systems Engineer at Ball Aerospace Corporation in Colorado.

Throughout the academic year, the Chapter continued working on several of our long term projects. The McMurry Physics trebuchet received the finishing touches to the current design, and was tested several times on different occasions. The video at *https:// www.youtube.com/watch?v=g95hnoQhrkk* shows one of these tests. In November, the trebuchet was used for conducting a fundraiser to help a wider campus effort to send relief buckets for Hurricane Dorian cleanup. An opportunity to shoot the trebuchet attracted many people. SPS members were standing by to assist with loading of the trebuchet and to collect donations. Students, faculty, and staff came by to pull the trigger to send a projectile into the air. Each person payed $4 or brought a bottle of spray insect repellent. All proceeds and insect repellents were used for relief buckets for the Hurricane Dorian relief effort. The Chapter was able to raise over $100 for this cause.

The new project that the Chapter started this year will promote the union of science and art. We will use the drawings created by Leonardo da Vinci and build a prototype of a helicopter based on his designs. To fund this project the Chapter applied and received support from the McMurry Student Government. The mechanical part of the project would have been finished by mid-April, however, after moving into remote learning mode, we were not able to work on the project as a group. Individual SPS members were still able to come to the machine shop to complete some minor tasks. *The video at https://www.youtube.com/watch?v=SkpbQRmVomI* shows the current progress on the model. We will continue working on this project in the fall.

In October, a group of physics students and faculty went on a tour of the Lockheed Martin Aeronautics Company plant in Fort Worth, TX. The tour was hosted by Taylor Freehauf '16 and Kent Grimes '16. Both Taylor and Kent are McMurry physics alumni who are currently working in different divisions of Lockheed Martin. After graduating from McMurry, Taylor earned his ME degree in Mechanical Engineering from Texas A&M University, Kent earned his ME in Civil Engineering from Texas Tech University.

The tour took us through a production line for F35 jet fighter planes which is the main product being manufactured at the Fort Worth location. Lockheed Martin produces F35s for more than a dozen countries. Even on Saturday, when out tour took place, the factory was busy. Currently, the planes are being made to fulfill orders of the US Air Force, as well as the air forces of Israel, Australia, and Korea. The production line involves many stages. Aircraft parts are being tested for defects using various optics and ultrasonic tests. They are then assembled together; electric parts and engines are attached. Painting and radar testing occurs at the final stages.

Here is what junior physics student, Joseph Watson, had to say about the trip. *"I thought that the trip was great. Getting to see engineering in practice, an assembly line for a modern military aircraft, and getting to visit with a few McMurry Alumni employees was an invaluable experience. My first reaction once we got inside Lockheed was realizing how daunting and extensive their projects are. There are so many different things that are done at Lockheed that go into one of a very few projects, and what this means for me as a physics major with an engineering focus is that there are many opportunities at a place like Lockheed that could become a career for me at some point in my lifetime. It gives me a picture of what could be and prompts me to think more specifically, about what I want to do, so that I can strive toward it…"*

Junior chemistry student, Ernesto Valle, said, *"I always suspected but never realized the extent of how much physics was involved in a project like the one we saw at Lockheed Martin. Not just the jets they were working on, even the machinery had physics crawling all over it. Nothing could be left to chance, every bolt, hole, covering, mass and connector had to have its tolerances found and to do that everything was tested and continuously so. It was useful to see how physics can be applied to real world problems and used to find solutions to eliminate them. There was many different systems that needed to be integrated to work properly, and each one had specialists that were assigned to them. Another useful bit of information was that people could switch between jobs at the plant, which means that they are not locked into a specific role. This means that the skills they have transfer over to other areas and are useful there. The only way for this to happen is if the skills are a fundamental knowledge, which was one of the first things I learned in the physics class. Probably the biggest thing about this trip was seeing firsthand how much the knowledge I am learning in class could impact the world…"*

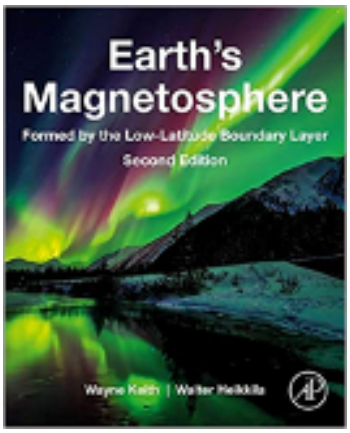
According to physics senior Andreas Rivera, "… One of the things I learned was how the production line goes. I saw that each plane had its own specifications based on where the planes were headed or depending on who bought them. Another thing I saw was that the components that they are made out of are interestingly thin and lighter than I expected, and the amount of tests they do at different stages also caught my attention…"

Unfortunately were we not able to take any pictures at the plant, because of security restrictions. We are grateful to the Science and Math Advisory Board and to the Ward-Bottom Science Fund for making this trip possible.

Some of you were able to visit us during the Homecoming in late October last year. Even though the current situation is very uncertain, please do mark your calendars for the weekend of October 15th-17th 2020. Even if we cannot visit in person, we might be able to come up with a virtual option for our Homecoming talk, please stay tuned for additional information.

We also hope that some of you will be able to participate in the **"What I did with my physics degree"** talk series. The experience of this spring showed that we could use technology to our advantage and bring virtual speakers from faraway places without them traveling to Abilene. As much as we want to see you in person, we would also welcome an

opportunity for you to talk to our students remotely. If you are interested in giving a talk to our students, please let us know and we will be happy to schedule your presentation online during one of our SPS meetings next year.



During this academic year, Dr. Keith has continued his work on the second edition of the book **"Earth's Magnetosphere"** by Dr. Walter Heikkila and Dr. Wayne Keith. Now, the book is almost finished and will be released in the fall. You can preorder your copy on Amazon, or at *https://www.elsevier.com/* using Dr. Keith's author discount code of **ATR30**.

In late June, Dr. Bykov attended the National Conference of Physics Department Chairs. This year, the conference was virtual, but it still presented many opportunities to interact with fellow department chairs and learn about the best practices from the physics departments around the country.

These are just some of the many events of the past academic year. You can always keep track of our current events by visiting us on Facebook (look for McMurry Society of Physics Students) or online at *https://sites.google.com/site/mcmurryphysicsdepartment/home*.

If you have been recently added to our database and/or never received this letter before and/or by some reason want to be removed from the list and/or prefer to update your contact information and/or prefer to receive an electronic instead of a paper copy of this letter, please do not hesitate to contact me at the address above or by email at *tbykov@mcm.edu*.

Tikhon Bykov - Wayne Keith - Timothy Renfro
The McMurry Physics Department