Department of Physics

Tikhon Bykov
Department of Physics,
1 McMurry University, Box 38
Abilene, TX 79697
(325) 793-4875
tbykov@mcm.edu

Friend

20-Jun-18

Dear Friend :

As we finish this academic year, we would like to bring you the latest news from the McMurry Physics Department.

This year the department had one graduating senior: Rody Johnson in the spring and will have another graduate: Jacob Ferguson in December.

Rody Johnson, working under the supervision of Dr. Keith, completed his senior research project on "How to Maximize Force When Hitting a Baseball". Rody's interest in that subject was driven by his being a member of the University Baseball Team for all four years while he was a student at McMurry. The purpose of the project was to determine what hitting factors should be focused on and improved to get the most force out of hitter's swing. A wide variety of hitting data were taken and it was found that the batters with greater mass did not necessarily result in more force, but the most force came from the greatest bat speed along with the shortest value for time to contact.

After graduating Rody plans to go directly into the workforce and find an engineering-related job. After working for several years in an engineering firm, he hopes to become a licensed engineer.

Even though the department did not have many graduates this year we do have a record large group of juniors who will be working on their projects next year. There were seven proposals for these projects presented to the public in May.

Jacob Ferguson, who is looking to have a career in civil engineering field after graduation, presented his proposal for the project "Structural analysis of cable-stayed bridge". He will be working under the supervision of Dr. Renfro. For the past forty years cable stayed bridges have proven their dominance against other long spanning bridges. Due to technical innovation, aesthetic appeal, and the efficient application of material, cabled-stayed bridges have provided new methods to maximize longevity. The objective of this project is to study in detail the basic structural behavior of the cable stayed bridge, and to present a structural analysis of a specific cable stayed bridge. Jacob's plan is to design a cable stayed bridge in SolidWorks, then perform analysis using this software. Jacob looks to follow this up by 3D printing a small model and performing stress testing on the model. His project will be of interest to the Texas Department of Transportation as they look to 3D print bridges.

Alexandria Mendoza, working under the supervision of Dr. Bykov, introduced the proposal "Droplets, Galaxies, and Collisions". The study of galaxy formation is a motivation behind this project. However, a hydrodynamic analogy is going to be used. It is known that some aspects of collisions between liquid droplets are very similar to collisions between astronomical objects. This project will study colliding liquid droplets of different substances. Droplets of different size will be sprayed in front of a high speed video camera. These collisions will be photographed and spliced together to create a time-lapse of the collisions. Depending on the substance, each collision will be compared to known astronomical occurrences, such as two galaxies colliding or colliding stars. If time allows, droplet collisions of multiple substances will be tested to see if

comparison can be drawn to other events, such as an asteroid colliding with a planet. The role of the Weber number will also be investigated. Alexandria will write her honors thesis on the basis of this project. This project was also awarded one of the Charles and Lisa Bloomer student research stipends for the 2018-2019 Academic Year. We are grateful to the Science and Math Advisory Board for supporting Alexandria's work on this project.

Tyler Sanchez we will be working with Dr. Renfro. His proposal is "Prosthetic 3D Hand". The goal of this project is to create a prosthetic hand that is capable of mimicking an actual human hand. This will be achieved through the process of additive manufacturing and will use a 3D printer, Arduino Uno, flex sensors, servo motors, resistors, a battery connector, regular breadboard, gloves, and a battery. This hand will be drafted in the computer-aided design (CAD) software SolidWorks and then will be 3D printed with two different materials, Polylactic Acid (PLA) and Methacrylic Resin solution, to see which hand overall is a better product. The better product will be determined by a series of tests such as response time, grip strength, and durability.

Jordan Speck, who will also be working under the supervision of Dr. Renfro, introduced the proposal "Vacuum chamber fluid dispenser". In this project a vacuum chamber will be built to transfer a preset amount of a fluid substance into a cup. Vacuum chambers are rigid enclosures from which air and other gases are removed. This results in low-pressure environment within the chamber. This project uses a vacuum pump instead of a regular pump to transport the fluid substances. The pump will remove the air from the container, creating vacuum, and will draw the fluids through the tubes and into the cup that sits inside the chamber. The goal is to make this device into an automatic titration system for chemistry experiments.

Juan Valadez, who is working with Dr. Bykov, wants to build a "Portable Wind Powered Cell Phone Charger". To do so, he will design a Vertical Axis Wind Turbine (VAWT) and a Horizontal Axis Wind Turbine (HAWT). These turbines can be installed in or around any public area and even at home for personal usage. The goal is to test both designs to see which has the higher efficiency and lower cost to charge a smart phone. The intent is to design and implement the two wind turbine systems at a low cost where it would be feasible for home owners.

Casey Walters, working under the supervision of Dr. Keith, is planning to build a "Vacuum Cannon". A vacuum cannon is a device that uses a pressure differential to accelerate a projectile (ping pong ball) to high speeds. The ball is placed at the end of the tube while the air pump is vacuuming out the air. Both ends are wrapped with a thin, airtight material. When one side is punctured, the air flows through the opening inside the pvc pipe that has no air. As the air flows through, it pushes the ball out the other end going at a very high speed. Possible improvements to the basic design include a high-pressure tank replacing ambient air and a "de Laval nozzle" between the high-pressure tank and vacuum barrel to create a supersonic flow.

David Winski, working with Dr. Bykov, will develop a project on "Collecting Kinetic Energy form Everyday Movement". The project will investigate the idea of using kinetic energy from everyday human activities and convert it to electricity in order to power small devices. To achieve that, a group of people will be studied that follow roughly the same schedule and do similar activities. The group will consist of males and females of varying height and weight in order to see if these variables affect the energy collection. The devices used to collect the data will vary from each other by the method they use to convert kinetic energy into electric energy. These devices will utilize the methods of piezoelectricity, electromagnetic induction, and acceleration. The data will be examined to see if it is possible/feasible to construct a device that can harness that energy to convert into electricity in order to power a small mobile electric device. David will write his honors thesis on the basis of this project. This project was also awarded one of the Charles and Lisa Bloomer student research stipends for the 2018-2019 Academic Year. We are grateful to the Science and Math Advisory Board for supporting David's work.

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

In the Thermodynamics II course, which was offered by Dr. Bykov in the fall, Alexandria Mendoza and David Winski completed a computational project on "Density Functional Theory study of first order phase transition in 2D lattice fluid." The Density Functional Theory was used to calculate phase diagrams and interfacial properties in a two-dimensional lattice fluid. In this lattice fluid model, only nearest neighbor and

next-nearest neighbor interactions were accounted for. The fluid was taken into consideration without any external field present. Thermodynamic potentials were found as functions of density. The density profiles for one-dimensional liquid-vapor interfaces were studied at different temperatures in coexistence. The behavior of the surface tension for a planar liquid-vapor interface was studied as well. The results of the project were presented during the Texas Section of American Physical Society meeting in March and the McMurry Academic Conference in April.

Other numerical projects were completed in the Classical Mechanics II course offered by Dr. Bykov in the spring.

The members of the baseball team: Juan Valadez, Jordan Speck, and Rody Johnson performed "Numerical Study of a Baseball in Flight using RK4 Method". To analyze the behavior of a baseball in flight several forces are to be accounted for. These include the drag force and the force of the wind that contribute along with gravity to the shape of the trajectory of the ball's path. The RK4 (Fourth-order Runge-Kutta) numerical method was used to calculate the trajectory of the ball using the FORTRAN programing language. Video analysis of experimental data was used to confirm that the numerical trajectory and real trajectory of the ball are consistent.

Jacob Ferguson and Tyler Sanchez performed a "Study of Nonlinear Effects in Vibrating Strings Using the RK4 Method" The goal of this project was to model nonlinear effects of vibrating strings. A vertical external force applied to a string can potentially create a two-dimensional elliptical trajectory for the motion of a string element. A code was created in the C programming language and used to integrate the non-linear equations of motion and study how the force's frequency affects the string's motion.

In "Automated Experiments" course the final project was to build a device to place 3 tennis balls in a cup using an Arduino Uno, servo motors, and cardboard structure. This project was a great example of applying general physics knowledge to a robotic system.

In "Engineering Drafting" class the final exam was for students to design, draft, 3D print and test either a whirly-gig or a small wind generation device. Students were encouraged to perform the engineering design process and to test their devices as well as make modifications before presenting their projects. Joseph Watson's whirly-gig proved to be of exceptional quality in design, 3D printing, and in operation. This design animated a small figure drawing a bow. Joseph's system used a gear system to reduce angular velocity and increase torque to allow his tiny bowman to draw his bow. This design can be seen on the MCMSPS Facebook page.

We had a very large group of sophomores and juniors this year, so for the first time in the recent history, the department had to offer two sections of the Advanced Physics Lab with Dr. Renfro and Dr. Bykov teaching these sections. With so many students participating, several final laboratory projects were completed. A vacuum cannon was built and tested by the students in Dr. Renfro's section. This project partly served as an inspiration for Casey Walters to introduce his senior research work that will address the same subject in greater detail. In Dr. Bykov's section, Aaron Herring, Jerett Bell and Christian Grimes addressed the request of the Chemistry Department to modify an experiment for measuring the ratio between the heat capacity at constant pressure and heat capacity at constant volume for an ideal gas. This goal could be met by performing high precision measurements of the speed of sound in that gas. The speed of sound traveling in gasses was measured by collecting data from electronically generated white noise put through an acoustic tube. The acoustic tube filled with normal air or Argon acts as a resonant filter for the white noise generated by the static radio signal. The second project was completed by Jose Mireles, Frances Narvaez and Colton Hunt. They have used a compound pendulum to perform high precision measurements of the acceleration due to gravity. Compound pendula or various sizes were used. One was a long steel bar with a heavy cylindrical mass that could be attached to the bar, the second pendulum was made from a meter stick. PASCO motion sensors and rotary motion sensors were used for the data collection.

In the Electronics course this spring, the two projects were revisits of Aaron Ramos' robot and Jordan Nix's coil gun. The robot was FINALLY made drivable, and a better (wired) controller built, but without speed control. Some mechanical repairs were made as well, and more can still be done, especially more secure mounts for the drive motors. The power rails previously added to the coil gun were redone so that

they could no longer contact each other, and each coil assembly was tested and repaired as needed. Making the final (fifth) coil functional still eluded this group, though.

The freshman class this year was not as large as last year. Still we should have eight to ten students who will continue to their sophomore year. At the same time due to a very large number of sophomores and juniors will have to offer two sections of the Electricity and Magnetism course in the fall with twenty two students who have already signed up for that course. With summer just starting, we do not know yet how large our incoming freshman class is going to be. 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.

Last fall we were very glad to see some of you during the Homecoming reception. David C. Miller '67 gave a memorable talk devoted to the history of science programs at McMurry and outstanding achievements of our alumni in the last fifty years. The talk captured the attention and brought many questions and comments from the audience. We are grateful to Mr. Miller for this interesting presentation. This year's Homecoming will take place during the weekend of October 12th-14th. We will celebrate sixty years since the Physics Program was started at McMurry by Dr. Virgil Bottom in 1958. You will be receiving a separate invitation for this event, please mark your calendars.

We also hope that some of you will be able to participate in the "What did I do with my physics degree?" talk series. If you happen to be in Abilene for any reason, please do come to see us, talk to our students, and learn about the latest news in the Physics Department. We are very grateful to Dr. Roger Ward and Mr. Bill Lebus who talked to our students last October about the importance of internships for successful careers in science-related fields. That talk definitely had an impact, since we do have seven students who will be participating in summer research programs and internships this year.

Alexandria Mendoza is participating in the National Science Foundation sponsored program "Research Experience for Undergraduates" at the University of Texas at Dallas. She is working with Dr. Lindsay King. The project involves the study of dark matter inside galaxy clusters and the cosmic web. It is based on computer simulations performed on a UT supercomputer in Austin, and the data collected from the Chandra X-ray observatory and Subaru telescope.

David Winski is working with a summer program of the Air Force Research Laboratory at Kirkland Air Force Base, NM. He is part of the ultrashort pulse laser (USPL) research group, working under the supervision of Dr. Jennifer Elle, to complete the construction and diagnostic of the short pulse laser. His task is to assemble all the optics for the diagnostic, make measurements, and write software to quickly extract useful information from the measurements.

For the second summer in a row, Casey Walters is completing an internship with the Abilene Office of the Texas Department of Transportation. He is working on engineering tasks in that office.

Also for the second summer, Juan Valadez is working with Cajun Industries, an engineering and construction firm in the Baton Rouge area. He is gaining an experience in the construction management and civil engineering field.

Jacob Ferguson has an internship with KFW Engineers, an engineering and surveying company in the San Antonio/New Braunfels area.

Eduardo Contreras is working with Belta-4. It is a small family owned manufacturing company in the Fort Worth area. He is helping engineers and machinists while they make and design parts. This company specializes in making small metal parts in fields such as aerospace, oil, Machine tools, DOD and DOE. He will learn how to use Mastercam software and how to use mechanical shop tools and machines.

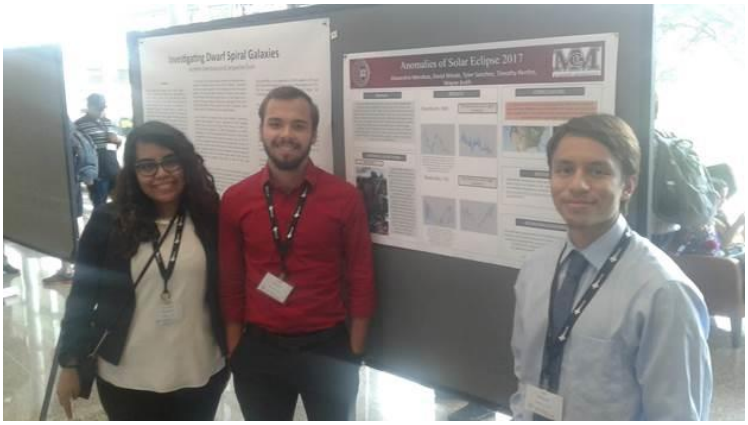
Mason Mireles is working as an intern on an oil rig with Ensign Energy Company in Greeley, Colorado.

Yet another unique opportunity for our students this summer will be traveling to Lowell Observatory in Flagstaff, Arizona. As in the past Dr. Keith will be taking a group of physics students to perform astronomical observations on a research grade telescope. The students will be in complete control of the telescope for several nights. The trip is still being planned, but as with previous trips, the primary objective will be asteroid hunting. The 31-inch telescope is having its mirror refinished just before our observing session, so hopefully we will get to participate in the "first light" observations with the refurbished mirror, rather than five days of hoping they finish putting it back together before we have to return home.

Some other departmental news from the past academic year are the following:

In late October a group of seven physics students and all physics faculty attended the Texas Section of the American Physical Society/American Association of Physics Teachers/Society of Physics (APS/AAPT/SPS) Students meeting in University of Texas at Dallas.

During the conference, three physics juniors: Alexandria Mendoza, David Winski, and Tyler Sanchez presented a poster on the "Anomalies of Solar Eclipse 2017". This poster was based on the data about light intensity and temperature that was collected from Dearborn, MO and Nashville, TN during the Solar Eclipse that occurred on August 21, 2017. Both of these cities were located in the path of totality. Dearborn experienced 2 min 29 s of totality and is about 21 miles from maximum totality, while Nashville experienced 1 min 55 s of totality and is about 19 miles from maximum totality. Physics students and Dr. Renfro traveled to Dearborn, while Dr. Keith traveled to Nashville to collect these data. Several anomalies, such as frequent dips in the light intensity graphs, do match up in both sets of data right before the point of totality. These anomalies were discussed in the presentation.

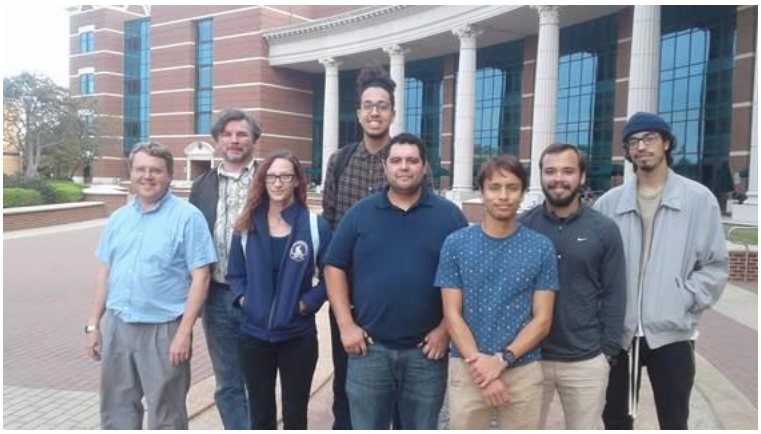


According to Alexandria, "The biggest impact this conference had on me was presenting our poster. I had been to the Women in Physics conference freshman year, so I had an idea of what a poster presentation was, but it was a totally different experience actually presenting it…In addition, I think it really helped my understanding of the overall research by having to explain it to multiple people". David was of the similar opinion: "Being my first poster presentation I think it went well. The people that came up, talked to us, and asked us questions. I was able to successfully answer or Alexandria and Tyler could answer if I was unsure of the answer".

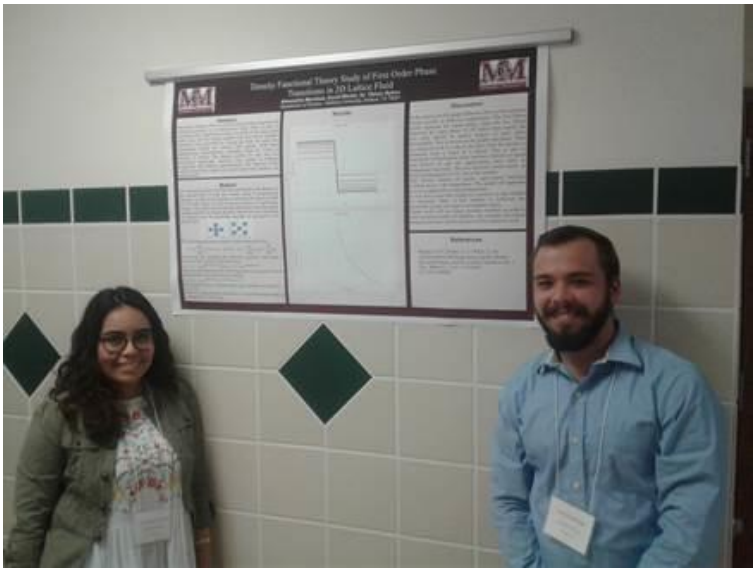
We are grateful to the Ward-Bottom Science Fund that made possible for our students to travel to observe the solar eclipse as well as to attend the meeting in UT Dallas.

In November, a group of six physics students accompanied by Dr. Bykov and Dr. Keith visited Baylor University to take a tour of laboratory facilities and learn more about graduate school opportunities at Baylor.

Visiting the Baylor Research and Innovation Collaborative (BRIC) Building was the highlight of that visit. That building is designed to house collaborative research teams that involve scientists from Baylor Physics Department, Baylor Engineering School as well as their industrial partners. These interdisciplinary teams can then work on real-life problems, such as a study of the "Solar Wind" and its effects on the Earth's magnetosphere, production of new environmentally friendly materials for different industries or even 3D printing real cars on a full scale. The group was also able to visit with several professors in various areas and with last year's McMurry physics graduate, Ryan Pittman, who is currently a graduate student pursuing a PhD in Physics at Baylor. Ryan was able to share his graduate school experiences with the current McM students. The tour was a great way for students to learn about graduate school and collaboration between industry and academia. We are grateful to the Ward-Bottom Science Fund that made this trip possible.



In March group of six physics students and all physics faculty attended the Texas Section of the APS/AAPT/SPS meeting at Tarleton State University in Stephenville TX. During the conference Alexandria Mendoza and David Winski presented a poster on "Density Functional Theory Study of First Order Phase Transition in 2D Lattice Fluid" based on the project they have completed as part of the Thermodynamics II course they took with Dr. Bykov. After gaining this experience they both are rather confident that they could do an oral presentation next time.



Both students and faculty enjoyed the talk given the by the head engineer of the NASA Cassini Mission, Julie Webster. The Cassini spacecraft studied Saturn and its moons for almost twenty years before ending its flight earlier last fall. It was an unforgettable experience to learn about details of that mission from the person who participated at all stages of the project starting from the spacecraft design and all the way till its final days before a controlled impacted with Saturn. It was especially interesting, because the McMurry SPS Chapter is currently working on a project to commemorate Cassini. We were also able to take a tour and attend the Star Party at the Tarleton Research Observatory.

The Physics Department is grateful to the Science and Math Advisory Board for making this trip possible.

During the Spring Commencement, an outstanding physics alumnus and long-time supporter of McMurry science programs, Mr. Roger Ward, was awarded the Honorary Degree of Doctor of Science from McMurry University. The degree was awarded for distinction in science and engineering, recognizing Roger Ward's many contributions to designing, developing, and manufacturing the industry-standard resonating quartz pressure transducer for the oil and gas industry. These sensors and hybrid electronics are widely used in laboratory, surface, and downhole tools and monitoring systems. They can work under a range of extreme conditions. Our sincere congratulations to Dr. Roger Ward for the well-deserved honor!

In October, Dr. Timothy Renfro was awarded the Sam Taylor Research Fellowship Award to work on the acoustic effects of 3D printed resonance cavities known as inverted phononic crystals or acoustic crystal structure. These types of structures were not possible until the development Stereo Lithographic (SLA) printers. The objective is to develop structured materials that act the same as photonic crystals that which were developed in the early 2000's for filtering narrow band light signals. Currently UC San Diego Mechanical Engineering Department and the US Department of the Navy has expressed interest in results from concept models.

In March, Dr. Wayne Keith was granted a sabbatical that he will take next spring. During that sabbatical, he will be working on the second edition of the book "Earth's Magnetosphere" by Dr. Walter Heikkila. Dr. Keith met with Dr. Heikkila in Dallas during the October meeting at UTD mentioned above, and was offered the co-authorship. The two have worked together previously; in fact, some of the data and figures in the first edition were supplied by Dr. Keith. The new edition will add a chapter on the inner magnetosphere, as well as new data from recent satellite missions and end of chapter problems for students.

In June, Dr. Tikhon Bykov traveled to the National Conference of Physics Department Chairs in Washington, DC. He was able to meet with fellow physics chairs from all over the country and learn more about best practices of building successful physics program. He also participated in Congressional Visit Day to meet with staff members of Texas Senators and with Texas 19th Congressional District Representative Jodey Arrington to advocate on behalf of the American Physical Society for the issues of science and science education funding.

In May, the McMurry Chapter of the Society of Physics Students was recognized as an Outstanding Student Academic Club of the year. Congratulations to all of ours students for the job well done!

These are just some of the many events of the past academic year. You can always keep track of our current news 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 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