Department of Physics

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Friend

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Dear Friend :

As the current academic year comes to its end, we are glad to bring you the latest news from the McMurry Physics Department.

Throughout this academic year our seniors, Taylor Freehauf, Kent Grimes, D. Jordan Nix and Kristopher Valdez have been finishing their senior research projects.

Taylor Freehauf, working under the supervision of Dr. Bykov, completed building a dual axis solar tracking system to operate the motion of a solar panel. With growing concern of fossil fuels depleting and alternative energy interest increasing, solar panels have become progressively more utilized in not only residential instances but in commercial as well. Often these panels are not being used to their maximum potential if the sun is not directly angled at the solar panel. By incorporating a dual axis solar tracking system into these panels, rather than a fixed or single axis system, the panels become more efficient and in turn, produce more energy. Many solar panels do not utilize this method, as they are expensive to produce and require more difficult and more frequent maintenance than fixed or single axis solar panels. In this project, a working prototype of the dual axis solar tracking system was designed and built on a small scale. To reduce the cost, parts of the system were printed on a 3D printer and LabVIEW programming language was used to control the motion. Analysis of the motion was preformed which would help in addressing the issues of a larger scale model. This project also served as Taylor's honors thesis. It was presented to the public during the McMurry Academic Conference and during a formal thesis defense in April. Taylor graduated with honors in May. He has been accepted to the Master of Engineering graduate program in Mechanical Engineering at Texas A&M University. He will start his studies there in the fall. Congratulations to Taylor!

Kent Grimes, working under the supervision of Dr. Bykov, completed building a small prototype hydroelectric generator. Alternative energy sources have gained importance in recent years. One such alternative energy source is hydropower. This project was inspired by the previous work of McMurry physics alumnus Daniel Zipprian. The purpose of this project was to build a small-scale hydroelectric generator at minimum cost, and to find out how much energy such a generator can produce. Strong permanent magnets were attached to a hydro wheel, while copper wire coils were housed on a stationary frame. The project started with the drafts of the hydro wheel, magnet and coil housings. These parts were then printed on a 3D printer. The frame was constructed out of square wooden dowel rods and connected with joints that were drafted then printed on the 3D printer. Once the construction process was complete, the generator's electric output was studied. The finished project was presented to the public during the McMurry Academic Conference and during a formal defense in April. Kent graduated in May and he is currently applying to graduate programs in Civil Engineering at several schools.

Both Taylor and Kent were recognized as outstanding physics seniors this year. Congratulations!

D. Jordan Nix, working under the supervision of Dr. Keith, has completed his project of building a coil gun (Gauss rifle). A coil gun is a device that uses an electromagnetic coil to create a magnetic field to launch ferromagnetic objects. The magnetic field is generated by current from a car battery passing through a series of coils. All of the coils are initially energized by a single trigger. In order to achieve maximum velocity, each of the four coils is shut off by a photo gate and related circuitry once the projectile emerges from the coil. The projectile itself must be as long as the coil, or the field will start to pull back on it and slow it down before it can emerge and trip the photo gate. The barrel is a section of glass tubing, which allows the photo gates to sense the projectile without the need to create openings in the barrel. You can see a video of the coil gun shooting an iron nail on our Facebook page. The project was presented to the public in May just before Jordan's graduation. After graduation, Jordan is planning to go directly into work force and find an engineering related job.

Kristopher Valdez, working under supervision of Dr. Bykov, finished his honors thesis, "Study of the Electro-magnetic Generator Pickup". The goal of this project was to study the magnetic field generated by the "Electro-Magnetic Generator" active pickup for electric guitars. A mathematical model of the field produced by the magnetic configuration specific to the EMG-85 active pickup has been developed. An instrument has been built to find the vertical component of magnetic field using Hall Effect senor moved on the X-Y table. The results found from both approaches have been analyzed and compared to one another. The similarities and differences between the two resulting data sets have been discussed. This project was also presented at the McMurry Academic Conference in April and during the formal defense of Kris's thesis. Kris has graduated in May with honors in physics and math. Kris was also elected to become a member of the McMurry Chapter of Sigma Pi Sigma, National Physics Honor Society. He will be taking a short break to spend time with his family and then he will start applying to physics graduate programs later this year.

Our two other seniors Robert Schmidt and Marco Flores are still working on the projects they started last year and will delay their graduation.

In addition, two physics juniors this is year presented their proposals for the projects that they will start in the fall.

Kirk Hodel, working under supervision of Dr. Bykov, made a proposal to conduct a study of feasibility of wind energy production on a small scale. This project was inspired by the work performed by McMurry physics alumnus Cristopher Cumby several years ago. It is well known that wind energy has been used on large scale especially in West Texas. However, the small-scale wind turbines are not that common. With 3D printing and other new technologies becoming more and more accessible to the public, the question arises if this can help with building of small-scale wind turbines. The purpose of this project is to determine if construction of a small-scale wind turbine and using supplemental wind energy from that turbine to assist in providing power to a building is a feasible idea. Feasibility will be determined by three factors: cost-effectiveness, estimated ease of mass production, and minimum required wind speed. In order to test the feasibility a wind turbine prototype will be tested atop the Finch-Gray Science Building using the wind conditions of Abilene. Before this test, smaller scale tests were conducted with varying designs in laboratory conditions to determine an effective wind turbine design. We are grateful to the Science and Math Advisory Board for awarding one of the two 2016-2017 Bloomer's Student Research Stipends to this project. Kirk will also serve as a vice-president of the McMurry Chapter of the Society of Physics Students next year. Congratulations to Kirk!

Ryan Pittman, working under the supervision of Dr. Keith, made a proposal to build a musical Tesla coil. The objective of this proposal is to continue McMurry physics alumnus Tyler McCracken's senior project and build a musical Tesla coil. However, the proposed design will incorporate a digital, rather than the traditional analog circuit for a Tesla coil, and will be able to interpret the different frequencies of musical notes. There will be three parts to the circuit: the interrupter, the logic portion, and the power portion. Music will be created by a rapid succession of arcs of electricity, discharging precisely at the correct frequencies of audible musical notes. We are grateful to the Science and Math Advisory Board for awarding the second of the two 2016-2017 Bloomer's Student Research Stipends to this project. Ryan was also elected to become a member of the McMurry Chapter of Sigma Pi Sigma, National Physics Honor Society and recognized as outstanding physics junior. He will serve as the president of the McMurry Chapter of the Society of Physics Students next year. Congratulations to Ryan!

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

In the Thermodynamics II course, which was offered by Dr. Bykov in the fall, Taylor Freehauf and Kent Grimes completed a computational project on "Density function theory and wetting transition". Density functional theory (DFT) has long been considered as too difficult a method to be accessible to an undergraduate student. However, recently the American Journal of Physics published an article illustrating a somewhat simplified, and yet very physical version of the DFT method describing the behavior of a two-dimensional lattice fluid. Inspired by this publication, Dr. Bykov introduced a DFT based project into the Thermodynamics II course this year. In this project, the wetting phase transition was studied. Wetting phenomena are strongly dependent on fluid-surface interactions. In order to understand such interactions, a DFT-based approach was utilized. The theory is based on determining the density profile of a fluid affected by an external field. In the proposed model, several assumptions were made to simplify the situation: the continuous fluid was replaced by a 2D lattice structure, only close neighbor interactions were taken into account. In the framework of DFT, different properties of a bulk fluid were found and discussed such as its chemical potential, pressure, the binodal curve and the spinodal curve. Then using Grand Canonical ensemble, one-dimensional and two-dimensional density profiles of the fluid were modeled along with the adsorption of the fluid to the wetted surface. These results were then compared to previously published work and are found to be in good agreement. Taylor and Kent presented the results of this study during the Science and Math Colloquium and then during the McMurry Academic Conference in April.

In November, Kristopher Valdez, attended the 2015 West Texas Undergraduate STEM conference at Midland College, in Midland TX. At the conference, Kris presented a poster entitled "Using a Computational Approach for Efficient Calculations of Electrostatic Fields in Two Dimensions". This poster was based on the project Kris completed as part of the "Electricity and Magnetism II" class he took with Dr. Bykov in the spring of 2015. The project was focused on finding the most efficient numeric method to solve Laplace equation for electrostatic potential in a two dimensional boundary problem with cylindrical symmetry. After

a formal defense of the poster in front of a panel of judges, Kris was awarded first prize and a $200 cash award in the "Engineering, Math and Computer Science" category.

As part of the "Classical Mechanics II" course that was offered by Dr. Bykov in the spring of 2016, several students completed computational projects. The subject of planetary motion unified all these projects. Taylor Freehauf studied planetary orbits and the chaotic tumbling of Hyperion. He has considered the planetary system of Saturn and one of its moons, Hyperion. The movement of Hyperion is known to be chaotic. In order to approximate these movements, a numerical approach was used utilizing the RK4 method for solving differential equations. This approach provided high accuracy and dependable results, in which the movements of both objects were graphed. Kent Grimes studied the precession of the perihelion of Mercury. Using the RK4 numerical method, the planetary motion of Mercury was modeled. The precession of the perihelion of Mercury was determined for different values of the deviation from the gravitational force law. The rate of precession as function of deviation constants was studied.

The final project this year for "Automated Experiments" course was to interface a PC using a National Instruments MyDAQ with a pre-existing radio controlled model car. Students Ryan Pittman, Nick Moore, and Rody Johnson did this by opening the manufactured remote that came with a $20 RC car from Walmart and soldered leads to the transistors that controlled the forward, reverse, left, and right motion. They then were tasked with writing a LabVIEW program that drove the car from the front doors of the science building to the stature in the middle of the quad. Although this was an enjoyable project for the students, they found out that a rough sidewalk made it difficult to control the vehicle without some sort of position feedback system, a project for a later date.

There were several labs and projects in the Digital Electronics course this last fall. Students for the first time tried several new labs. For the first time in recent history, they attempted to design a circuit board for a 555-timer circuit in Multisim, and then print this circuit using photolithography. Unfortunately, the glass used to hold the transparency mask to the single side PCB was quartz and caused the exposer to not develop properly. The physics department hopes to change to a new method in the near future by purchasing a laser-cutting table that will be used to etch the circuit on the PCB. Students also practiced their soldering technics by assembling LED Christmas tree displays and a 555 timer driven alarm system. Students had lots of fun with their results and several complaints were made to resident advisors in the dorms due to the alarm noises. The final project for the class was the studying and assembly of a 5x5x5 light cube display. Students were to study the circuit for this device then select a kit to assemble. Soldering of kits took several days and troubleshooting the circuits took almost as long. In the end one student managed to successfully complete a very difficult project which taught them patience, work ethic, and troubleshooting techniques. They can also say now that flow soldering is sometimes better than flux core soldering.

In Advanced Physics Lab this spring, there were two project for the final exam. Students broke into two teams. The first team decided to test the conductivity of saline suspended in gel. The second team chose to do a comparison of ESTES rockets to a 3D printed rocket, which is a hot topic among online 3D printing groups. The first group managed to produce six different samples and suspend the material in gel long enough to take conductivity readings. They found out that it was possible to vary conductivity by changing the salinity of a material while it was in a gel. They also found out that when passing current through these gels, the material began to produce bubbles and a smelly gas. Applications of these findings are yet to be determined. Unfortunately, for the 3D printed rocket, time became too great of a factor and it was not completed. The small group was given the go ahead to complete the project this summer and report when they return this fall.

In the Electronics course in the spring the project was to build a set of digital dice. Three dice were designed and built by Kris Valdez on breadboards that were capable of randomly displaying 1 to 6 LEDs. Each value was also color-coded using special multi-colored LEDs so that multiples of the same value across the dice could be easily identified. In addition to individual roll buttons, a master roll and number of dice selector switch was included on a separate board. A demonstration of the project is available on our Facebook page.

In the fall Solar System Physics course, Kris Valdez, one of the students who accompanied Dr. Keith to Lowell Observatory August 2015, completed an analysis of the data collected on that trip. The goal was to

find and report on the locations of poorly observed asteroids, and possibly discover something new. One high-priority asteroid has been identified and position measurements made through a process called astrometry. Kris presented a poster on this project at the end of the spring semester.

We had a large freshman class this year. Many of these students are very promising. Twelve students will continue to the sophomore year. Our Modern Physics, Automated Experiments and Engineering Statics courses in the coming fall will be completely full with no open seats left. However, as usual at this time of the year, we do not know yet how large our incoming freshman class is going to be. So if you do know of any prospective students who might be interested in physics or engineering, please direct those students' attention towards the McMurry Physics Program.

As usual in the fall, we were very glad to see many of our alumni during the Homecoming reception. Adam Davidson '07 was our invited speaker this academic year. In his talk "The Road" Adam recalled his experiences in McMurry and beyond and discussed how the McMurry experience led him on his journey. Next academic year, David Upshaw '08, who has recently moved into a new position with Los Alamos National Laboratory, will present his Homecoming talk. You will be receiving a separate invitation for this event that will take place during the weekend of October 7th-9th 2016. Please mark your calendars.

We hope to see even more of you as speakers in the "What did I do with my physics degree?" series and visit with you during Homecoming. 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 those of you who were able to come this year.

Many of you know Mr. Roger Ward '67 as a good friend and continuous supporter of McMurry science programs. Mr. Ward graduated from McMurry in 1967 with B.A. in Physics. He also earned M.S. in Physics from Purdue University. Before his retirement in 1999, he served as the President and CEO for Quartzdyne, Inc. Under his direction, Quartzdyne grew from a start-up company to becoming an internationally recognized leader in producing high precision pressure measurement sensors. The generosity of Roger and Kimberley Ward has enabled our Physics Program to flourish. During the Homecoming last fall, Mr. Ward was recognized as an Outstanding McMurry Alumnus. He was able to meet with our students to talk about the lessons he learned while at McMurry, the profound influence Dr. Virgil Bottom had on him and the value of the McMurry physics degree for his career. During a special ceremony, an updated version of the Ward-Bottom Science Scholarship agreement was signed. Inspired by the successes of the Physics Program, Mr. Ward decided to make this scholarship available not just to physics but also to chemistry and biology students. Roger and Kimberly Ward have also made an additional gift to the Ward-Bottom Endowment. We are deeply grateful to Wards for their generosity!

In November, we were glad to welcome back yet another outstanding McMurry physics graduate. Our guest was Mr. Larry Conlee '71. He received his B.A. in Physics from McMurry in 1971. He then worked as a "crystal engineer" with Motorola, Inc. in Chicago. At Motorola, he improved the quality and the utilization of the synthetic quartz used in the devices made for use in pagers, 2-way radios, and the first generation of cellular telephones. His team developed the first digital cellular phones, GSM, in 1992. In 2001, he joined "Research In Motion" (BlackBerry) as Chief Operating Officer, Product Development and Manufacturing. He retired in 2009. We are very grateful to Mr. Conlee that he was able to find time in his busy schedule and spent an afternoon talking to our students about his career, his experience at McMurry, and the role of a liberal arts education in achieving his professional goals. We would also like to congratulate Mr. Conlee for being inducted to McMurry Math and Science Wall of Honor earlier last fall.

In April, David Upshaw '08 participated in the Induction Ceremony for the new Sigma Pi Sigma, Physics Honor Society members. In his talk, he described some recent projects he has been involved in at Los Alamos National Laboratory and invited McMurry physics students to apply for internships there.

Some other news from the past academic year include the following.

In November, all physics faculty and senior physics student Taylor Freehauf attended Texas Section of American Physical Society meeting in Baylor, Waco TX. The United Nations declared 2015 "the year of light". Therefore, many talks at that meeting were devoted to the physics of light and other forms of radiation. In particular, Dr. Marlan Scully of Baylor University gave a talk entitled "From Newton and Maxwell to Einstein and Schwinger" on the history of the discovery and evolution of the concept of a photon. Dr. Scully

was fortunate to meet and work with the "giants of modern physics" responsible for the foundations of quantum mechanics, such as Nobel laureate Willis Lamb. It was very interesting to hear him talk based on his own memories of these historic events. Dr. James Kakalios of the University of Minnesota gave a talk devoted to "The Physics of Superheroes". A talk by Dr. Don Olson of Texas State University on video analysis of the Tacoma Narrows Bridge Collapse in 1940 inspired Dr. Keith to find vintage recordings of the collapse in the McMurry physics department. In particular, the 1982 Laserdisc at McMurry may be the best surviving example in existence according to one of its creators. Also during the conference, Dr. Bykov presented a poster on behalf of the recently graduated physics student Richard Garcia. The poster, entitled "The Numerical Analysis of Baseball's Trajectory in Flight", was based on the project Richard completed in the Classical Mechanics II class he took with Dr. Bykov last year.

In January, physics freshman student Alexandria Mendoza attended the national conference for undergraduate women in physics in San Antonio, TX.

At the beginning of the spring semester, the Physics Trebuchet was finally completely finished and put to test during the "McMurry Science Saturday". That brought back many memories from the times when the old trebuchet was launched during preview days. In those days, it required almost ten people to be able to take it from the shop to the middle of the campus quad for shooting. The new trebuchet has wheels and it has been permanently residing behind the Science Building during the last year. The field tests were a lot of fun for prospective students who visited McMurry on that day. The new and improved trebuchet only requires a couple of people for launching. We are grateful to physics senior Taylor Freehauf, physics freshman Curtis Summers and Dr. T.J. Boyle of the Biology Department for assisting on that day. You can see videos of trebuchet shooting on our Facebook page.

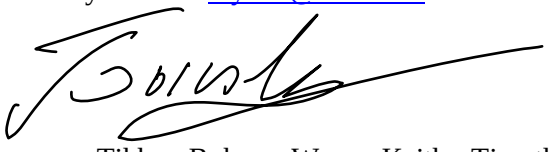
Another long-time project, which was completed this year, is the installation of the "Physics Dept." neon sign on the glass wall of the physics suite. The sign, which was built by a physics student in the 1970s has received a facelift, was refilled with neon and got a new frame, so it could be placed on a permanent display. You can see the pictures of the sign on our Facebook page.

The active work of the McMurry Chapter of the Society of Physics Students (SPS) in recent years and its wiliness to serve the university community was recognized in April, by naming our SPS the "Outstanding McMurry Student Academic Organization of the Year". Our congratulations to Taylor Freehauf and Kent Grimes for their outstanding work as SPS president and vice-president this year. In addition, Dr. Bykov was named an "Outstanding McMurry Student Advisor of the Year".

Last, but not least, we would like to congratulate Dr. Keith on being promoted to the rank of full professor starting next fall.

These were just some of the many events we had during 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 our web site is located 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