GUSTAVUS PHYSICS

Physics Department Newsletter

September 2018

Inside this issue:

Summer Internships	2
Research in Germany	4
2018 Graduates	6
An Honors Degree	8
Sigma Pi Sigma	9
Department Awards	10
SPS Activities	12

Important Fall Dates:

Classes Begin	Sept. 4
Last Day to Register for Fall Classes	Sept. 17
Nobel Conference	Oct. 2-3
January Term Registration Begins	Oct. 29
Spring Semester Registration Begins	Nov. 5
Final Exams Begin	Dec. 17

Research Experiences as a Part of the Gustavus Physics Program

There are many reasons to include explicit research experiences in an undergraduate physics major, whether or not they officially "count" toward the academic degree. Gustavus encourages and provides such experiences in a number of distinct ways.

Why would a student want to undertake a research experience in addition to all of the rigorous, academic coursework required for a physics major? Is it to enhance a personal CV/resume for potential employers or graduate schools? Or is it because that student has an individual passion to conduct research in a particular area of physics? Or, might it be an opportunity to try out a potential career in a particular branch of physics or engineering to see if, indeed, they want that area to be a part of their future? Or, perhaps, could it be for the purpose of living and working for an extended time in an actual graduate school or industrial environment, again, to decide if they want to pursue post-graduate plans in that direction? Is it a chance to "get a foot in the door" with a potential employer? Could it be about earning money to help pay for the next school year?

A potential answer to each of these questions is "yes." And, precisely because personal motivations to undertake physics-related research are so varied, the kinds of such experiences that are made available to our students must be diverse in terms of their level of engagement, time duration, and in their connections with the curriculum in our physics major.

On subsequent pages you will find examples of students who were involved this past year in research experiences both on and off-campus, during the academic terms or in the summer, both domestically and abroad, for academic credit or not, in engineering , physics, and a breadth of other disciplines. This diversity represents the kinds of experiences that our students have every year, and which we hope helps to prepare each of them, individually, for life and career tracks after Gustavus. One hallmark of our entire physics program is that it has never been "one size fits all."

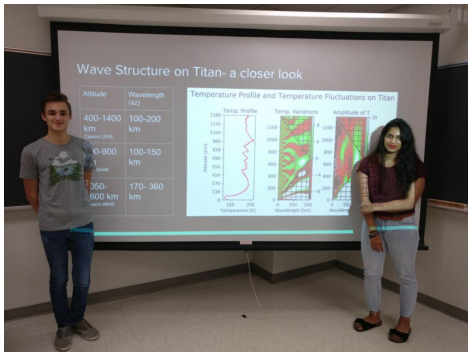
Summer 2018 Internship Experiences

During this past summer, more than a dozen of our physics majors were involved in a summer research internship of one kind or another. Many of them have written to share their experiences and, taken together, they paint a picture of the breadth of such experiences that are available to qualified students, from first-year's to graduating seniors.

Positions in these summer programs are highly competitive and so, in addition to strong, personal motivation, the students who qualify are generally academically strong performers in our major. A student's GPA (especially in physics courses), their ability to write a compelling and coherent application essay, and the fact that their work has earned strong recommendation letters from their professors, all play roles in their qualifications for an internship.

This summer **Vatsala Adile '20** (Gustavus Facuty/Student Presidential Scholarship Grant) and **Espen Fredrick '21** (Gustavus First Year Research Experience Grant) worked with **Dr. Darsa Donelan** as research assistants on her project about Detection of Atmospheric Gravity Waves through Wavelet Analysis.

They write, "We used an analysis technique to study wave structures in planetary atmospheres (Venus, Mars and Titan). We learned how to use Python code to analyze the existing data and extract information out of it."



Espen and Vatsala present results of their models of Titan's atmosphere.

Matthew riding a Polaris vehicle

Matthew Blomquist '19 says, "This is my second year interning at Polaris in Wyoming, MN, and I am working with the Wyoming Powertrain Component Testing Team. This is a very technical and hands-on internship, and I have enjoyed it very much! My team tests and completes test requests that different engineers in the company may have to test quality, strength, etc. of both on-road and off-road engines and transmissions.

"My tasks vary day to day depending on what testing needs to be done, but I do a lot of fuji paper tests to measure bolted joint pressures, load testing to measure strength of components, leak testing to ensure seal quality of different areas, and I help run the dynamometers to measure power and endurance of engines and engine components.

"The site that I work at is the newest Polaris facility made, with around 600 employees total. Around 400 of these are engineers, so I am able to work with and see all kinds of different engineering careers and what they do day to day."

Katy Hagen '19 writes, "I worked this summer in Indiana University's Physics REU program with Dr. John Beggs on directionality in neural networks.

"The Beggs lab uses novel technology consisting of a 512 microelectrode array that records electrical activity from slices of rat cortical tissue. The tissue, despite not being in an animal, is still alive and shows spontaneous bursts of electricity known as avalanches that propagate through the neural network. The microelectrode array has both the spatial and temporal resolution to show exactly how this electricity travels. We use transfer entropy, a value in statistical physics, to predict connections between neurons in the network.

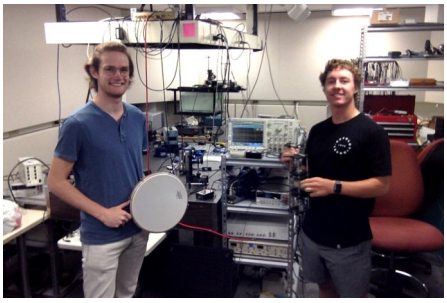
Katy and her fellow REU students from Indiana University visit the Fermilab National Accelerator

"My specific project examined directionality in connectivity space, meaning I only looked at electrical activity, or information flow, in valid connections. Using MATLAB, I sorted the

(Continued on page 3)

(Continued from page 2)
neurons in each network by physical parameters (such as the number of connections each neuron had) and looked for changes in the patterns of information flow throughout the course of avalanches."

Zeke Haugen '20 and **Bobby Nelson '19** spent the summer working under the auspices of a National Science Foundation Research at Undergraduate Institutions grant in **Dr. Tom Huber's** acoustics lab at Gustavus, which specializes in ultrasound research. Their work was to study how sound waves propagate off various surfaces using tomographic methods and ultimately studying alternative methods to diagnose osteoporosis using heel bone samples. They write that they spent their time "streamlining data analysis, and writing code to improve tomography videos of heel bones and other objects." They point out that: "The scanning vibrometer we use costs over $300,000!"



Bobby and Zeke in the ultrasound lab

Clark Hickman '18 says, "I spent the summer in Menlo Park, CA at the SLAC National Accelerator Laboratory as an intern. While there, I learned the basics of accelerator physics and x-ray FELs (free-electron lasers), the latter of which is currently the purpose of SLACs main, kilometer-long, accelerator. "My project consisted of learning about a unique toolkit for radiation simulation, TOPAS, and then writing code in it to be used to quantify and optimize the radiation from a variety of linac geometries."

Shelby at BYU

Shelby Klomp '20 writes, "I am doing an REU program this summer in the Physics Department at Brigham Young University in Utah. I have been working with Dr. Karine Chesnel on a project fabricating and characterizing magnetite nanoparticles. I have gotten to spend time in a chemistry lab creating batches of nanoparticles, as well as in several other labs imaging the nanoparticles and taking measurements of their magnetic properties. I have gotten to work with equipment such as a Transmission Electron Microscope and a Vibrating Sample Magnetometer. It's a really great program because I have gotten to do lots of sightseeing across Utah with the other REU students and our program directors, and the community in Provo has been extremely welcoming. "

Andrew LaGrange '19 writes, "I've spent the summer learning about precision machining at CNH Machine in Anoka, MN. The first half of my time there was spent learning how to properly inspect parts as a part of quality control. As I was told, 'You can't make good parts if you can't check them.' This included learning how to use: a variety of sizes and types of micrometers, calipers, radius gauges, optical comparators, surface profilometers, pin gauges and more. I also learned more about print reading and how the machinery works, while inspecting parts going out to customers or to outside servicing (parts being sent to plating, tumbling, grinding, and so on). In the second part, I began learning the operation of the CNC lathes and Swiss turning machines. This involved learning how to change out tooling, make offsets to keep parts in tolerance with the prints as tools wear down, and load material into the machines. I've also learned other types of machine and tool maintenance, as well as other shop operations."

Dalton Myers '19 says, " I'm working at IRD Ceramics in Alexandria as an engineering intern. It's a manufacturing place that makes customized ceramic and optical/structural sapphire components for a variety of companies and for the Department of Defense (which is about 35% of our business). It's a very small subsidiary (~12 people) of the larger IRD Glass in Litchfield, so I've had to be a team player in a lot of small projects. I do maintenance on interferometry equipment used for measuring surface quality of polished sapphire components. My main role (and the reason that I was hired) was to work on process improvement for the optical sapphire lap/polish process. I work with a machine that uses different pads, plates, and slurries to surface qualities with average irregu-

(Continued on page 5)

Junior Physics Major Spends the Spring in Germany

Xiaoqi Yu '19 spent the spring semester in a research/study-aboard program at the University of Munich. She wrote to reflect on her experiences in Germany:

"I took a German class with other exchange and visiting students during March, but unfortunately I haven't really spoken German since April. There're only 3 Germans out of 20 people in my research group (physical cosmology). It's really international in here: the director is from Japan; another senior staff is German. We have people from Europe (Western and Eastern), the Middle East, Asia, and South America.

"In term of physics, I worked on the cosmological dependence of the power spectrum responses. The large scale structure of the universe (LSS) refers to the large scale distribution of matter and structure in the universe. We can use the statistical information in the LSS to extract cosmological information about the universe. However, the higher-order statistics are hard to measure, and the power spectrum responses, which are measured with second order statistics, are a way to approximate higher-order statistics with reduced computational complexity. Cosmologists have been using the responses in the past by neglecting their dependence on different cosmological parameters. So, the goal of my project is to determine whether such dependence is a concern when taking the response approach. I ran three sets of 15 separate universe simulations with different density parameters, and measured their responses to the first order. What I found is that the first order response does depend on cosmology, but it only varies by 3% from the existing Planck satellite observations. (That is based on the assumption that our universe follows the LambdaCDM model). However, we are even not sure yet if the universe obeys the LambdaCDM, so 3% is negligible.

"Even though the work I did won't result in any publication (and the goal of undergraduate research is not to get publications anyway), it is a great experience to know more about the field, and I definitely learned more about how to do physics, and the way I should approach it. (Physics is not just coding and solving homework problems or homework-like problems in research.) ☺

"European education is pretty pragmatic and egalitarian. Universities are free, and entrance depends only on academic performance. They divide their tracks for education usually at the age of 10-15 based on academic performance; less than half of the kids go to academic high school. For those who want to learn physics and engineering in university, general physics with calculus is taught in high school, along with philosophy and humanities subjects. During the three-year-bachelor's program in Germany, it's normal that 80% of the students fail the first year of classes. Students are expected to survive on their own, but won't be kicked out of the program; they can try the exams and courses as many times as they want if they really want to do physics. Education is almost free, and one can opt to not show failing grades on their transcript.

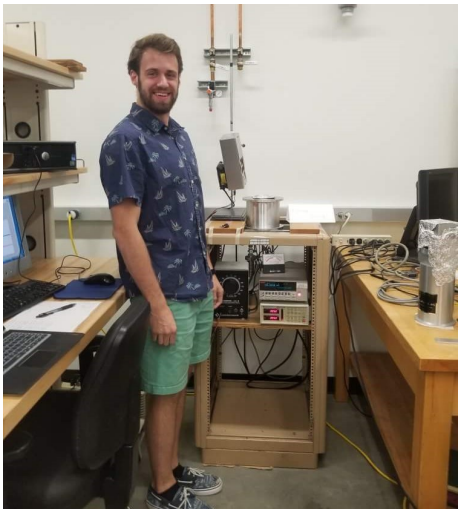
"The American education system in private universities and liberal-arts colleges is good in terms of cultivating interests and caring for students at a personal level, but it's also expensive and inaccessible for normal citizens. The European system, as well as the Chinese system, require a lot more independence and self-motivation on the part of the students. Students are responsible to find out what they want in life and what fits them the best on their own. Fortunately I have experienced both systems, so I brought my independence into the US system, which cares more about students at a personal level, and that results in maximum benefits for me personally. Researchers are mostly self-motivated learners; I found people in my research group to be very 'liberal arts' without a liberal-arts education in school. I realized that for people living in the US, a liberal arts education is actually necessary for them. The social and cultural environment in the US has a pretty narrow focus, so students don't really have chance to experience, to travel, and to cultivate a liberal-arts mind outside of school.

"Overall, my time here was rewarding and relaxing. It's the only semester that I never worked on weekends. I usually hike in the Alps or go to the lakes then. I definitely want to live here again in the future."

Student Summer Research Internships

(Continued from page 3)
larity heights on the order of the wavelengths of light we use to detect them (HeNe laser). I have finished my proposal to the company to turn the 3-step process (lap, mechanical polish, chemical polish) into a 4-step process (lap, surface grind, mechanical polish, chemical polish) which will, hopefully, significantly shorten polishing times, which are ~10 hours each for $7,000 worth of product, and should reduce final parts that have to be scrapped due to failing inspection. Many of the parts we make are on a need-to-know basis as to their uses, but one of the sapphire windows we make which is 1.75mm in diameter and 1mm in height is used in a weapon sight made by BAE systems. We also make an optical sapphire component used by Seagate in some of their hard drives as well as the optical window used on Tomahawk missiles for their optical guidance. The machines we used for the process are made by a French company (SOMOS), cost about $150,000 each, and the two that we have were the first two in the US."

Hannah Nolte '19 says, "I was working at Gustavus Adolphus College in the psychological science department. My advisor was Dr. Lauren Hecht. I was involved in her olfaction and attention project. She is studying how essential oils, mainly peppermint and lavender, affect attention in an attention task. My role was characterizing how the homemade olfactometer worked using the mass spectrometer in the chemistry department. One interesting aspect of my project was how it was interdisciplinary between psychology, chemistry, and physics."



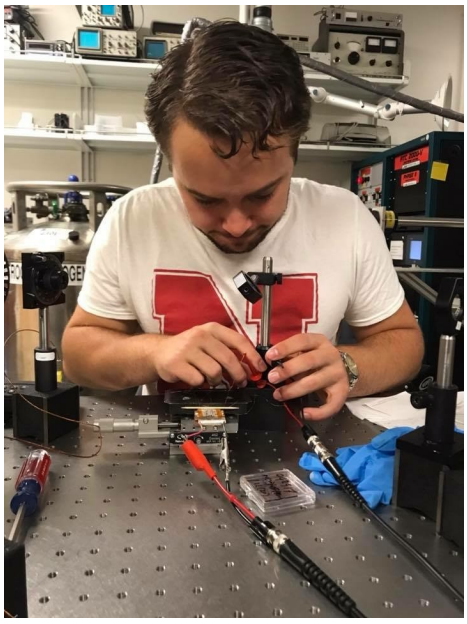
Ben in the lab at the University of Minnesota

Ben Rorem '19 writes, "I'm working for the University of Minnesota's physics REU program. I am a part of a condensed-matter, applied-physics lab and have two solo projects that deal with semiconductor-nanocrystal electrical conduction.

"The Physics Department is split between two buildings. I work in the Physics and Nanotechnology building, which houses mostly applied physics professors and labs. Throughout the summer, we've heard presentations from various faculty, both theoretical and applied. Dr. Jim Kakalios, my advisor, is not only an expert in semiconductor physics, but is also the well-known author of *The Physics of Superheroes*."

Karl Satterlund '19 says, "I have spent my summer conducting research in the nanotechnology program at the University of Nebraska, Lincoln sponsored by a National Science Foundation Research Experience for Undergraduates (REU) grant. My lab group fabricates and characterizes multilayer, multiferroic thin films on the order of less than 50 nanometers. The magnetoelectric properties of each sample are studied using a variety of techniques, primarily with the magneto-optic Kerr effect (MOKE) which detects rotation of the polarization plane of incident light, and the pyroelectric effect which measures current across the layers of a sample induced by small changes in temperature from a chopped laser. My particular project was in fabricating a sample of chromium, vinylidene fluoride (VDF), cobalt, and chromium.

"There is more to Nebraska than just corn. The historic downtown areas of Lincoln and Omaha have a multitude of great shops and food. The zoo in Omaha is fantastic, and I even got to watch one of the games at the College World Series. The REU program provided a lot of opportunities to spice up any down time that we had outside of lab. It was an incredible experience that got me to think critically about graduate school and research as a whole."



Karl in the Nanotechnology Lab at the University of Nebraska

The Physics Graduates of 2018

The graduating class of 2018 and physics faculty members posed for this photo at the Observatory platform on the roof of Olin Hall. (L to R) Dr. Darsa Donelan, Dr. Steve Mellema, Dr. Brianna Dillon Thomas, Dr. Jessie Petricka, Eli Sontag, Dr. Chuck Niederriter, Josh Weisenfeld, Saad Tariq, Elise LeBoulicaut, Dr. Paul Saulnier, Kelly Neubauer, Hailey Nelson, Ryan Sullivan, Patrick Neri, Kevin Treb, Clark Hickman, Travis Boskowitz, Sean Jordan, Ryan O'Neil and Matt Mehrkens. In the background is the crane marking the construction and of the new, $70-million, Nobel Hall of Science.

Fifteen Gustie physics majors walked across the stage at the Commencement exercises held on Saturday, June 2. Their immediate post-graduation plans are varied, and a number of them have provided those, along with their observations and advice for future physics majors.

Scott Eischens says, "I have started working full time at CommScope in Shakopee (where I interned last summer) as a Development Engineer.

"My experience at Gustavus was incredible, I would not have wanted to go to school anywhere else. The people that I met and connected with through the physics major and Gustavus as a whole will be bonds that will last a lifetime.

"I have two pieces of advice for the current physics students:

"1) Lean on each other for help with homework and studying; it makes the suffering much more bearable when it is shared!

"2) Utilize the opportunities that are presented by the professors for internships and summer research. Having a personal connection to wherever you are applying helps a ton in the application process. It is all about the connections that you can make that go a long way towards getting into grad schools or landing a full-time job, as my internship did."

Clark Hickman writes, "I have just moved to Raleigh, NC to begin graduate school at North Carolina State University this fall, where I hope to do research in Nuclear & Particle Physics once I've completed my courses."

Sean Jordan says, "My current plans after graduation are to work for the summer and join the Air Force in the fall."

Elise LeBoulicaut contributed the following: "When arriving at Gustavus, I had no idea I would develop such a passion for physics. At first, it was the welcoming and friendly atmosphere of the physics department that got me interested, but as I advanced though the classes, I became more and more fascinated with the topics. Now, I could not imagine myself doing anything other than physics (at least in the near future). I am planning on obtaining a Ph.D. from Duke University, hopefully studying particle physics. My goal would be to work on a project at CERN in Geneva, Switzerland and

(Continued on page 7)

(Continued from page 6)
spend some time there during and after graduate school. Long term, I think I would like to do research and teach, but I have no definite plans for the moment. The most important advice I can give to other students would be to get to know your professors and your fellow physics majors, especially upperclassmen. They can help you with homework, random physics questions and also life questions! Make use of the tutors (they get bored otherwise!) and work in groups (as long as you are still being productive)."

Matt Mehrkens wrote, "Memories: Endless hours in Olin, but it always felt more like my home than my dorm did. Research with Ben in Tom's lab and with Grace-e in Jessie's lab. Dodgeball vs. Chem Club and Ultimate vs. MCS. Learning tons in my Physics Classes.

"Future Plans: Currently I'm working through my second month at Epic (a healthcare information software company in Madison, WI). I'm part of the technical services team working with the Radiology application. Long term is still a bit fuzzy, but I wouldn't mind returning to graduate school, probably for a masters in Electrical/Computer or Acoustical Engineering.

"Words of Wisdom: Never shy away from an opportunity to work hard, you won't regret it in the end. Get to know your professors, they are a wonderful resource when you need help and are all really nice people! Get involved with SPS, it's a fun way to get to know the other people in the major, and upper class students are often another great resource for help. It's cliché, but your four years really do go fast; enjoy every minute of it.."

Hailey Nelson (Physics Teaching Major) says, "My experience at GAC was what you hope for in college. I was challenged in my academics and in personal life, and came out stronger. I made life-long friends, fantastic relationships, and learned how to help my community. I am starting my first year teaching high school physics at Forest Lake Area Senior High, and recently acquired a rescue dog while doing mission work in Blackfeet Nation, Montana. The only words of wisdom I have to offer new physics students are these: Don't forget to live a balanced life - get out of Olin and see a play by the theater department, play Gustie golf, or hang out with friends for an hour. Then go back to your homework with a new perspective and try to solve the last two problems that none of your friends have figured out yet."

Kelly Neubauer writes, "I loved my time at Gustavus. I got to take incredible classes, learn from great professors, meet wonderful peers, and have life-changing experiences across campus and beyond the hill. I appreciate the supportive and inclusive environment in which I could study physics at a high level while developing complementary skills and interests in other subjects and activities.

"I am beginning a physics Ph.D. program at Rice University in Houston, Texas. I plan on working in one of the experimental condensed matter groups at Rice and to study the magnetic structure and novel behavior of various materials in conditions such as high field, high pressure, and low temperature.

"I would encourage students to thoroughly partake in the liberal arts experience. Take classes from departments all across campus, study abroad, and support the arts. Don't limit your curiosities and passions."

Ryan O'Neil is a Server Systems Engineer with Epic Systems in Madison, Wisconsin.

Eli Sontag is pursuing a Master of Arts in teaching degree at Hamline University. He writes, "My future plans are to get married, finish a masters degree in teaching physics and math at Hamline, and live in Greece with my future wife! One piece of advice I'd give is to be intentional about spending time with your fellow physics classmates."

Ryan Sullivan is in the physics Ph.D. program at Wake Forest University in Winston-Salem, North Carolina.

Kevin Treb says, "This coming fall I will be a Ph.D. student in the Medical Physics department at the University of Wisconsin, Madison working in the CT imaging group. My advice to other students is to talk with professors as soon as possible to learn about research opportunities both at Gustavus and elsewhere. They're some of the most valuable experiences you will get and will open doors for you in the future."

Josh Weisenfeld has entered the Cardozo School of Law at Yeshiva University in New York City, with plans to pursue a career in intellectual property and information law.

Achieving Departmental Honors in Physics

In addition to the regular major in physics, our department offers an Honors track containing additional requirements. In particular, the Honors major requires at least 1.0 course of research in physics plus the completion and defense of a senior thesis based upon the student's research.

Due to the additional work inherent in these requirements, the number of students who go on to achieve the honors major is quite small—less than one per year in our graduating classes, which average about 17 majors.

Nevertheless, the physics honors track is perfect for a student who has a real passion to do research in some particular area, and who can find the time in their already busy schedule to do both the research and the thesis writing. **Elise LeBoulicaut '18** had an internship at the CERN nuclear accelerator laboratory in Switzerland in the summer of 2017, and came away knowing that she wanted to go on to do graduate studies in experimental nuclear or particle physics. As a senior at Gustavus last year, she really wanted to pursue a project in that area. Combining her interests and skills with the interests and expertise of Gustavus' physics faculty, Elise undertook a project to design, build, and deploy a light-weight cosmic-ray muon detector that could be used on one of the department's high-altitude, helium-balloon flights.

Elise loading the detector into the payload box

Like all research projects, Elise's began with a review of available literature and a lot of background study to understand the physics of muon production in Earth's atmosphere, as well as muon detection. (Cosmic-ray muons are relatively light, charged particles which are very energetic and pass easily through matter.)

Elise and her research partner, **Josh Weisenfeld '18**, working with faculty members **Chuck Niederriter** and **Steve Mellema**, modified the design of a detector originally published by a group at MIT, in order to incorporate a coincidence between signals coming from two detectors stacked vertically. (That is the specific signature of a muon, as opposed to some other forms of cosmic radiation.)

Josh and Elise each took a full-course Independent Study course of research (Elise in January term, Josh in Spring Semester) in order to design, construct, and test the new muon detector assembly. During the construction, Josh became our local expert on surface-mount soldering—a very delicate task that is necessary when constructing electronics of the smallest possible size and weight.

Once the detector was constructed and tested in the lab, a high-altitude balloon flight was scheduled for April 27, in order to take real atmospheric data. The ultimate goal of the study is to map the presence of muons as a function of altitude. The theories of muon production predict a peak in the number of muons (the so-called Pfotzer maximum) at an altitude of around 60,000 feet.

Josh and Elise prepare the balloon for launch

Our balloons usually achieve a final altitude of around 90,000 feet before bursting and returning by parachute. For reasons that are still unknown, this payload box separated from its balloon, parachute, and GPS tracker during the ascent (at an altitude of about 33,000 feet) and plummeted to Earth. After several days of searching the payload was eventually recovered and some limited data obtained. Future flights providing more data and analysis will be needed to create the map of the muon flux as a function of altitude. But, that is precisely how scientific research moves forward—step-by-step, sometimes in unpredictable ways, building upon previous efforts.

Elise's Honors Thesis (some 41 pages long) detailing muon/detection theory, detector construction (both hardware and software), analysis, and results, is available to guide the next students who will work on this project. Just as important, it provided her with a springboard to her graduate studies in nuclear and particle physics at Duke University.

National Physics Honor Society

At the annual banquet held on May 5, nine Gustavus seniors from the class of 2018 were inducted into our chapter of Sigma Pi Sigma, the national physics honor society. The speaker for the occasion was **Dr. Dan Mellema '11**, himself a Gustavus ΣΠΣ member. Pictured above (L to R) are **Ryan O'Neil, Eli Sontag, Kelly Neubauer, Dan Mellema, Elise LeBoulicaut, Kevin Treb, Clark Hickman, Ryan Sullivan and Matt Mehrkens**. (**Hailey Nelson** was unable to attend.)

ΣΠΣ is a member of the American Institute of Physics and "exists to honor outstanding scholarship in physics; to encourage interest in physics among students at all levels; to promote an attitude of service of its members towards their fellow students, colleagues, and the public; to provide a fellowship of persons who have excelled in physics."

At Gustavus, election to membership in the Sigma Pi Sigma chapter requires a minimum 3.0 physics GPA, involvement in the Society of Physics Students, and nomination by two different professors. In addition, each nominee must have fulfilled the requirements for at least one of three induction tracks: academic, research or departmental service.

Dan Mellema received his Ph.D. in Biomedical Engineering and Physiology from the Mayo Clinic Graduate School of Biomedical Sciences. His talk, entitled "Shaking Things Up: Developing a new method to monitor liver fibrosis," explained the science behind his Ph.D. thesis project. That work involved the creation of a novel probe which, when attached to an ordinary ultrasound imaging machine, creates a mechanical vibration of the tissue while simultaneously passing ultrasound waves through it. That combination allows for an accurate determination of the rigidity of the patient's liver tissue—an important diagnostic in cases of advanced liver disease.

He also described to our students the cycle of ups and downs in the life of a graduate-school researcher. In particular, after presenting the successful, final results of the unique combination of hardware and software that he had created to measure liver fibrosis, he emphasized the almost two-year struggle, in the middle of that project, that consisted of much trial and error and involved many failures of other approaches to the problem.

Dan concluded with advice to the students about how to consider what they want to pursue in graduate school, and when and where to do it. Perhaps most importantly, he advised that they be continuously thinking about what they want to do <u>after</u> graduate school, and let that shape their graduate studies.

Student Awards

Each year the Physics Department presents a number of awards to student majors who have distinguished themselves through academics, research, and service to the department.

The 2018-2019 Milward T. Rodine Award in Physics was presented to **Matthew Blomquist '19**. This prize is named for the longtime Gustavus professor of physics (he taught here from 1933-1969) and is awarded annually to a rising senior physics major on the basis of interests and scholarly achievements.

This year's winner of the John Borneman Prize Par Excellence in Mathematics is **Bobby Nelson '19**. This prize is decided by the Department of Mathematics, Computer Science and Statistics in consultation with the physics faculty, and was designated in memory of John Borneman '55 by his family. It is presented annually to an outstanding student in the fields of mathematics and physics.

Xiaoqi Yu '19 was awarded the John Chindvall Scholarship in Physics for the 2018-2019 academic year. This endowed scholarship was established in memory of 1970 Gustavus graduate John Chindvall by his parents and friends. It is awarded annually to a student majoring in physics.

Benjamin Rorem '19 is the recipient of the Gerald and Julia Swanson Scholarship in Physics for the 2018-2019 academic year. This scholarship was established to honor the work of the physics department faculty who provided Gerald Swanson with a background that prepared him for graduate study in physics and for a career with the Bendix Corporation. The scholarship is to encourage physics students of promise who are enrolled at the College.

The 2018-2019 Julian A. Crawford Memorial Prize was presented to **Hannah Nolte '19**. This prize is named in memory of the former chair of the Gustavus Physics Department (1967-69). It is awarded to a good student who has been active within the department and who has the potential to well represent physics to the larger society.

Kyle Krippner '21 and **Kate McGregor '21** are co-winners of the Harold Q. Fuller and Richard M. Fuller Memorial Award in Physics this year. This award is given to a first-year student majoring in physics who has compiled the highest overall grade record in the physics course sequence. This award was established in 1997 by Professor Emeritus Richard M. Fuller (who taught at Gustavus from 1968-1999) and his wife, Judith. The award honors Richard's late father "HQ", a researcher in the Manhattan Project and physics professor and dean at the University of Missouri, Rolla, for his lifetime commitment to the teaching of young people. It also reflects Dick Fuller's own outstanding 31-year career teaching physics at Gustavus.

For the upcoming academic year, the department has designated **Tyler Brau '19** and **Karl Satterlund '19** as the Physics Academic Assistants for Fall 2018, and **Ethan Henneman '19** and **Daniel Nold '19** as Physics Academic Assistants for Spring 2019. These positions, offered to students who have displayed both academic prowess and dedication to the physics department, come with a small stipend and carry the expectation of additional work in research, course development or other activities that will assist in the work of the department.

In a similar capacity, physics major **Katy Hagen '19** has been named a Fall 2018 Department Assistant in the Neuroscience Program.

National Awards for Two Gustie Physics Majors

On March 16 it was announced that two Gustavus physics majors had won 2018-2019 scholarships from the Thomas D. Rossing Fund for Physics Education. **Xiaoqi Yu '19** won a $10,000 Rossing Physics Scholar Award, and **Ezekiel Haugen '20** won a $5,000 award.

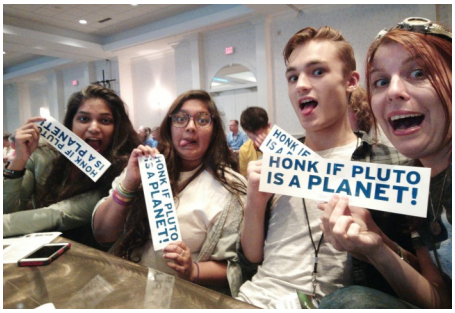
The awards, given annually for exemplary students in physics, are made possible through generous gifts from Dr. Thomas D. Rossing who created the fund through the Foundation of the Evangelical Lutheran Church in America.

This marks the sixth consecutive year that one or more Gustie physics majors have won a Rossing Scholarship. Congratulations to Xiaoqi (pictured in the story on page 4) and Zeke!

Zeke Haugen '20

Faculty Happenings

Darsa Donelan writes, "This summer I did research with physics majors **Vatsala Adile '20** (Presidential grant) and **Espen Fredrick '21** (FYRE grant) on using a Morlet wavelet-analysis technique to study gravity waves in planetary atmospheres. I also attended/participated in six different conferences and workshops including the AAPT New Faculty Workshop where I was a speaker for a session on a Faculty Online Learning Community (FOLC) for early career physics and astronomy faculty members across the United States. I will be facilitating a FOLC cohort this academic year. I also attended ALCON (Astronomical League Convention) with Vatsala, Espen, and **Tasnim Lamisa '19**. While there, we networked with and are now members of the Night Sky Network. We also met and had conversations with the bad astronomer himself, Phil Plait (PBS – Crash Course Astronomy) and Citizen Science director, Pamela Gay. This academic year I will be continuing a collaboration with Jessica Imholte (Chemistry) and former physics visiting assistant professor Dan Young on a Scholarship of Teaching and Learning project funded by the Kendall Center. We are developing supplemental lab videos, and will be assessing their effectiveness."



Vatsala, Tasnim, Espen and Darsa at ALCON

Tom Huber is making a transition from a sabbatical last spring to being department chair. This summer he had NSF funding to allow him to collaborate with **Bobby Nelson '19** and **Zeke Haugen '20** on ultrasound and acoustics research. This was the second year of a three-year grant funded by the National Science Foundation. One major focus of the sabbatical and summer research was to develop algorithms for doing tomographic reconstruction of the traveling ultrasonic waves in 3D using our optical measurement technique. Tom wrtites, "Similar to how a CAT (Computer Aided Tomography) medical imaging takes x-ray images at many different angular projections to build up a 3D image, we rotate the target and scan with the laser to build up 3D images of traveling ultrasonic fields. Another major research focus involved developing algorithms for using machine learning for noise reduction of ultrasound signals. We use a training set to teach a deep learning convolution neural network so the system "learns" what ultrasound pulses look like; the program can then use this system to extract ultrasound pulses from a noisy background."

Steve Mellema and his wife, Shirley, spent a little more than two weeks visiting Spain in late June and early July. This fall Steve will teach First Term Seminar and Quantum Mechanics—the two bookends of the department's fall curriculum. And, this year he will serve on the Faculty Senate, the Faculty Compensation Committee, the College Internal Budget Committee, the Retirement Subcommittee of the Employee Compensation Committee, the Board of Trustees Marketing and Communication Committee.

It was a different summer for **Chuck Niederriter**. He spent most of it in Rochester, Minnesota, with his wife, Debbie who had a stem-cell transplant. While they lived in Rochester, Chuck worked on his FTS and other projects, rode many of the bike trails and visited most of the parks in the area. Before moving to Rochester, Chuck and Debbie spent a long weekend in Door County, Wisconsin, with daughter Gretchen. They did make their annual summer trip to Pennsylvania in August, but it was necessarily short. Chuck is looking forward to a year of not being chair of anything and spending more time doing research with students.

Jessie Petricka spent most of the summer traveling and tent camping with his family. In the process, he drove to all three coasts (NC, CA and U.P. of Mich), decided enough was enough, and bought a used minivan. He also visited 10 national parks, hiked his tallest peak ever (Lassen Peak, CA), bested that two days later (Wheeler Peak, NV), and managed (barely) to avoid all the wildfires out west. In the fall, Jessie will teach a new course (for him) Math Methods, and return to teaching Thermal/Senior Seminar.

Paul Saulnier will be teaching Electromagnetic Universe and Mechanics this fall. In the department, he will serve as the external speaker coordinator and pre-engineering advisor while outside of the department he serves on the faculty Personnel Committee.

Gustavus Society of Physics Students Garners Two Awards

Gustavus is home to one of the country's most active chapters of the Society of Physics Students (SPS).

Last October, Gustavus' SPS was selected by the American Institute of Physics as a 2016-17 Blake Lilly Prize recipient from . The award letter stated: "Your Chapter's outreach efforts and dedication to physics education has visibly made a difference in your community and the SPS National Office is proud to present you with this prestigious award."

Jared Zaun '21 and Josh Theis '20 demonstrate physics to children at the Science and Nature Camp

In December, SPS named Gustavus a 2016-2017 Distinguished Chapter. The award citation reads, "We are consistently amazed each year at how much time, energy, and effort everyone devotes to their department and local community."

SPS usually meets twice per week during the school year—once for a social activity (usually Friday afternoons) and once for a professional activity. The latter consist of guest speakers, student research seminars, outreach activities to local schools, community service, field trips, etc.

This year the SPS co-presidents are **Ben Rorem '19** and **Vatsala Adile '20**, the Treasurer is **Hannah Nolte '19**, the Communications Manager is **Karl Satterlund '19**, and the class representatives are **Matt Blomquist '19**, **Shelby Klomp '20** and **Josh Theis '20**, and **Kyle Krippner '21** and **Kate McGregor '21**.

SPS Highway Cleanup happens in the fall and spring

This year the group will take part in a new activity in high-powered rocketry as part of NASA's Minnesota Space Grant Consortium. The group plans a field trip to a rocket launch on Saturday, September 8, so sign up right away if you're interested.

Also, look for the opening SPS chapter meeting the following week.

National Prominence of the Gustavus Physics Program

In the latest data from the National Science Foundation Survey of Earned Doctorates, here is the ranking of top liberal-arts colleges as the baccalaureate origin of eventual physics Ph.D.'s over the past 20 years (1997-2016). The list includes all such schools that generated more than 30 eventual physics Ph.D.'s. (The total number of physics Ph.D.'s over 20 years is given in parenthesis after the name of each school.)

Harvey Mudd College (140)
Reed College (76)
Carleton College (67)
Swarthmore College (63)
Williams College (59)
Gustavus Adolphus College (50)
Lawrence College (40)
Haverford College (37)
Amherst College (36)
Grinnell College (36)
Oberlin College (35)
University of Puget Sound (30)
St. Olaf College (30)

Of course, the primary goal of the Gustavus physics major is not to produce physics Ph.D.'s. Our program aims to provide a strong foundation for a wide variety of post-graduate employment and advanced-degree options. (In fact, just as many of our graduates during these two decades went on to earn advanced degrees in engineering.) Nevertheless, we believe that these statistics are one reflection of the rigor and quality of our program.

This Newsletter is issued at the beginning of the fall semester for the benefit of students, alumni, faculty and others interested in the physics program.

Editor: Steve Mellema
Cover Photo courtesy of Chuck Niederriter and his DJI Phantom drone camera.

Physics Department
800 West College Avenue
St. Peter, MN 56082 USA
Phone: +1(507)933-7308
gustavus.edu/physics

@GAC_physics

gac_physics

GUSTAVUS
GUSTAVUS ADOLPHUS COLLEGE

MAKE YOUR LIFE **COUNT**™