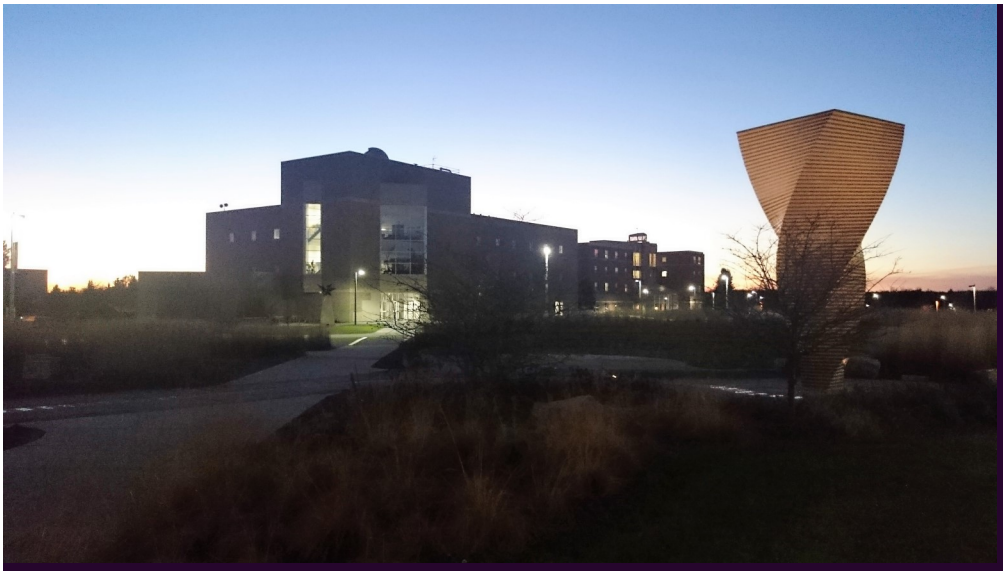


GUSTAVUS PHYSICS

Physics Department Newsletter September 2016

Inside this issue:

Important Fall Dates:

Classes Begin	Sept. 6
Last Day to Register for Fall Classes	Sept. 19
Nobel Conference	Sept. 27-28
January Term Registration Begins	Nov. 1
Spring Semester Registration Begins	Nov. 7
Final Exams Begin	Dec. 16

New NSF Grant Award for Research

In August, Tom Huber received word that he had been awarded a $200,000 grant from the National Science Foundation. This is a three-year grant "Detection of ultrasound waves in water and air using a laser interferometer." It is Tom's 11th grant from the NSF, with a total award amount of over $1.6 million. He has had NSF funding for Gustavus students every summer since 2006; the new grant will enable him and Gustavus students to investigate a unique method—using a laser to optically measure ultrasound instead of using a conventional ultrasound transducer. This technique allows full-field videos of traveling wavefronts. These measurements will not be susceptible to some of the artifacts observed when ultrasound is measured with conventional transducers. This technique will allow non-invasive, real-time monitoring and control of ultrasonic fields. In collaboration with researchers utilizing ultrasound for osteoporosis detection, this laser interferometric technique will enable novel measurements related to ultrasound wave propagation in bone. Interferometric measurements of ultrasonic fields will be used to investigate the fluid/structure interactions that lead to Mach shock formation when a wave pulse passes through an object. A strong outreach effort will use measured videos of acoustics fields to motivate secondary students to become interested in science and engineering. These videos will allow students to engage in topics such as how ultrasound imaging works, why shock waves produced by pile driving are of concern for marine life near construction sites, and how layering in the ocean is used for long-range communication by both the military and marine mammals. Gustavus students interested in acoustics, signal processing, and computer programming are encouraged to contact Tom about how to become engaged in this research.

Laser interferometric measurements showing the Mach shock wave cone emitted from a steel rod in water impacted by a short ultrasound pulse

Introducing the New Members of the Physics Department

2016 has brought two new members into our physics family on the 2nd floor of Olin Hall.

After the unexpected death of our Administrative Assistant Stacie Miller in January, **Laura Boomgaarden** was hired into that position. Laura started in March as the A.A. in both the Physics and MCS (Mathematics, Computer Science and Statistics) departments. Laura writes: "Having graduated from Gustavus, it is great to be back on campus. It's comforting to know my way around and there are many familiar faces.

"After graduating from Gustavus with an accounting degree, I worked in Minneapolis and Eden Prairie and obtained my MBA from the University of St. Thomas.

"My family consists of my husband Mark and our three daughters. They are very active participating in extracurricular activities so we spend most of our free time attending their events, watching Wild Hockey or the Minnesota Twins. I also love to travel.

Laura and her family

"We moved to St. Peter about ten years ago and it is the perfect fit for our family. It has a small town feel with great schools, and Gustavus offers many opportunities to the community. There is such a great energy within the Physics Department and the campus as a whole. The commitment to students by the professors is inspiring. Gustavus is a wonderful place to work."

Following the retirement of our long-time lab instructor, Jim Miller, we are very pleased to have hired **Dr. Darsa Donelan**, who joins us as Instructor of Physics beginning this fall.

Darsa grew up in Berkshire County, MA and attended Berkshire Community College (BCC) where she received an A.A. in Fine Arts and numerous awards for her artwork. She then attended the Massachusetts College of Liberal Arts (MCLA) where she graduated summa cum laude with a B.S. in Physics and a B.A. in Mathematics. As an undergraduate, she participated in several internships including breast cancer research at the Dana-Farber Cancer Institute, characterization of optical cavities for the Laser Interferometer Space Antenna (LISA) at the University of Florida, and developing analysis code to simulate data for the MINERvA detector at Fermilab.

Darsa then attended graduate school at the University of Florida (UF). In 2010, she received the Wayne Bomstad II Memorial Award for Teaching Assistants from the UF Department of Physics. In 2011, she received the Outstanding Teaching Assistant Award from the UF Graduate School. She was awarded the Scientific Teaching Summer Fellowship in 2013 from the UF-HHMI (Howard Hughes Medical Institute) Science for Life Program for her work in X-Lab, an accelerated and advanced inquiry-based interdisciplinary laboratory. While attending UF, Darsa initially worked on laser frequency stabilization for the LISA mission at NASA Goddard Space Flight Center, but her Ph.D. research focused on planetary atmospheres. She worked with Dr. Katia I. Matcheva to study the effects of atmospheric gravity waves in the atmosphere of Titan, finishing in 2016.

Darsa teaching a lab

Darsa enjoys attending science fiction conventions, dressing up as characters from Star Trek (especially the Borg), running marathons, and being the world's greatest Auntie. She has two cats, Miso and Congee.

Dorea Ruggles '06 Wins the Gustavus First Decade Award

During alumni/graduation weekend in May, Gustavus physics graduate **Dr. Dorea Ruggles '06** received the Gustavus Alumni Assocation's First Decade Award. She was introduced at the Alumni Awards Banquet by Dr. Florence Amamoto, of the Gustavus English Department. Here is an excerpt from her introduction:

Dorea shows off her award, accompanied by her parents, Professor Amamoto, her husband Joel, and her former academic advisor, Steve Mellema

"Dorea left Gustavus in 2006 for the prestigious Rensselaer Polytechnic Institute to pursue a degree in architectural acoustics, combining her love of Physics and Music. Becoming more interested in the neuroscience of auditory perception, she transferred to Boston University to do PhD work in biomedical engineering with an NSF Graduate Research Fellowship. With a predoctoral fellowship from the NIH, Dorea produced several papers, including two high-impact ones whose focus is captured in the title of one of them: 'Why middle-aged listeners have trouble hearing in everyday settings.' Her papers helped foster attention on what is now a major topic in her field known as 'hidden hearing loss.'

"PhD in hand, Dorea then moved to a postdoctoral position at the University of Minnesota. One part of her position was designing and building a new multi-sensory research laboratory used by auditory, vision, and kinesiology researchers from the entire university, which has been so successful, it has now expanded to a recognized center at the U: the Center for Advanced Translational Sensory Science (CATSS), which facilitates multi-sensory research and collaboration with industry. The position also allowed her to continue research using a novel EEG method to study complex perceptual mechanisms of the auditory system. She is currently a research associate at the U.

"While I was not surprised by how successful Dorea has been in this short time (there was more I could have said about her research and honors), I think the change in her career trajectory is telling. Dorea's interest in architectural acoustics spoke to her love of physics, music, and architecture, but her work in biomedical engineering, if anything, is even more interdisciplinary and has the potential to make people's lives better. When Dorea asked me to do this introduction she said it was because in her words: 'I'm most proud of the things that CII was foundational for: Being a strong, well-rounded person, being able to think critically about interdisciplinary topics, working hard but with perspective.' What I think that last phrase means is with an ethical as well as intellectual grounding and seeing her life as interconnected with others."

The First Decade award was established to recognize one male and one female for early professional achievement by graduates of the 10th anniversary class. Criteria appropriate to selection include the difficulty of accomplishment; quality, creativity, and distinctiveness of performance; recognition by professional peers; and lasting contribution to the world of ideas and affairs. As the tenth physics major to receive the First Decade Award in the past 21 years, Dorea joins previous physics alumni **Dr. Chad Olinger '85**, **Dr. Jim Wade '86**, **Dr. Annette Boman '88**, **Dr. Kirsten Tollefson Rockwell '92**, **Dr. Debbie Lightly Mascaro '96**, **Dr. Jason Smerdon '98**, **Dr. Brian Smith '00**, **Dr. Mike Bland '02** and **Dr. Kelly Younge '05**. The fact that physics majors make up only 2-3% of the average Gustavus graduating class and yet have won almost 25% of the First Decade Awards is an indicator of the strength of the physics program within the College for the past two decades.

Student Awards

As we do every year, the department is recognizing a number of returning majors with awards.

Mikaela Algren '17 is the winner of the Milward T. Rodine Memorial Physics Award. This prize is named for the longtime Gustavus professor of physics, who taught here from 1933-1969. It is awarded annually, on the basis of interests and scholarly achievements, to a physics major who has completed the junior year.

In consultation with the Physics Department, the Department of Mathematics, Computer Science and Statistics has chosen **Elise LeBoulicaut '18** as the winner of the John Borneman Prize Par Excellence in Mathematics. This award was designated in memory of John Borneman (a 1955 Gustavus graduate) by his family. It is presented annually to an outstanding student in the fields of mathematics and physics.

Nicholas Hulstrand '17 has received the Gerald and Julia Swanson Scholarship in Physics. This endowed 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 Bendix Corporation. The scholarship is intended to encourage physics students of promise who are enrolled full-time at the College.

Grace Kerber '17 was awarded the John Chindvall Scholarship in Physics. 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.

Ian McKeag '17 was selected as the winner of the Julian A. Crawford Memorial Prize in Physics. The prize is named in memory of the former chair (1967-69) of the Gustavus physics department and awarded to the student with "the greatest potential for contributing to physics and society."

Katy Hagen '19, **Daniel Nold '19** and **Ben Rorem '19** each received the Harold Q. Fuller Memorial Award in Physics, which is given to the first-year students (male and female) who have the highest overall record in physics courses. 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, physics professor and Dean at the University of Missouri, Rolla) for his lifetime commitment to the teaching of young people.

Joseph Satek '17, and **Matthew Merkens '18** each received a "Positive Derivative Award", as a physics major within their class who showed great improvement during the 2015-16 academic year.

Will Riihiluoma ('17) and **Jill Malecha ('17**) will serve as the Physics Departmental Assistants for Fall Semester 2016. These positions have a nominal expectation of four hours per week in research, course development or other activities that will assist in the work of the department.

Congratulations to all of these brilliant and hard-working students.

Students Win National Physics Scholarships

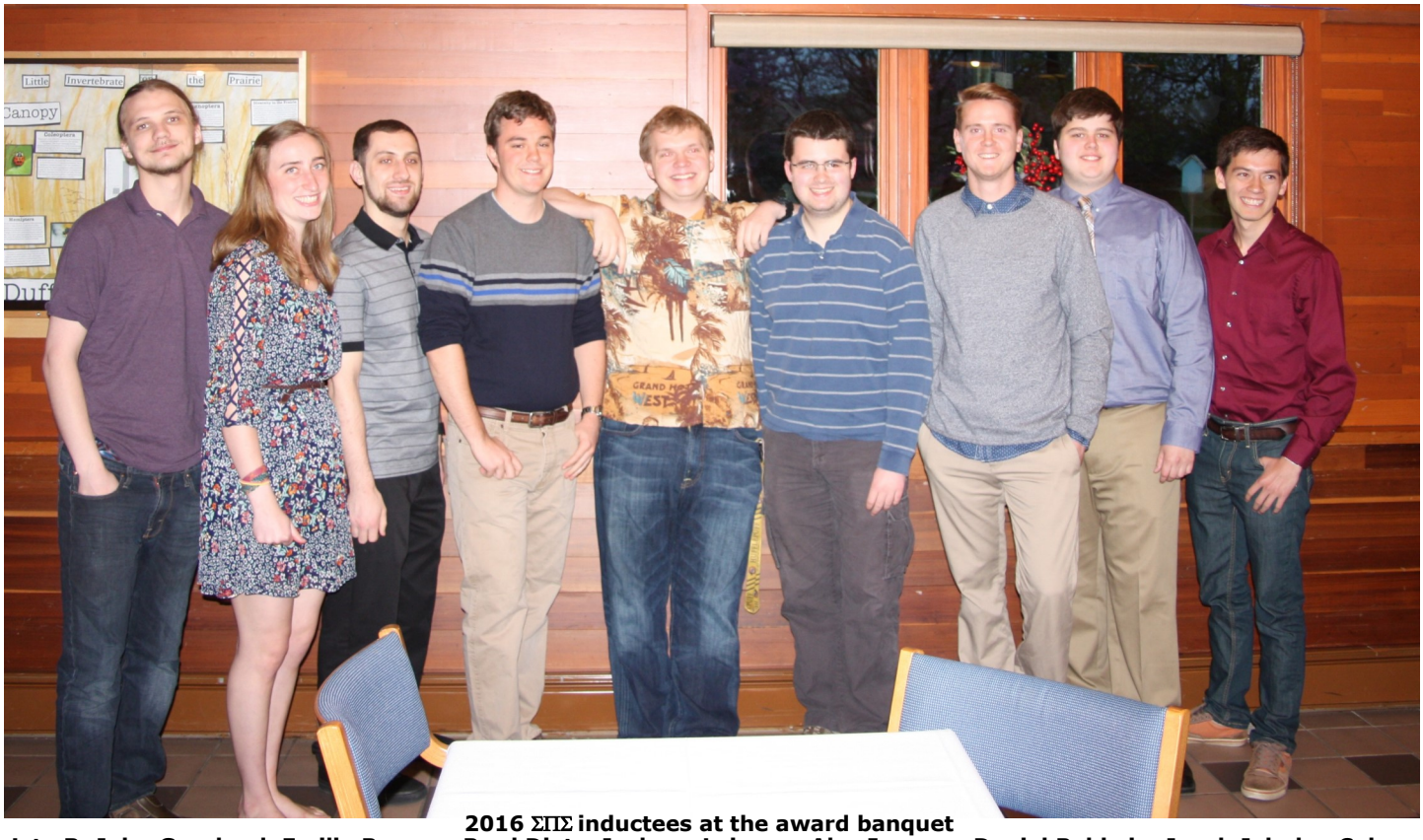
Senior physics majors **Nicholas Hulstrand '17**, **Grace Kerber '17**, and **Ian McKeag '17** have each received a 2016-2017 Rossing Physics Scholar Honorable Mention scholarship.

The Thomas D. Rossing Fund for Physics Education awards scholarships every year to exemplary students in physics at colleges and universities affiliated with the Evangelical Lutheran Church in America (ELCA). For the coming year, a total of three Rossing Physics Scholar $10,000 awards and eight Honorable Mention $5,000 awards were given nationally. Gustavus was the only school to have as many as three students win awards this year.

This summer, Nick is carrying out research in neutrino detection at Rensselaer Polytechnic Institute in New York, Grace is doing research with ultrafast lasers at the University of Colorado, and Ian is conducting research in ultrasonic acoustics with Dr. Tom Huber at Gustavus. (See more details in the article that begins on page 8.)

Congratulations to three very deserving seniors on these national physics awards!

Gustavus Sigma Pi Sigma Chapter Inducts Its 12th Class



2016 ΣΠΣ inductees at the award banquet
L to R: John Granlund, Emilie Benson, Brad Dietz, Jackson Laingen, Alec Iverson, Daniel Baldwin, Jacob Jahnke, Cole Raisbeck and Eric Wagner

Sigma Pi Sigma is the national physics honor society, and Gustavus has hosted a chapter since 2004. Nine seniors from the class of 2016 were inducted into the chapter in April.

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."

National Ranking of Liberal-Arts Physics Programs

The most recent versions of two annual lists comparing physics programs at undergraduate institutions indicate the strength of Gustavus' physics program in the national liberal-arts context.

The number of baccalaureate physics degrees per year (averaged from 2012-2014) as tabulated by the American Institute of Physics listed the top liberal arts colleges (and their average annual physics degrees) as:

St. Olaf College (29)
Reed College (23)
Carleton College (20)
Harvey Mudd College (19)
Bethel University (18)
Williams College (18)
Bowdoin College (17)
Gustavus Adolphus College (17)

The National Science Foundation list for the baccalaureate origins of physics PhD's gives the liberal arts colleges that were the top sources (with number of physics PhD's for the ten years from 2005-2014) as:

Harvey Mudd College (68)
Reed College (38)
Swarthmore College (33)
Carleton College (31)
Williams College (31)
Gustavus Adolphus College (23)
Lawrence University (21)
Amherst College (20)

The Physics Graduating Class of 2016

Back Row (L to R): Chuck Niederriter, Jessie Petricka, Tom Huber, Alec Iverson, Jacob Douglas, Alex Blixrud, Emilie Benson, Brody Ziegler, Jacob Jahnke, Jackson Laingen, Steve Mellema, John Granlund, Daniel Baldwin, Brittany Bice Front Row (L to R): Dan Young, Eric Wagner, Danny Kimlinger, Parker Gessner, Cole Raisbeck, Peter Hurd, Nathan Alverson, Adam Proue, Andy McRae, Brad Dietz

On May 29, 2016, the Gustavus graduating class contained 19 physics majors. This is the third largest class in our department's history, with the only larger ones coming in 2014 (23 majors) and 2015 (26 majors). A number of the graduates have offered information on their immediate future plans, as well as their advice for future physics graduates.

Emilie Benson writes, "After this summer I will be attending the University of Pennsylvania for a PhD in physics. That may be as big of a culture shock as moving to Japan (this past summer; see the article on page 8). I have been grateful for the things that I was able to learn while at Gustavus, especially the experiences outside of the classroom. The experiences that I got as a TA have been very valuable because they made me really learn the material to be able to pass the knowledge on to other people. No matter where I end up working, I am sure that teaching will be a part of it, evidenced by the amount that I have already taught this summer. Being able to interact with others at a different level than you, both the students and the professors, is a valuable skill. My biggest piece of advice to anyone, regardless of their major, is to soak up as many experiences as you can. You never know when they will come in handy, and at the very least you probably got to know someone better, which is great for networking."

Daniel Baldwin is attending graduate school in physics at the University of Wyoming.

Brittany Bice writes, "I am currently looking for internships and applying for graduate schools. I hope to go for electrical engineering, focusing on renewable energy and energy systems. Words of wisdom for students: they should try to catch a meteor shower on the roof of Olin with friends before they graduate."

Alex Blixrud is attending graduate school in Mechanical Engineering at the University of Minnesota.

Brad Dietz is attending graduate school in Electrical Engineering at the University of Notre Dame.

Jacob Douglas is attending graduate school in Mechanical Engineering at the University of Minnesota.

Parker Gessner is attending graduate school in Engineering at the University of Michigan.

Alec Iverson says, "My time at GAC was wonderful. I met so many awesome people and learned so many cool things, it was incredible! The Physics Department really is the best. My immediate plans are to go

(Continued on page 7)

(Continued from page 6)
to Colorado State University for graduate school in physics in pursuit of a PhD. After that, we'll see—something to put what I've learned to use. Make sure you enjoy your time at Gustavus, especially in the physics department. It's a special place that can help you achieve whatever you set your mind to, and you'll be supported on the way. Don't let the workload get you down, as physics is an extremely rewarding discipline."

Jacob Jahnke says, "My time at Gustavus was great. I met a lot of great people and learned about myself and the world around me. I participated in many groups on campus and that is what helped me develop so much. This fall I will be in a PhD program in Environmental Engineering at the University of Iowa. I hope to continue working with the environment when I am done, in an effort to limit human impact on our ecosystems. The things that helped me the most in Physics were: asking my professors questions; starting homework early; and working by myself and with others on problems. I practiced independence in figuring stuff out, but also working collaboratively with my peers."

Danny Kimlinger writes, "My future plans are to complete a two-year Masters of Engineering program at Iowa State University and become a mechanical engineer in the Midwest. Ideally, I would like to research and design the most efficient air conditioning, heating, sprinkler systems, and other building necessities using computer generated models. My words of wisdom to incoming students would be as follows: Find a study buddy or buddies. Finding time to study and complete homework was a search that fluctuated weekly, and the benefit of having close friends to work with and keep me motivated was essential to my success, especially in one of Gustavus's most challenging and accelerated majors. Don't be afraid to interact with peers if you don't understand material, and always remember; if any instrumentation in electronics lab fails to operate after lengthy inspection of all controls and components... make sure it's plugged in."

Jackson Laingen sends the following advice: "The most important thing I learned at Gustavus was to have a malleable brain. College courses, especially upper level physics, will challenge your default thinking patterns. There will be days when you won't believe a word the professor is saying, or you get lost in the derivation. There will be days when Tom shows that the answer is 42, but you found the answer to be zero. There will be other days when everything is crystal clear and fascinating. The point is, your brain will need to be flexible. Learn to learn in new ways. Write out the mathematical steps for yourself. Draw a picture about what you're reading. Ask for help. Use a different concept to describe the same phenomenon. And most importantly, try everything!"

Cole Raisbeck is attending graduate school in physics at Ohio University, where he has been awarded a Teaching Assistantship.

Eric Wagner writes, "At Gustavus I felt like I was part of a great community of both students and professors. This is one of the things that makes GAC so awesome and shouldn't be taken for granted. I am currently going to Dartmouth College to get my PhD in Engineering. My advice to upcoming physics students is to go to journal club. You'll get used to reading scientific papers which is important no matter what field you go into."

Brody Ziegler is attending graduate school in Mechanical Engineering at the University of Minnesota.

New Engineering Dual Degree Program

Starting this year, the physics department has established a dual-degree engineering program with Washington University in St. Louis, MO. WashU's School of Engineering & Applied Science is ranked among the top Engineering schools, and focuses intellectual efforts through a new convergence paradigm, particularly as applied to medicine and health, energy and environment, entrepreneurship and security. The Dual Degree Program is an attractive alternative to traditional engineering curricula. Program graduates are "liberally educated engineers" with strong communication and problem-solving skills, a broad background in the humanities and social sciences and a high-quality technical education. On Thursday, September 29th, Christopher Ramsay, the Assistant Dean of their School of Engineering, will be on campus to meet with students and give an evening presentation about this program. More details about the transfer program can be found in the Physics Advising guide, or by contacting Paul Saulnier, the physics department's Pre-Engineering Advisor.

2016 Student Summer Internships...

This summer a record 19 Gustavus physics majors (freshman through senior) took part in summer internship programs in science or engineering-related fields. Here are reports from some of them:

Mikaela Algren '17 writes, "I've spent this summer working for the U.S. Naval Research Laboratory in Washington, DC in a ten-week internship program called the Naval Research Enterprise Internship Program (NREIP) with at least 80 other students, most currently pursuing undergraduate degrees. I'm one of two students in a group of researchers in the NRL's optics division, and I've been working on a few different projects throughout the summer on different types and applications of fiber-optic sensors.

"One of the best things about working here this summer has been getting a glimpse of the type of work done by researchers who are trying to strike the balance between producing something that is practical for some particular use (implementation in the Navy in this case) and learning as much as they can about the world around them (doing good science). The other best thing has been interacting with and befriending students from all over the USA who are working on a variety of interesting research projects and who have educational experiences that are very different from my own."

Emilie Benson '16 sends the following, "I am working at the National Institute of Materials Science in Japan for the summer. This is an opportunity through the National Nanotechnology Coordinated Infrastructure, with my particular program based out of Cornell. I am working here on the characterization

Emilie traveling in Japan

of thermoelectric materials. I am gaining experience on lots of instrumentation including spark plasma sintering and ZEM, although I am best at using the oxy-acetylene blowtorch and XRD. A lot of the instrumentation has been more difficult than typically because most of the computer programs are in Japanese, which I still can't read. I have been given my own material system to characterize and dope.

"I have been very fortunate to travel a lot while I am here. This past weekend we climbed Mt. Yarigatake, the fourth highest mountain in Japan, and even saw snow, so it was like being back in Minnesota. The cultural experience has been great, with the most difficult being food."

James Bork '17 says, "I'm at the University of Nebraska, Lincoln working in a physics REU in the optics laboratory. My advisor focuses on ultrafast electron diffraction (UED). My subgroup is working on developing a source of electrons for use in UED experiments. Using a Ti:Saph laser (10Hz, 200 MJ/pulse) and focusing it down to ~3 by 5 microns, my group is trying to generate relativistic electrons using plasma wakefield acceleration. This method should produce electrons of high enough energy with short enough pulse duration (a few fs) to reduce the temporal resolution of UED to a level where photo-induced reactions and other molecular dynamics in the gaseous state can be directly studied and molecular movies be created.

"I've done many things including focusing the beam, and taken many photos of generated plasma and phosphor screens in search of electron signal. My largest contribution so far has definitely been programming, specifically a camera interface in LabVIEW to control multiple cameras, display live video and photos taken in a hardware trigger, save and automatically stack images."

Tyler Brau '19 sent the following: "Over the course of this summer, I have been working in Dr. Dwight Stoll's laboratory, located in the Analytical Chemistry laboratory of Nobel Hall. I was fortunate enough to be accepted into the lab as a Gustavus First Year Research Experience (FYRE) student, although the funding for me and the project I'm working on comes from the NSF.

"One of the important things we do is separate out complex mixtures of compounds into their individual components. One of our most powerful tools is called High Performance Liquid Chromatography (HPLC), which uses liquids to push a sample though a specialized silica column to separate the compounds of the sample out from each other. Silica beads interact with the sample, 'pulling' on it inside the column while the liquid 'pushes' it out. Different compounds interact differently with the beads, which allows us to separate the compounds out from each other. I am running experiments to better characterize what happens inside the system, and collecting data so that we can move toward simulating the technology

(because we can run thousands of simulations in the time it takes to do one experiment)."

Katy Hagen '19 writes, "I am in the FYRE program doing on-campus microbiology research with Dr. Laura Burrack. I am working individually on an entirely new project with her guidance.

"My project involves analyzing the stiffness of the centromere (which is thought of similar to the spring constant) in yeast cells by analyzing the forces acting on the cell. To do this, I am placing two glowing dots on the centromere (GFPs, Green Fluorescent Proteins) and I can then see these dots through the microscope. The average distance between the dots from cells in a certain part of the cell cycle gives an idea of the stiffness and the forces. A smaller distance means that the tension and stiffness are greater, whereas a greater distance means that the tension and stiffness are smaller because it stretches further.

"I will be applying different types of stresses to the cells (such as heat shock and neocentromere creations) that are known to cause problems when the chromosomes split during mitosis."

Nathan Huber '17 says, "I completed a research project in the Biomedical Engineering and Physiology division of the Mayo Clinic in Rochester, MN. We created a phantom which emulated magnetic resonance (MR) images of perfusion observed within a human prostate. (Perfusion is the passage of blood and nutrients across the membranes of capillaries and arteries.) In our phantom, variable densities of polyester fiber within a fixed volume shell produced predictable variations to the flow re-

Nathan in his lab at Mayo Clinic

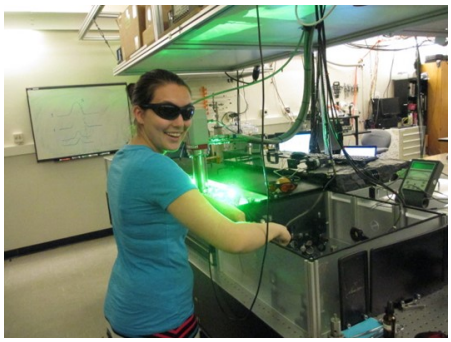
sistance. Variations in flow resistance affected the rate of MRI enhancement observed in the phantom. The enhancements closely mimic those seen in the tissue enhancement of a perfusing prostate. One can change the phantom density to replicate either malignant or benign tissue. Previous studies have indicated that prostate perfusion has a high diagnostic value for prostate cancer. This phantom could be of great benefit to groups refining the use of MRI as a diagnostic technique.

"The Mayo Clinic is a unique setting for research and graduate school because of how education, research, and clinical practice are all in the same location. I was impressed by the quality mentorship offered and sincerely enjoyed the project."

Nick Hulstrand '17 writes, "I am at Rensselaer Polytechnic Institute in a physics REU with Professor Brown. He works with rare interaction and ultra-low background experiments using xenon— both Xenon1t, a dark matter detector, and NEXO, a neutrino characterization experiment. I have been working on design and simulation for a future dark matter detection project. It has involved physics simulation in COMSOL, CAD modeling, and programming."

Grace Kerber '17 says, "I worked at the University of Colorado-Boulder, in partnership with the Extreme UltraViolet Engineering Research Center (EUV ERC) with Colorado State University and University of California-Berkley. This summer I am working on repairing the Frequency-Resolved Optical Gating (FROG) system. FROG is the leading method to measure ultrashort laser pulses. It splits the pulse into two identical copies of itself, and auto correlates the beam (uses the two identical copies against itself, with one arm on a variable delay) to retrieve a spectrogram.

"I worked on implementing a ptycographic FROG. Ptycography is an imaging technique that, rather than having each scan be of a completely new area, there is overlap between scans. This forces a constraint in the reconstruction that the overlap areas must be the same."



Grace aligning some of the optical equipment in the lab

Elise LeBoulicaut '18 writes, "I am participating in the physics REU program at the College of William and Mary in Williamsburg, Virginia. There are over 20 students in the program, from schools across the country. It has been interesting to

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Summer Internships Provide a Breadth of Experiences...

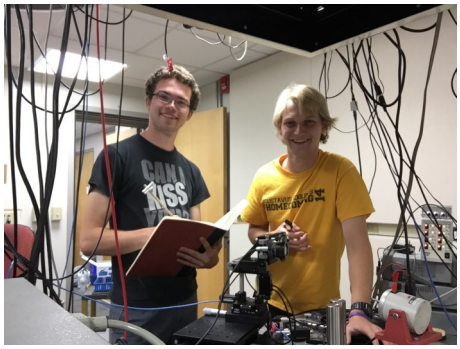
(Continued from page 9)
interact with these students and hear about various physics departments.

"I am working on a project entitled 'Electronic Detection and Diagnosis of Health and Illness of Premature Infants'. This is part of a broader collaboration with professors and doctors from the University of Virginia. The goal is to improve the health of premature babies held in incubators in Neonatal Intensive Care Units (NICU) by monitoring their heart rate signals. My job has been to find a new way of calculating the HeRO score (a number ranging from 0 to 7, which measures how likely a baby is to get sepsis in the near future) to make it more reliable and accurate. I have been writing MATLAB programs to run statistical analyses on data from a large scale clinical trial, to try and develop a HeRO score that will more dramatically increase leading up to illness."

Jonathon Lombardi '17 writes, "My internship at Lund Boats has taught me a lot so far. I would describe this work as very hands-on, and often times I work independently. I just finished a successful project where I designed and built a drawer system capable of holding 500 pounds of torque per drawer. At first I thought, 'How hard could it be to build a reinforced shelf?', but later I discovered that the system was required to have drawers at heights accurate to 1/16", accommodate for a very uneven floor, be as small as possible, and possess drawers that slide both smoothly and safely with a few hundred pounds of tools resting on top of them. So after applying some physics knowledge, conducting research online, and learning how to weld, I was able to construct the shelf. Lund as a company has been well-known for making high quality fishing boats, and their staff has helped make this internship an enjoyable one."

Jill Malecha '17 says, "This summer, I am a mechanical engineering intern at a telecommunications company, CommScope, in Shakopee. The group I work under is Enterprise fiber connectivity solutions. I am working on two projects right now, one is for Google and another is for Verizon. For Google, we are broadening and adding to their range of fiber connectivity. We are creating a new model for modules to be put into trays and into the cabinets. Everything is about increasing bandwidth here for the network, so we are finding ways to use more fiber in the same modules to increase the amount of data coming through."

Ian McKeag '17 and Will Riihiluoma '17 are both working with **Dr. Tom Huber** in NSF-sponsored acoustic research on cantilevers at Gustavus this summer. Ian writes, "We use the ultrasound radiation force to excite cantilevers to various resonant frequencies of a brass cantilever. We investigated a few aspects of these modes and then moved the set-up to water. After we performed the same tests in the water, we 'nibbled' the cantilever, which means we damaged it a small amount. After it is nibbled, we perform the same tests in air and water to look for changes in the vibrations. This will hopefully be applicable in industrial fields to find damage in equipment."



Will and Ian in the acoustics lab

Matt Mehrkens '18 says, "I'm currently working at the Soudan Underground Physics Laboratory in Soudan, MN. The lab had many research projects going on, but the main two were MINOS, which stands for Main Injector Neutrino Oscillation Search, and CDMS, Cryogenic Dark Matter Search. MINOS was a steel detector with the purpose of detecting muon neutrinos sent from Fermilab in Illinois. CDMS was a collection of Germanium detectors brought to a temperature just above absolute zero (0.4K) with the purpose of identifying WIMPs (Weakly Interacting Massive Particles), which is a type of particle hypothesized to constitute dark matter. In the past couple of years, the projects in the lab have been shut down, MINOS was just shut down on June 30th. The University of Minnesota will be taking apart most of the facilities and removing it over the course of the

Matt in the Soudan mine

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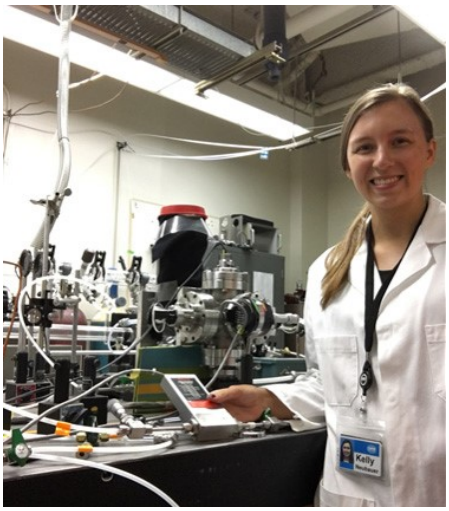
next year. Much of my responsibility in the lab is to aid in the deconstruction process. Part of my duties as an intern here this summer has been outreach, where I've been learning as much as I can about the projects and related physics, so that I can convey it to visitors. I've also been using my electronics knowledge to build displays to help convey aspects of the experiments in small-scale models."

Kelly Neubauer '18 writes, "This summer I have been researching at SRI International in Menlo Park, California. The Stanford Research Institute was founded by Stanford University as a nonprofit research institute in 1946. In 1970 SRI International became independent from the university, and has grown to 20 locations across the world today.

"I work in the Advanced Technology & Systems Division as a part of the Center for Geospace Studies. The research investigates chemical processes that occur in Earth's upper atmosphere, is relevant to studying weather and climate on Earth, and can be applied to the study of the atmospheres of other planets and their moons.



Kelly in her lab at SRI

"I have worked on two separate projects this summer. The first studied the kinetics of reactions H+HCl and $H+C_2H_4$, and $H+O_2$ ($+O_2$) at a range of temperatures. The second project is the development of a cavity ring-down spectroscopic (CRDS) diagnostic for ground-state O_2. Our goal is to use CRDS to detect ground-state O_2 formed by the three-body process of $O+O+N_2$ recombination. I have been involved with the set-up and alignment of all the optics and electronics and have worked on LABView programming for the data analysis."

Karl Satterlund '19 says, "I am currently employed as an Engineering Intern at Pequot Tool and Manufacturing in my home town of Pequot Lakes, MN. PTM is a small manufacturing company, fabricating contract parts and finished products for production and sales by other firms. Several of the parts produced at Pequot Tool are sent to large companies such as Boeing and Magnum Research Firearms, while other parts are contracted by smaller firms.

"I found myself stepping into a one-of-a-kind role at a fantastic company. My internship consists of a well-rounded experience in a real-world career environment. I have been involved in training sessions geared toward shop safety, print reading, and tolerancing. Most of my time is spent on the production floor in a variety of departments, including fabrication, turning, and packaging. By the end of the internship I will also have spent time in the engineering, milling, and quality inspection departments."

Kevin Treb '18 writes, "I'm working at Mayo Graduate School in Rochester as part of the SURF program. I'm researching the effects of genetic background on sensitivity to chemotherapy-induced peripheral neuropathy (CIPN) using a fruit fly model. To do this, I'm looking for differences in neuron death in different fly strains treated with chemotherapy drugs."

Rochelle Widmer '17 and **Ben Rorem '19** are researching wind energy on the Gustavus campus with **Dr. Chuck Niederriter** as their advisor. Rochelle is being funded by the Gustavus Presidential Student and Faculty Collaboration Grant and Ben is being funded by the Gustavus First Year Research Experience (FYRE) program. They are studying the power produced by a small (44-inch diameter) Sunforce wind turbine when enclosed by a Venturi tube. Theoretically, the Venturi effect should increase wind velocity and power output, allowing turbines to be smaller, yet produce the same power as a larger one.

Ben and Rochelle collaborated to plan and construct the Invelox System designed by Sheerwind's Dr. Daryoush Allaei. They are using aluminum rings and bars to create the frame, while marine shrink-wrap encloses the frame. The system then rests on a wooden frame, allowing the flexible rings to stay circular.

Rochelle and Ben with a portion of their giant Venturi tube

Physics Faculty Summer Notes

Tom Huber had NSF funding to allow him to collaborate with **Ian McKeag ('17)** and **William Riihiluoma ('17)** on ultrasound and acoustics research (see the article on page 8). Tom also maintained active collaborations with the ultrasound research lab at the Mayo Clinic, studying wave propagation in thin membranes under tension, which is a method Mayo is investigating for non-invasive measurements of bladder compliance. Another collaborative project, with the physics department at Rhodes College, involved imaging of ultrasound propagation through bone related to detection of osteoporosis. He will continue to explore these research areas for the next several years as part of an NSF grant he was awarded this summer (see a description on page 1). Tom also began his duties as the new chair of the Physics Department.

In addition to participating in the Gustavus Academy for Faith, Science and Ethics in June, the Academic High Altitude (Ballooning) Conference in July, as well as the High-Altitude Ballooning Camp in July (see the story on page 13), **Steve Mellema** traveled to Malaysia in August to visit Universiti Sains Malaysia in Penang. Steve will be on sabbatical leave from Gustavus during spring semester 2017, and has received a Fulbright Visiting Scholar award from the Council for the International Exchange of Scholars to do research and teaching at USM from January-July, 2017. Steve's work in Malaysia will focus on collaborating with Malaysian faculty members to implement and evaluate the success of active learning techniques in the physics classroom.

It was a busy summer for **Chuck Niederriter**. In addition to working with Rochelle and Ben on the wind amplifying system, he offered two robotics camps at South Central College, attended the Academic High Altitude (Ballooning) Conference, and with Steve Mellema ran the Gustavus Ballooning summer camp. There was time for lots of sailing, a few canoe/kayak trips on local rivers, a trip to Pennsylvania to see family, and a camping trip up north. At the end of the summer, Gustavus was invited to prepare an experiment for a rocket launch in November. So Chuck and Rochelle built a small payload to count cosmic rays during the flight and particularly the 15 minutes the payload is 140 km above the surface of the earth.

This will be a busy year for Chuck, teaching Mechanics and Experimental Modern Physics lab, as well as serving on the Faculty Senate and helping facilitate the curriculum revision process. Hopefully there will be time to continue the work on sustainability and renewable energy, including the wind system and pushing for a possible 1 MW photovoltaic project.

Jessie Petricka returns from sabbatical leave this fall. While away he spent time in the basement—that is, with the ion trap in the Olin basement and with the 3D printer in his own basement. He also spent time preparing for his new FTS this fall entitled "Compared to What?" that will not only explore the relevance of scale in the universe, but will allow him to say his signature phrase on a daily basis.

Jessie also spent sleepless nights with his family, as he and wife Jalean welcomed a new daughter, Alara Helen Joy, on April 20th. After two and a half months of being the primary bottle feeder, Jessie is grateful that Alara has transitioned to a more direct feeding method. The summer had the requisite camping and sailing, refreshing the family for the fall. The boys are as rambunctious as ever and are eager to get back to attending SPS events in the fall, as Jessie will once again advise the physics student organization (SPS, see the article on page 14).

On the personal side, **Paul Saulnier's** summer took some unexpected twists and turns. He had expected to spend some time ferrying his kids to summer research and graduate school, but when his mother-in-law fell and injured herself, he ended up unexpectedly spending several weeks in Connecticut helping with rehab, home repair, and elder proofing a home. In all, Paul estimates that he spent at least 125 hours on interstate highways this summer. Keep on truckin'…

On the professional side, Paul prepared a talk based on a recent research publication on which he was a co-author, wrote a required funding report for an internal grant the department received to underwrite a recent retreat, reviewed a tenure dossier and began drafting the corresponding letter, and prepared for fall classes. This academic year, in addition to teaching duties, Paul will be serving as a new faculty mentor, and as a member of the Faculty Review Committee, and has several service duties in the physics department.

Dan Young writes, "Over the summer I had the chance to relax a little bit and focus my research and pedagogical efforts for my final academic year at Gustavus. In addition to attending the American Association of

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Physics Teachers conference where I presented a poster based on my research from last year (find it somewhere on the physics floor), I visited my family in Arkansas and we spent some time at Dollywood (Dolly Parton's theme park) in Tennessee.

"This year I have three big goals in mind. First, I will be expanding my curriculum to focus on in-class activities that will support the theory of the lecture (including creating more demos, writing some code to present simulations, etc). Second, I am spending a good chunk of time working on a pet project that I am extremely excited to present, namely my January-term course entitled 'Game Show Theory.' Finally, I will be focusing my research efforts towards three new projects and would be more than happy to accept a student to help me out. These include (1) coding and testing questions which will appear on a national fluids assessment, (2) analyzing student work from my graduate studies to hit a concept that we were unable to finish (student understanding of viscosity), and (3) generating mental models (resource maps) that will investigate how students chain ideas together in non-causal topics such as quantum mechanics.

"I am extremely excited to have been asked to teach here for one final year and look forward to working with you all over the course of fall and spring semesters!"

After 11 years as our department's Lab Instructor, computer guru, and equipment manager, **Jim Miller** announced his retirement at the end of last spring semester. He writes, "An education in physics and engineering has led me to a satisfying and colorful career: developing software for the MK50 torpedo program, traveling the world for a small instrumentation manufacturer, saving energy with Owens Corning and PNNL, and working with students at Gustavus. With this still-gas-in-the-tank retirement comes the hope that Laurie and I will find new ways to play and contribute."

Third Annual High-Altitude Ballooning Summer Camp

In July, **Steve Mellema** and **Chuck Niederriter** conducted a week-long camp for high-school students that focused on using high-altitude helium balloons to probe Earth's atmosphere and near space. Students learn physics, electronics, computer programming and data analysis skills.

This year, five students attended the camp from July 10-16. They lived on campus, learned some physics, electronics and computer coding in the daytime, and then had social activities in the evenings.

The goal was to build and fly instruments that would ascend through the atmosphere, take video and still photos, use sensors to measure quantities like temperature, pressure, humidity, magnetic field, and cosmic radiation, and then return by parachute to have their data downloaded and analyzed. The balloon was chased and tracked using amateur radio transmissions containing GPS location information. After a two-hour flight, in which the balloon ascended to (and burst at) an altitude of 27 km (about 89,000 feet), it landed in a recently planted field southwest of Owatonna.

All of the instruments and cameras were recovered, and on the last day the students made presentations to show their families what they had learned.

Balloon campers with their instrument boxes just prior to launch

Launch time!

Success— recovering the payload

Gustavus Society of Physics Students

Once again this year, the Gustavus chapter of the Society of Physics Students (SPS) was awarded an "Outstanding Chapter Award" by the American Institute of Physics.

SPS officers meet every week and work together with the SPS advisor to plan events and activities. At Gustavus, SPS is a very active group, generally hosting two activities per week during the semester —one educational (like a research talk) and one social (game night, broomball, water polo, ultimate Frisbee, etc.)

Traditional events include an opening meeting for all SPS members (where faculty introduce their research, SPS officers introduce themselves and talk about what the club is all about, and we make liquid nitrogen ice cream), a late summer/early fall game of Capture the Flag in the Linnaeus Arboretum (this is usually our first group activity of the year), a fall picnic (where we play football and grill out), semi-annual highway cleanup (as a club, we've adopted a stretch of Highway 169 several miles north of St. Peter), physics demos for kids, Halloween pumpkin carving, and more.

The Adopt-a-Highway crew

SPS meetings are the venues for visiting speakers (including the alumni career talks described in the article on page 16). And, throughout the year, students who have worked on scientific research present talks about their projects. The talks this past year included:

- **Mikaela Algren '17** and **Cole Raisbeck '16**, "Modeling the output of air-coupled ultrasound transducers"
- **Emilie Benson '16**, "Electrostatic Gating of MBE grown Neodymium Titinate Thin Films"
- **Nathan Huber '17**, "SiO_2 Capping of $SrTiO_3$ 2DEG for Increased Electron Mobility"
- **Alec Iverson '16**, "AES Emittance Measurements at the National Superconducting Cyclotron Laboratory"
- **Grace Kerber '17**, on summer research at UC Boulder
- **Ian McKeag '17**, on summer research at Mayo Clinic
- **Kelly Neubauer '18** "Implementing LABView software to control optical instruments"
- **Rochelle Widmer '17**, "Computer Graphics for Connecting Facial Motion to Emotional Intent"

Some other specific events and activities hosted this past year were:

- Ultimate Frisbee
- Fall hike and picnic
- Dodgeball game against Chemistry club
- Summer research Q&A (students who've done summer research talk about experiences and answer questions of their classmates and underclassmen)
- Research Seminar by Dr. Peggy Nelson, University of Minnesota on Wind Turbine Noise and Psychoacoustics

Grace Kerber '17 (and her friend) at the Halloween pumpkin carving

- Broomball
- A trip to the movies to see Star Wars Episode 7
- Physics Christmas carols
- Wallyball
- Water polo
- Spring Picnic
- Physics demonstrations for area elementary schools

Making liquid-nitrogen ice cream

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For the coming year, SPS is planning a trip to the Science Museum of Minnesota together with the Gustavus Chemistry Club.

The SPS Officers for 2016-2017 are:

Co-Presidents: **Will Riihiluoma**
Matt Mehrkens

Treasurer: **Rochelle Widmer**

Activities: **Patrick Neri**

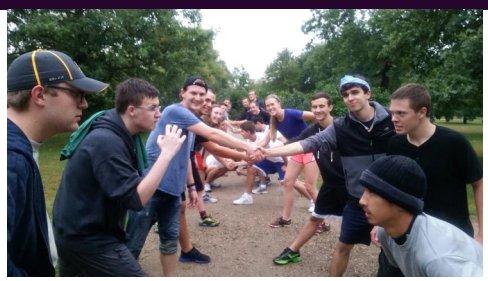
Communication: **Ian McKeag**

Senior Rep.: **Mikaela Algren**

Junior Rep: **Kelly Neubauer**

Sophomore Rep: **Ben Rorem**

The faculty advisor for 2016-2017 is **Jessie Petricka**.



The Fall Classic: Capture the Flag

All physics students are encouraged to be active members of SPS, and to begin the year by attending the opening meeting, which will take place on an evening during the second week of fall classes. On that evening, all of the physics professors will introduce themselves and their research programs.

Watch for the announcement!

Hannah Nolte '19 teaching elementary-school students

Lip-sync battle at the SPS lock-in

Studying Abroad as a Physics Major

Three current senior physics majors will all have studied abroad for a semester before they graduate.

Grace Kerber '17 says, "I chose to study abroad, because I have always wanted to see the world, have the opportunities to live in another culture, and practice French in day-to-day life rather than just in a classroom. I decided to go to Geneva, Switzerland. The specific program was intended for junior year physics majors, so they understood the need for specific courses to be offered. We took courses at the University of Geneva (UniGe) and had a part time internship at CERN as a Visiting Scientist. I worked with the AEgIS (Antihydrogen Experiment: Gravity, Interferometry, Spectrometry) collaboration. This was a once-in-a-lifetime opportunity to be able to work in such a place with the history and prestige that CERN has, as well as being able to run into world famous scientists in the cafeteria."

Ian McKeag '17 writes, "My program was superb. I spent four months in Galway, Ireland and could not have been happier. Although adjusting to Irish life took some time, I was able to find some camaraderie in the form of other American students. Together, we traveled across both Ireland and Europe. Thankfully, I was able to study abroad during Spring of my junior year, meaning I only missed a project course and Advanced Math Methods. With some work on my own, I will be able to resume the major with few hiccups. I was not able, however, to find physics courses in Ireland that would challenge me enough to engage me, while still allowing for travel and cultural immersion in Ireland."

Rochelle Widmer '17 tells us, "Even before I came to Gustavus, I knew I wanted to study abroad. I love traveling and exploring unfamiliar cultures, and studying abroad seemed like the perfect way to partake in both of these things while still getting an education. I will be studying at the University of Aberdeen in Scotland during the fall semester of my senior year. I knew I wanted to study abroad somewhere in the United Kingdom, and Aberdeen really fit what I was looking for. I believe that this sort of program will allow me to grow in new ways and compel me to connect with new people. Luckily for me, Aberdeen is a rather large University and has a wide variety of physics classes to offer. I was able to register for the physics classes I will be absent for."

Physics Alumni Return to Campus

For the second year in a row, a number of Gustavus physics alumni visited campus to give seminars describing their varied career paths.

In September, **Mike Theilmann '86**, spoke via Skype from his home in Dallas, Texas. Mike is the Managing Director of Slome Capital, and his talk, entitled "From Science to Business...", encouraged our majors to consider careers outside of science and engineering. Mike is a strong believer that the kinds of quantitative-reasoning and problem-solving skills developed by a physics major are keys to success in the business world.

In October, **Christy Tupy '09** gave a talk entitled "Destined for Healthcare Improvement." After graduating from Gustavus, Christy earned a Master's degree in Industrial and Systems Engineering from the University of Minnesota. She is currently a Performance Improvement Consultant with Abbott Northwestern Hospital and Allina Healthcare Systems in Minneapolis. Christy emphasized the way her physics major prepared her to tackle complex logistical problems within the healthcare industry.

In November, **James Trevathan '14**, currently a Ph.D. student in biomedical engineering at Mayo Graduate School, gave a talk on "Controlling Neural Circuits: Development of Techniques to Computationally Model and Control Dopamine Release Evoked by Deep Brain Stimulation." James' thesis work, the goal of which is to help patients with Parkinson's disease, is a joint effort of the biomedical engineering and physiology labs at the Mayo Clinic in Rochester.

In February, **Sam Schwartz '09**, gave a talk entitled "Gustavus to Electrical Engineering to Industrial Machine Automation." Sam, who went on to earn a Masters' degree in EE from the University of Minnesota, is currently a Controls Engineer with PERBIX in St. Louis Park, working with robots and automation in manufacturing.

On April 19, **Jason Haaheim '01** gave an amazing talk entitled "From Gustavus, To Nanotechnologist, to the MET Orchestra—The Power of Physics-Minded Problem Solving." Jason, who was a Physics and Music double major, has had a unique and unorthodox career path—beginning at Gustavus, progressing through a Masters' degree in Electrical Engineering at UC-Santa Barbara, working for ten years at a Chicago-based nanotechnology company, and finally landing his dream job as the Principal Timpanist for the Metropolitan Opera in New York City. His talk focused on how physics training provided indispensable skills to navigate diverse challenges along these seemingly disparate paths. He discussed how decades of research have proven that "talent" does not predict success, but rather a highly-specialized form of hard work called "Deliberative Practice." He elaborated on how its attributes overlap nearly perfectly with the scientific method, and how this applies across a wide range of disciplines. In showing how his Gustavus physics training made him a better timpanist, he provided examples of how physics study cultivated a generalized framework for problem solving, and how he still employs physics on a daily basis while performing with one of the greatest orchestras in the world.

A few days later, **Dr. Danielle Berg '08** gave a talk on "Building A Cosmological Abundance Scale ." Following her graduation from Gustavus, Danielle obtained a Ph.D. in Astrophysics from the University of Minnesota. She then spent a year (2013-2014) as a Visiting Assistant Professor here at her alma mater, before becoming a Postdoctoral Research Associate at the University of Wisconsin-Milwaukee, where she studies the abundances of chemical elements in distant galaxies.

Our alumni are a reflection of the diversity of future career options that are available to our current students. Their eagerness to return and share their experiences with us makes us both proud and grateful.

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.

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