GUSTAVUS PHYSICS

Physics Department Newsletter

September 2015

Inside this issue:

Important Fall Dates:

Classes Begin	Sep. 8
Last Day to Register for Fall Classes	Sep. 21
Nobel Conference	Oct. 6-7
January Term Registration Begins	Nov. 2
Spring Semester Registration Begins	Nov. 9
Final Exams Begin	Dec. 17

What Do Our Graduates Do With a Gustavus Physics Degree?

During 2014-2015, the Physics Department's seminar program featured nine physics alumni from the past 30 years. They were able to show our current students the amazing variety of career paths that are available to a Gustavus physics graduate.

The series began in September with a visit from **Dr. Jason Hiltner '96** who is a Technology Development Fellow at ACIST Medical Systems in Eden Prairie, Minnesota. Jason spoke about "Development of an Ultrathin Pressure Measurement Catheter Utilizing Fabry-Perot Interferometry for Determining the Significance of Lesions in Coronary Arteries." Jason received his Ph.D. in physics from Colorado State University, and is (obviously) working in the medical device industry.

Then, in October we had a visit from **Dr. Amanda Havnen-Smith '02**, who is a medical physicist with certification in therapy physics at Minneapolis Radiation Oncology, P.A. Mandy received her Ph.D. from Wake Forest University. The title of her talk was "The Medical Physicist in Radiation Oncology." She works closely with cancer patients undergoing radiation treatments at a Burnsville, Minnesota facility.

In November, **Disa Wahlstrand '92** spoke about "Solving Campus Infrastructure Challenges: Civil Engineering Projects." Disa, who obtained an M.Sc. in Civil and Environmental Engineering from the University of Iowa, is Manager of Municipal Services at Ayres Associates in Eau Claire, WI. Especially for our women students, it was great to meet an alumna who is in a senior managerial position at an engineering firm.

In February, **Dr. Matt Weibold '06**, who is Assistant Professor of Physics at St. Olaf College, spoke to us about "Plasmas for Spacecraft Propulsion." Matt has continued to do research work in this

(Continued on page 2)

Alumni Talks Showcase a Variety of Possible Career Choices

(Continued from page 1)
area, which he began during his Ph.D. studies in Electrical Engineering at the University of Wisconsin - Madison. Matt was the one visiting speaker last year who is pursuing a traditional academic (teaching plus research) career at a liberal-arts college that is like Gustavus.

In March, we had two visits from members of the Gustavus class of 1985. **Dr. Greg Haugstad**, is a member of the graduate faculty in the Department of Chemical Engineering and Materials Science and also Senior Research Associate and Director of the Characterization Facility at the University of Minnesota. Greg's talk on "Probing Nanoscale Structure and Properties of Matter with Atomic Force Microscopy Methods" showed our students the career possibility of a physics Ph.D. (from the University Minnesota) with a university job whose primary career has been in cutting-edge research rather than teaching.

Later that month, **Dr. Chad Olinger**, Group Leader in Applied Modern Physics at Los Alamos National Laboratory, a Ph.D. physicist (from the University of Washington), gave another perspective of working as a research scientist, but in his case at one of our government's premier national labs. The title of his talk was "Proton Radiography of Meteorite Samples," a subject with a decidedly astrophysical interest. Chad, who won the Gustavus Alumni Association's First Decade Award in 1995, has done applied physics research in a number of different areas during his career at Los Alamos.

In April, **Kathleen DeWahl '08**, who is a Research Associate and Cryogenics Technician with the U.S. Antarctic Program, gave a talk entitled "On the Harsh Continent: Life and Science in Antarctica." Since receiving her M.Sc. in Astrophysics. from the University of Minnesota, Kathleen has had two extended stays in Antarctica working on the international science collaborations there. Her photos and stories of living and working at the South Pole were really amazing!

Capping off the year, at our annual Sigma Pi Sigma induction banquet in May, **Dr. Jared Lee '05** gave a talk entitled "From the 'Hill' to the Foothills: My Early Career as an Atmospheric Scientist." Jared is Project Scientist I at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. He earned a Ph.D. in Meteorology from Penn State University, and is at one of the country's leading labs working at the intersection of climate, weather and energy forecasting.

What a joy and a privilege it was to showcase nine such diverse and successful alumni of our department. The hope is that our current students will begin to understand and explore the many options available to them after they successfully complete a Gustavus physics major.

Faculty Service Awards

On May 20, a ceremony was held honoring Gustavus faculty members achieving milestones in terms of years of service to the College.

Two physics faculty members were honored that day, as Gustavus President Rebecca Bergman gave a 10-year award to **Jim Miller** and a 30-year award to **Chuck Niederriter**.

Congratulations to our two faculty members whose long and dedicated service has made such a difference in the lives of so many Gustavus physics students.

Jim (with wife Laurie) and Chuck (and wife Debbie) with President Bergman

Congratulations to Jessie!

In April, **Dr. Jessie Petricka** was granted tenure on the Gustavus Faculty and promotion to the rank of Associate Professor of Physics.

Jessie, a native of Northfield, Minnesota and a Carelton College alum, joined the physics department in 2009 after completing his Ph.D. in physics at Yale University and serving as a Post-Doctoral Research Associate at Duke University.

His specialization is in experimental atomic and molecular physics, and he has worked with a number of our physics students to successfully build and characterize a cold ion trap in his lab in the basement of Olin Hall. Dr. Petricka's research on ion trapping investigates the production and chemical and electrical stability of dipolar species. This research is important for the atomic physics community which is searching for methods to produce cold polar molecules.

Jessie Petricka with sons Leif and Ambrose at the tenure installation ceremony in Christ Chapel

Tenure is only granted to faculty members who demonstrate: excellence as a teacher as reflected in quality of and enthusiasm for work, effectiveness of methods, interest in subject matter, concern for student learning, and effective advising of students; an emerging pattern of professional activities as reflected by publications and presentations at scholarly meetings or conferences; and an emerging pattern of involvement in the activities of the College.

Based upon those criteria, Jessie underwent an evaluation last year and was granted tenure by the Board of Trustees in January. The tenure installation service was held in April for Jessie and six other Gustavus faculty members.

Kelly Younge '05 Wins the Gustavus First Decade Award

At the Gustavus Alumni Association banquet on May 30, **Dr. Kelly Cooper Younge '05** was presented with the Association's First Decade Award. First presented in 1968, 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.

After graduating from Gustavus, Kelly did her graduate studies in the Applied Physics program at the University of Michigan. She received her Ph.D. in 2010 for work involving quantum states of highly ionized atoms.

Most unusual for a person who has just obtained a Ph.D. in Applied Physics studying quantum optics, but characteristic of the kind of person Kelly is, she decided to pursue a residency in Medical Physics because, as she says, "I wanted to help people."

Kelly completed that residency and was a staff medical physicist an Mississauga, Ontario, for a year before moving back to Ann Arbor, where she is currently a Clinical Assistant Professor at the University of Michigan Health System.

Congratulations, Kelly!

Physics Department Chair Steve Mellema '72 with Kelly Younge '05 as she receives her First Decade Award

Student Awards

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

Emilie Benson '16 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 has chosen **Daniel Baldwin '16** 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.

Alec Iverson '16 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.

Jacob Jahnke '16 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.

Alex Blixrud '16 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."

XiaoQi Yu '18 and **Ryan O'Neil '18** 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.

Rochelle Widmer '17, Derek Huntley '16 and Eric Wagner '16 each received a "Positive Derivative Award", as a physics major within their class who showed great improvement during the 2014-15 academic year.

Brad Dietz ('16) and **Jackson Laingen ('16**) will serve as the Physics Departmental Assistants for Fall Semester 2015. 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.

Finally, congratulations to two of last year's graduating seniors, **Spencer Batalden '15** and **Will Doebler '15**, who were inducted into the Eta of Minnesota Chapter of Phi Beta Kappa, the nation's oldest academic honor society. The Eta of Minnesota Chapter of the society was founded at Gustavus in 1982.

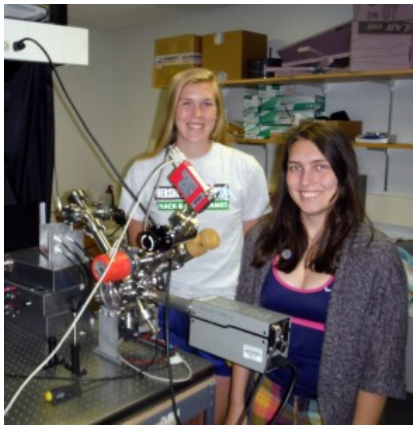
Students Win National Physics Scholarships

Mikaela Algren '17 and **Grace Kerber '17** have been named Rossing Physics Scholars for 2015-16. Mikaela is one of five students to receive a $10,000 scholarship for next year, while Grace is one of seven students to receive a $5,000 honorable mention scholarship for this year.

The Thomas D. Rossing Fund for Physics Education awards scholarships annually to exemplary students in physics at colleges and universities affiliated with the Evangelical Lutheran Church in America (ELCA).

Mikaela and Grace are outstanding students, who both took advantage of the College's First Year Research Experience program in summer 2014, when they spent 10 weeks working with **Jessie Petricka** in his ion trapping lab.

Congratulations, Mikaela and Grace!



Mikaela and Grace in the lab

Largest Ever Induction into the National Physics Honor Society

Inductees Attending the Sigma Pi Sigma Banquet:

Back Row (L to R): Josh Wolanyk, Marcus Blackstad, Nick Gersch, Zach Jensen, Ross Breckner and Dr. Jared Lee '05

Front Row: (L to R) Elise Mesenbring, Patrick Ernst, Spencer Batalden, Will Doebler, Lindsay Rothschiller, Seth Doebbeling and Calvin Samborski

As mentioned in the front-page article of this newsletter, **Dr. Jared Lee '05** delivered the keynote lecture at this year's Sigma Pi Sigma banquet, held on May 4 at the Melva Lind Interpretive Center of the Linnaeus Arboretum.

In all, thirteen graduating seniors from the class of 2015 were inducted into the Gustavus Chapter of ΣΠΣ. They are: **Spencer Batalden**, **Marcus Blackstad**, **Ross Breckner**, **Seth Doebbeling**, **Will Doebler**, **Patrick Ernst**, **Nicholas Gersch**, **Zach Jensen**, **Elise Mesenbring**, **Briana Mork**, **Lindsay Rothschiller**, **Calvin Samborski** and **Joshua Wolanyk**.

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 one of three induction tracks: academic, research or departmental service.

It comes as little surprise that our largest ever graduating class would provide us with our largest ever induction class for ΣΠΣ. Congratulations to all the inductees!

26 Physics Majors Graduate in the Class of 2015

2015 Gustavus Physics Graduates

Back (L to R): Jim Miller, Jessie Petricka, Chuck Niederriter, Tom Huber, Dan Young, Steve Mellema, Paul Saulnier, Spencer Batalden, Andy Pearson, Jack Walsh, Jared Henning, Ross Breckner

Middle: (L to R): Ben Burney, Sally Johnson, Lindsay Rothschiller, Logan Rudstrom, Aly Skoglund, Marcus Blackstad, Josh Wolanyk, Justin Cunningham

Front (L to R): Nick Gersch, Josh Root, Elise Mesenbring, Mike Hintze, Seth Doebbeling, Calvin Samborski, Zach Jensen, Nick Ulen, Will Doebler, Patrick Ernst

(Not Pictured: Anthony Afful, Connor Brausen, Briana Mork)

On May 31, the largest graduating class in Gustavus history walked across the stage at Hollingsworth Field on the way to receiving their degrees. Among that group were 26 physics majors, by far the largest number ever. What follows is some news about their future plans along with their advice to current majors.

Anthony Afful (a double major in Music) will be pursuing graduate studies in Music Performance (oboe) at Bowling Green State University in Ohio.

Spencer Batalden will be joining the Applied Physics Ph.D. program at the University of Michigan.

Connor Brausen says, "My plans for next year are to go to UMass Lowell and pursue a doctorate degree in Medical Physics. A bit of advice for the youngsters: Make sure you find time to enjoy all that Gustavus has to offer and don't get too caught up in one aspect of college life."

Ross Breckner has put his long-term plans on hold. He says, "I have decided to take a gap year to weigh my graduate school options and find out what exactly I want to do later on with Physics. A friend has presented me a temporary, year-long job at 3M to gain experience in the lab, and I feel that taking time to choose a career path will be helpful. I will be able to retake the physics GRE exam, do research into schools more, and hopefully land where I need to be." He adds, "The Gustavus Physics Department gives a sense of community like none other. I felt a sense of togetherness in the halls of Olin. The professors were always willing to talk and give help, as were the other students."

Justin Cunningham has a job as a software engineer with General Dynamics corporation.

Seth Doebbeling will be pursuing

(Continued on page 7)

(Continued from page 6)
graduate studies in Mechanical Engineering at the University of Nebraska.

Will Doebler writes, "In August I will be moving to State College, PA to start working toward a Ph.D. in Acoustics." His advice is, "Knowing how to write computer programs has been essential for all of the research positions I have held. I advise everyone to take as many programming courses as you can while at GAC. Go to journal club. It's fun and a good way to help you learn to read scientific literature before you're immersed in it in grad school."

Patrick Ernst writes, "I'm starting my Ph.D. in Biomedical Engineering at the University of Alabama at Birmingham this fall. My advice for current physics students would be to work together on homework and studying for tests. Everyone's going to have at least one chapter that trips them up, and, if you regularly work with another person/people, it'll be that much easier to ask for help when you really need it. Even if you already know the material pretty well, guiding someone through it who doesn't understand it will help cement it in your brain."

Nick Gersch is joining the Ph.D. program in Mechanical Engineering at the University of Minnesota.

Jared Henning, is beginning graduate studies in Mechanical Engineering at the University of Minnesota.

Mike Hintze is beginning graduate studies in Mechanical Engineering at the University of Minnesota.

Zach Jensen will be joining the Peace Corps this fall to teach high school chemistry in Mozambique.

Elise Mesenbring writes, "Becoming a physics major at Gustavus was one of the best decisions I've made in my life. The community formed between students and professors over four years on second floor Olin was one I feel is incomparable. Having a curriculum where almost all majors in the same graduating year take the same classes together really made our graduating class close and supportive of each other, and I'm eternally grateful to the physics department for encouraging that type of community. Starting this fall, I'll be entering the Mechanical Engineering Ph.D. program at the University of Colorado Boulder. I'll hopefully be working in either a biomechanics or air quality field, but really I'll just see where my interests take me!"

Briana Mork writes, "I will be in the Integrated Biomedical Sciences Ph.D. program at Notre Dame. The program itself is very interdisciplinary. I am so far planning for three rotations: one in applied physics, one in pharmacology and toxicology and one in applied mathematics. I am really looking forward to the wide range of opportunities that this program has to offer. I hope to study the brain as a network, observing the changes in cases of autism and neurodegenerative disorders." Her advice to other students is, "Fill your time with what you will be happy remembering and what will make you happy in years to come."

Andy Pearson has a job as a consultant with Boom Lab. He says, "Overall the job could be better described as Analytical Problem Solver. I will be able to go in with a team, find a problem, find different solutions to that problem, then come up with efficient ways to integrate these solutions into everyday business operations."

Calvin Samborski is beginning graduate studies in Mechanical Engineering at the University of Minnesota.

Jack Walsh is beginning graduate studies in Mechanical Engineering at the University of Minnesota.

Josh Wolanyk is joining the Ph.D. program in Physics at Iowa State University.

Three Generations Make Graduation a Family Affair

A very special moment for the physics department was captured in this photo, when **Marcus Blackstad '15** and his father (another Gustavus physics major) **Peter Blackstad '85** posed along with **Ed Blackstad**—Peter's father and Marcus' grandfather. Ed was a lab instructor in the Gustavus Physics Department from 1985-86, and worked with **Steve Mellema** and **Chuck Niederriter**, who are also shown in the photo.

Many thanks to Cathy Blackstad for taking and then sending in the picture.

Note: Photobombed by **Richard Fuller**!

2015 Student Summer Internships

This summer as usual more than ten Gustavus physics students participated in summer internships. Some have supplied us with details:

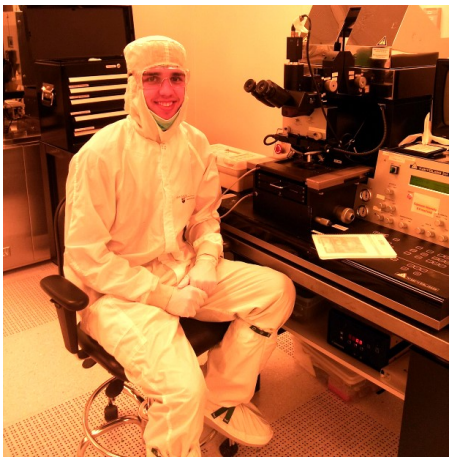
Emilie Benson '16 wrote, "I am participating in the National Nanotechnology Infrastructure Network REU program at the University of Minnesota. The title of my project is Growth Characterization of Complex Oxide Thin Films and Heterostructures via MBE. I am working on characterizing neodymium titanate (NTO) by electrostatic gating using ion gels and attempting to adjust the Mott Hubbard gap. In order to do this, I am developing an electric double layer transistor using photolithography, ion mill and MBE, which means I get to spend time in a clean room.

Emilie in the clean room at Minnesota

We are also characterizing the surface of NTO and the device using x-ray diffraction, x-Ray reflectivity and atomic force microscopy. In order to determine the effectiveness of the device, the electrical properties are tested in a PPMS to determine the resistance as a function of temperature and gate voltage. Our primary goal is to be able to electrostatically gate NTO so that it may be characterized without the need for chemical doping to determine if it could be used in future electronic applications."

Will Doebler '15 says, "I am a research intern at the Naval Surface Warfare Center in Port Hueneme, CA through the Naval Research Enterprise Internship Program. I am working in a lab researching speech recognition for use aboard Naval ships. I write code in MATLAB and Android/Java to judge how well a speech recognition algorithm works. I live across the street from the ocean with two other research interns. The weather is perfect. They don't install air conditioning units because it's a perfect 68 degrees every day. Down the street is a Driscoll's fruit farm and a Dole vegetable farm. Also, the lighthouse by the port uses a fourth-order Fresnel lens!"

Nathan Huber ('17) worked at Penn State University on the formation and optimization of a 2-D electron gas (2DEG) at SrTiO3 (STO) surface. This research project was funded by the National Science Foundation (NSF), the National Nanotechnology Infrastructure Network (NNIN), and the Materials Research Institute (MRI). Nathan's main role in this project consisted of sample fabrication and measurement preparation. Using contact mask photolithography, he was able to fabricate precise multi-layered measurement units of various sizes on the micrometer scale. Other equipment he used during the summer included a scanning electron microscope, an apparatus for e-beam lithography, sputtering chamber, pulsed laser deposition chamber, and various types of vacuum systems. Nathan writes, "This research opportunity introduced me to several fascinating subjects. It also helped me put to work concepts I have learned from professors at Gustavus. The 2DEG heterostructures are a fascinating subject of research because their high conductivity can be easily controlled. This makes 2DEGs very applicable for future electronics. Both the research and free time in Pennsylvania led to many enjoyable and educational experiences."



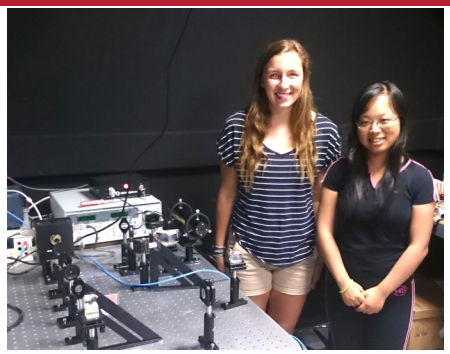
Nathan in the clean room at Penn State

Grace Kerber '17 wrote, "I am in an REU through the EUV ERC (Extreme Ultra Violet Engineering Research Center) centered in Fort Collins, Colorado at CSU (Colorado State University), working with the Kapteyn- Murnane Group at CU-Boulder (University of Colorado-Boulder), in Boulder, Colorado. The project uses wide band infrared laser light that has been converted from a Ti-Sapphire laser. Some of the IR is converted to ultraviolet light through High Harmonic Generation. This is a non-linear process that occurs in a gas confined by a glass capillary. The group I am in uses the infrared to heat a nanostructure, and the ultraviolet is diffracted off of this nanostructure. By changing the delay between the infrared and the ultraviolet, the diffraction patterns can be

reconstructed to understand how heat is transferred in the nanostructure. They can investigate the size of the nanostructures and their spacing from this process, at a small scale that is otherwise unable to be observed. My role in the project is to re-design and re-write their computer control system for data collection. The current main control system is at least ten years old, with many generations of grad students' edits upon it with no documentation. This means that my program is being built from the ground up. By participating in this REU, I am able to live at home, for a summer of no humidity. Looking out the window everyday gives a beautiful view of the mountains."

Grace-e's view out the window

Kelly Neubauer '18 and Xiaoqi Yu '18 write: "We have been working in Dr. Mellema's optical scattering lab this summer as a part of Gustavus' First Year Research Experience (FYRE) program. Our project included modernizing the lab by programming our equipment using LabView and building an interferometer



Kelly and XiaoQi in the Optical Scattering Lab

that would eventually be able to detect unscattered photons from a highly scattering medium. Throughout our research, we developed programs to control a voltmeter, lock-in amplifier, power supply, and stepper motor through a Phidget. Using these programs we attempted to find the coherence length of a He-Ne laser and diode laser, both of which have coherence lengths longer than our table space. We were able to change the path difference of our interferometer in fine increments using various micrometers and piezoelectric actuators. In taking data we found that the piezo does not expand linearly, but rather shows hysteresis, a dependence on past direction and voltage. Our research this summer has improved the ability to use the equipment in the lab with our programming and has brought us closer to building our final modified Mach-Zehnder interferometer, which will include a near infrared diode laser, acousto-optic modulator, and a scattering medium."

Ian McKeag '17 writes, "I am working at the Mayo Clinic in Rochester, within the CT CIC: the Computed Tomography Clinical Innovation Center. Essentially, the department works to develop methods of utilizing CT scanners more effectively, efficiently, and safely. I am working on a project that seeks to identify, using CT scans, the morphological constants that affect the fragility of kidney stones. Hopefully, in the future my work will be used to make predictions as to the effectiveness of certain surgical methods. I am the only student assigned to my project, bringing the grand total of researchers to two: myself and my mentor, Juan—a research technician. So, we carry the brunt of the research, performing scans on stones of various sizes, writing MATLAB code to analyze the images, and checking up on the literature as to the function of CT scanners and previous studies about kidney-stone disease. Some neat interesting information: I work in the same lab that **James Trevathan '14** worked at the past few years (and he now attends Mayo Graduate School). And, even though I'm simply an undergrad student, I am treated with all of the respect that the Ph.D. and M.D. folks give each other, which is a very admirable trait for such a prestigious environment, in my opinion."

Ian in his lab at Mayo Clinic

Cole Raisbeck '16 and Mikaela Algren '17 say, "We have been working with Dr. Tom Huber in his acoustics lab this summer under an NSF grant, contributing to an ongo-

(Continued on page 15)

2015 Faculty Notes

A full summer will be followed by another busy year for the Physics Department faculty members. Here are some notes on their comings and goings:

Tom Huber had NSF sponsored funding this summer to allow him to collaborate with **Cole Raisbeck ('16)** and **Mikaela Algren ('17)** working on ultrasound and acoustics research. This is a collaborative project with mechanical engineering faculty at the University of Massachusetts, Lowell with the goal of utilizing the acoustic radiation force to vibrate objects. Much of the summer was spent studying the force distribution delivered by different ultrasound transducers and how this compared to theoretical distributions. He also started working on a project studying how to utilize the vibrometer in his lab to image ultrasonic acoustic fields. This project, in collaboration with a physics professor at Rhodes College, has potential applications in diagnosing osteoporosis by measuring ultrasound scattering from bone. Students with an interest in acoustics should contact him about research opportunities. This year, Tom will continue serving as the department's advisor for pre-engineering, internships and the teacher-education program.

Steve Mellema had a full summer. For the first ten weeks he mentored **Kelly Neubauer '18** and **XiaoQi Yu '18** in optical-scattering research in the basement of Olin Hall. They describe their research efforts on page 9 of this newsletter. They worked incredibly hard, with minimal supervision, and managed to completely transform the various instruments in that lab into an integrated setup run entirely with LabView software.

Steve and Chuck Niederriter also ran a one-week summer camp on high-altitude ballooning, which is described in detail beginning on page 14 of this newsletter. In late July, Steve presented a paper at the Summer Meeting of the American Association of Physics Teachers (AAPT) at the University of Maryland. In addition to a reunion with former Rydell Distinguished Professor Jim Gates (a faculty member there), it was an opportunity to catch up with Gustavus alumni who are also physics teachers (see photo below).

Chuck and Steve had an AAPT lunch break with Jing-Han Soh '08 and Larry Engelhardt '00

Steve and his wife Shirley also had vacation time in Washington, DC after the meeting. Then, they made a vacation road trip to Nashville, TN and Hannibal, MO that was a fun combination of music and history.

He also found time to write a grant proposal to the Fulbright Foundation, requesting a fellowship during his 2017 sabbatical leave in order to bring recent advances in physics education research to the School of Physics at Universiti Sains Malaysia. (Malaysia was Steve's Peace Corps country after graduating from Gustavus. He has returned their often, including leading the Gustavus Semester in Malaysia in Spring 2014.)

Steve continues as Physics Department Chair this year, and will also serve as a faculty representative on the College's Internal Budget Committee.

Jim Miller writes, "I worked part of the summer for Pacific Northwest National Laboratory, publishing a user manual for my web-based system simulator for roof-top commercial air conditioners. For Gustavus, I developed new pre-lab content for Moodle that will run this fall in General Physics. As usual, I plan to get up to Mille Lacs Lake this for the fall windsurfing season." Jim will get more of a chance than usual to do that, because he is taking a leave from teaching classes during Fall Semester 2015.

Chuck Niederriter had a productive, but different kind of summer with more time spent working at home than in Olin. After all of the Olin lobby plants were in their summer homes, the plumbing for the ponds was updated, the front porch rebuilt, and some of the basement walls were waterproofed. In addition, Chuck and his family repainted the entire house. The garage awaits cooler fall weather.

Chuck continues to help build a sustainable robotics program in St. Peter. The Saint Peter Area Robotics Association was formed to support all levels of robotics in St. Peter - FLL, FTC, and FRC. In June, Chuck and students from St. Peter worked with high school teacher Mike Shores to offer VEX robotics camps at South Central College and at Gustavus. Both camps, intended for middle and high school students, used VEX robot kits and were set up so students could build and program their robots to compete in a mini competition at the end of a day. Chuck and students also offered two Lego camps at the St. Peter Community Center for younger students interested in Legos and robotics.

(Continued on page 11)

(Continued from page 10)

Chuck made three trips to his hometown of Erie, Pennsylvania this summer. The first was to prepare his childhood home for sale, as his parents had moved into a nursing home. The house sold quickly, necessitating the second trip when Chuck and his sisters divided up the contents among their five families. Everyone returned to Erie just two weeks later to celebrate the life of Chuck's father, who passed away on August 20.

Chuck and his wife, Debbie, also spent some time traveling to liberal arts colleges in the Midwest, along the East Coast, and in New England in search of the "right" school for their daughter, Gretchen. There was also time to review a couple of chapters for an astronomy text to be added soon to the OpenStax collection of online textbooks.

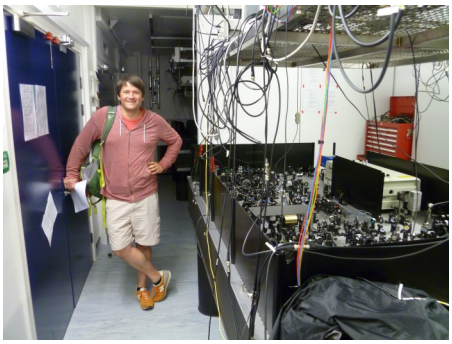
This will be a busy year for Chuck, teaching Mechanics and lots of labs, as well as serving as the Vice-Chair of the Faculty Senate. Hopefully, there will be time to continue the work on sustainability and renewable energy, including a possible 1 MW photovoltaic project at the College and a divestment summit during the spring semester.

During the summer, **Jessie Petricka** spent much of his time away from St. Peter on vacation with family. Destinations included Spain, Maine/Massachusetts, and Central Wisconsin. He also completed First Term Seminar training in anticipation of a future FTS (watch out next year's freshmen!), worked on updating the department's website, and prepared for teaching Electromagnetic Universe this fall. In the spring of 2016 Jessie will be on sabbatical leave, and

Jessie and Jalean Petricka in Mallorca

he plans to upgrade the ion trapping project with a new ion detector, take reaction measurements, and do some writing.

Paul Saulnier is returning from sabbatical. He spent a good deal of time in the fall studying quantum optics in preparation for his spring trip to the U.K. In the spring, he spent time working in the Oxford University research lab of Dr. Brian Smith, Gustavus physics class of 2000. Brian got his start in optics working in Paul's Gustavus lab and thus this trip possesses an appropriate amount of symmetry. In Brian's lab, Paul worked on a joint spectral measurement of an entangled photon pair source that they built. In addition to research work, Paul also completed his service on the Faculty Senate's shared governance task force and his



Dr. Brian Smith '00 invited Paul Saulnier to work in his optics research lab at Oxford University

term as the Kendall Center Faculty Associate for new faculty programs. Paul will teach Experimental Modern Physics and the Physics Senior Seminar this fall.

Dan Young writes, "I am completely thrilled to be back at Gustavus for a second year and am looking forward to interacting with you all in person over the course of the semester! After a very enjoyable yet intense first year of teaching I had the chance to read student feedback and reflect on my courses over the summer, in addition to doing a bit of traveling. I spent two weeks with my immediate family touring Civil War sites in the south (Mississippi and Louisiana), in addition to spending some time in California catching up with relatives and grad-school friends. Honestly though, while I had a lot of fun on the beach, I was really looking forward to getting back to Minnesota and beginning preparations for another school year.

"I am very grateful to the physics department here for asking me back for a second year, as there are a number of small improvements that I am making to my courses and am very glad to be able to test them out. Not only do I get to teach my favorite subject of all time (Quantum Mechanics), I am also picking up a new course in the spring (PHY102: Astronomy, Cosmology, and Astrophysics) on top of still trying to turn my Ph.D. thesis into a paper or two. If you are interested at all in discussing teaching styles, current physics education research, or the quantum indeterminacy of nature, stop by my office anytime! Best of luck to you all with your homework assignments and exams this upcoming academic year."

Gustavus Society of Physics Students

For the second time in three years, Gustavus Adolphus College's SPS chapter was awarded an "Outstanding SPS Chapter" award by the national office. SPS Chapter Awards, selected by Zone Councilors and Associate Zone Councilors, are determined by carefully reviewing the information, photos and supporting material presented in the annual chapter reports. Criteria include: the chapter's involvement in local, zone and national SPS meetings and other professional meetings; participation in SPS programs; outreach efforts to the grades K-12 or the general public; participation in community service; contributions to student recruitment and retention; participation in social events; and interactions with the department's alumni. As seen below, the Gustavus chapter excels in all of these areas.

The SPS, a member society of the American Institute of Physics, is the professional society for physics students and their mentors. At the national level, the mission of SPS is to help students transform themselves into contributing members of the professional community. Course work develops only one range of skills. Other skills needed to flourish professionally include effective communication and personal interactions, leadership experience, establishing a personal network of contacts, presenting scholarly work in professional meetings and journals, and outreach services to the campus and local communities.

Locally, regionally, nationally, and internationally, the SPS offers the opportunity for these important enrichments to the student's experience. SPS now has over 700 chapters on campuses across the country. About 5,000 students take part in chapter activities each year, making SPS the fourth largest physics society in the country.

At Gustavus, SPS helps students to connect with one another and with the faculty and department alumni. The chapter plans and hosts activities approximately twice per week during the school year in four broad areas, with examples given below.

Sally Johnson '15, Elise Mesenbring '15 and Lindsay Rothschiller '15 help to clean up Highway 169

1. **Research talks**: student research; external speakers; alumni talks

2. **Social activities**: Frisbee; soccer; wallyball; water polo; movies; board games; etc. plus occasional field trips, picnics, etc.

3. **Service to the community**: Elementary school physics shows; adopt -a-highway; Habitat for Humanity;

(Continued on page 13)

Camping Trip to the Soudan Mine Neutrino Detector Facility

Andy McRae '16, Dr. Jessie Petricka, Patrick Neri '18, Clark Hickman '18 and Sean Jordan '18 try to keep warm by the campfire

Students inside the mine

Camping breakfast for Daniel Baldwin '16, Brittany Bice '16, XiaoQi Yu '18 and Jackson Laingen '16

Boo!

(Continued from page 12)

College environmental sustainability

4. **Career development**: Journal club; internship and graduate school workshops; alumni networking

The physics events calendar on the department's website always has a list of recent and upcoming events.

In 2014-15, in addition to the nine alumni talks highlighted in the cover story of this newsletter, and the Sigma Pi Sigma induction banquet featured on page 5, SPS held weekly social activities, spring and fall department picnics, and a camping trip to the MINOS neutrino-detector facility at the Soudan mine in northern Minnesota.

They also hosted several groups of elementary school students for Physics Demonstration Days, Science on Saturday, and the fall Science and Nature Camps.

And, the SPS group made its semi-annual trips to clean a section of U.S. Highway 169 near Le Sueur.

Of course, there was time for traditional annual activities like the Halloween pumpkin carving "contest."

The SPS officers for 2015-2016 are:

Co-Presidents: **Emilie Benson '16**, **Will Riihiluoma '17**

Treasurer: **Mikaela Algren '17**

Communications: **Ian McKeag '17**

Activity Coordinator: **Alex Blixrud '16**

Service Coordinator: **Nathan Huber '17**

Junior Representative: **Rochelle Widmer '17**

Sophomore Representative: **Matt Mehrkens '18**

All physics students, and especially new students, are encouraged to be regular participants in SPS. The first meeting of the fall semester will be held on one of the evenings in the second week of classes. At that meeting, the SPS officers will introduce themselves and seek feedback from students on the kinds of activities they would like to have during 2015-2016.

SPS Officers at the Fall 2014 introductory meeting

At the same meeting, all of the professors will introduce their research programs, and talk about openings that exist for students to be involved in research during the year. And, if tradition holds, there will be liquid nitrogen ice cream to top things off!

Liquid nitrogen ice cream is a favorite at SPS meetings

Outreach to Local Schools

Matt Mehrkens '18 demonstrates angular momentum with a bicycle wheel

Ben Burney '15 draws a crowd around his liquid nitrogen demonstrations

Will Riihilouma '17 and Josh Weisenfeld '17 prepare to fire the "potato cannon"

Second Annual Summer Camp in High-Altitude Ballooning

During the week of July 19-25, Gustavus professors **Steve Mellema** and **Chuck Niederriter** held an academic summer camp for high school students. The goals of the camp were to stimulate interest in science (and physics in particular) among high schoolers, to learn some basic physics (mechanics, thermodynamics, and atmospheric physics), and to develop specific skills in computer programming, instrument building and interfacing.

The basic framework of the camp is to divide the students into teams (which change daily) to solve various problems en route to doing an actual exploration of space with a balloon flight near the end of the week.

At launch, the balloons are roughly six feet in diameter, filled with helium, and can lift up to twelve pounds of payload. The balloons expand as they rise through the atmosphere, and usually reach their bursting point at an altitude of around 90,000-100,000 feet. (This is roughly three times the height of an intercontinental airplane flight.) At that altitude the balloon and its instrumentation are well into the stratosphere, so the temperature profile on ascent first decreases but then begins to increase again. Once it bursts, the payload descends by parachute. The balloon payload contains a GPS module with a radio transmitter using amateur radio frequencies.

By carrying a portable radio receiver with a computer interface inside the chase vehicle, we are able to track the entire flight by latitude, longitude and altitude, with these values conveniently displayed on a map. The goal is to follow the balloon and actually see it land in order to easily recover the payload instruments.

2015 High-Altitude Balloon Campers

Temperature, atmospheric pressure, humidity, illumination level (in the visible, IR and UV portions of the spectrum), level of cosmic-ray muon radiation, and magnetic field are all physical quantities of interest whose values change throughout the flight.

We have small, light-weight sensors that can be flown to measure each of these quantities, along with real-time clocks and GPS sensors to simultaneously record latitude, longitude and altitude,. There are even accelerometers to measure the turbulence experienced during the flight. Some of these sensors are stand-alone, but most rely on the use and programming of an Arduino microcomputer to interface with the sensors and a micro-SD card to record their values for downloading once the payload boxes are recovered.

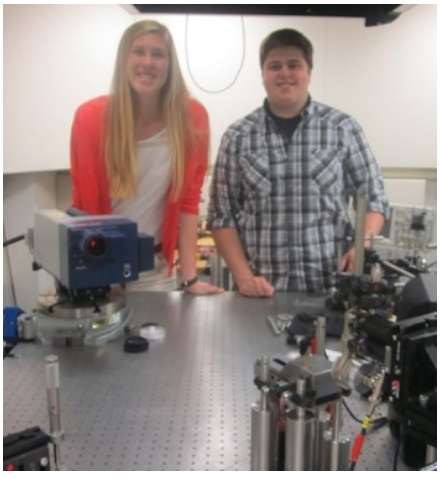
A major issue is providing both instrument power and heat to the payload boxes, because at 90,000 feet the outside temperature is around 60 below zero Fahrenheit. (Payload boxes are built from highly insulating Styrofoam.)

On Sunday evening, the campers arrived, registered, had dinner with the professors, and then attended an overview talk and tour of the physics labs in Olin Hall. On Monday, they learned about Newton's Second Law, buoyancy, gravity, air resistance, and ascent velocity. They tested their knowledge by launching a small helium balloon inside the atrium of Beck Hall, making a video recording of its ascent, and then dig-

(Continued on page 16)

Summer Internships

(Continued from page 9)
radiation force of ultrasound. The hope with this research is that it might soon be used to test for damages or defects in mechanical parts, such as jet turbine blades. The theory behind this testing is that damaged or defective parts will vibrate differently than parts that are in good condition. Of the potential methods for exciting vibration in objects, ultrasound is a promising choice because it can produce a large bandwidth of excitation frequencies, it's non-contact, and the focal spot of the force distribution it produces is quite small (a few millimeters in diameter) when compared with most other methods of excitation, such as mechanical shakers and low-frequency speakers. In our lab we use the acoustic radiation force of ultrasound to vibrate a small (about 19.6 mm tall, 8 mm wide, and .3 mm thick) brass cantilever. To measure these vibrations, we use a super cool PSV-400 Scanning Doppler Laser Vibrometer, which determines the velocity of material at the focus-point of its laser by measuring the Doppler Shift of returning light.



Mikaela and Cole in the Ultrasound Lab

After working to characterize the outputs of a few different ultrasound transducers this summer, we have lately been working with one transducer, the Broadband Air-Coupled Transducer (BAT) 6, which is among the most powerful air-coupled transducers in the world. Armed with a data set from the manufacturer of the radial pressure distribution for the output of this transducer, we have set out to develop a method for reproducing these data with measurements that we can take in our own lab."

Rochelle Widmer '17 writes, "I am involved in the CDC (the Coalition to Diversify Computing)/CRA-W (Computing Research Association-Women) Distributed Research Experiences for Undergraduates (DREU). I got matched with a computer science professor at the University of Minnesota who specializes in graphics, animation, artificial intelligence, and robotics. The project was proposed by a plastic surgeon who worked a lot with facial reconstructive surgeries on patients that had partial paralysis. Many of the surgeries that the doctor had performed were to reconstruct smiles. To do this, she had to replace the paralyzed facial muscles with functioning muscles from other parts of the body. The surgeon was mostly interested in viewing what the outcome of the procedure would look like before performing the surgery. What I'm working on is displaying the face graphics on a 3D TV to determine if seeing the digital face in 3D is useful for the doctor (rather than just 2D). We also want to have the movement of the face image displayed on the 3D TV to be controlled by the user viewing the image. We are doing this by using face tracking. To track the user's face, we are using an infrared camera placed on the TV and reflectors attached to the user. The infrared camera sends out infrared signal and the reflectors send the signal back to the camera. From this, the camera is able to detect the location of the user. With all of this, the face we have displayed on the TV will appear 3D and the user will be able to physically move around in front of the camera to move the image around on the TV. I've attached a picture of the face that I'm working with."

The 3D Computer-Reconstructed Face

Internships are an important part of a physics major's experience. As evidenced in this article, they can give students exposure in a wide variety of technical fields, and help them to decide where their interests lie for future careers and graduate studies. We encourage all students to talk with their advisor or physics professors to learn about applying for internships for next summer.

This Summer's High-Altitude Balloon Flight

(Continued from page 14)

itizing and analyzing the video to determine the terminal velocity.

On Tuesday, they learned to operate standalone sensors and began to interface other sensors with the Arduinos. On Wednesday, they continued their Arduino programming and also learned to operate both video and time-lapse cameras. That day concluded with payload box construction. On Thursday, everything came together for an afternoon launch.

As a result, the international group of attendees, with three from Cancun, Mexico, two from California, and one from Minnesota, learned about the earth's atmosphere firsthand by building payloads to record data and take pictures as the balloon

Launch time!

Balloon chasers' picnic dinner at Madison Lake

rose to 87,000 feet. The highlight, of course, was the launch and chase of the balloon with three payloads attached. Because of the relatively slow ascent, we were able to enjoy a leisurely dinner on Madison Lake and a break for Dairy Queen in Owatonna before the balloon burst and the payload began its descent. It finally landed, shortly before dark, in a corn field just outside Blooming Prairie. Using a GPS we searched through the 10-foot high corn until we had to give up for fear of getting lost in the darkness and corn. We were able to recover the payloads quickly the following morning, although we had to drive back and forth to Blooming Prairie again. Although one box of instruments failed completely due to power problems, we found quite a few good pictures and videos and one almost complete set of data from the variety of sensors onboard the other boxes.

High-altitude balloon flights are a relatively inexpensive and interesting way to study near space. The Gustavus physics department also plans both fall and spring-semester launches to involve our own students in this fun and exciting activity.

Parachute and payload in the corn

Happy campers reunited with their payloads

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: Chuck Niederriter using his quadcopter camera

Physics Department
Olin Hall
800 West College Avenue
St. Peter, MN 56082 USA

physics.gustavus.edu

Phone: +1(507)933-7308