



GUSTAVUS



PHYSICS

Physics Department Newsletter

September 2013

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Important Fall Dates:

Classes Begin	Sep. 3
Last Day to Register for Fall Classes	Sep. 16
Interim Experience Registration Begins	Nov. 4
Spring Semester Registration Begins	Nov. 10
Final Exams Begin	Dec. 16

Goodbye and Hello to Familiar Faces

After more than two decades, our dedicated Administrative Assistant retires; after only five years, one of our own physics graduates comes back to teach at Gustavus.

Linda Hewitt Retires

Ever since we moved into the newly constructed Olin Hall in the fall of 1991, **Linda Hewitt** has served as the Administrative Assistant for the Departments of Physics and Mathematics/Computer Science. Linda has announced her retirement, effective Friday, September 13, 2013.

On behalf of every faculty member who has taught in each of the departments, and especially those of us who have served as department chairs over the years, we want to thank Linda from the bottoms of our hearts for keeping us on track and going forward for all these years.

It is a tremendous workload to serve two departments with almost twenty faculty members, manage dozens of student workers, and administer almost yearly faculty searches, in addition to performing all of the other administrative tasks that the College demands.

Linda writes, "I've enjoyed working



Linda and Al Hewitt at Big Sur

in the Physics and MCS Departments these past 25 years. I certainly will miss the people at Gustavus. But, I am looking forward to retirement. In November, Al and I will become first-time grandparents. We had always planned to do more traveling when we retired, but with a grandchild in New York City, we definitely expect to be going to the Big Apple a little more often."

Above is a photo of Linda and her husband Al on a vacation trip this summer to the Big Sur area of California. We wish Linda and Al many such happy journeys in retirement.

Thank You, Linda!

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Student Majors Garner Awards

Ten Seniors Inducted into Sigma Pi Sigma

On the evening of April 16, at a banquet attended by faculty, students, and family members, ten senior physics majors were inducted into the Gustavus chapter of Sigma Pi Sigma, the national physics honor society.



Nick Neutkens ('13) leads the buffet line at the Sigma Pi Sigma banquet

$\Sigma\Pi\Sigma$ 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.”

This year’s inductees, all from the graduating class of 2013, were **John Bisgaard, Andrew Broscoff, David Buckley, Anna Caruso, Laura Dahl, Brian Grundmeyer, Nicholas Neutkens, Lucas Seewald, Samuel Weiers and Madison Wroge.**

Gustavus physics alumna **Dr. Heidi Manning ('90)** delivered the annual



Inductee Laura Dahl ('13) receives her Sigma Pi Sigma Award from Physics Chair Paul Saulnier



Banquet speaker, Dr. Heidi Manning ('90), with one of her mentors, Emeritus Professor of Physics Dr. Dennis C. Henry

Sigma Pi Sigma lecture entitled "The Curiosity Rover and the Martian Atmosphere". After graduating from Gustavus, Heidi attended graduate school at the University of Minnesota, where she received her Ph.D. in Physics in 1995. Since 1997 she has been on the faculty at Concordia College in Moorhead, where she holds the title Professor of Physics. She is also an active experimental researcher in planetary atmospheres and a NASA collaborator. As one of the scientists who built the instruments for the Curiosity rover, she gave us a fascinating look into the current state of knowledge of the Martian atmosphere.

2013-2014 Departmental Awards

As we do every year, the department is recognizing a number of returning majors with awards for the 2013-2014 academic year.

Ed Kluender ('14) has been selected as 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, and 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 **Peter Crady ('14)** as the winner of the 2013-2014 John Borneman Prize Par Excellence in Mathematics. This award was designated, by his family, in memory of John Borneman, a 1955 Gustavus graduate. It is presented annually to an outstanding

student in the fields of mathematics and physics.

Marah Sobczak ('14) 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.

Troy Seberson ('14) 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.

Mara Johnson-Groh ('14) 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."

Eric Hanson ('16) received the Harold Q. Fuller Memorial Award in Physics, which is given to the first-year student who has 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 and physics professor and dean at the University of Missouri, Rolla) for his lifetime commitment

to the teaching of young people.

Jeffrey Dubose ('14) and Patrick Ernst ('15) each received a Most Improved Award, as the physics major within their class who showed the most improvement during the 2012-2013 academic year.

Elliot Bell ('14) and James Trevathan ('14) will serve as the Physics Departmental Assistants for Fall Semester 2013. 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.

Student Receives Two National Awards

Gustavus physics major **James Trevathan ('14)** has won two prestigious national awards. James is the recipient of a 2013 Barry M. Goldwater Scholarship, the premier undergraduate award for students pursuing careers in the fields of mathematics, the natural sciences, and engineering. An Apple Valley native, he is the 19th Gustavus student since 1992 to receive a Goldwater Scholarship. James is one of 271 undergraduates to receive a 2013 Goldwater Scholarship, which covers the cost of tuition, fees, books, and room and board up to a maximum of \$7,500 per year for two years. Scholars were selected on the basis of academic merit from a field of 1,107 mathematics, science, and engineering students who were nominated by faculty members at colleges and universities nationwide.

James has also been named a Rossing Physics Scholar for 2013-14. James will receive a \$10,000 scholarship from the Thomas D. Rossing Fund for Physics Education. The

fund is named for Dr. Thomas Rossing, an accomplished physics scholar who chose to support the study of physics at colleges and universities affiliated with the Evangelical Lutheran Church in America (ELCA) by providing scholarships and other financial aid to exemplary physics students.

In his three years at Gustavus, Trevathan has taken advantage of numerous student-faculty research opportunities, interned at the Mayo Clinic in Rochester, and earned a scholarship from the Minnesota High Tech Association.

James spent the summer after his freshman year conducting research in **Tom Huber's** acoustics lab. That research involved the vibration of cantilevers with the use of a laser vibrometer. He has also worked with **Paul Saulnier**, studying the intensity distribution of laser speckle produced by the spatially coherent waves passing through diffuse media.

After he graduates from Gustavus in the spring of 2014, James is planning to apply for a seven-year graduate school program at Mayo Graduate School that would allow him to earn both an M.D. and a Ph.D. in biomedical engineering.



**Gustavus physics major
James Trevathan ('14)**

Physics Graduating Class of 2013



Back Row (Faculty): Jim Miller, Jessie Petricka, Paul Saulnier, Steve Mellema, Chuck Niederriter; Middle Row: John Bisgaard, Nick Neutkens, Derek Evenson, Laura Dahl, Anders Culver, Brian Grundmeyer, Mike Patton. Front Row: Madison Wroge, David Buckley, Anna Caruso, Lucas Seewald, Sam Weiers, Amanda Hawkinson, Andrew Broscoff.

On June 2, seventeen physics majors crossed the stage at Commencement 2013 and then came to receive their diplomas from the physics faculty. As is true every year, they are leaving with a wide variety of post-graduation options. Some of them have shared their plans and left advice for future physics graduates.

John Bisgaard will be attending graduate school in electrical engineering at the University of Minnesota.

Andrew Broscoff has accepted a job at IBM Corporation in Rochester.

David Buckley writes, "I plan to attend graduate school for mechanical engineering at the U of MN - Twin Cities this fall. While I considered graduate programs in physics,

math, and several different types of engineering, I ultimately decided mechanical engineering was the path that fits best with my interests. I hope to do research on improving the efficiency of photovoltaics or sustainable life-cycle analysis.

"In my opinion, doing research as an undergraduate is an essential piece in determining what path to take upon graduation. Plus, it's really fun! I also encourage anyone new to the program to go to SPS events! The community available in the SPS at Gustavus is wonderful. Finally, do not hesitate to contact alumni to inquire about opportunities, applications, or just general future advice."

Jeremy Caplin will pursue graduate studies in mechanical engineering at Iowa State University.

Anna Caruso says, "Gustavus students are lucky in that we have opportunities presented to us every step of the way. At Gustavus I was able to play in the band and orchestra, play with animals at Pound Pals, play Bingo at nursing homes, become a bit more globally aware with Crossroads, travel abroad with the orchestra, read books and discuss films in the English department, and take ballet classes just for fun, all while working for and taking classes in the physics department.

"I found it to be a place where students are not pigeonholed and a place where students take priority. I must admit that I am currently a little nostalgic for those endless opportunities as I start my grad school ca-

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reer at the University of Utah and find myself, for the first time, having to actually focus on one topic. This summer, I have been able to start on my research and am currently working on understanding and improving some drive-level capacitance profiling techniques that will be used to analyze the density of defect states in layers of semiconductor materials used to make photovoltaics. And while my school work will be focusing on my research and Electrical Engineering in general, I still possess the true Gustie spirit to do it all and plan to join a community orchestra and a dance class or two this year.”

Anders Culver writes: “I just accepted a job offer with TUV SUD America as an Electromagnetic Compatibility Technician, running emissions and immunity tests on electronic systems and components. It is actually the position that was formerly held by **Ryan Chouanard** (#12) too! As for long term goals, I hope to use this experience to begin a career in engineering, I'm especially interested in the semiconductor production industry, and potentially going into graduate studies for this.

“Words of wisdom: Have a great time with the students in your major, they will become a group of great friends through your years at Gustavus.”

Laura Dahl says, “My experiences at GAC were amazing. I am so thankful for all the encouragement and support I received throughout my four years. My ‘words of wisdom’ would be to cherish your time with your peers and to get started on your future plans sooner rather than later. This makes spring semester very enjoyable if your plans are set! As of now I am working as a

Loudspeaker Engineering Intern and will be moving to Bozeman, Montana very soon to pursue a Ph.D in Electrical Engineering at Montana State University. Good luck and keep your heads up this coming year at GAC.”

Derek Evenson writes, “Recently I have received a few job offers for mechanical engineer positions and hopefully will be starting work in the engineering field in early September.

“Don't be afraid to have a life outside of physics. Get out on campus and get involved. Join a club, make a club or join Greek life. I'm equally as grateful for the skills I learned being involved as I am for the ones I learned in the classroom.”

Brian Grundmeyer says, “I had an awesome time while in the physics department at GAC! I was very impressed with all the professors I had the opportunity to learn from. The ability to excel in the classroom and on an athletic field is just one of the great things about Gustavus. I will be attending the University of Minnesota in the fall to pursue a graduate degree in Mechanical Engineering. My advice would be: use the tutors if you are struggling with the transition from high school, don't be afraid to ask questions, and don't wait until the night before it's due to start an assignment.”

Amanda Hawkinson has applied to join the Peace Corps, and is awaiting an invitation for a posting, hopefully this year.

Nick Neutkens writes, “I am currently working as a research assistant at the UW Madison Atmospheric Science program. I will begin classes in the fall as I work towards obtaining either a Masters or Ph.D. degree (I have the flexibility to decide which

I want to pursue in the next couple years). If I receive my Masters, I plan on working for the National Weather Service, or to continue working as a researcher for another research facility (many students from my program have worked at the Goddard Space Flight Center, so that is definitely an option). If I receive my Ph.D., I'll most likely want to teach at a college or university in Minnesota.

“My words of wisdom would be to get ahead in your homework and studying when you can. Doing one or two problems a day sure beats the stress of an all-nighter, and it gives you the opportunity to track down your professors with your questions before you turn in an assignment!”

Lucas Seewald is pursuing a Ph.D. in physics at Rensselaer Polytechnic Institute in Troy, NY.

Madison Wroge tells us, “When I realized that physics was the science that truly interested and challenged me, I switched my major and began taking physics classes my sophomore year. The first year in physics may have been the most challenging for me, as my brain was learning how to work in a different way and my mind was trying to overcome the fears of starting the major a year behind. Through the unconditional support and help of the professors, through the classes that continued to challenge and excite me, and through the assistance and friendship of my classmates, I finished my physics major in three years. As of now, I plan to attend the University of Minnesota in the fall on track for a PhD in Mechanical Engineering. Although this next step in my education seems daunting, I feel my major from Gustavus has prepared me well for the newest endeavor in my life.”

2013 Student Summer Experiences

Internships of an Amazing Variety

A record seventeen Gustavus physics majors were involved this summer in internship experiences that were both geographically and topically diverse. Most of them have written to share something of their experiences.

Wyatt Adams ('14) writes, "I have been working on a research project in the University of Utah NSF Materials Research Science and Engineering Center (MRSEC) REU. The MRSEC is focused on studying two cutting-edge interdisciplinary fields, plasmonics and organic spintronics. I am working in the research group led by Prof. Michael Scarpulla, who is also my project advisor.

"My project is formally titled 'electrical characterization of bulk-heterojunction organic solar cells'. The goal is to confirm a hypothesis that the addition of a spin one-half radical molecule called galvinoxyl to the active layer of P3HT/PCBM organic photovoltaic devices significantly increases their efficiency. They believe the reason for this is that the galvinoxyl spin flips the photogenerated polaron

pairs (polaron pair meaning an electron and a hole) inside the active layer, taking them from a singlet state to a triplet state. The triplet state is more stable and has a longer lifetime, which allows the electron and hole more of a chance to break their Coulombic bond and contribute to the short-circuit current of the device, therefore increasing the efficiency. When the polaron pairs fail to do this and radiatively recombine, they output a photon in a process called photoluminescence. My job is to measure the time-resolved photoluminescence of these devices in order to show that the reason they exhibit higher efficiencies is in fact that the galvinoxyl decreases the recombination rate of polaron pairs. If I am able to this, we will have new knowledge of how organic photovoltaics work and how we can continue to improve them."

This summer, **Peter Crady ('14)** and **Ed Kluender ('14)** worked with **Professor Tom Huber** researching ultrasound acoustics at Gustavus. They write, "The end goal of the summer was to characterize the air signal of a converging ultrasound transducer that is used to induce non-contact vibrations in materials. The benefit of non-contact vibration is that it allows you to measure the vibrational modes of an object without disturbing its natural frequencies. If you were to place a mechanical shaker on an object, wherever your shaker is touching will vibrate with the shaker as opposed how it would vibrate freely. The ultrasound transducer emits a combination of two ultrasound waves that are a certain frequency apart. This difference in frequency creates beats in the signal

that in turn drive the object to vibrate.

"Over the course of 10 weeks, we wrote and tested new programs to both emit the signals and to record the vibrations. In order to measure the ultrasound wave in the air, a vibrometer is shot through the wave. The difference in air density changes the speed of the sound and creates a Doppler shift that is measured by the vibrometer. Using a lock-in amplifier, the signal can be measured more precisely. The relationship between the strength of the vibrations caused by the signal and the air signal was measured and is beginning to be quantified. Other fun objects' vibrational patterns were also studied, including organ-pipe reeds, drum heads, and even guitars."

Will Doebler ('15) and **Josh Wolanyk ('15)** write, "We spent the summer here at Gustavus working under the supervision of **Dr. Jessie Petricka** in his Atomic Molecular Optics (AMO) Ion Trap lab. We worked toward the installation and calibration of a homemade Time of Flight (ToF) Mass Spectrometer as well as many side projects. Over the course of 10 weeks we gained experience in many helpful research skills such as computer modeling and programming, as well as elec-



Wyatt and a Nd:YAG laser



Josh and Will and the ToF Mass Spec



tronic, vacuum, and laser systems. Spending more than 40 hours per week in the lab helped prepare us for future research opportunities and maybe even the 'real world'.

"The tube with the "T" connector in the photo is the ToF mass spec that we put into place. We also built the components inside the metal boxes on the left. The components included wire wound, center-tapped transformers, and a pair of high voltage, fast turn-on circuits. We also installed the tube on the right, which houses a residual gas analyzer, and put on a mass flow regulator that will be used in later projects to pump in buffer gasses to cool the trapped ions. We learned how to be effective in the machine shop at Gustavus, working on the lathe and mill and also fixing a couple of vacuum pumps. It wasn't all work: we were able to go sailing with the other on-campus physics researchers which was a boatload of fun!"

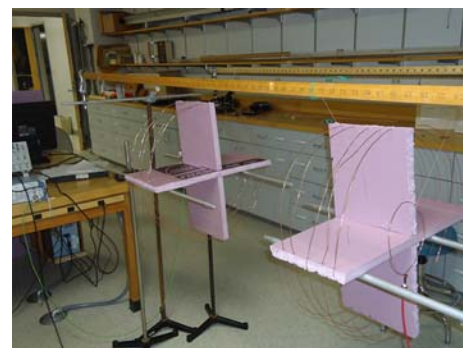
Kellan Euerle ('14) writes, "I am participating in the NanoScience and MicroSystems REU at the University of New Mexico under the guidance of Dr. Plamen Atanasov, whose research group works on the development of inexpensive non-platinum electrocatalysts for use in fuel cells. My project is to test and optimize the combination of non-



Kellan working on an electrochemical cell.

platinum inorganic catalysts with enzymes. The reason for combining the two is that each has desirable electrochemical properties for oxygen reduction, and hopefully the combination will produce optimal activity. The final goal is to employ these catalysts at the cathode of bio-fuel cells. Throughout the summer I have been creating samples and running electrochemical tests on them. In the near future I will be working on optimizing a specific combination."

Eric Hanson ('16) says, "I am spending my summer right here at Gustavus performing research related to wireless power transfer with **Dr. Jessie Petricka**. I found this opportunity via Gustavus' First Year Research Experience (FYRE) program. This program allowed eight first year students to find research projects to work on at Gustavus this summer, effectively giving us an opportunity to get a jump start on undergraduate research. My specific project attempts to use coupled, highly resonant LC circuits to transfer power over variable distances. The project consists of theoretical modeling done with COMSOL Multiphysics and of experimental work done using copper loops and helices. By taking two tuned LC circuits, I am able to drive one with an alternating current and couple it with the other circuit. At the resonance frequency, this produces wireless power transfer. The resonant frequencies are in the radio region of the electromagnetic spectrum and have very long wavelengths. This allows them to travel through barriers such as foam pieces, wood, and even cement. To date, I have managed to transfer enough power to light an LED."



Eric's Wireless Power Transfer Coils

Mara Johnson-Groh ('14) writes, "This summer I'm doing an REU in association with the National Center for Atmospheric Research and the High Altitude Observatory in Boulder, Colorado in solar physics. I'm working to calibrate a new telescope, ChroMag, which images the chromosphere of the sun at specific wavelengths in order to infer the magnetic field of the chromosphere. Most of the summer I have been working on developing a method to flat field images. ChroMag is currently a prototype instrument that will eventually be placed on Mauna Loa, Hawaii."

Serenity Mahoney ('15) sent this: "**Patrick Ernst ('15)** and I are working as full-time interns for the Sudan Underground Physics Laboratory. We start our days by traveling 1/2 mile underground in the old miner's cage down a shaft that runs at a 78 degree angle. Like the miners, we ride down in complete darkness, only seeing light when we pass the two pumping stations. Once we make it down to the 27th level, 2,341 feet below the surface, we enter the high energy physics laboratory. We start our 10-hour days by running through the MINOS (Main Injector Neutrino Oscillation Search) detector checklist that we share with Fer-

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Student Summer Internships

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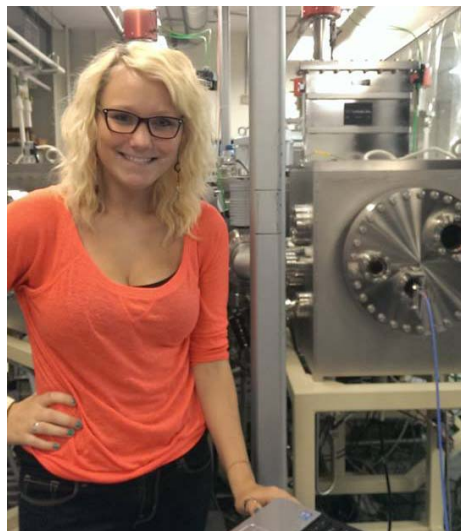


Serenity Gives a Tour of the Soudan Underground Laboratory

milab. Besides checking the detector, we also give tours twice daily. When we are not giving tours we are expanding the outreach program, researching the physics behind the experiments, and helping the lab technicians test and replace parts on both the MINOS and CDMS (Cryogenic Dark Matter Search) detectors. On Thursdays we also travel 80 miles north to the NOvA (NuMI Off-Axis Electron Neutrino Appearance) detector that is currently being built. We give tours of the facility and explain the new detector's purpose.”

Elise Mesenbring ('15) says, “I'm doing an REU at the University of Toledo with faculty mentor Nikolas Podraza. UT does a lot of work producing thin-film solar cells. The group I'm working with is focused not only on producing the solar cells, but also looking at chemical interactions during the process to see what makes the solar cells most efficient. They take ellipsometry measurements, both during and after the making of the cells, and use this information to change deposition parameters to improve the cells. This summer I've learned how to take the ellipsometry measurements of the solar cells, and learned how to use the chamber tool used to produce the solar cells. We ordered a spec-

trometer for our lab, and I got to be the first person to learn how to use this new equipment and its software during depositions. I've focused on using optical emission spectroscopy during sputtering depositions of Zinc Oxide in argon plasma. I take OES measurements of the sputtering plasma every 45 seconds during these depositions and look at the wavelengths emitted by the plasma to identify the specific species in said plasma. My goal was first to confirm that the zinc and argon peaks appear where the literature suggests, and secondly to look at the intensity vs. wavelength graphs over the course of the deposition to see if the plasma chemistry is changing over time.



Elise and the Chamber Tool

Then I've also changed some of the deposition parameters such as the rf power of the plasma to see how this affects the OES graphs.”

Briana Mork ('15) has been at the University of Michigan Biophysics REU. She is using pulse shaping to enable selective, multi-color, two-photon fluorescence microscopy using a broadband, pulsed laser. Development of the pulse shaping has used genetic algorithms to selectivity

excite fluorophores (enhancing or suppressing fluorescence).

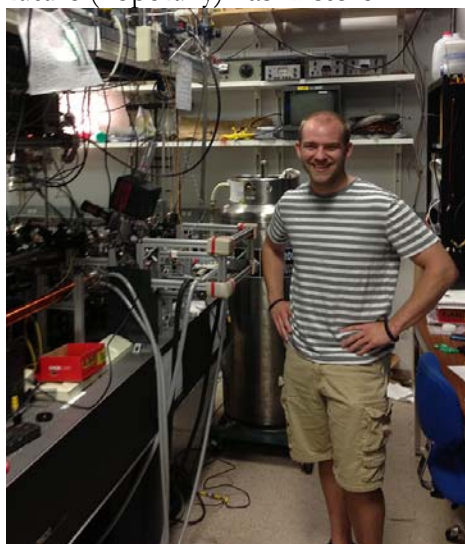
Olivia Palmer ('14) writes, “I spent the summer working in a microbiology lab through Idaho State University's NSF-REU program. My work involved isolating desiccation resistant samples of psychrophiles from Antarctica and halophiles from the Great Salt Lake and examining their stress response mechanisms in comparison to *Deinococcus radiodurans*, the most radiation resistant organism known. There is a strong correlation between radiation resistance and desiccation resistance. The hope is to understand the mechanisms behind these powerful stress response systems to see if there are any analogous structures in eukaryotes that would allow us to utilize the stress response mechanisms seen in these extremophiles. This could potentially lead to protecting tissue surrounding a cancerous tumor from radiation therapy, as well as many other awesome biotechnology applications. Idaho State University is known for their center which houses over 40 accelerators. In the future, the samples I have isolated may be irradiated to test for radiation resistance. It was a really fun REU program; every weekend we did a range of activities like caving, hiking, whitewater rafting, horseback riding, and we even took a trip to Yellowstone to go camping for 4th of July weekend.”



Olivia and the other students whitewater rafting

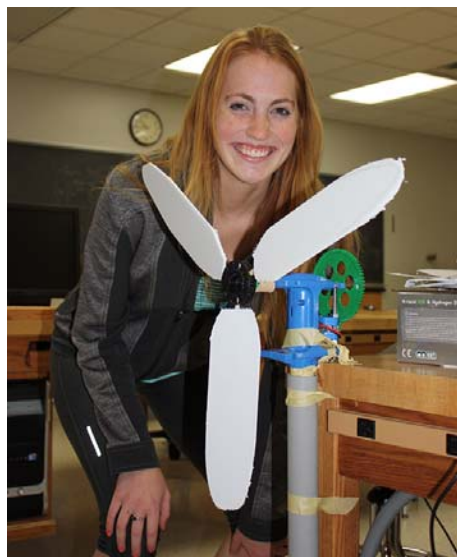


Grant Rorem ('14) says, "I am participating in a 10-week REU funded by NSF at the University of Michigan. I am working in Dr. Georg Raithe's AMO (Atomic Molecular and Optical) physics lab, with ten other graduate students. My responsibilities include helping build and design parts of an experimental apparatus that will attempt to measure the Rydberg constant with high precision, up to 12 decimal places. A recent experiment measured the radius of the proton to be much smaller than previous measurements. This result has prompted the investigation into potential shifts in the Rydberg constant, as well as possible deficiencies in the model of Quantum Electrodynamics. I have been fabricating lasers and electronics for the new experimental setup that attempt to measure the Rydberg constant more accurately. Along with research, our REU visited Fermilab, which was the first time I had seen it. It is a beautiful facility, and is a great inspiration for an aspiring physicist. Overall, the summer has been a great opportunity to learn new physics and experience what the future (hopefully) has in store."



Grant at the University of Michigan

Lindsay Rothschilder ('15) writes, "This summer, I am working with **Professor Chuck Niederriter** on incorporating sustainability across the curriculum. I helped edit labs that future students will perform in science classes at Gustavus. I have been designing a lab exploring wind turbines. Using materials from Kid Wind (<http://learn.kidwind.org/>), I'm working on creating a lab that will encourage students to build the most efficient wind turbine.



Lindsay's Wind Turbine

Students will experiment using gears and magnets to generate electricity and choose from different materials, shapes, sizes, pitch and number of blades. Recently, I have been working on finding a way to measure temperature in the geothermal pipes under Olin. I have been using an Arduino, which is an open-source electronics prototyping platform. The temperature in the pipes can be measured using an Arduino board and writing the data onto an SD card. We hope to have a prototype system up and running by the end of the summer."

Troy Seberson ('14) says, "I am at NIST (National Institute of Stan-

dards and Technology) and I am working on an experiment to measure the electric dipole moment of the neutron (nEDM). The Standard Model of Particle Physics is known to be incomplete, as it omits gravitation and fails to explain dark matter or dark energy which together make up 95% of the universe. The neutron electric dipole moment (nEDM) may hold the key to understanding these problems in the Standard Model. Current limits put the nEDM as no greater than 2.9×10^{-25} e-cm. Predicted to be non-zero from Super Symmetry and other theories, a discovery of a nEDM would revolutionize our understanding of the universe.

"The method to measure the nEDM is being systematically verified through a measurement of the magnetic dipole moment of the neutron (nMDM) which is well-known through previous experiments. Both the nEDM and nMDM experiments use spin-polarized neutrons that are reflected many times down a slotted perfect crystal held in a magnetic field. On each reflection a small rotation of the neutron's spin occurs via the interaction with the atomic electric fields in the crystal. The degree of rotation is directly related to the nEDM or nMDM through known physical constants. Multiple reflections in the crystal increases the neutrons' spin rotation to a measurable amount. I simulated the apparatus and each component's magnetic field contribution in Mathematica. I wrote a program in Visual Basic so that I was able to cancel Earth's magnetic field contribution using four Helmholtz coils. And currently I am mapping the magnetic field in the apparatus experimentally."

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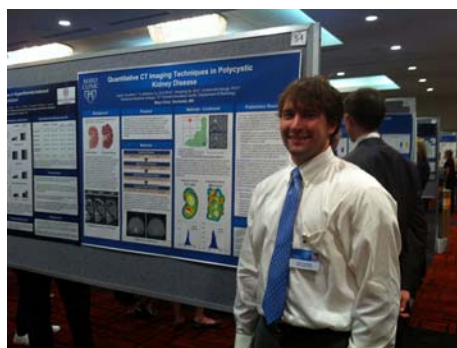
Department News

Student Summer Experiences

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James Trevathan ('14) writes, “I have been working at the CT Clinical Innovation Center at the Mayo Clinic. The CT Clinical innovations center is an interdisciplinary collaboration formed between clinical investigators, research scientists, and industry partners with the mission of facilitating high-impact imaging innovations that will translate into impacts in patient care. I have continued a project which I started last summer developing quantitative CT imaging methods for Polycystic Kidney Disease (PKD). I started the summer writing an algorithm to quantify the volume of calcification in the kidneys of PKD patients and applying it to a cohort of 500 CT

scans with the hope of correlating calcification volume to kidney function and being able to better predict end-stage renal disease. I then moved on to apply an algorithm for quantifying the spread in curvature of an object to polycystic kidneys with the hypothesis that kidney curvature could be used as a surrogate



James presents his results on CT imaging

measure for deformation of functional tissue in the kidney. I was able to show that the combination of kidney volume and kidney curvature as a metric for disease progression leads to a better correlation with kidney function.”

Having a summer internship experience is extremely valuable for a physics major, and we encourage everyone to participate in at least one during their years at Gustavus. They provide real world experience and a chance to evaluate a potential career. Students should talk with their advisor and keep an eye on the department bulletin board and web pages for internship opportunities for the summer of 2014.

Changes in Physics Department Staff

(Continued from page 1)

Danielle Berg Returns

In May of 2008, Danielle Berg graduated from Gustavus, one of a record-breaking seven women physics majors. This year, she returns to join us as Visiting Assistant Professor of Physics. She writes, “I am excited to be returning to Gustavus as a visiting physics faculty member!

“I received my B.A. in physics and math at Gustavus in 2008 and completed my Ph.D. in astrophysics at the University of Minnesota in 2013. I study the chemical evolution of other galaxies using optical spectroscopy. In particular, I look at the amount of oxygen, nitrogen, sulfur, and carbon relative to hydrogen in star-forming regions, which trace the cumulative history of star formation

in those galaxies. I have traveled to some of the largest optical telescopes in the world and taken observations of many dwarf and spiral galaxies in the nearby universe. These data allow us to place better constraints on theoretical models and improve our understanding of galaxy evolution.

“I love to interact with students, and am particularly excited to bring some of this real world astronomy research to the spring Astrophysics class here at Gustavus. Outside of academia, I enjoy teaching group fitness, traveling, and being as active as possible. I live in and LOVE Minneapolis. I love running and biking around the lakes, trying any type of new food, and attending any type of music, dance, or art event! And of course, I love meeting new people.



Dr. Danielle Berg ('08)

“I look forward to meeting all of you this Fall. Please stop by my office to say hi, chat, or ask questions any time.”

"The Universe at Its Limits"



(Continued from page 16)

Prize winner in physics, and principal investigator on the AMS experiment aboard the International Space Station, which aims to identify the origin of dark matter in the universe.

George Smoot is Professor of Physics, University of California, Berkeley; and Senior Scientist, Lawrence Berkeley National Laboratory. He won the 2006 Nobel Prize in Physics, and is a cosmologist who studies the cosmic microwave background radiation from the early universe.

Lawrence Krauss is Foundation Professor of the School of Earth and Space Exploration, Department of Physics and Director of the Origins Project, Arizona State University. He

is a cosmologist whose popular books "The Physics of Star Trek" and "A Universe from Nothing" have helped bring the science of cosmology to a general audience.

Father George Coyne is McDevitt Chair of Religious Philosophy, Le Moyne College, Syracuse, N.Y. and Emeritus Director of the Vatican Observatory. An experimental astronomer and a Jesuit priest involved in the dialog between science and religion, he has advocated a "third way" to envision the role of God in the universe.

Sylvester James Gates, Jr., is University System of Maryland Regents Professor, John S. Toll Professor of Physics, and Center for String and

Particle Theory Director, University of Maryland. A renowned string theorist, he studies the mathematical symmetries that underpin the most fundamental entities in our universe.

In addition to speaking at the conference, Professor Gates will serve as this year's Rydell Visiting Professor. He will deliver a conference preview lecture on **Friday, September 20 at 2:30 PM in Alumni Hall.**

And, on the afternoon before the conference convenes, Gustavus physic alumna **Dr. Kirsten Tollefson ('92)**, Assistant Professor of Physics at Michigan State University, will present a talk on her work in high-energy physics at 4:30 PM, Monday, September 30, in Olin 103.

Nobel Conference 49 Schedule

Date/Time	Speaker	Title of Talk
Tuesday, Oct. 1, 10:00 AM	Professor Frank Wilczek (Nobel Prize in Physics, 2004)	"Geometric Fantasy"
Tuesday, Oct. 1, 1:00 PM	Professor Tara Shears	"The Innermost Universe; Exploring the Subatomic Frontier"
Tuesday, Oct. 1, 3:00 PM	Professor Alexei Filippenko	"Dark Energy and the Run- away Universe"
Tuesday, Oct. 1, 6:30 PM	Professor Samuel C.C. Ting (Nobel Prize in Physics, 1976)	"Dark Matter in the Makeup of the Universe"
Wednesday, Oct. 2, 10:00 AM	Professor George Smoot (Nobel Prize in Physics, 2006)	"Mapping the Universe and Its History"
Wednesday, Oct. 2, 1:00 PM	Professor Lawrence Krauss	"A Universe from Nothing"
Wednesday, Oct. 2, 3:00 PM	Professor George Coyne	"Quantum Cosmology and Creation"
Wednesday, Oct. 2, 7:30 PM	Professor S. James Gates, Jr.	"The Audience of Nature"

Physics Faculty News

Tom Huber had NSF sponsored funding to allow him to collaborate with **Peter Crady ('14)** and **Ed Klunder ('14)** in the newly completed acoustics lab. In order to interface newly acquired equipment, Ed and Peter quickly became expert programmers in C++ and Visual Basic. One important project involved the first-ever measurements using a laser system to measure ultrasound transmission in air simultaneous with the vibration that it produced. In another interesting project, they worked with **Charles Hendrickson (GAC Physics 1957!)**, president of Hendrickson Organ Company, to investigate vibration of reed organ pipes. Remarkably enough, they discovered that the acceleration of the end of the reed when it was being blown was over 6000 g's! In a final project, Ed and Peter designed an experiment to use the vibrometer to study the vibration of beakers that are used for the classic "Speaker Beaker Breaker" demonstration. They will be preparing a paper based on this project. Huber attended the American Society of Mechanical Engineers (ASME) conference in Portland, Oregon in early August. He gave presentations on the organ-pipe research, and research he did in previous years on ultrasound excitation of microcantilevers. Students with an interest in acoustics should contact him about research opportunities.

Steve Mellema had a most unusual summer. On June 11, he underwent open-heart surgery at the Mayo Clinic to repair an aortic aneurysm and the defective aortic valve that was its cause. That meant almost two months of recovery from surgery, including a cardiac rehabilitation program. Having fully recovered by August, he was able to participate

(along with Chuck Niederriter) in a high-altitude ballooning workshop and flight experiment in collaboration with the University of Minnesota's NASA Space Grant. He also wrote a book review for the *American Journal of Physics*, refereed a long article for *Reports on Progress in Physics*, and edited this newsletter. There was even time in late August for a 5-day vacation trip to Washington, DC. Steve is looking forward to teaching Quantum Mechanics, a Cosmic Universe lab, and the Natural World courses this fall, and especially to leading a group of 13 students on the inaugural Gustavus Semester in Malaysia: Living Diversity in Spring Semester 2014.



Chuck Niederriter prepares to launch a high-altitude balloon

This summer **Jim Miller** worked on posting videos, source code, and other supporting content from his 2013 January-Term class on [game physics](#). (An easy way to find this is to do a web search on *Miller physics engine*.) Looking forward to the new school year, Jim reports, "We've got a few new recruits this fall in our small army of department com-

puters. These new systems will be seen in our advanced labs and the two second-floor lecture rooms." The Miller family also made their annual trip up to Mille Lacs lake and also escaped the late-August heat wave with a trip to the North Shore.

It seemed to take **Chuck Niederriter** until the Fourth of July to get all of the reports written and really get into summer. But, it was still a good one. **Lindsay Rothschilder ('15)** helped put the finishing touches on lab write-ups for the NSF funded project to improve science education using sustainability as a focus. And, Chuck was invited to give a talk at the summer meeting of the American Association of Physics Teachers meeting on that and other sustainability efforts at Gustavus.

A good deal of time was spent preparing for the 2013 Nobel Conference, "The Universe at its Limits." The Nobel magazine went to press in July, giving our audience a quick look at each of our eight superb speakers. In June, Chuck also helped lead a group of eight high-school teachers in a workshop to develop curricular materials to prepare high-school students for the conference. Those eight were joined by five more in July to test and refine the materials, all of which should be on the web very soon.

There were some opportunities to get away this summer, too. Chuck and wife Debbie visited son Robert in Boulder, ostensibly to pick up a new x-ray machine for the department. And Chuck, Robert, and third son Joe (all physicists, by the way) camped on the Oregon coast for three days before the AAPT meeting in Portland. Most of the family visited the grandparents in Pennsyl-

A Balloon Flight and Other Summer Fun



vania for about 10 days, helping with routine maintenance and making occasional trips to the beach.

Hopefully this year will be less busy for Chuck, who is on leave in the spring. His duties as the Director of the Nobel Conference only continue through the fall, and, being on leave, he isn't serving on any College committees. So, that just leaves the Cosmic Universe class, one lab, and advising the SPS group and the Newman Club.

As mentioned above, Chuck and Steve were invited to attend a workshop on high altitude ballooning where they learned how to prepare payloads, launch and track balloons, and recover them. The second day of the workshop saw them chasing their balloon across southern Minnesota. The helium-filled balloon,



Balloon's-eye view of the Gustavus campus taken just after launch. The box seen immediately below the balloon contained a GPS tracking device that broadcast the balloon's position using amateur radio frequencies.

launched from Olin Hall at Gustavus, flew to an altitude of over 80,000 feet before it burst from the increased volume. A parachute then brought it to rest some 52 miles away, just east of Dennison, Minnesota. Possibly the best part was seeing the pictures and video from the on-board cameras (see the photos on this page), as well as the data from the array of sensors in the payload. We were able to monitor latitude,



Balloon view of the Earth from space (Note the curvature of the surface as well as the layer of atmosphere.)

longitude, altitude, atmospheric pressure, interior and exterior temperature, the magnetic field along three perpendicular axes, as well as the instrument box's acceleration along three axes.

Recovery of the instrument box was interesting, and involved a combination of technology, skill and luck. Once it landed, the GPS tracker's antenna lay along the ground, limiting the range of its transmission. Only when we got within about 1/4 mile of the balloon did we receive the GPS details of its location. Once we were within about 50 feet, we could finally hear the attached siren blaring. The lucky part was that it landed in an unplanted portion of a farm field, and only about 30 feet from a tall stand of trees that was directly in its flight path. Had it come down more gradually, we might have been doing some serious tree climbing!

This flight may be the beginning of something new and exciting for the Gustavus physics department.

During the summer of 2013, **Jessie Petricka** worked with three students on two separate projects. Research on the ion trapping project continued with **Will Doebler ('15)**, and **Josh Wolanyk ('15)**. Together they successfully implemented a time of flight mass spectrometer to measure the contents of the ion trap, in the

process trapping elements and molecules from lead to strontium fluoride and much in between. Together with student **Eric Hanson ('16)**, a research project to transfer power wirelessly saw the first lighting of an LED bulb, at a distance of one meter from the source. This project explored and built two separate designs to transfer the power and tested them for their efficiency. In addition to research, Jessie and the students explored the area pizza buffets, and got to take the sailboat out for some good times. In all, much was accomplished to move the projects forward, and their future looks good continuing into the fall. After wrapping up work for the summer, Jessie and his family spent some time hiking and camping in the beautiful Canadian Rocky Mountains.

During the summer of 2013, **Paul Saulnier** spent a significant amount of time preparing to teach the senior seminar course for the Three Crowns Curriculum. The course will be co-taught with Lisa Heldke (Philosophy). This preparation involved readings from philosophy, physics, literature, poetry, and viewing films. Co-teaching this course will be a very different and challenging experience. The summer of 2013 was also filled with preparation for responsibilities that Paul will be charged with during this coming academic year. Paul will serve as the physics department chair and the Kendall Center faculty associate for new faculty programming. As department chair, Paul will try to keep the administrative gears turning. As a Kendall Center associate Paul will be responsible for the new faculty mentoring program and all orientation and training sessions.



Gustavus Society of Physics Students

Gustavus has a very active Society of Physics Students (SPS). SPS is a professional association explicitly designed for students. Membership, through collegiate chapters, is open to anyone interested in physics.

SPS conducts weekly social activities on Friday evenings throughout the year, including wallyball, softball, ultimate frisbee, etc. There are also weekly SPS meetings focused on physics. This past year, 17 Gustavus physics students presented summer and academic year research results at our local SPS meetings. Two students, **Troy Seberson ('14)** and **Mara Johnson-Groh ('14)**, presented their summer research at national meetings. Seven outside speakers from a variety of universities also gave talks on various subjects. Informational meetings, presented by faculty and students, helped students apply for internships and graduate schools. In the spring of 2013, 15 Gustavus physics alumni participated in a panel discussion of careers in physics and related fields. During the year, five Gustie physics alums returned to present individual talks about their current work.

SPS also involves students in community service and outreach activities, including the Minnesota Department of Transportation's



The SPS Adopt-a-Highway cleanup crew from Spring 2013

“Adopt a Highway” program.

This past year members of the SPS club helped hanging sheet rock and rolling sod at a St. Peter Habitat for Humanity house. Members also helped organize the annual shed build for Habitat on the Gustavus campus.

As part of the South Central Service Cooperative's “Science and Nature Camp”, the SPS club provided four physics workshops (demonstration shows) for approximately 145 students from grades 2-6.

The SPS club also helped organize “Science on Saturday” and hosted approximately 250 grade school aged children for demonstrations.



Grant Rorem ('14) demonstrates electrostatics at Science on Saturday

The club hosted the sixth-grade classes from North Intermediate School in St. Peter, when approximately 150 students visited Gustavus for an afternoon of physics demonstrations. SPS was then visited by the third-grade classes from a Mankato elementary school, engaging 55 more students. Members of the club also provided Saturday morning science opportunities on air pressure at the Mankato Children's Museum.

The SPS club also makes field trips. This past year eighteen students and two faculty members toured the MINOS neutrino detector facility at the Soudan Mine and camped out at



SPS Students at the MINOS detector 2,431 feet underground at the Soudan mine in Tower, Minnesota

Bear Head Lake State Park.

For 2013-2014, the Gustavus SPS officers will be:

Briana Mork ('15) and **Troy Seberson ('14)** (Copresidents)
Nicole Ball ('14) (Secretary)
Haley Totzke ('14) (Treasurer)
Jenna Legatt ('14) and **James Trevathan ('14)** (Activities Coordinators)
Lucas Schoen ('16) (Sophomore Representative)

Each fall at the opening SPS meeting, a panel of the physics professors discusses their research projects and presents opportunities for students to become involved. All students are invited and encouraged to attend. Watch for the announcement in the first week of classes and don't miss the event (and the liquid-nitrogen ice cream)!



SPS students and faculty members enjoying liquid-nitrogen ice cream



New NSF Grant for Ultrasound Research

Tom Huber is the lead author on a new \$500,000 grant awarded this spring by the National Science Foundation (NSF). The grant will fund a three-year collaborative project with Gustavus and modal-analysis researchers at the University of Massachusetts-Lowell. The collaboration will use the ultrasound radiation-force excitation technique for vibration testing of objects such as integral blade turbines from jet aircraft engines. By using two ultrasound beams focused onto the object, they can vibrate it without any physical contact. The goal of the project is to move ultrasound radiation force excitation from being a physics technique developed in Huber's acoustics lab into a methodology that can be utilized by the engineering community. Gustavus' \$200,000 portion of this grant will allow Huber to work with two Gus-



The Polytec scanning laser vibrometer in Tom Huber's ultrasound lab has provided a state-of-the art student summer research experience for numerous classes of students. Shown here are James Trevathan ('14), Amanda Hawkinson ('13) and John Schmidt ('12).

tavus students for three summers; **Peter Crady (14)** and **Ed Kluender ('14)** were supported by the grant this summer.

Work Begins in Renovated Labs

This was the first full summer in the physics department's upgraded basement research labs. In October 2010, the department received a \$253,000 NSF-ARI grant for upgrading the research labs in the basement of Olin Hall. During the summer of 2012, the construction finally took place, so these facilities could finally be used this summer. One of the primary goals was an upgraded air-handling system which eliminated the serious problems of humidity, noise and vibration that have hampered the high-precision, low-noise experiments that we pursue in the departmental research labs.

Tom Huber's acoustics research lab now has sufficient sound insulation

that very loud projects (such as organ pipe research) do not disturb other occupants, and so that external noise sources do not disturb experiments that need a quiet environment.

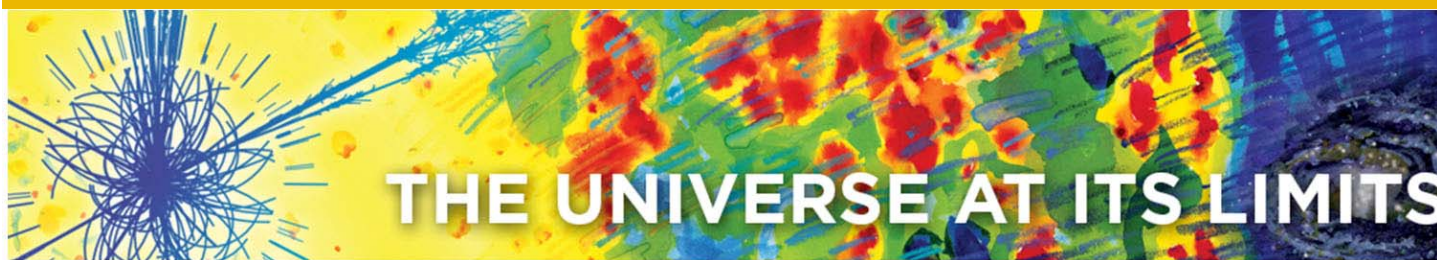
Throughout the basement, the labs' infrastructure has been greatly enhanced by adding overhead equipment racks that include electrical and internet connections, along with other upgrades to the electrical, network, mechanical and safety systems. These upgrades had a significant impact on the research projects this summer, and should facilitate high-quality on-campus faculty/student research opportunities for many years to come.

Gustavus as the Springboard to a Physics Ph.D.

In the latest data available from the NSF's WebCASPAR database for the baccalaureate origins of Ph.D.'s, in the ten-year period from 2002-2011, here are the top liberal arts colleges in the country according to the numbers of their alumni who obtained a physics Ph.D. during those ten years:

Harvey Mudd College	60
Reed College	40
Swarthmore College	27
Williams College	27
Gustavus Adolphus College	25
Carleton College	24
Lawrence University	24
Bryn Mawr College	17
University of Puget Sound	17
Colorado College	15
Grinnell College	15
Oberlin College	15
Amherst College	13
College of Wooster	13
Mount Holyoke College	13
Kenyon College	11
Bethel College	10
Bowdoin College	10
Franklin and Marshall Coll.	10
Haverford College	10
Luther College	10
St. Olaf College	10
Wellesley College	10

Nobel Conference XLIX Preview



On October 1-2, 2013, Gustavus will host the 49th annual Nobel Conference entitled “The Universe at Its Limits”. We will listen to eight eminent physicists and astronomers as they explore two extremes—physics on the largest and the smallest scales. Given the subject matter, it is only fitting that the physics faculty is very involved, including Nobel Conference Director **Chuck Niederriter** and Nobel Conference 49 Chair **Steve Mellema**.

Western Science has roots in ancient Greece, where two seemingly opposite lines of inquiry began over 2000 years ago. The first was astronomy, the study of what is “outside”, beyond the boundaries of Earth. Over the centuries astronomy has looked ever outward to our solar system, our home galaxy, and beyond, to examine the large-scale structure of the Universe. The second was the study of what is “inside” matter, which began with the concept of the atom and has now expanded to the realm of subatomic particles and the fundamental forces in nature.

In the 20th century, astronomy culminated in Big Bang cosmology, a theory of the origin and evolution of

an expanding Universe. At the same time, subatomic physics led to the “Standard Model” of the constituents of energy and matter that make up that Universe.

However, along the way, a number of crucial discoveries have shown us that these two seemingly opposite limits of the very large and the very small are intimately connected with each other. The finite speed of light tells us that, the farther we look out into space, the farther back we look in time. The expanding universe implies that, at an earlier time, it was once much hotter and denser than it is today. The Standard Model, in its attempts to unify the forces of nature, shows that such unification can only occur under the kind of hot, dense conditions that existed right after the Big Bang. So today we seek the answers to the questions of the origin, constituents, and evolution of the universe both in telescopes, that look outward to examine the vastness of the cosmos, and in particle accelerators that look inward, and seek to discover its most fundamental building blocks.

A schedule of all of the talks at Nobel Conference 49 can be found on

page 11. Below is some brief background on the speakers.

Frank Wilczek is Herman Feshbach Professor of Physics at Massachusetts Institute of Technology. He received the 2004 Nobel Prize in Physics, and works on symmetries in universe and connecting the ultrasmall and the ultralarge.

Tara Shears is Professor of Physics and Royal Society University Research Fellow at CERN, University of Liverpool. She studies elementary particle physics, and is an experimenter at CERN's Large Hadron Collider (LHC) where the Higgs boson was recently discovered.

Alex Filippenko is Richard and Rhoda Goldman Distinguished Professor in the Physical Sciences, Department of Astronomy, University of California, Berkeley. His work includes the study of white-dwarf supernovae and the evidence for a dark energy accelerating the expansion of the universe.

Samuel C.C. Ting is Thomas Dolby Cabot Institute Professor of Physics, Massachusetts Institute of Technology. He is the 1976 Nobel

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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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