Fall 2016/Winter 2017

THE UNIVERSITY OF TENNESSEE KNOXVILLE
DEPARTMENT OF PHYSICS & ASTRONOMY

CrossSections

The Newsletter for UT Physics Alumni & Friends

The Lessons of Experience

Summer 2016 saw our undergraduate majors get real-world exposure in physics: from campus to Oak Ridge National Lab to NASA to Italy. Here are a few of their summer snapshots.

JOSE BONILLA

Where did you work?
I worked in theoretical nuclear physics with Lucas Platter at UT.

What were your responsibilities?
My research consisted of re-normalizing an inverse cube potential for a three-body system. But since a three-body configuration has a certain degree of mathematical complexity, I studied a two-body system first. This allows me to obtain and understand results that are similar for a three-body system when an inverse cube potential is present. For its short range characteristic, this type of potential is relevant for nuclear physics, and also for atomic dipole-dipole interactions.

UT's Society of Physics Students has a list of students supported by summer internships in their chapter report, available at: www.utksps.org/projects/.

What was the most important thing you learned?
When I started doing the research I didn't know that much about quantum mechanics, so I had to teach myself, and with the help of Dr. Platter and his grad student, I was able to have a really good understanding of what was going on in the nuclear world.

What did you enjoy most?
The learning part.

What, if anything, surprised you?
It's kind of hard to grasp the reality of that type of physics, so the understanding of that is really tremendously hard. It's hard for a student who's starting to study these types of topics to really understand the depth of the concept. You pretty much learn how to calculate binding energies, how these bodies are bounded, and how they interact using this type of potentialized study. It's just the process of discovery.

What are you future plans?
Right now I'm still working with Dr. Platter on the same research, still studying the two-body system. Hopefully he'll let me move on to the three-body system. I plan to go to grad school and I would say I'm "hooked" by starting to study this with Dr. Platter. I would say this is the hardest physics I have really experienced.

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What's Inside

Message from the Department Head

Hanno Weitering
Professor and Head

The Case for Science

This fall, we have welcomed two new colleagues. Dr. Sowjanya Gollapinni joined our faculty as an assistant professor in high-energy particle physics. Sowjanya earned her PhD at Wayne State University in Detroit and completed a postdoc position at Kansas State University and Fermi National Accelerator Laboratory. Sowjanya developed scientific equipment for the detection of extraterrestrial neutrino particles: mysterious particles that permeate our bodies by the billions each second while moving at the speed of light. Her research on so-called neutrino oscillations aims to answer some of the most profound questions in science, such as the mystery of the matter-antimatter asymmetry in the Universe. Sowjanya is joined by her husband, Kranti Gunthoti, who was appointed as lecturer and outreach specialist.

While our department already has a very successful astronomy outreach program, thanks to the tireless efforts and great enthusiasm of Paul Lewis, Kranti brings much experience and great ideas for expanding and professionalizing physics outreach. He is also working to establish internships and other learning opportunities for undergraduates outside the confines of academic research. Profiles of Sowjanya Gollapinni and Kranti Gunthoti can be found in this newsletter.

I personally have very mixed feelings about the old and the New Year. In many ways 2016 has been a good year for the department. Student enrollments are up, the faculty is growing, research spending is on the rise, and our faculty and students received numerous awards. The good news has been overshadowed, however, by tragic events such as the loss of our good friend and colleague Professor Jon Levin. Several among us have lost loved ones recently, and we are all deeply saddened by the loss of life and property due to the wildfires in nearby Gatlinburg. On the bright side, we will start the New Year with a new Chancellor and it is expected that the search for a new Provost will be resumed very soon.

Arguably, the biggest unknown we are facing today is the science policy of the incoming administration in Washington D.C. Will the new President support basic research or will the emphasis shift to consumer-driven applied research? It is expected that the mission of the national labs will be under close scrutiny, as well as the funding and funding portfolio of federal agencies such as the National Science Foundation, the National Institutes of Health, and the Department of Energy. Not all change has to be bad, but the scientific community's unease is growing. In our department nearly all faculty are funded through basic research programs at NSF and DOE and, consequently, major funding shifts will have a direct impact on the financial position of our department, our faculty, their research, and their ability to support graduate students and postdocs. Tougher visa policies will make it more difficult to recruit foreign students and postdocs. This recruitment is critically important to science departments and national labs across the U.S.

Of course, questions always arise with the change of guard, but historically, congressional support for basic science has always been strong. Unfortunately, we seem to be living in times where scientific evidence is no longer an "inconvenient truth" but flatly rejected by some. Professional societies such as the American Association for the Advancement of Science and the American Physical Society work very hard to inform lawmakers and administration officials about the science that is critically important to public policy making. They need our strong support. It is also up to us as a department to make sure that we keep producing the best science and provide a top-notch education to a new generation of critical thinkers and future policy makers. We cannot afford complacency in times where research funds are scarce and the public rightfully wants answers on how those funds are spent. Last but not least, science advocacy should not only be left to the scientists. All of you: faculty, students, staff, alumni, and friends can become forceful advocates for science. Our future depends on it.

I wish you a healthy and prosperous 2017.

"IN MANY WAYS 2016 HAS BEEN A GOOD YEAR FOR THE DEPARTMENT. STUDENT ENROLLMENTS ARE UP, THE FACULTY IS GROWING, RESEARCH SPENDING IS ON THE RISE, AND OUR FACULTY AND STUDENTS RECEIVED NUMEROUS AWARDS."

BROOKE CARTER

Where did you work?
NASA Goddard in Greenbelt, MD [WFIRST (Wide Field Infrared Survey Telescope) Mission].

What were your responsibilities?
Public engagement: creating informational documents, outreach, tabling for mission.

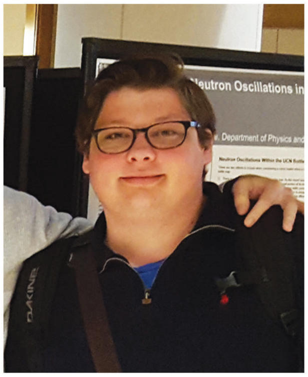
What was the most important thing you learned?
I learned how to work in a professional government environment.

What did you enjoy most?
I was able to tour many facilities and even see the James Webb telescope fairly close.

What, if anything, surprised you?
NASA treats their interns exceptionally well, where everyone wants to help and teach us however they can.

What are you future plans?
Currently I plan to go to grad school and maybe get a job in some engagement or outreach position at NASA.

ALEX CORLEW



Where did you work?
UT Department of Physics and Astronomy with Dr. Steve Johnston's condensed matter group.

What were your responsibilities?
I was tasked with optimizing the groups code to allow for implementation on supercomputer architectures. This mainly consisted of using parallel programming techniques, and threaded libraries.

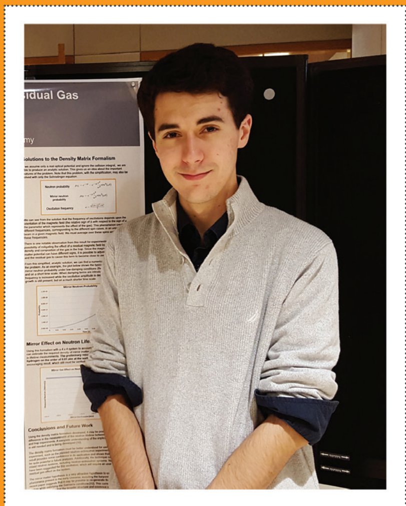
What was the most important thing you learned?
I learned that being familiar with how computers work (i.e., memory, infrastructure, hardware) is essential in many theoretical and experimental physics fields.

What did you enjoy most?
I really enjoyed learning how to write and manipulate code for very large projects.

What, if anything, surprised you?
The wait time for job submissions on supercomputers can be very long and even if you have dedicated nodes, the codes take a while to run, so getting performance results for optimization takes some time.

What are you future plans?
Shortly after my internship, I spoke with Dr. Anthony Mezzacappa, whom I had spoken with before during my internship, about some of the supercomputer hardware, and he pointed me to a team at the Joint Institute for Computational Sciences (JICS), and I am now working with them doing research in parallel programming on supercomputers. I plan to continue this research throughout the semester, and into the summer; maybe longer.

LOUIS VARRIANO



Where did you work?
I worked at the Laboratori Nazionali del Gran Sasso (LNGS) in L'Aquila, Abruzzo, Italy. The experimental facilities of the lab are in tunnels bored out of the Gran Sasso mountain, making it a great place to conduct high-precision, low-background experiments, such as dark matter searches, and neutrino-less double-beta decay searches.

What were your responsibilities?
I was part of the XENON1T direct dark matter detection experiment. I specifically worked with the muon veto group. This group worked on the water chamber surrounding the core experiment, the purpose of which was the suppression of and detection of muon and neutron interference in the experiment. I worked on a novel method of calibrating the PMTs (photomultiplier tubes) inside the muon veto chamber. These PMTs detected Cherenkov light from particles passing through the water chamber and will be used to veto data taken during contamination from other particles.

What was the most important thing you learned?
I got experience programming in ROOT, the language most used by particle physics experiments, which will help me in my future career. In addition, I learned a great deal about PMT design and calibration, also important for many other experiments.

What did you enjoy most?
I enjoyed meeting and working with the other scientists from across the whole world. Since European countries collaborate so closely in science, it was neat to be exposed to different languages and cultures daily. It was also a lot of fun to get some hands-on experience on the experiment. Since the experiment was still under commissioning, I was able to help apply some of the foil cladding inside the water tank, a small but important element of the experiment.

What, if anything, surprised you?
I was surprised by the degree to which my Italian improved over the summer. I take Italian at UT, and although I did not speak very much during the summer, my ability to understand Italian improved drastically over just the two months I was there.

What are you future plans?
I plan to attend graduate school and would be interested in working on experiments searching for Beyond Standard Model interactions, like those direct dark matter detection experiments hosted at LNGS.

NOAH FRERE

Where did you work?
UT/Oak Ridge National Laboratory and JICS (Joint Institute for Computational Sciences).

What were your responsibilities?
Learn about gravitational waves from supernovae in order to write a Matlab graphical user interface to analyze the theoretical waveforms resulting from supernovae simulations.

What was the most important thing you learned?
Research can be slow and static, but eventually breakthroughs happen and success can be achieved. Also, it can be very difficult finding the specific kind of help you need even in this huge modern world. Persistence pays off.

What did you enjoy most?
Those moments of breakthrough when days of arrest are immediately converted into success.

What, if anything, surprised you?
The difficulty of finding the specific help I required to move forward at certain times.

What are you future plans?
Applying to grad school for astronomy this fall.

An Unlikely Rebel

Sowjanya Gollapinni appears an unlikely rebel. Gracious and articulate with a quick smile and an easy laugh, she hardly seems one to buck the system. And yet that's exactly what made her a scientist.

Gollapinni, who joined the faculty in August as an assistant professor, was born and raised in India, leaving for the U.S. in 2007 to pursue a doctorate in physics.

"The reason I got interested in physics is rather unusual," she said. "Being a woman, in my home and outside I was asked to follow so many restrictions. So I started asking questions, and people didn't like that. But you know, that's where I saw the connection between physics and society; instead of blindly believing or restricting a human being, it's important to ask questions. That's my motivation to come into physics."

Gollapinni's specialty is particle physics, a subfield that first intrigued her during graduate studies at the University of Hyderabad in India.

"When you think about the universe, it's so big," she said. "There are so many stars and galaxies, but then all that can be explained by something so little that we can't even see with our naked eyes."

Given that her bachelor's degree is in physics, math, and computer science, experimental particle physics gives her the perfect balance of the three. As a PhD student at Wayne State University she began working at Fermilab, home to key neutrino experiments, which ultimately brought her to MicroBooNE.

Sowjanya Gollapinni

KEEPING THINGS PURE, WITH A NOD TO THE DIRTY DETAILS

The MicroBooNE collaboration built and maintains a detector that houses 170 tons of extremely cold liquid argon as a target for neutrinos to interact. The cryostat arrived at Fermilab in 2013 and by late 2015 the experiment was taking data. MicroBooNE uses the innovative liquid argon time projection chamber technology (LArTPC) to search for a possible fourth type of a neutrino called "sterile neutrino" and also aims to understand how neutrinos interact with the argon nucleus, all while serving as a design example for future multi-kiloton LArTPC experiments.

Gollapinni, who has worked on MicroBooNE since its early days, recalled the challenges of getting a new project off the ground, particularly when the scale is unprecedented. Scientists had worked with tabletop experiments before, she explained, but this one was the size of a large truck.

"Keeping the liquid argon pure is one of the fundamental requirements for the detector and the technology to work," she said. "Doing that requires a whole lot of cryogenics filtering and recirculation, and it was never done before to an experiment as big as MicroBooNE in the U.S."

There were other considerations. MicroBooNE's read-out wires are immersed in liquid argon, which can make the wires expand and contract during the cooling and filling cycles. The varying capacitance of the wires adds noise. Techniques and software had to be developed, tested, and tweaked to deal with noise and other challenges. This is exactly the kind of work Gollapinni savors.

"I am more on the technical R&D side; getting into all the dirty details," she said. "Data to me is very exciting, but I think all the things that we need to do to get to the point of taking data is even more exciting.

“THE ONE THING I TELL PEOPLE IS THAT YOU DON’T HAVE TO BE BORN SMART TO DO PHYSICS. IT IS THE PASSION AND INTEREST THAT MATTERS. YOU WORK HARD, AND YOU *BECOME* SMART AT IT. THAT’S MY APPROACH TO IT.” *—Sowjanya Gollapinni*

It’s very, very challenging, but it’s also very exciting because you get to do things for the first time.”

Now that MicroBooNE is generating data, she’s analyzing the data and keeping the detector running smoothly.

“Once a neutrino comes in and interacts with argon, it makes a bunch of charged particles,” she explained. “Those charged particles ionize the liquid argon, which means that they strip off the electrons from argon atoms and leave argon ions. These ionization electrons are our signal. Liquid argon is unstable; it flows around—so it moves the ions and electrons around. When the electrons travel from where they’re produced to our charge collection planes, a lot of things like the liquid argon flow, impurities in argon, etc., can eat away our signal.”

Gollapinni is heavily involved with accounting for factors that can cause that signal loss, including impurities in the argon or interference from cosmic rays. She’s also responsible for giving researchers an “eye” of what’s going on inside MicroBooNE’s truck-sized container. Once the cryostat was sealed, they needed remote monitoring tools to keep tabs on the system. Gollapinni basically wrote the control software for those remote controls, she said, “so a person sitting thousands of kilometers away can open their computer and check how the detector is doing.”

She’s doing the same work for SBND, the Short-Baseline Near Detector, part of the same short-baseline detector program as MicroBooNE. Building further on her neutrino interests, Gollapinni is also getting actively involved in DUNE, the Deep Underground Neutrino Experiment, also based at Fermilab.

“This is like the holy grail for neutrino physics,” she said. “DUNE is one of the biggest experiments we will ever build. But before we do that we’re trying to build some prototype detectors, much larger than MicroBooNE, but with almost the same design as DUNE, just to make sure that we can build it, operate it, and take the data.”

Those prototype detectors, called protoDUNEs, will be commissioned at CERN in Switzerland. Gollapinni’s strong research presence at Fermilab and broadening interests in neutrino science will give her students hands-on experience building detectors and taking data at some of the world’s top facilities. Yet it’s not only in the research sector that she wants to make a positive impact on future scientists.

WORKING HARD AND BECOMING SMART

When Gollapinni was growing up, there were no outreach programs in her school and encouragement wasn’t easy to find for a young woman with a passion for science and math.

“When I got admission into one of the best schools in India to do a master’s in physics, the first thing I heard from family is that, ‘For a woman, a school teacher is probably more suitable. You don’t want to do science if it gets your life so busy that you cannot give time to your family and kids.’ That’s something I grew up hearing all the time.”

Gollapinni, however, not only earned a PhD and became a physics professor, she and her husband, Kranti Gunthoti, are also raising two children who enjoy science and have even made videos explaining how things work. When she’s not immersed in her research or teaching, family time is her priority, along with sneaking in a few movies and some hiking or reading. This is the example she hopes to set for young women in physics.

“I think it’s important for young girls to see role models,” Gollapinni said. “I think telling people explicitly that we have kids, we have families, is important. It is extremely hard balancing both, but I wouldn’t have it any other way.”

Science outreach in general is important to her, she said, to emphasize “the importance of doing science for human beings and society as we push the limits of technology.”

She was featured with Professor Yuri Efremenko in the department’s first-ever Facebook Live Chat in November. Gunthoti, who is spearheading physics outreach for the department, organized this series called “Ask A Physicist” to boost the department’s engagement with the scientific community and the public at large. For Gollapinni, there’s nothing about physics that should scare anyone away.

“Whenever I tell people I’m a physics professor or I have a PhD in physics, the first thing they say is ‘Oh, physics is so hard, I could never do that,’ she said. “And I see my kids standing next to me hearing that. The one thing I tell people is that you don’t have to be born smart to do physics. It is the passion and interest that matters.

“You work hard,” she said smiling, “and you *become* smart at it. That’s my approach to it.”

Physics Family News

ALUMNI

Watheq Al-Basheer (PhD, 2006) has been promoted to Associate Professor in the Physics Department (College of Sciences) at King Fahd University of Petroleum & Minerals in Saudi Arabia.

Usama al-Binni (PhD, 2011) is a Lecturer in the Physics Department at the University of Washington in Seattle.

Amal al-Wahish (PhD, 2014) has accepted a Post-Doctoral Fellowship at the University of Missouri Research Reactor (MURR).

William D. Brandon (BA, 1988, PhD, 1997) is an Associate Professor in the Department of Chemistry and Physics at the University of North Carolina – Pembroke.

Tanner Devotie (BS, 2013; MS, 2015) has been selected to become a pilot for the U.S. Air Force.

FACULTY

Physics Professor Robert Grzywacz has been elected a Fellow of the American Physical Society. He was recognized "for pioneering use of digital signal processing for decay studies of exotic nuclei to identify extremely short-lived proton emitters and, through its unique triggering capabilities, to discover super-allowed alpha decay." The honor came a few weeks before element $Z = 117$ was officially named Tennessine. Its existence was in part confirmed by Grzywacz's work measuring the decay of nuclear materials. The number of APS Fellows elected each year is limited to no more than one half of one percent of the APS membership. UT Physics and Astronomy now boasts 11 fellows among current faculty: **Cristian Batista, Elbio Dagotto, Mike Fitzsimmons, Geoff Greene, Robert Grzywacz, Tony Mezzacappa, Adriana Moreo, Thomas Papenbrock, Lee Riedinger, Soren Sorensen, and Hanno Weitering.**

Robert Grzywacz

Physics faculty were among those honored at the College of Arts and Sciences Convocation Awards on December 1. **Professor Robert Grzywacz** was awarded a senior level Research Award for excellence in scholarship and creative activity. **Professor Stuart Elston** was selected for an Advising Award for his outstanding work advising undergraduates, and **Professor Marianne Breinig's** stellar teaching was recognized with the James R. and Nell W. Cunningham Outstanding Teaching Award.

STUDENTS

Louis Varriano was awarded the 2016 Society of Physics Students Award for Outstanding Undergraduate Research for his work with **Professor Z. Berezhiani** (University of L'Aquila, Italy), **Professor B. Kerbikov** (Institute for Theoretical and Experimental Physics, Moscow) and **Professor Yuri Kamyshkov** (University of Tennessee) on neutron-mirror neutron oscillations in a residual gas environment. As part of the honor the SPS sponsored his August trip to the International Conference of Physics Students in Malta, where he presented a student lecture. The award also provided the UT chapter with an honorarium.

Volunteers
MAKE A DIFFERENCE

Our Society of Physics Students Science Saturday outreach was featured in the university's Volunteer Stories: www.utk.edu/volunteer_stories/science-on-saturdays

PHYSCON 2016

With support from the department, our undergraduate physics majors descended on San Francisco in November for the 2016 Quadrennial Physics Congress (PhysCon), the largest gathering of undergraduate physics students in the world. The program included distinguished speakers, field trips to SLAC and Google's Moonshot Factory, and workshops on careers and community. Our students presented posters on a range of topics:

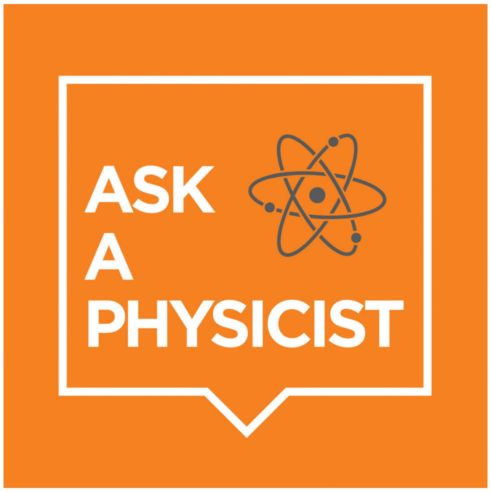
Undergraduates Jesse Buffaloe, Amos Manneschmidt, and Christopher Matteson at PhysCon 2016.

- **Jesse Buffaloe**: Using Discontinuous Galerkin Methods to Solve the Euler Equations in Curvilinear Coordinates
- **Peyton Nanney**: Perovskite Compound Synthesis via Solid State Reaction
- **Caroline Bowen**: Diecut Colored Paper Illustrations of Mathematical Functions
- **Noah Frere**: Analysis of Gravitational Wave Signals from Core-Collape Supernovae Using Matlab
- **Louis Varriano**: Neutron-Mirror Neutron Oscillations in a Residual Gas Environment
- **Brandon Barker**: Discontinuous Galerkin Methods in Context of Nuclear Astrophysical Simulations

Caroline Bowen (pictured left) won Best in Show **and** the People's Choice awards in the art competition for her piece "Asterism."

Brandon Barker, Tara Skiba, and Louis Varriano won PhysCon Reporter Awards to help report on the meeting, while **Noah Frere and Peyton Nanney** won PhysCon Travel Awards.

Physics Family News



The department is pleased to welcome **Kranti Gunthoti**, who joined us in August as an outreach specialist. He has a master's in physics from Wayne State University and has taken the lead in expanding the department's efforts in physics outreach, both within the field and to a wider audience.

Kranti Gunthoti

Gunthoti has begun a series of **Facebook Live Chats called "Ask a Physicist."** The first two installments this fall featured faculty chats on neutrinos and the quark gluon plasma. Be sure to follow the department (**www.facebook.com/UTKPhysicsAndAstronomy)** for the next live chat in January.

Retired Associate Department Head Jim Parks took this photo of **Professor Hanno Weitering's** original scanning tunneling microscope, which won First Place in the Science & Technology Category (Black and White Division) at the Oak Ridge Camera Club's annual salon in November.

Thank you to our Donors

The department is pleased to acknowledge the generosity of our donors for their support:

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Ming Zhang

(Gift records forwarded to the department dated August 1 through November 30, 2016.)

Giving Opportunities

Thank you for your interest in supporting the Department of Physics and Astronomy. You can "help where it's needed most" by giving to the Physics Enrichment Fund, which funds a range of priorities. You can also contribute to a specific scholarship, fellowship, or other support fund. See our website for opportunities at www.phys.utk.edu/alumni-physics/giving.html.

If you'd like to explore more options for supporting students, faculty, equipment or other priorities in physics, Don Eisenberg would welcome your call at 865-974-2504 or your e-mail at don@utfi.org. You can also donate online by going to artsci.utk.edu and clicking on "Give to the College of Arts and Sciences."

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