

WAVES

Number 18

April 2016

DEPARTMENT CHAIR'S COMMENTS



Anderson-Huang

Greetings to all! I hope this newsletter finds you well. Last year, my message started with the announcement of the retirement of President Jacobs and departure of Provost Scarborough. They were succeeded by College of Engineering Dean Nagi Naganathan as interim president and Jon Barrett of UT Law as interim provost. Since then, the University has appointed President Sharon L. Gaber who joined the

University on July 1, 2015. A city and regional planning expert, Gaber came to the UT presidency following six years as provost and vice chancellor for academic affairs at the University of Arkansas. We are happy to say that she is an enthusiastic supporter of all parts of the academic mission and student affairs. Interim Provost Barrett has served us well but is retiring from the position at the end of the academic year. Following a search, Dr. Andrew Hsu has been selected as UT's next provost. Dr. Karen Bjorkman served on the search committees to select both Dr. Gaber and Dr. Hsu.

As noted inside under Notable Staff News, as of August 2015 we have a new business services officer or BSO, Ms. Lori Benschoter. Our previous BSO, Ms. Lindsay McLaughlin, accepted a position as payroll financial analyst in the controller's office. Ms. Benschoter has integrated well into the department, and has become a favorite for all sorts of financial issues among the students and other staff. She enjoys a good relationship with Ms. Jamie Fager, the BSO for the college. She and our administrative assistant, Ms. Lynda Obee, continue to make life in the department much easier and more family-like. Both always adapt to a variety of ambiguous questions, and lead the student, faculty, or co-worker to understand what the topic is about, what information each can provide, and what information she will find for the questioner. They always come through.

We are happy to welcome Dr. Dileep Karanth as a new lecturer, primarily for the introductory physics sections. He has expressed an interest in teaching at higher levels, as well as in rejuvenating retired professor Bernie Bopp's fondly remembered course on the physics of music and sound.

Many of you will remember professors Thomas Kvale and

James Palmer, who retired in June of 2015. Both are continuing with superannuate appointments, Dr. Kvale as director of the Office of Undergraduate Research in the Jesup Scott Honors College and Dr. Palmer as director and instructor of technical physics courses in our department. We certainly wish them well!

We are proud of all the efforts reported in this edition of Waves, and hope to develop even more in future years. Of particular note are the elections of Professor Jacques Amar as Fellow of the American Physical Society, and of Professor Ishmael Parsai as Fellow of the International Organization for Medical Physics. Internal awards included this year's Dean's Award for Excellence in Research on the Health Science Campus for Dr. Parsai, and the first award of the Helen Luedtke Brooks Endowed Professorship of Astronomy to Dean Karen Bjorkman. Related to the latter, The University of Toledo honored the first director of its planetarium with the naming of the Helen and Elgin Brooks Theater inside the Ritter Planetarium. See the article later in this issue describing Ms. Brooks' long association with physics and astronomy at the University. Yanfa Yan received the Dion D. Raftopoulos / Sigma Xi Award for Outstanding Research and the February University of Toledo Shining Star Research Award, and Jillian Bornak received the February University of Toledo Shining Star Teaching Award. Congratulations to all.

If you'd like to help us grow and improve, including adding to the planetarium projector upgrade, there is information elsewhere in this newsletter about how you can contribute. There are several funds to support various efforts within the department. The department is very fortunate to have strong supporters in the community and beyond, and we are grateful to all of you.

In closing, let me just say that we value all our supporters, friends, former students and colleagues. We'd love to hear from you, so please do drop us a line sometime and tell us what you're doing these days. If you happen to be in the area, do stop in and visit us. I would also like to take this time to announce my retirement in May 2016, and to introduce my successor, Professor Sanjay Khare as the new chair of the department. It has been a pleasure to serve the department in this role.

Lawrence Anderson-Huang

NOTABLE STAFF NEWS



Lori Benschoter

APPOINTMENT OF LORI BENSCOTER AS BUSINESS SERVICES OFFICER

Following the departure of Lindsay McLaughlin, Lori Benschoter was hired as the departmental business manager. While Lori is new to UT, she has had extensive previous experience as an HR/payroll administrator and also as an accounts payable accountant. Aside from attending UT to obtain her Bachelors Degree in Accounting, she is also a state of Ohio licensed real estate agent. Lori enjoys watching her daughters thrive and play sports, as well as long motorcycle rides with her fiancé. She resides in Archbold with her fiancé and two of her three daughters. She writes that she is very excited to be here at The University of Toledo!



Dr. Richard Irving

DR. RICHARD IRVING RECEIVES CNSM OUTSTANDING STAFF MEMBER AWARD FOR AY 2014-15

Congratulations to Dr. Richard Irving for receiving the College of Natural Sciences and Mathematics' Outstanding Staff Member Award for Academic Year

2014-15! At the award presentation, which was made at the college convocation in August, Dean Bjorkman cited Dr. Irving for "his incredible dedication and willingness to go far above and beyond, any time of day or night, to help and support others, and for his vast knowledge of both the institution and the technical aspects of the department and college, which he freely shares, all while maintaining a sense of humor and an always collegial and cheerful approach."

DEPARTURE OF LINDSAY MCLAUGHLIN AS BUSINESS SERVICES OFFICER

Lindsay McLaughlin, our business services manager, left our department for another position within the

University. We thank Lindsay for her dedication to the department and wish her well!

NOTABLE FACULTY NEWS

DR. DILEEP KARANTH APPOINTED AS LECTURER IN THE DEPARTMENT OF PHYSICS AND ASTRONOMY



Dr. Dileep Karanth

The Department of Physics and Astronomy welcomes Dr. Dileep Karanth, who was appointed in fall 2015 as a lecturer in the Department of Physics and Astronomy. Dr. Karanth earned his doctorate at the University of Arkansas at Fayetteville in 2005. His doctoral work on semiconductor (InP) nanostructures involved a study of empirical pseudopotential methods. For nine years since his doctorate, he worked as lecturer at the University of Wisconsin-Parkside, where he taught

undergraduate physics, and also developed an interest in statistical mechanics. In his free time, Dileep likes to translate from languages like German, Russian and French. He is also interested in the history of science and mathematics. He loves to sing, if only to himself. Welcome, Dr. Dileep Karanth!

RETIREMENTS OF PROFESSORS THOMAS KVALE AND JAMES PALMER



Professor Thomas Kvale

Professor Thomas Kvale, who joined the Department of Physics and Astronomy in 1984 and served as the initial director of the UT Office of Undergraduate Research (OUR) from 2006-15, retired in June. Professor Kvale also served as PI, and later co-PI, of the department's NSF-REU (Research Experiences for Undergraduates) and co-PI of the Choose Ohio First Scholarship Program: "Building Ohio's Sustainable Energy Future" grants. Through his involvement in the REU grants and OUR, he has facilitated the involvement of well over 500 undergraduates in research at the beginning of their professional development. Professor Kvale will continue to serve as OUR director through August 2016.



Professor James Palmer

Professor James Palmer, who joined the University in 1977 and moved to the Department of Physics and Astronomy in 1999 as the lead faculty member in physics for students in engineering technology programs, retired in June. Professor Palmer's research interest is biomechanics. He has also been active in chiropractic research, most notably as director of research for the Upper Cervical Research Foundation and as editor of the Upper Cervical Monograph.

CONGRATULATIONS TO MICHAEL CUSHING AND NIKOLAS PODRAZA



Associate Professor
Michael Cushing



Associate Professor
Nikolas Podraza

Congratulations to Michael Cushing and Nikolas Podraza, who have been promoted to associate professors.

CONGRATULATIONS TO RANDY ELLINGSON, SANJAY KHARE, AND TOM MEGEATH

Congratulations to Randy Ellingson, Sanjay Khare, and Thomas Megeath, who have been promoted to full professors.



Professor Randy Ellingson



Professor Sanjay Khare

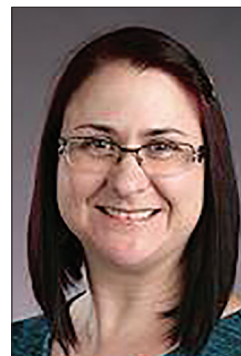


Professor Thomas Megeath

Congratulations to Jillian Bornak for receiving the February University of Toledo Shining Star Teaching Award!



Professor Yanfa Yan



Professor Jillian Bornak

Congratulations to Yanfa Yan for receiving both the 2014 Dion D. Raftopoulos /Sigma Xi Award for Outstanding Research and the February University of Toledo Shining Star Research Award!

OTHER FACULTY NEWS

PROFESSOR JACQUES G. AMAR ELECTED A FELLOW OF THE AMERICAN PHYSICAL SOCIETY

Professor Jacques G. Amar, whose research is in the areas of computational physics, surface physics and thin-films, and whose current research is focused on the use of computational methods to obtain a fundamental understanding of non-equilibrium processes, has been elected a 2015 Fellow of the American Physical Society in the Division of Computational Physics for "the development and use of novel computational methods which have advanced our fundamental understanding of a range of problems in condensed matter and statistical physics, including the kinetics of domain growth, surface roughening, crystal growth and thin film deposition." Professor Amar joins six other faculty, Professor Robert Collins, Professor Steven Federman, Professor Bo Gao, Professor Yanfa Yan, Emeritus Professor Larry Curtis, and Emeritus Professor Philip James, who are also Fellows of the American Physical Society.

PROFESSOR ISHMAEL PARSAI ELECTED A FELLOW OF THE INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS



Professor Ishmael Parsai

Professor Ishmael Parsai, professor of radiation oncology, adjunct professor of physics and astronomy, chief of the UT medical physics division and director of the graduate medical physics program, has been elected a Fellow of the International Organization for Medical Physics. Professor Parsai was also the recipient of this year's Dean's Award for Excellence in Research on the Health Science Campus.

PROFESSOR NIKOLAS PODRAZA

Professor Nikolas Podraza, with co-principal investigators Professor Robert Collins at The University of Toledo and Sylvain Marsillac at Old Dominion University, received a two-year award from the Office of Naval Research titled “Hybrid Solid and Gas Phase Deposition of Hydrogenated Silicon for Photovoltaics.” This grant supports the study of physical vapor deposition with gas-phase dissociation to potentially produce high electronic quality silicon thin films at high deposition rates. Professor Podraza also received a three-year subcontract through the National Renewable Energy Lab for the award “Advanced Thermal Management for Higher Module Output” funded by the Department of Energy SunLaMP program. His work involves infrared spectral range characterization of materials used to design optical and thermal improvements for solar cells.

PROFESSOR J.D. SMITH

Professor J.D. Smith was awarded a Humboldt Research Fellowship for Experienced Researchers, which he took in fall 2014 to the Max Planck Institut für Astronomie (MPIA) in Heidelberg, Germany. The fellowship is in support of a total of nine months of research visitation at MPIA over a three-year period.

PROFESSOR VICTOR KARPOV

Professor Victor Karpov has been awarded a three-year grant by the Semiconductor Research Corporation to investigate the fundamental physics underlying resistive switching random access memory (RRAM) technology. This technology has demonstrated significant potential as a new generation scalable nonvolatile memory governed by the development and dissolution of conductive filaments formed by impurity or intrinsic ions or in dielectric hosts.

DEAN AND PROFESSOR KAREN BJORKMAN



Dean and Professor
Karen Bjorkman

Congratulations to CNSM Dean and Professor Karen Bjorkman for being selected as the first recipient of the Helen Luedtke Brooks Endowed Professorship of Astronomy!

RECENT PAPER BY PHOTOVOLTAICS FACULTY AND STUDENTS SELECTED AS ACS EDITORS' CHOICE

Organometal halide perovskites have emerged as an important new class of materials for photovoltaics. The materials exhibit excellent optoelectronic properties and can be easily formed by solution-based processes. A recent paper, entitled “Impact of Processing Temperature and Composition on the Formation of Methylammonium Lead Iodide Perovskites,” by graduate students Zhaoning Song, Suneth Wattage, and Brandon Tompkins, research assistant professor Adam Phillips, and professors Randy Ellingson and Michael Heben, which explores the phase and processing space for formation of methylammonium lead iodide perovskites, was recently published in the journal *Chemistry of Materials* and was selected as the American Chemical Society Editors' Choice. It was also one of the “top downloads” from the journal in July and was featured on the cover.

PROFESSOR RUPALI CHANDAR RECEIVES GRANT AWARD TO STUDY STELLAR CLUSTERS



Associate Professor
Rupali Chandar

Professor Rupali Chandar, whose current research is focused on obtaining a better understanding of the life-cycle of star clusters, has received a three-year grant award from the U.S. National Science Foundation (NSF) to study *The Birth and Death of Stellar Clusters: Uncloaking the Roles of Stars, Gas, and Physical Environment in Nearby Galaxies*. This project will address the formation of star clusters and their destruction in nearby galaxies. A particular goal of this research is to shed light on two as-yet

poorly understood epochs in the life cycle of a star cluster – just before they are born and very soon after they form.

UT PROFESSOR UTILIZES TWO TELESCOPES SIMULTANEOUSLY TO EXAMINE PLANET-STAR HYBRID

(adapted from UT News, June 24, 2015)

Dr. Mike Cushing, director of Ritter Planetarium and associate professor of astronomy, is observing a newly discovered brown dwarf, named WISE 1405+5534 utilizing both the Spitzer Space Telescope, named for Toledo native Lyman Spitzer, and



Associate Professor
Michael Cushing

the Hubble Space Telescope simultaneously. “Hubble looks at ultraviolet, visible and infrared light. Spitzer looks at infrared light with wavelengths longer than Hubble can see,” Cushing said. “Since they look at different wavelengths, they are good for examining different things.” He is able to access the data from each telescope, stored as images, and download what he needs to his computer.

Cushing’s team is using Hubble to look deeper into the atmosphere and Spitzer to look higher into the atmosphere. Their observations, which can take months to review, will help astronomers not only better understand brown dwarfs, but also advance knowledge about the atmospheres of gas giant planets located outside of our solar system. “Brown dwarfs are so cold and low-mass that instead of generating their own heat and light, they are similar to embers plucked from a fire — warm

at first, but slowly cooling off with nothing to keep them hot,” Cushing explained. Cushing and his team will study how the brightness of the brown dwarf changes as it spins on its axis, which will help astronomers learn how clouds are distributed in the atmospheres of brown dwarfs. “We know these objects have clouds of potassium chloride and sodium sulfide, and that they are probably patchy like we see on Jupiter,” Cushing said. More than 1,000 have been spotted since the first brown dwarfs were confirmed in 1995. Brown dwarfs come in various sizes and temperatures, but Cushing and his group are focusing on the colder brown dwarfs, measuring less than 500 Kelvin, which is equal to 440 degrees Fahrenheit. The coldest brown dwarfs on record have reached temperatures as low as 300 Kelvin or 80 degrees Fahrenheit.

OTHER DEPARTMENTAL NEWS

MEDICAL PHYSICS NEWS

Two Ph.D. students graduated this past year. Nava Paudel, Ph.D., started his residency in radiation oncology physics at the University of Arkansas, and Nicholas Sperling, Ph.D., started a fulltime position at The University of Toledo Medical Center’s Department of Radiation Oncology as an assistant professor and clinical medical physicist.

UT MEDICAL PHYSICS GROUP HOSTS OHIO RIVER VALLEY CHAPTER MEETING

The University of Toledo Medical Physics group hosted the Ohio River Valley Chapter (ORVC) meeting of the American Association of Physicists in Medicine (AAPM) – comprising medical physicists from Ohio, Kentucky, and Indiana - in April 2015. The keynote speaker was a UT alumnus, Todd Pawlicki, Ph.D., professor of radiation oncology at the University of San Diego. In addition, this year’s ORVC chapter’s elected officials, Dr. David Pearson, assistant professor of radiation oncology, Dr. Nicholas Sperling, assistant professor of radiation oncology, and Dr. Ishmael Parsai, professor of radiation oncology, were from the UT medical physics program. Medical physics students also presented five papers at this meeting. The second keynote was Sean Tanny, a medical physics Ph.D. candidate who also is chair of the AAPM working group.

NEWS FROM RITTER PLANETARIUM

Ritter Planetarium had another exciting and productive year, with annual attendance increasing slightly over last year’s attendance of approximately 21,000. Ritter Planetarium also continued to provide instructional enrichment to students in other academic departments, including environmental science, communication and foreign languages. In addition, more than 1,500 astronomy students attended programs in

the planetarium last year. Kindergarten-high school programs were popular, in addition to private space-themed birthday parties and general weekend public programs. After the debut last December of Ritter’s first in-house produced full-dome program, Santa’s Secret Star, the first commercial sale of this program to another planetarium was recorded. An educational program developed by Professor J.D. Smith and UT graduate Morgan Hayward, which explains the Hertzsprung-Russell diagram, one of the fundamental diagrams used to describe stars, is being produced. To date, more than 40 planetariums now have the program, including facilities in Poland and the Czech Republic.

THEATER NAMED FOR UT PLANETARIUM’S FIRST DIRECTOR

(adapted from UT News, October 2015)

The University of Toledo honored the first director of its planetarium with the naming of the Helen and Elgin Brooks Theater inside the Ritter Planetarium. Helen Brooks, who was one of two UT astronomy professors for many years and the first director of the planetarium, was the central figure in the creation of the Ritter Observatory and Planetarium.

“Naming the planetarium theater for Helen and Elgin Brooks is our way of recognizing their contributions both to the study of astrophysics and to The University of Toledo,” said Dr. Michael Cushing, UT associate professor of astronomy and director of the planetarium. “Helen was instrumental in the creation of an astrophysics group at UT, and this is one way that we are honoring her memory.”

Brooks, who received bachelor’s and master’s degrees from UT, as well as an honorary doctorate, retired from UT in 1972 but remained an active participant in Astronomy Department events for many years. She died in 2011, and her husband, Elgin, had passed away in 1999. The Brooks’ support to UT also includes their 1987 contribution that established the Brooks Observatory atop McMaster Hall and a \$1.26 million trust gift that established the Helen Luedtke Brooks Endowed Professorship of Astronomy. The couple established

the professorship to recognize and support a current UT astronomy professor's research. The first award recipient is Dr. Karen Bjorkman, Distinguished University Professor of Astronomy and dean of the College of Natural Sciences and Mathematics, who was recognized at the dedication ceremony for the theater Sept. 17.

BROOKS OBSERVATORY UNDERGOING RENOVATIONS

The Brooks Observatory, which hosts an array of small telescopes, including the six-inch Brashear refracting telescope that has been on UT's campus since 1931, has been closed for renovation since summer 2015. The observatory at the top of McMaster Hall opened in 1987 and is dedicated to undergraduate education and public outreach. A Celestron 14-inch, high-definition telescope will replace the Brashear telescope, according to Alexander Mak, associate director of the UT Ritter Planetarium.

"The new telescope can gather more than five times as much light as the old telescope and will let us view fainter and more exotic objects than ever before," Mak said. "The new mount and pedestal will offer a stable platform for the telescope and allow us to quickly move the telescope from one target to another. This will let us showcase more objects for our students and guests." To accommodate the sightlines of the new telescope, the observatory will be significantly modified. "The current telescope in the dome is more than 100 years old and was originally housed on top of University Hall," Mak said. "It is a historically significant telescope, having been manufactured by a noted craftsman."

Dr. John Alfred Brashear, a late American astronomer and instrument builder, dedicated his time to manufacturing astronomical and scientific instruments. The Brashear telescope will be placed in storage during the renovation; eventually, it will be on display, Mak said. The updated facility will be a state-of-the-art instructional observatory that will continue the mission of undergraduate education and public outreach. New undergraduate laboratory exercises will be developed, and more public observing opportunities will be scheduled once work is completed.

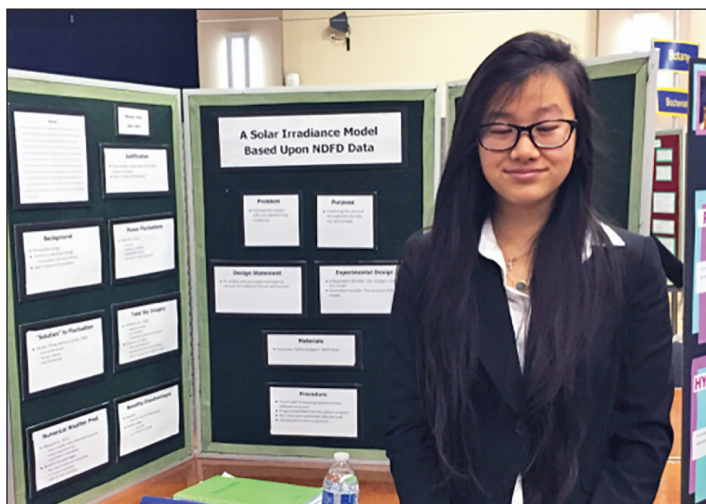
The project is funded through support from the College of Natural Sciences and Mathematics and an endowment established by the late Helen and Elgin Brooks.

RISE INTERNS' RESEARCH LEADS TO HONORS AND AWARDS

During the summer of 2014, The University of Toledo continued to provide summer internships to high school students through the Research in Science & Engineering (RISE) Program. The 2014 RISE class consisted of five students: Donovan DeMilt from Ottawa Hills High School; Alan Fong, Melissa Liang and Allison Clausius from Sylvania Southview High School; and Richard Jin from Maumee Valley Country Day School. Their projects covered a wide range of topics

pertaining to renewable energy science and technology. Each student was paired with a faculty mentor and a junior mentor (e.g., a postdoctoral associate, a graduate student, or an undergraduate student). Each high school researcher became part of a larger team for eight weeks while working on an individualized project. The students received stipends provided by a combination of NSF funding and funds from endowments associated with the Wright Center Endowed Chair for Photovoltaics (Professor Michael Heben) and the Ohio Research Scholar Endowed Chair (Professor Yanfa Yan). Four of five students presented their work in various science fairs. Two of four of Ohio's delegates to the Intel International Science and Engineering Fair (ISEF) came from the RISE program. The Intel ISEF is the largest and most prestigious pre-college science competition in the world.

Accomplishments of note from the RISE class of 2014 include the work of Melissa Liang (pictured below), who



participated in the Buckeye Science and Engineering Fair (BSEF) in Columbus. She scored a perfect 40/40 for her work on modeling cloud coverage and movement and the impact of solar irradiance. For this work, Melissa implemented the Atwater clear sky model, along with atmosphere chemistry and physics cloud transmittance models. She and her mentors created an algorithm that could calculate the irradiance and allow comparison to the measured value. Melissa found that the model worked best on clear sky days, with error less than 6 percent, but on cloudy days the error increased to 25 percent.

Richard Jin also scored a perfect 40/40 at the BSEF and was selected to be one of the top four to advance to the Intel ISEF. Richard investigated the sulfurization of copper antimony sulfide thin films used in photovoltaic applications. To do this, Richard placed a sputtered copper antimony sulfide thin film in a sulfurization furnace at various temperatures to crystallize the thin films. X-ray diffraction of the thin films after sulfurization showed that treatment at temperatures under 340°C resulted in a predominantly Cu_3SbS_4 crystal structure, while sulfurization above 340°C exhibited a mixed phase crystal structure of CuSbS_2 and Sb_2S_3 . The amorphous and sulfurized films had band gaps of 2.0 and 1.5 eV, respectively, and exhibited high optical absorption. Sulfurization increased carrier density and reduced the band gap. The best single cell

power conversion efficiency of 0.66 percent was obtained with a sulfuration temperature of 310°C.

Alan Fong performed research on the properties of sputtered thin films and studied how the properties of the films were affected by the state and age of the sputtering target. He participated in District Science Day at UT and received a superior rating and perfect score. He received the Governor's Thomas Edison Award (first place) for Excellence in Student Research in the Advanced and Alternative Energy category, and qualified for BSEF and the



State Science Day at Ohio State University. At State Science Day, he received a Superior Rating (39.5/40) and won the Governor's Award for Excellence in Environmental Protection Research and a Stone Laboratory Scholarship.

Allison Clausius (pictured above) also scored a perfect 40/40 at BSEF and advanced to the Intel ISEF. Allison also was a RISE Intern in 2013. For her 2014 RISE project, she combined her interests in fashion, technology, and photovoltaics to create a photovoltaic dress that can power portable electronics. Working with her mentors at the UT Wright Center for Photovoltaics Innovation and Commercialization, Allison selected the appropriate solar cells, designed and built the needed electronic circuitry, and fabricated the solar cells into a high fashion, wearable dress. Her combination of technology and fashion attracted tremendous interest from both the fashion and solar cell technology communities. Allison has worn her dress in several fashion and technology shows, and her work has been the subject of many news and online blog stories. A particularly good story on her work was presented by the Society for Science and the Public.

UPDATE ON THE UNIVERSITY OF TOLEDO 32 KILOWATT CDTE PHOTOVOLTAICS ARRAY

The UT Wright Center for Photovoltaics Innovation and Commercialization (UT-PVIC) serves as the steward for the 32 kW CdTe photovoltaic array located along Dorr Street outside the Research and Technology Complex 1 building. The array consists of 432 CdTe PV modules manufactured by First Solar; 216 of the modules were purchased in 2005 (model FS-57, 57 W rating, and ~ 8 percent efficiency), and installed in the rows closest to Dorr Street. The other two rows of the array consist of 216 modules, donated to UT-PVIC by First Solar. These modules are model FS-390, which generate 90 W under standard test conditions and operate at 12.5 percent efficiency. Installation of rows 3 and 4 resulted in a completely operational 32 kW (DC) PV system as of late

June 2014. The increased efficiency, from 8 percent for model FS-57 in 2005 to 12.5 percent for model FS-390 in 2013 (date of manufacture), corresponds to an annual improvement of approximately 6 percent in the First Solar technology's ability to extract electrical energy from sunlight. During the past two years, First Solar has continued to improve their module efficiency at a remarkable pace, now reaching a commercial module efficiency of >15 percent. The UT CdTe system produces an average of approximately 42 MWh of electricity per year, which is enough to power the average Ohio home's electricity needs for 107 months. During the seven years that rows 1 and 2 had been installed at UT, one of the 216 modules had failed based on environmental or mechanical stress, and two others had apparently fallen prey to vandalism in which a passerby threw an object at the array. In spring 2015, a UT grounds crew accidentally damaged three modules in the new row 4. Undergraduate and graduate students from UT's School for Solar and Advanced Renewable Energy (SSARE) crafted a plan, with input from Facilities to ensure proper safety procedures were followed, to repair the broken modules and return the PV system to peak performance. In May 2015, UT students including David Raker, Paul Roland, Peymon Zereshki, Ebin Bastola and others performed the repairs. The



Undergraduate student David Raker and graduate student Paul Roland replace damaged modules to repair UT's 32 kW CdTe PV array.

resulting system is now operating at peak levels, and on July 15, 2015, the system set a new record for electrical energy generated in a single day: 210 kWh. The system has since June 2014 generated approximately 50 SRECs, representing generation of 50 MWh. The system's total AC generated since the 2006 commissioning of rows 1 and 2 stands at more than 122 MWh. The total would be higher, but for several years row 2 was configured only for DC operation as required to generate hydrogen fuel for fuel cell vehicles operated by UT Facilities. The UT CdTe array is monitored and the data is logged for the system's electrical performance. In addition, UT monitors atmospheric conditions, including plane-of-array (POA) irradiance, global horizontal irradiance (GHI), ambient air temperature, and back-side module temperature. This data allows for development and testing of basic models to describe

and compare how the atmospheric and weather conditions influence the actual production of the PV array. The data will be incorporated with a planned new course on photovoltaic performance modeling, which is currently under development as an elective course component of UT's Professional Science

Masters in Photovoltaics. The performance modeling course addresses the increasingly important topics of predicting and optimizing the electrical energy extracted from PV systems over both near-term and long-term periods of time.

ASTRONOMY STUDENTS CONDUCT RESEARCH WITH DISCOVERY TELESCOPE

(adapted from UT News, February 2016)

UT students Megan Banks, left, Anthony Howarth, center, and Jessica Moore posed for a photo last fall with Lowell Observatory's Discovery Channel Telescope in Arizona.

Several UT students had the opportunity last fall to observe and collect data on celestial objects in a way that most astronomers don't get to experience until well into their professional careers.

In a recent visit to the Lowell Observatory's Discovery Channel Telescope located outside of Flagstaff, Ariz., Dr. Karen Bjorkman, dean of the UT College of Natural Sciences and Mathematics, and Distinguished University Professor of Astronomy, and her class had the opportunity to observe a number of stars, planetary nebulae and galaxies.

The telescope was conceived and built by the historic Lowell Observatory, where Pluto was discovered, using private funds, led by a major contribution from the Discovery Channel. It was completed and dedicated in 2012.

UT, Boston University and the University of Maryland joined in a scientific partnership with the Lowell Observatory to conduct research using the Discovery Channel Telescope, with UT joining in 2012. In subsequent years, the partnership grew to include Northern Arizona University and Yale University.

For three years, Bjorkman has taken her undergraduate

Observational Astronomy class for hands-on experience with the 4.3-meter telescope. Last fall, student travel and observation was made possible by support funds from the Helen Luedtke Brooks Endowed Professorship of Astronomy.

While the class gets the opportunity to work with the 1-meter telescope at the Ritter Observatory on campus for most of the semester, the much larger Discovery Channel Telescope allows for significantly more detailed images of a wider range of objects. It is the fifth largest telescope in the continental United States and one of the most technologically advanced, and its location within the Coconino National Forest offers the clear dark skies that are crucial for observing the cosmos.

"I try to integrate the use of the Discovery Channel Telescope with everything else we do in the class," Bjorkman said. "They learn the basic techniques of observing at our own Ritter Observatory, and they learn about the process, we talk about all the techniques, and they prepare their own mini-research project. During the semester, we talk about the different instruments that astronomers use."

"For my project, I chose a reflection nebula, NGC 7023," said Jessica Moore, a senior astronomy student. "This experience helped me with the project by letting me gather my own data. I was able to see everything that goes into an actual science image from start to finish. It also gave the data some passion because we are the ones collecting it."

Graduate students also are able to request time at the telescope, and one joined Bjorkman's class. Cody Gerhartz, a fifth-year graduate student working with Bjorkman toward a doctorate in physics with a concentration in astrophysics, is monitoring a set of hot stars with gaseous disks that are found in star clusters. Through long-term observations, he's working to determine more information about the processes of formation and evolution of the disks.

Bjorkman said that while the opportunity to use a new telescope is exciting, the partnership aspect of the agreement also is extremely beneficial to the University.

"Through this partnership, we've built relationships and collaborations with our colleagues and astronomers and their students at all these other institutions, which is really good," she said. "It builds good relationships and collaborative opportunities for the University nationally and internationally."



FOCUSED ON LEARNING: UT students Jessica Moore, left, Anthony Howarth, center, and Megan Banks posed for a photo last fall with Lowell Observatory's Discovery Channel Telescope in Arizona.

RESEARCH EXPERIENCES FOR UNDERGRADUATES (REU)

The summer 2015 NSF-REU program in physics and astronomy gave enhanced research opportunities to 13 undergraduate students from nine colleges and universities in seven states. Student participants were chosen competitively from 96 applications representing students in 29 different states in all regions of the U.S.

In addition, during the 2014-2015 academic year, research involving previous REU students led to four refereed publications and four conference presentations. We expect that additional manuscript(s) from summer 2015 are in preparation and will be submitted shortly to refereed journals and/or presented at conferences. Additionally, this summer a student traveled to the National Terawatt Facility in Reno to continue participation in actual experiments involving high temperature plasma physics.



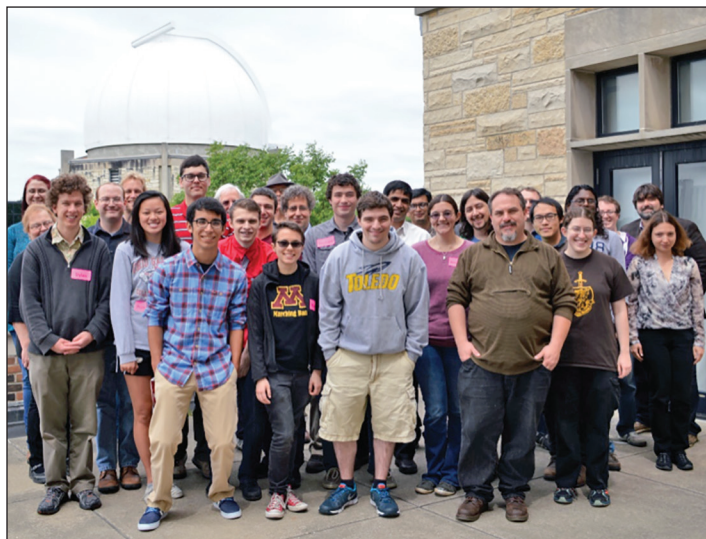
As part of our NSF program, the REU students helped host a physics and astronomy outreach.

In summer 2015, the REUs caught Pluto fever and decided to join forces with Ritter Planetarium's outreach program for the Pluto flyby of the New Horizons spacecraft. Interactive physics and astronomy demos entertained guests before the planetarium show in July. After the well-received planetarium presentation, people were treated to liquid nitrogen ice cream – a fitting end to a hot topic on such a cold subject!



First Solar

Aside from Pluto fever, the REU group had green energy fever and organized two tours to provide relief. A trip to Bowling Green's 7.2 megawatt wind farm provided the students with an opportunity to explore the wind turbines inside and out. Students had many good questions ranging from the impact on wildlife (e.g., birds and bats) to career opportunities as a wind turbine technician. A tour of the First Solar plant was no less informative. The First Solar guides escorted groups of students throughout the plant to view various aspects of the manufacturing process for the CdTe solar panels. People were very impressed with the technologies used to provide the quality control needed to produce a good solar panel. A very illuminating presentation with a question-and-answer period followed. UT's connection with First Solar also was mentioned. After the presentation, Dr. Upali Jayamaha, a consultant to First Solar, and Dr. Viral Parikh, a staff scientist at First Solar – both of whom received their Ph.D.s from UT's physics and astronomy department – dropped by to meet with the REU students.



REU students, mentors and other research students.

REU SUMMER 2015 PARTICIPANTS

NAME	INSTITUTION	MENTOR	RESEARCH
Tim Alderson	The University of Toledo	Khare	Condensed Matter Physics
Kendra Bergstedt	University of Minnesota, Twin Cities	Ellis, Irving	Atomic Physics
Sierra Ashley	University of Denver	Witt	Astrophysics
Michael Bowman	Huntington University	Yan	Condensed Matter
Devon Shustarich	Iron Range Engineering, MSU - Mankato	Khare	Computational Physics
Dylan Hamilton	College of Wooster	Yan	Condensed Matter
Mikhael Semaan	California State University, Long Beach	Amar	Computational Physics
James McCulloch	Brigham Young University Idaho	Shvydka	Condensed Matter
Amanda Menechella	The University of Toledo	Nagy, Megeath	Astrophysics
Hannah Salmon	University of Cincinnati	Podraza	Plasma Physics
David Raker	The University of Toledo		
Alex Robinette	The University of Toledo	Heben	Condensed Matter
Jacob Noon	The University of Toledo	Irving, Darling	Plasma Physics

CNSM CHAIRS PARTICIPATE IN GLASS CITY MARATHON RELAY

In April 2015, department chairs from the College of Natural Sciences and Mathematics participated in the Glass City Marathon Relay. From L-R are Doug Leaman, chair of biological sciences; Don White, chair of mathematics and statistics; Ron Viola, professor and recent chair of chemistry and biochemistry; Tim Fisher, chair of environmental sciences; and Lawrence Anderson, chair of physics and astronomy. The chairs' relay team finished the race in 4 hours, 17 minutes, and enjoyed the dual challenges of getting around the course by car and on foot. They also commented, "It was a great day for a run, and, though we have not yet made a commitment to try this again next year, we challenge the entire university to generate teams across departments and maybe even colleges."



OTHER NOTABLE NEWS

GRADUATE STUDENT NEWS

Khagendra Bhandari's poster, entitled "Enhancement of Efficiency of CdTe Solar Cells Using Iron Pyrite Nanocrystal as an Interface Layer," was nominated as Best Poster candidate at the 42nd IEEE Photovoltaic Specialists Conference. Khagendra had seven UT co-authors on this work, which resulted in a related publication in the journal Solar Energy Materials and Solar Cells.

Paul Roland was selected for an internship in the Air Force Research Laboratory Scholars program at Kirtland Air Force Base, New Mexico. His project focused on applying the "reciprocity relation" to 4J IMM solar cells, comparing beginning of life versus end of life (an established technique for previous 3J III-V). This analysis technique ties optical processes (EL and EQE) with electrical performance (voltage drop across each sub cell) to investigate changes within a multi-junction stack.

CONGRATULATIONS!

The following graduate students successfully defended their Ph.D. dissertations or received an M.S. degree in late 2014 or 2015:

Dr. Khagendra Bhandari, Ph.D.

Dr. Laxmi Karki Gautam, Ph.D.

Dr. Neale Haugen, Ph.D.

Dr. Bradley Hubartt, Ph.D.

Dr. Prakash Koirala, Ph.D.

Dr. Alexander Mulia, Ph.D.

Dr. Paul Roland, Ph.D.

Dr. Deepak Sainju, Ph.D.

Dr. Tingting Shi, Ph.D.

Dr. Lesley Simanton, Ph.D.

Dr. Carl Starkey, Ph.D.

Dr. Sean Tanny, Ph.D.

Justin Brown, M.S.

Robert Daine, M.S.

Yao Xie, M.S.

Eric Ha, M.S. (Professional Science Master's in Photovoltaics)

Hanma Haneef, M.S. (Professional Science Master's in Photovoltaics)

Elizabeth High, M.S. (Professional Science Master's in Photovoltaics)

Patrick Krantz, M.S. (Professional Science Master's in Photovoltaics)

Anthony Matthews, M.S. (Professional Science Master's in Photovoltaics)

Hamed Shahram, M.S. (Professional Science Master's in Photovoltaics)

Chuanxiao Xiao, M.S. (Professional Science Master's in Photovoltaics)

RECOGNIZING OUR DONORS

The Department of Physics and Astronomy recognizes and thanks all donors who generously made gifts during the past calendar year from Jan. 1-Dec. 31, 2015. Donors are listed alphabetically.

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GRADUATE AND UNDERGRADUATE AWARDS CEREMONY

The Department of Physics and Astronomy's 14th Annual Recognition Ceremony and Sigma Pi Sigma induction were held April 20, 2015. The following awards were presented:

UNDERGRADUATE AWARDS

Physics & Astronomy Outstanding Graduating Undergraduate Student: *Adam Smercina*

Elgin C. Brooks Memorial Astronomy Scholarship: *Shaeley Diemer*

A. Jackson and Sally K. Smith Scholarship: *Skyler Baugher*

Chad Tabory Memorial Award for Outstanding Undergraduate Research in Physics and Astronomy:
First Place: *Adam Smercina*
Second Place: *Brooke Paquin*

Robert and Noreen Stollberg Award: *James Windsor*

Edwin Jayamaha Scholarship Award: *Timothy Alderson*

C.V. Wolfe Scholarship in the Natural Sciences: *Jacob Noon*

RECOGNITION OF SOCIETY OF PHYSICS STUDENTS (SPS) OFFICERS

President: Brooke Paquin

Faculty Advisor: Dr. Richard Irving

THE 2015 SIGMA PI SIGMA INDUCTEES (PROFESSOR SCOTT LEE, FACULTY ADVISOR) WERE:

Anna Barnes

Nikhil Bhandari

Kevin Hardegree-Ullman

Jennifer Greco

Corey Grice

Zhi Liu

Adam Smercina

GRADUATE AWARDS

David Turnbull Scholarship in Materials Science: *Zhaoning Song*

Physics & Astronomy Outstanding Service Award: *Corey Grice*

Robert and Noreen Stollberg Graduate Teaching Award: *Peymon Zereszki*

RECOGNITION OF STUDENTS RECEIVING UNDERGRADUATE DEGREES

Anna Barnes, B.S. - Physics

Travis Collier, B.S. - Physics

Kyle Heckel, B.A. - Astronomy

Nathan Jean-Louis, B.A. - Astronomy

Robert Maltby, B.S. - Physics

Ryon Michalak, B.S. - Applied Physics

Brooke Paquin, B.S. - Applied Physics

David Sarnowski, B.S. - Physics

Saji Schermaker, B.S. - Astrophysics

Adam Smercina, B.S. - Astrophysics

ALUMNI NEWS

Robert Cooper (B.S. 2002) recently accepted a tenure-track assistant professorship at New Mexico State University in Las Cruces, N.M. This is a bridge position with Los Alamos National Laboratory (LANL). In addition to teaching at the University, Robert will conduct research at Fermilab, supporting LANL, and pursue his interests in neutrino physics and dark matter searches.

Giridhar Nandipati (Ph.D. 2009) has accepted a permanent staff position as materials scientist at Pacific Northwest National Laboratory in the Reactor Materials and Material Design Group.

Adam Ritchey (Ph.D. 2009), currently a research scientist at the University of Washington, has a funded project to use the Hubble Space Telescope. Co-investigators include collaborators at Princeton University, the University of Washington, and Professor Steven Federman.

Mikhael Semaan (REU student 2015) received the 1st place **Helen Quinn Award for Undergraduate Research Theory** for a talk he gave at the 2015 American Physical Society Far West Section Meeting, based on research he conducted with Professor Jacques Amar at UT during summer 2015.

THE UT ENDOWMENT FUND CAMPAIGN

Alumni and friends of the Department of Physics and Astronomy are urged to remember our department and college as they consider giving. The department has several established funds, some of which are endowed, and others may not yet be endowed. Other funds may have dipped below the threshold required by the UT Foundation for returning spendable earnings that can be used – for example, for scholarships, honoraria for speakers, etc.

John J. Turin Memorial Fund

Established to honor John J. Turin, former department chair and dean of the College of Graduate Studies. He was integral in building UT's first Ph.D. program in the 1960s. This endowment funds annual awards to physics students, based on merit (3.5 GPA or higher).

Chad Tabory Outstanding Undergraduate Research Fund

This account, founded in memory of Chad Tabory, a UT physics graduate and research lab technician, funds the outstanding undergraduate research award.

Ritter Observatory Publication Fund

This fund helps support the cost of publishing the Ritter Observatory annual report, as well as student papers, when possible.

Reach for the Stars Fund

This fund supports student access, research, and remote observing with the Discovery Channel Telescope (DCT) in Arizona. UT established a long-term scientific partnership agreement with the Lowell Observatory in 2012 to guarantee access to the DCT for UT students, post-doc students and faculty to conduct cutting-edge research in astronomy and astrophysics at this new, state-of-the-art facility located at an excellent observing site.

The Planetarium Progress Fund

The purpose of the Planetarium Progress Fund is to hold the subscription donations of the Friends of Ritter Planetarium and all other gifts in support of our astronomy outreach programming. All funds are used for large capital expenses and the growth of an endowment portfolio, the interest from which will help cover operating expenses.

Physics and Astronomy Funds for Excellence

The Funds for Excellence supports scholarships and fellowships, acquisition of research equipment, special colloquia, etc., which are essential for departmental excellence.

Sigma Xi Dion D. Raftopoulos Outstanding Faculty Research Award

This is a perpetual memorial in honor of Dion D. Raftopoulos for support of the Sigma Xi Award for Outstanding Research at UT. This award remains one of few awarded by the faculty to peers in recognition of their outstanding contributions to the research enterprise at UT. We are proud to note that eight of the total 29 winners of this award through 2014 have been from the Department of Physics and Astronomy.

The UT ALUMNI ASSOCIATION wants to hear from you. Check out their website at toledoalumni.org. Please join the movement!

GIVE A GIFT, MAKE A DIFFERENCE

The support of our alumni and friends is paramount to the success of our educational programs. Your generous financial support will impact the lives of current and future students in the Department of Physics and Astronomy at The University of Toledo.

For more information about giving, including setting up scholarships or additional gift funds, please contact Nick Kulik, major gifts officer for the College of Natural Sciences and Mathematics, and College of Languages, Literature and Social Sciences at **419.530.5428** or nicholas.kulik@utoledo.edu

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