ΦYAST ΦLYER

The Homer L. Dodge Department of Physics and Astronomy

Ferah Munshi and Dan White Join the Faculty

Ferah Munshi

The faculty in the Department of Physics and Astronomy are joined this fall by two new members: Ferah Munshi, who will be the new assistant professor in the Astronomy group, and Dan White, the new assistant professor with expertise in physics education research.

Munshi received her doctorate in 2014 from the University of Washington, where she worked with Tom Quinn using Nbody+SPH galaxy formation simulations as a tool to understand star formation in both dwarf and Milky Way-sized galaxies. Her first postdoc was at the University of Oklahoma, where she worked on testing and performing some of the highest-resolution dwarf galaxy simulations that

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Dan White

Born and raised in Norman, White completed his undergraduate studies at the University of Oklahoma, earning degrees in both physics and philosophy. He received his doctorate in physics education working with Andrew Heckler from Ohio State University on developing a detailed learning progression for specific ideas in force and motion and studying complex problem solving in physics. Before coming to OU, he was a lecturer at California Polytechnic State University, where he put his research into practice in real classrooms. He hopes to help develop teaching strategies and tools, and he looks forward to getting a chance to investigate cognitive models of student learning in the future.

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Lin Hall to Be Dedicated This Fall

Lin Hall after completion in July. Main entrance (left) at the northeast side of the building. Northwest side of the building (right), showing in the background the dome of the newly built observatory, which sits on the roof. Lin Hall and Nielsen Hall will form the new Dodge Physics Complex.

Lin Hall is a state-of-the-art research facility named in recognition of Chun C. Lin, an OU physics professor from 1955 to 1968. Professor Lin recently retired as the John and Abigail Van Vleck Professor of Physics at the University of Wisconsin-Madison. Lin Hall boasts more than 18,000 square feet of world-class research space, allowing for 12 research laboratories for AMO and CM physics experiments. It is one of only a few buildings in the world to meet the NIST-A requirements on vibrations, temperature and humidity, as well as

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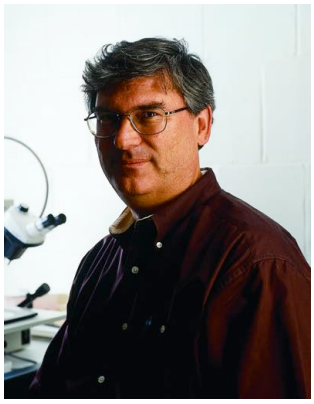
From the Chair



Finishing my first year as department chair, I've come to appreciate the work that administrators perform. Being able to maintain a research program, teach, and the constant administrative demands of being chair can only occur with the help of others. In this case my graduate students, postdocs, and the office staff. I suspect that the second year will be easier since I know what to expect on the administrative side of the job. Before discussing the state of the department, I want to thank Greg Parker for the excellent work he did as chair making things easier for me.

The most exciting event on the horizon is the completion of Lin Hall and dedication of the Dodge Physics Complex, which is composed of Nielsen Hall and Lin Hall. We have Greg Parker to thank for the vision he had to see that this could be accomplished. In addition, we thank both the Avenir Foundation and Professor Chun C. Lin, whose generous gifts helped fund the construction of the state-of-the-art NIST-A laboratory building, one of the few in the nation. The dedication will occur Saturday, Oct. 13, and we hope that many of you can attend. Further information will be mailed later, and you can also get information at https://link.ou.edu/PhysicsDedication.

Over the past few years, we have had a large number of faculty retire, with many of them still here performing research and some on occasions teaching. We have started the task of hiring faculty to fill the positions of those who have left. Joining us this year are Ferah Munshi, whose field of research is in stellar evolution, and Dan White, whose field of research is in physics education. We welcome both to the department. In addition, this coming year we will have three faculty searches, thanks to the efforts of the AMO and condensed matter groups who put together a white paper on "Quantum Technology" that leverages the new labs in Lin Hall, the traditional strengths of our department, and a new national initiative on Quantum Technology. We would like to thank Dean Wrobel, who has been a champion for our department, Provost Kyle Harper, and VPR Kelvin Droegemeier, who have both been very supportive of this effort.

Our students continue to excel. This past year, M. Peters was named a Goldwater Scholar and C. Dabbieri was selected an Astronaut Scholar. We congratulate both these students on their achievements. Also, one of our recent graduates, J. Berdis, was awarded a prestigious NASA graduate fellowship, for which we congratulate her. Many of our students reached the milestone of receiving their diploma both at the undergraduate and graduate level. Congratulations to all.

Beyond classroom teaching, the most important role of the department is the acquisition of new knowledge and the training of students in the research techniques needed to acquire it. Even though it is clear that the goal of the Ph.D. program is designed to develop independent researchers, it is important that our undergraduates also have an opportunity to participate in our research program, which is the case for many of our undergraduate majors who work in our research labs and on projects in theoretical physics. Our faculty have roughly 65 grants with expenditures of over $4 million, which funds our research and allows our students to participate in major research projects in both theoretical and experimental physics. The experimental work is performed at labs both local and elsewhere, including at the CERN Large Hadron Collider; various telescopes around the world; in our local labs in atomic, molecular and optical physics; and in condensed matter physics.

We look forward to a very productive year, and hope to see many of you during the Dodge Physics Complex and Lin Hall dedication in October.

What Is Where?

The ΦYAST ΦLYER is the official newsletter of the Homer L. Dodge Department of Physics and Astronomy, College of Arts and Sciences, University of Oklahoma, and is published each spring by OU Printing Services at a cost of $1.70/copy to the taxpayers of the State of Oklahoma. The newsletter staff includes Bruno Uchoa, Arne Schwettmann, John Wisniewski and John Stupak. The University of Oklahoma is an equal opportunity institution. www.ou.edu/eeo

Neal Lane Publishes Op-ed Piece in The New York Times

Neal Lane

Neal Lane, a member of the department's Board of Visitors, recently coauthored with Michael Riordan an op-ed article in The New York Times. The piece alluded to the dangers of public policies that are not anchored in solid scientific advice, and noted that the White House had not nominated a presidential science adviser yet. The piece was published in January and the position still remains to be filled.

A presidential science advisor is expected to provide "independent, expert judgment and assistance on policy matters which require accurate assessments of the complex scientific and technological features involved." Sound expert advice is especially critical in the arena of nuclear weaponry. For that reason, most previous presidential science advisors have been physicists.

"The science advisor is the one individual who can quickly pull all the relevant information together for the president, cut through conflicting advice coming from other senior advisers and Cabinet secretaries, and get evidence-based options in front of him. Especially important has been the adviser's role in helping the president deal with crises — Sept. 11, the subsequent anthrax attacks, the Fukushima nuclear nightmare in 2011, the Ebola and Zika outbreaks, hurricane devastation and cyberattacks," they wrote in the piece. They conclude the article by stating that the lack of sound scientific advice in the White House may imperil future negotiations involving nuclear compliance with other nations and may adversely affect the course of environmental policies.

Lane was the science advisor to President Bill Clinton and is a senior fellow in science and technology at the Baker Institute at Rice University. Riordan has taught history of physics at Stanford and the University of California Santa Cruz. The complete article can be found at: https://www.nytimes.com/2018/01/04/opinion/trump-disdain-science.html

OU Alum Wins Prestigious NASA Fellowship

Jodi Berdis, an undergraduate alum of the Department of Physics and Astronomy at OU, recently received a prestigious fellowship from NASA to fund her research on identifying surface water ice on solar system objects. She currently is a graduate student at New Mexico State University and was one of six graduate students who received NASA's Aeronautics Scholarship and Advanced STEM Training and Research Fellowships. Specifically, she received the Harriett G. Jenkins Graduate Fellowship issued through the NASA Education Minority University Research & Education Project. There were 124 applicants.

Typically, Berdis said, water that freezes into a random pattern is frozen quickly, such as by solar radiation, whereas a structured pattern usually indicates a more gradual freezing during which the water molecules had more time to fall into their structured form, such as by meteor impacts.

"My research entails looking at the freeze patterns on objects in the solar system," Berdis said. "Depending on which pattern the water ice exhibits, I can determine the environmental conditions upon ice formation. This will tell me what kind of activities or processes were occurring on the object at a given time and will give us a better understanding of that object's evolutionary history."

Berdis is able to examine the surface ice on other solar system objects, thanks to spacecraft observations and a technique called spectroscopy. Starting in September 2017, the Harriett G. Jenkins Fellowship will fund her research for the next three years and will allow her to travel to the Jet Propulsion Laboratory in Pasadena, California.

At OU, Berdis worked with profesor John Wisniewski on the subject of massive stars.

Read more: https://www.lcsun-news.com/story/news/education/nmsu/2018/01/27/nmsu-grad-student-study-frozen-water-space-nasa/1072236001/

The OU-Feynman Connection

Richard Feynman's first graduate student, G. Rossi Lomanitz, was an OU graduate. Lomanitz came to Oklahoma in 1926 at age 5 with his parents. He was an academic prodigy, becoming a freshman at OU at age 14 and obtaining his bachelor's degree in physics at age 19. Under the advice of Rud Nielsen, Lomanitz joined Robert Oppenheimer as a graduate student at UC-Berkley in 1940. His work with Oppenheimer was interrupted by World War II. After the war, Oppenheimer suggested that Lomanitz go to Cornell University to continue his doctoral research. At Cornell in 1947, Lomanitz became Richard Feynman's first Ph.D. student. Feynman was only 3 years older than Lomanitz. In the spring of 1950, he completed his Ph.D. with a dissertation titled "Second Order Effects in the Electron-Electron Interaction." The photo at left shows four of Oppenheimer's graduate students (from left): Joe Weinberg, Rossi Lomanitz, David Bohm and Max Friedman. The picture was taken in front of the Sather Gate at UC-Berkley.

After the war, Lomanitz struggled to find a suitable academic position because of the McCarthyism. He ended up becoming a professor and later department chair at New Mexico Tech Socorro, retiring in 1991. He died in 2003. A long interview with Lomanitz can be found at https://www.aip.org/history-programs/niels-bohr-library/oral-histories/24703-1.We thank Tom Miller, OU faculty from 1978 to 1994, for the intriguing story. If you are aware of interesting news about OU alumni, let us know!

Ferah Munshi: Continued from pg. 1

exist to date. She continued to study dwarf galaxies when visiting Rutgers to work with Alyson Brooks. In their work, she used simulations to study the low mass end of the stellar-to-halo-mass relationship in order to understand what drives its scatter.

Since then, Munshi has been at Vanderbilt as a VIDA postdoctoral fellow, and has collaborated to create the largest set of high-resolution simulated dwarf galaxies that exist (nicknamed the MARVEL-ous dwarfs and the Justice League dwarfs). Her research program at OU will leverage this unique, statistical set of simulated dwarf galaxies, in varying environments, in order to constrain both baryonic physics (star formation, feedback, gas dynamics, metallicity evolution) as well as dark matter physics (a subset of the simulations have also been run with alternative dark matter scenarios).

Outside of research, Munshi is active in pushing towards a more inclusive and equitable environment in astronomy and physics. She has been involved with several initiatives that aim to recruit and retain underrepresented groups in astronomy and is a vocal advocate for inclusion. In her free time, Munshi enjoys spending time with her toddler and two spoiled pugs as well as trying to catch every opportunity to sleep when she can!

Lin Hall Inauguration: Continued from pg. 1

electromagnetic interference. The roof will be used for astronomical research and teaching, and includes one 14-inch telescope along with smaller telescopes for student use. Together, Nielsen Hall and Lin Hall are collectively named "The Dodge Physics Complex," in recognition of Homer L. Dodge, who served as chair of the OU physics department from 1919 until 1944.

The celebration and dedication of The Homer L. Dodge Physics Complex and Lin Hall will take place Oct. 12 and 13. The activities will begin with a public lecture titled "Football: Its Physics and Its Future" by guest speaker Timothy Gay at 7:30 p.m on Friday. Gay currently is a Willa Cather Professor of Physics at the University of Nebraska-Lincoln. Light refreshments will be provided just prior to the 10 a.m. dedication of the research building on Saturday, followed by heavy hors d'oeuvres on the patio and tours of the building. A banquet is planned Saturday evening at 6 in the Sam Noble Museum. Be sure to register to attend the Lin Hall gala by Oct. 1!

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Dan White: Continued from pg. 1

When not designing challenging (and hopefully thought-provoking) physics problems, he enjoys playing card games. He's always looking for more people to play bridge.

Student Awards

The departmental award ceremony has been expanded into an afternoon of events, including a photoshoot and a buffet of snacks offered to all who attended the ceremony, including undergraduates, graduates and faculty. This was followed by the presentation of the undergraduate and graduate student awards. Refreshed by the food, the department held its second "Departmental Quiz Bowl" for the entertainment of all. This time, the faculty team triumphed, recovering from their defeat from last year. Three-person teams were fielded by graduate students, undergraduates and the faculty to answer questions on physics, OU trivia, departmental trivia, and general trivia. The faculty team of professors Abraham, Santos and Strauss romped to a first-place finish, winning the "Alec Montec Norris Award for Trivial Accomplishment."

Listed below are the names of those students who were presented with awards. Note that there are three general classes of undergraduate awards (general departmental awards, P&A awards and Engineering Physics awards). One of our undergraduates also was awarded a prestigious Goldwater Scholarship and another the Astronaut Fellowship. The graduate awards include the Kalbfleisch Award, the Nielsen Prize, and the Shafer-Ray Award.

Homer L. Dodge Departmental Awards

Dodge Outstanding Sophomore	Dodge Outstanding Junior	Fowler Prize
Hannah Day	Nathaniel Lydick	Jonathan D. Kunjummen

J. Clarence Karcher Award

Erik Flom and Matthew Peters

Duane E. Roller Award

Visal So and Cameron Parker

William Schriever Award

Claire L. Riggs, and Matthew R. Welty

Outstanding Graduating Senior

Chris Brown, Chris Leonard, Alison Roeth, Caroline Buckles, Adam Marrs

Meritorious Scholarships

Seniors: Miranda Brugman, Caroline N. Bucles, Phillip R. Collins, Collin M. Dabbieri, Erik R. Flom, Phillip P. Heitert, Gavin E. Jergensen, Jonathan D. Kunjummen, Christopher A. Leonard, Adam N. Marrs, Angelo A. Marshall, Collin L. Mcleod, Connor J. Moore, Matthew Peters, Thomas S. Pharis, Avraham A. Revah, Colin J. Riggert, Alison J. Roeth, Matthew T. Swann, Cassidy M. Wagner, Ethan B. White; *Juniors:* Smuel K. Bayliff, Philip D. Bobek, Jeremiah J. Buenger, Grayson C. Garmaker, Dustin R. Gier, Amy C. Griffin, Allison C. Jones, Cameron S. Parker, Julia A. Rusert, Visal So, Morgan B. Turner *Sophomores:* Robert T. Beuchamp, Hannah J. Day, Ryan S. Hazlett, Willow E. Kirkpatrick, Christopher Lenhart, George A. Mau, Claire L. Riggs, Dayana C. Sloane, Kyle C. Sutherland, Matthew R. Welty, Alexander O. Yates *Freshmen:* Joshua G. Bonner, Melissa A. Callen, Travis W. Casey, Benjamin R. Cottrell, John D. Cox, Kurtis L. Felker, Nathaniel B. Gunter, Gannon Lawley, Mitchell S. Mason, Blake M. McDonald, William P. McNulty, Latta Miller, John V. Milligan, Mark A. Mitchell, Jacob C. Moser, Michael O. Osisanya, Alexander S. Parsells, Sara M. Paugh, Abigail N. Phillips, Seth D. Pickle, Aidan T. Powers, Noah P. Reidy, Michael A. Smith, Austin G. Stejskal, Jacob E. Sturges, Lucas H Sturm, Jaycie J. Thaemert, Evelyn A. Vargas Olmos, Jeremiah D. Westerman, London E. Wilson, John. A. Wrench

Engineering Physics

J. Clarence Karcher Award

John E. Brown

Duane E. Roller Award

Alec Gaddie

William Schriever Award

Lijah Robertson and Israa Yusuf

Meritorious Scholarship

Seniors: Christopher Brown, John E. Brown, Drew G. Wild, Nicholas B. Wiley, Tyler J. Erickson, Jacob A. Young, Russel B. Hobson, Jocelyn L. Roberts, Delano P. Usiukiewicz, Jackson D. Sloan, Hannah L. Harrel, Jacob T. Whitson; *Juniors:* Nathanial E. Lydick, Alec C. Gaddie, Omar Robles, Alexander G. Grove, Jessica G. Chandler, Jesse L. Aragon de Galvez, Zachary T. Chesnut, Elisabeth A. Moffat; *Sophomores:* Elijah R. Robertson, Israa G. Yusus, Madison Jones; *Freshmen:* Katherine E. Sloan, Kevin M. Robb, Brian J. McGee, Montserrat Diaz Marroquin

Matthew Peters Named 2018 Goldwater Scholar

Matthew Peters

University of Oklahoma honors student Matthew Peters was named a 2018 Goldwater Scholar, placing OU in the top ranks of universities nationally with 53 Goldwater Scholars since the competition began in 1991. The prestigious scholarships are awarded on the basis of potential and intent to pursue research careers in mathematics, the natural sciences or engineering.

"We are proud of Matthew for earning the prestigious Goldwater Scholarship," said then-OU President David L. Boren. "His achievement is another example of the tradition of excellence that defines the University of Oklahoma."

Peters, a junior pursuing dual degrees in physics and mathematics, is from Purcell, Oklahoma. He works with OU professor John Wisniewski in a research project on stars with circumstellar disks. He presented his work at the annual American Astronomical Society Meeting and is listed as co-author on an article in preparation. In addition, Peters participated in a project on solar cells with professors Robert Witteck and Henning Schulte-Huxel at the Institute for Solar Energy Research in Hameln, Germany. His work there was funded by the DAAD-RISE Scholarship, an international award for undergraduate research at a German university.

During his freshman year, Peters worked with Braden Abbott, OU professor of physics and astronomy, on a project using particle physics data from the European Organization for Nuclear Research (CERN). His summer plans are to contribute to the development of the Laser Interferometer Space Antenna Space Telescope at Goddard Spaceflight Center. Upon graduation from OU, he plans to pursue a doctorate in propulsion or astrophysics and conduct research at NASA.

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Collin Dabbieri Selected as Astronaut Scholar

Collin Dabbieri

Homer L. Dodge astrophysics major Collin Dabbieri has been named one of the 2018/2019 Astronaut Scholars of the Astronaut Scholarship Foundation. This scholarship recognizes an elite group of students in the United States with exemplary academic performance, ingenuity and unique aptitude for research. The incoming Astronaut Scholars are invited to attend the ASF Innovators Gala in Washington, D.C., in September, where they will receive the Neil Armstrong Award of Excellence, recognizing their achievements. An astronaut will present all Astronaut Scholars with their award on stage during the Saturday night gala.

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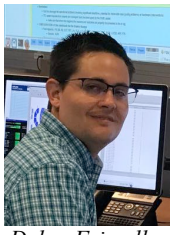
Kalbfleisch Award to Frizzell; Nielsen Prize to Rifki; Rich Recipient of Shafer-Ray Award


Dylan Frizzell

The *George Kalbfleisch Memorial Scholarship* is awarded to deserving graduate students of strong character showing potential in the field of physics, with preference to students studying high energy physics. It is not restricted to a graduating student, and the preference for the field of high energy is only applied if candidates are otherwise equal. This year the award and a $1,000 check was given to **Dylan Frizzell**, who works with Phil Gutierrez in the measurement of the associated production of a top quark and a Z boson at CERN.


Othmane Rifki

The *Nielsen Prize* is awarded to graduating doctoral students who have displayed excellence in research. It is intended to be given only to students who are exceptional among those who have been awarded doctoral degrees from the department of Physics and Astronomy over the years. The award is intended for students who have completed their thesis and defense in that academic year, and there is no limitation on their number, nor a requirement to give out any award at all if the faculty so chooses. The award comes with a $1,000 check and a standing invitation to return in the future to give a departmental colloquium on a research topic of their choice. Faculty voted to award the Nielsen prize to graduate student **Othmane Rifki** for his thesis work "Search for supersymmetry in final states with two same-sign or three leptons and jets using 36 1/fb of sqrt{s}=13 TeV pp collision data with the Atlas detector". Othmane worked under the supervision of Brad Abbott.


Evan Rich

The *Shafer-Ray award*, which includes $2,000 check, was given to **Evan Rich**. Evan currently works with John Wisniewski on imaging the gas and dust disks that surround stars as a probe for planets actively forming in these disks.

The *Homer L. Dodge Student Scholarship* is an annual fellowship that provides a complete graduate student stipend for one year given to an outstanding full time graduate student in the department. The award this year was given to three students: **Hamidreza Esmaielpour**, **Soumya Bhattacharya** and **Dylan Frizzell**.

Congratulations!

Ph.D.s, Master's Degrees Awarded

Since May, 2017, 22 Physics and Astronomy students have successfully defended their dissertations. Those students who completed their Ph.D. degrees (and their advisers) are: **Phillip McCoy** (Kao), **Timothy Miller** (Henry), **Michael Savoy** (Baer), **Othmane Rifki** (Abbott), **Wei Wang** (Watson) **and Shen Yu-Ting** (Skubik). Sixteen students also defended their master's thesis: **Matthew Goodman** (Baer), **Nathan Grieser** (Strauss), **Anita Bhagat** (Schwettman), **Li Murphy** (Gutierrez), **Hua Wang** (Mullen), **Matthew Clement** (Kaib), **Daniel Vagie** (Kao), **Kyle Doorman** (Santos), **Sang Wook Kim** (Uchoa), **Francis MacInnis** (Leighly), **Hora Mishra** (Dai), **James DerKacy** (Baron), **Joseph Lambert** (Abbott), **Hyunseop Choi** (Leighly), **Renae Wall** (Kilic) and **Joseph Muse** (Gutierrez). We congratulate these individuals and wish them well in their careers.

Summer Research for Undergraduates

The Research for Undergraduates program at OU, which is sponsored by the National Science Foundation, will have 17 students from different universities as well as from OU. These students will help conduct research in the department for two months during the summer. The OU program is overseen by Brad Abbott and Mike Strauss.

The students and home institutions are: Mitchell Bredice Saint Vincent), Rochelle Horanzy (Connecticut), Collin Mcleod (OU), Juan Zuniga (UT Dallas), Avraham Revah (OU), Susannah Brodnitz (Oberlin), Rebecca Bitzgarrald (Nebraska-Lincoln), Connor Moore (OU), Dana Peirce (Bowdoin), Maya Kovalik (Mary Hardin-Baylor), Cole Le Mahieu (Union), Parker Cameron (OU), Jordan Rhodes (Central Arkansas), Dustin Gier (OU), Ryan Hazlett (OU), Jonathan Franco (OU), Erick Powell (Western Washington).

We wish them our welcome and a great productive summer!

Yearly Review of Lunar Sooners

Lunar Sooners had a great 2017-2018 academic year, kicking off with the Solar Eclipse Star Party and adding new star parties outside libraries near Oklahoma City. We continue to grow by hosting various groups with hands-on demos, star parties, and the Soonertarium. In 2018, the department, along with Lunar Sooners, the Norman Public Schools, and the OKC Astronomy Club, are co-hosting a 12-part lecture series called "Postcards from the Universe." Lunar Sooners has been hosting a sidewalk star party at the end of each lecture. We thank our previous officers (Evan Rich, Hora Mishra, Kyra Dame, and Nick Reynolds) for their great work in the past year and congratulate our 2018-2019 officers: Hora Mishra, Joseph Choi, Kyra Dame, London Williams and Nick Reynolds. We can't wait for the next year, when we will begin to host star parties at the new Lin Hall Observatory!

Back Row (from left): Allie Jones, Jenna Miller, Malia Jenks, Hora Mishra (President), Renae Wall , Kyra Dame (Treasurer), Jon Franco, Saloni Bhatiani. Front row: Braden James, Rhiannon Griffin, Adam Marrs, Francis MacInnis, Shaun Steele, Paul Canton, Tim Miller, Evan Rich , James DerKacy, Sean Bruton, Erin Cooper.

Postcards from the Universe

In collaboration with Norman Public Schools, the OKC Astronomy Club, and local businesses, the astronomy group continues to organize and hold free, monthly public lectures via the "Postcards from the Universe" lecture series. Each free monthly talk, held at the Sam Noble Museum, spans a range of astronomy and related topics and features both departmental faculty speakers as well as a range of external to the department speakers. Lunar Sooners is helping to provide star party viewing of the nighttime sky following each event. More information about these lectures can be found at: http://www.nhn.ou.edu/news-and-events/postcards

Faculty Research

Astronomy, Astrophysics and Cosmology

Eddie Baron's supernova numerical radiative transfer group is proceeding apace. His group is in store for changes. Jeremy Lusk will defend his dissertation on June 11. He is already happily employed at the University of Central Arkansas. Malia Jenks will defend her dissertation in the fall. She will shortly submit her first paper on the analysis of the Nearby Supernova Factory data, and is working hard on hydro models of merging white dwarfs, on which we hope to get first results on this summer. Lisa Simpson has decided to move on, and we wish her the best in her future endeavors. New postdoc Andrea Cristini is coming up to speed on solar models and Baron will attend a workshop at the Weizmann Institute in June. Third-year student James Derkacy has been driving our observational effort on both APO, and now Gemini, as well as working on Extremely Luminous Supernovae models. The group had a great REU student Chris Cain, who already is a co-author on one paper on SN 2012fr, is the first author on a second paper and is working on a third paper. Incoming student Andy Block is looking into adding implicit time dependence to their code PHOENIX.

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John Wisniewski's group included Brennan Kerkstra, Kellen Lawson, Evan Rich, Matthew Peters, and Steven Silverberg. Wisniewski continued efforts to enhance diffuser-aided photometry at the APO 3.5m, including procurement and commissioning of a custom filter optimized for transit science. Jamie Lomax and Wisniewski discovered evidence of time variable colors in resolved imagery of the AU Mic debris disk. Rich led a paper describing the fundamental stellar parameters of the SEEDS survey, and led a successful HST/VLA proposal to image the HD 163296 protoplanetary disk. Silverberg submitted a paper detailing new discoveries and false-positives in the Disk Detective survey.

Astro group (from left): Baron, Dai, Henry, Leighly, Kaib, Kilic and Wisniewski.

Nathan Kaib's group recently published work, led by graduate student Matt Clement, showing that the Earth-Mars mass difference may be due to an orbital instability among the outer giant planets in the early solar system. Additionally, postdoctoral researcher, Billy Quarles, published a paper showing that most circumbinary planetary systems (systems where planets orbit two stars) possess stable regions near the stars where undetected planets may reside. Finally, undergraduate Ethan White and Kaib published a paper demonstrating that the elliptical shape of the Fomalhaut star's debris belt may be a gravitational signature of Fomalhaut's very distant (and frequently ignored) stellar companions.

Xinyu Dai's research group continues working on areas of extragalactic astronomy, including gravitational lensing, galaxy clusters, active galactic nuclei, and extragalactic planets. Utilizing the gravitational microlensing technique, with nano-arcsec resolutions, Dai's group (including post-doc Guerras, graduate students Bhatiani, Dogruel, and undergraduate Elmborg) has constrained the accretion disk structure, non-thermal emission around supermassive black holes, and the sub-stellar population in lens galaxies. The group is joining the ASAS-SN collaboration (an all-sky monitoring project for bright objects) to study active galactic nuclei. Graduate students Nugent, Bhatiani, and Mishra, and undergraduate Bruton work on properties of large-scale structures in the universe, including galaxy clusters and cosmic voids.

AMO group (from left): Abraham, Blume, Marino, Schwettman, Shaffer, Watson and Parker

Atomic, Molecular and Optical Physics

Eric Abraham's group current efforts focus on the study of electromagnetically induced transparency using Laguerre-Gaussian beams, whose distinguishing characteristic is they carry orbital angular momentum. Transferring that momentum between laser beams is important in optical computing. In the summer of 2017, we published our latest work comparing LG beams with normal Gaussian beams of constant power. Matthew Holtfrerich is the graduate student working on the experiment, and he completed a thorough theoretical analysis of the system this summer, comparing systems of constant EIT signal size, and working toward experimental verification.

Doerte Blume's NSF-supported theoretical research program involves three postdocs, a graduate student, and an undergraduate student. Doerte gave invited talks at Frankfurt University in Germany, a workshop at the Max Planck Institute in Dresden (Germany), the Wuhan Institute of Physics and Mathematics in China, and several universities in the United States during the past eight months. During the summer, she will be giving invited talks at a cold-atom-meets-nuclear-physics workshop in Italy and at the ICAP conference in Spain. First-year graduate student Jugal Talukdar as well as postdocs Qingze Guan and Su-Ju Wang will be presenting their results at the annual DAMOP meeting in May.

Alberto Marino's group continues to work on the control of quantum states of light and their application to quantum enhanced sensing. Graduate student Javad Dowran and postdoc Ashok Kumar continue to study ways to further enhance plasmonic sensors with quantum resources. Postdoc Aye Win joined this effort at the beginning of the year. Tim Woodworth has been working on experiments to determine the ultimate precision in transmission measurements with quantum resources. Another graduate student, Saesun Kim, has been working on techniques to control the frequency of the generated quantum states of light. Finally, Gaurav Nirala has been working in collaboration with a group from Brazil on novel techniques to characterize quantum states of light. Over the last year the group published papers in *Optica, Physical Review A, Optics Letters,* and *Physical Review B* and presented at

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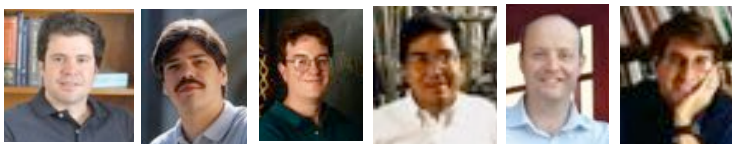
several international conferences, such as *DAMOP*, *CLEO*, *QCMC*, and *ICSSUR*. Alberto received an NSF CAREER award to study the ability to control the spatial degree of freedom of entangled beams of light to enhance quantum networks.

Arne Schwettmann's group created the University of Oklahoma's first Bose-Einstein condensate (BEC), a gas so cold that it behaves like a single quantum object. Graduate students Shan Zhong, Qimin Zhang, Isaiah Morgenstern and Hio Giap Ooi laser-cooled a gas of sodium atoms to create the BEC. They demonstrated control of ultracold spin-changing collisions for sensing applications. Anita Bhagat successfully defended her M.S. thesis. Undergraduate students Jeremy Norris (REU) and Logan Baker (Capstone) built a microwave source to control collisions, and Michael Osisanya (Capstone) built a blue laser to study impurities. The group presented their progress at DAMOP, Fort Lauderdale, Florida.



CM group (from left): Uchoa, Bumm, Mullen, Santos, Sellers and Mason.

Deborah Watson's study of thermodynamic properties of ultracold fermions has yielded good agreement with recent experiments, suggesting a conceptually different way to understand the emergence of collective organizational phenomena, including superfluidity. The driving force for superfluidity in ultracold atomic gases is seen to be the Pauli principle and its selection of specific normal modes at ultracold temperatures. Although conceptually simple, this physics is based on an exact first-order solution of a fully interacting Hamiltonian. Her method circumvents challenging numerical demands by applying the Pauli principle "on paper" and obtaining a first-order excitation spectrum using group theoretic techniques. This work is supported by NSF.

Condensed Matter Physics

Over the last 12 months, **Bruno Uchoa** gave invited talks in the United States and was an invited speaker in the 2017 Symmetry conference in Barcelona, Spain. He published two papers in *Physical Review B Rapid Communications* and another in *Proceedings of the National Academy of Sciences*, in collaboration with an experimental group in University of Illinois at Urbana-Champaign. Graduate student Xu Dou will be defending his Ph.D. thesis in the summer. Uchoa's group has been working to identify novel topological phases of matter. In a recent work with Xu as the first author, they proposed that CrO_2 bilayers are candidate materials for the observation of chiral topological superconductivity. This state could reveal the presence of Majorana fermions, exotic particles which are equal to their own anti-particles.

Ian Sellers's group continues to develop new materials for next generation photovoltaics. Sellers gave several invited talks, including at Old Dominion University, and the universities of Oxford, Sheffield, and University College London in the U.K. Graduate student Hamidreza Esmaielpour presented his work on hot carriers in quantum wells at the Photonics West in San Francisco and the recent World Conference on Photovoltaic Energy Conversion in Hawaii, while Yang Cheng successfully defended his Ph.D. dissertation and has now taken a position at Intel in China. This year also saw the group initiate exciting next research programs with the National Renewable Energy Laboratory and NASA Glenn Research Center.

Mike Santos's research group continues to focus on the molecular beam epitaxy of narrow-gap semiconductors. They collaborate with Ian Sellers's group on materials for photovoltaic applications, including superlattices and dilute nitride layers. They also grow complex multilayer structures for projects with Rui Yang's group (in Electrical Engineering) on infrared lasers and detectors. In addition, they work with Amethyst Research, a small company in Ardmore, Oklahoma, on materials for magnetic field sensors and infrared detectors.

Kieran Mullen has continued his collaboration with Dan Glatzhofer (OU Chemistry) to design molecules to improve the thermal conductivity of carbon nanotube composites. Experiments using initial designs have demonstrated nearly triple the thermal conductivity of unfunctionalized composites. Using genetic algorithms to search the space of possible designs, they hope to improve this result even further. Genetic computer algorithms work by "breeding" good designs to form a new population of candidates that are then tested and winnowed to produce even better ones. The software may have applications in other condensed matter problems. He also is collaborating with Bruno Uchoa (OU Physics) to understand how electrons interact with Coulomb impurities in strained graphene sheets.

High-Energy Particle Physics

Brad Abbott has continued to work on several projects for the ATLAS experiment at CERN. He has been studying the expected sensitivity of searches for vector-like leptons in various signal regions. He also has been involved in

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understanding interference effects in a measurement of a single top quark production in association with a Z boson. Additionally, he is continuing to help develop the ability to put ATLAS pixel modules under various stresses to detect any possible defects in their design.

HEP group (from left): Abbott, Baer, kao, Gutierrez, Milton, Skubic, Sinha, Strauss and Stupak.

During 2017-2018, **Howard Baer** studied the capability of LHC upgrades, both high-luminosity and high-energy, to discover weak scale supersymmetry (SUSY) particles. According to his results, the energy upgrade to 27 TeV collisions will be required to falsify SUSY (although discovery could occur at any time). Baer also has published work on string theory phenomenology in the context of the heterotic mini-landscape model and also statistical analysis of IIB string theory. His group has discovered another natural SUSY model: natural anomaly-mediated SUSY breaking, which makes distinct predictions from other natural SUSY models. He has been engaged in the CERN European Strategy update report for LHC upgrades and also in studies for the capability of the International Linear e+e- collider to discover SUSY.

Phillip Gutierrez continues work with his graduate students as members of the ATLAS collaboration at the LHC. Graduate student Q. Wang's dissertation, which should be completed this summer, is a search for Dark Matter and vector-Like top quarks based on a simple generic model. Dilan Frizzell has moved from Argonne National Lab, where he had a fellowship, to CERN, and is now participating in a measurement of the pp->tZ cross section. This measurement will follow up on the paper postdoc M. Alhroob, Q. Wang, and Phillip published this year. H. Lee has been working on completing her general exam and on various aspects of the pixel detector upgrade. Graduate student J. Muse will finish his general exam this fall, but in the meantime has been working on a search for vector-like leptons.

Kuver Sinha has been investigating several new ideas since his arrival last fall. He published a couple of papers on detection methods for dark matter that only couples to our world through the exchange of photons via loop processes. These candidates appear in strongly coupled hidden sectors, flavored dark sectors, etc. He also finished a paper on theoretical systematics in the calculation of dark matter observables in supersymmetry, and another paper on the possible signature of axion-like particles in the hard X-ray spectra of magnetars. He will be welcoming his postdoc Huaike Guo in the fall, and open up new research directions in gravitational wave signatures of phase transitions in the early Universe.

Mike Strauss is analyzing data from the ATLAS detector at CERN with the primary purpose of measuring properties of the standard model Higgs boson to see if it behaves exactly as expected or if deviations from expectations give hints of physics beyond the Standard Model. He and David Shope have just completed work as part of a small group, which should shortly lead to the submission of a paper on the "Measurement of gluon fusion and vector boson fusion Higgs production cross-sections in the H→WW→eμνν decay channel in pp collisions at center of mass energy of 13 TeV with the ATLAS detector."

John Stupak is leading three exciting efforts within the ATLAS collaboration: a task force studying the reconstruction of novel detector signatures, a forum coordinating actives related to long-lived particles, and the physics analysis group, which oversees unconventional searches for beyond the Standard Model physics. Stupak and postdoc Giuliano Gustavino concluded a search for exotic decays of the Higgs boson to long-lived particles with lifetimes ranging from 0.15 to 15 ps. Building on this work, in conjunction with graduate student Amber Roepe, they are now developing new strategies to extend the search to probe lifetimes up to ~1,500 ps. Stupak and Gustavino also are conducting a search for Dark Matter.

Marino News Release: "OU Physicist Developing Quantum-Enhanced Sensors for Real Life Applications," https://www.nhn.ou.edu/research/featured-research/ou-physicist-developing-quantum-enhanced-sensors-for-real-life-applications

Kilic News Release: "Detached Eclipsing White Dwarfs Predicted to Merge Into Exotic Star," http://www.ou.edu/publicaffairs/archives/2017/OUAstrophysicistPredictsDetachedEclipsingWhiteDwarfstoMergeIntoanExoticStar

Discovering Extragalactic Planets With Microlensing

A University of Oklahoma astrophysics team has discovered for the first time a population of planets beyond the Milky Way galaxy. Using microlensing—an astronomical phenomenon and the only known method capable of discovering planets at truly great distances from the Earth among other detection techniques—OU researchers were able to detect objects in extragalactic galaxies that range from the mass of the Moon to the mass of Jupiter.

Xiniu Dai and OU postdoctoral researcher Eduardo Guerras, made the discovery with data from the National Aeronautics and Space Administration's Chandra X-ray Observatory, a telescope in space that is controlled by the Smithsonian Astrophysical Observatory. "We are very excited about this discovery. This is the first time anyone has discovered planets outside our galaxy," said Dai. "These small planets are the best candidate for the signature we observed in this study using the microlensing technique. We analyzed the high frequency of the signature by modeling the data to determine the mass."

While planets are often discovered within the Milky Way using microlensing, the gravitational effect of even small objects can create high magnification leading to a signature that can be modeled and explained in extragalactic galaxies. Until this study, there has been no evidence of planets in other galaxies. "This is an example of how powerful the techniques of analysis of extragalactic microlensing can be. This galaxy is located 3.8 billion light years away, and there is not the slightest chance of observing these planets directly, not even with the best telescope one can imagine in a science fiction scenario," said Guerras.

For this study, OU researchers used the NASA Chandra X-ray Observatory at the Smithsonian Astrophysical Observatory. The microlensing models were calculated at the OU Supercomputing Center for Education and Research. This work has been published in the *Astrophysical Journal Letters*. Read more: http://www.ou.edu/web/news_events/articles/news_2018/ou-discover-planets

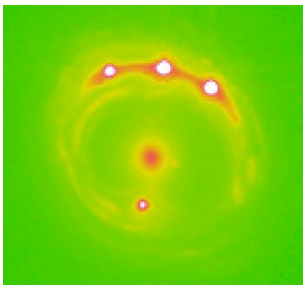
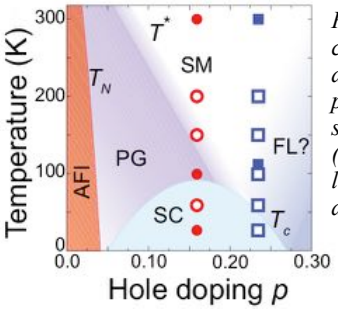


Image of the gravitational lens RX J1131-1231 galaxy with the lens galaxy at the center and four lensed background quasars. It is estimated that there are trillions of planets in the central elliptical galaxy in this image.

Strange Metals Get Stranger

The strange metal is a poorly understood state of matter found in a variety of quantum materials, notably both Cu- and Fe-based high-temperature superconductors. This phase is believed to be key for the understanding of superconductivity in those materials, which have been observed at record-high temperatures. OU Professor Bruno Uchoa coauthored a paper published in the *Proceedings of the National Academy of Sciences* with an experimental group from the University of Illinois. They found experimental evidence that this phase exhibits an exotic property called "local scale invariance," which seems to challenge previous assumptions about this state.

Strange metals exhibit a non-saturating electrical resistivity that scales linearly with temperature, suggesting the absence of electron quasiparticles, the elementary excitations in the Fermi sea. This property is at odds with conventional Fermi liquids, justifying the "strangeness" of this phase. Using inelastic electron scattering, this study reports for the first time the momentum-resolved measurement of the dynamical charge fluctuations of optimally doped $Bi_{2.1}Sr_{1.9}CaCu_2O_{8+x}$. The results suggest that it does not exhibit propagating collective modes, such as the plasmon excitation of normal metals, but instead shows a featureless charge response lacking either temperature or momentum dependence. The charge dynamics in the strange metal is found to be made of purely local excitations in which the space and time axes are entirely decoupled. The findings indicate that this state is defined by a singular kind of charge dynamics for which there is no generally accepted theory. See also: http://www.pnas.org/content/115/21/5392



Phase diagram of the cuprates, temperature versus doping. The strange metal phase (SM) lays above the superconducting dome region (SC). In that phase, the Fermi liquid picture (FL) breaks down.

New Rare Pairs of Heavy Friends in ATLAS

Observing rare productions of heavy elementary particles can provide fresh insight into the Standard Model of particle physics. In a new result first presented by OU postdoc **Muhammad Alhroob**, the ATLAS Experiment presents strong evidence for the production of a single top quark in association with a Z boson.

The high proton–proton collision energy and rate of the Large Hadron Collider (LHC) makes it possible to produce the heaviest elementary particles, such as the top quark — which is about 175 times heavier than a proton — in many different combinations. The production of a single top quark through the weak interaction was observed already in the second year of LHC data-taking. A few years later, the production of a W boson in association with a top quark (tW) was observed. The next in line, the production of a Z boson in association with a top quark (tZ), is much harder to observe as its production rate is about one hundredth that of tW.

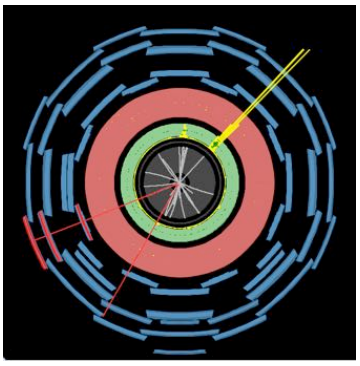
Because this process is so rare, separating it from other sources (background events) is very hard. Finding the most promising event topology — that is which decays of the top quark and Z boson to consider — for the search is a challenge in itself. The researchers in the collaboration first considered events with one, two or three leptons before deciding that the three-lepton topology was the most promising for a first observation.

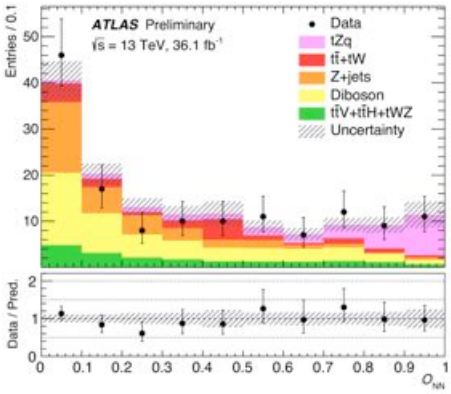
The events that were searched for contain leptons (electrons or muons), jets (sprays of hadrons) and transverse momentum imbalance. A key input to the analysis is to combine and condense all the information from the measured particles into one "discriminator" trained to separate signal from background events. The output of this discriminator informed the scientists for a data event whether it is more background or signal-like.

The filtration of the background noise was done using an artificial neural network (ANN). The network learns what signal and background events look like using simulated data. It is thus necessary to carefully check that the simulated events match well with the actual data. This is achieved with the use of validation regions defined to be similar to but not equal to the signal region, which allowed the researchers to test the simulation while not exposing the signal.

The latest preliminary ATLAS result looks at data collected in 2015 and 2016. During this time, roughly 700 million collisions per second occurred at a proton–proton centre-of-mass energy of 13 TeV… very much looking for a needle in a haystack! The result after the event selection finds 25 signal events, where a Z boson was produced in association with a top quark, together with 120 background events. Applying the ANN allowed us to further separate these two categories leading to a significance for signal of 4.2 standard deviations. This constitutes strong evidence that the associated production of a single top quark and a Z boson has been seen, and the observed production rate agrees with that predicted by the Standard Model.

With the additional data to be collected over the next years, ATLAS will be able to study tZ production in more detail, and improve its searches for the even rarer and more elusive production of a top quark in association with a (single) Higgs boson.





Left panel: Event display of one tZ signal candidate event collected in 2016. This event contains one electron, two muons and two jets. Muons tracks are shown in red, while the energy clusters in the calorimeters, used to reconstruct electrons and jets, are shown in yellow. Right: ANN output (ONN) distribution for the events selected by the analysis. Data is shown in black, the simulated signal is shown in pink and backgrounds are shown in other colors. The high part of the ONN spectrum is dominated by signal events.

Marino Wins NSF CAREER Grant

OU physics professor Alberto Marino is the recipient of a $500,000 National Science Foundation CAREER (Faculty Early Career Development Program) Award. Marino will study new possibilities for the use of spatial degree of freedom in applications ranging from long-distance quantum communications to quantum imaging. The inclusion of such degree of freedom in long-distance quantum networks can bring about a revolution to the field of quantum information science by making it possible to transmit large amounts of information through a quantum channel.

The ability to control the distribution of spatial quantum correlations present in continuous-variable entangled twin beams will make it possible to gain new control over the spatial degree of freedom. The implementation of a source with such capability has a wide range of transformative applications, such as secure communications, information processing and distributed quantum computing.

This research will be integrated with an education program that will develop the problem-solving skills of undergraduate students through participation in research and teaching laboratories. Another outreach opportunity will involve high school teachers from the NSF Research in Engineering and Teaching Program. Efforts will be made to involve underrepresented groups in the research program.

Congratulations!

Clements Leads Research on Early History of Mars

The particular dynamics of the instability between the giant planets kept Mars from growing to an Earth-mass planet.

A University of Oklahoma astrophysics team led by graduate student Matt Clement explains why the growth of Mars was stunted by an orbital instability among the outer solar system's giant planets in a new study on the evolution of the young solar system. The OU study builds on the widely accepted Nice Model, which invokes a planetary instability to explain many peculiar observed aspects of the outer solar system. An OU model used computer simulations to show how planet accretion (growth) is halted by the outer solar system instability. Without it, Mars possibly could have become a larger, habitable planet like Earth.

"This study offers a simple and more elegant solution for why Mars is small, barren and uninhabitable," said Clement. This work had the collaboration of OU professor Nate Kaib, and of two groups in the University of Bordeaux, France, and the Southwest Research Institute. A paper, "Mars' Growth Stunted by an Early Giant Planet Instability," has been published in the online version of the scientific journal, *Icarus*. For more information, see: https://www.eurekalert.org/pub_releases/2018-05/uoo-aos050418.php

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Matthew Peters: Continued from pg. 6

Peters is a member of the OU Honors College and holds a perfect 4.0 grade-point average. In addition to performing research at the Institute for Solar Energy Research in Hameln, he has studied at the University of Leipzig in Germany. He was one of 45 students nationwide to receive the Astronaut Scholarship, an award for superior students in science and technology worth up to $10,000. He also was one of three students to receive the Duane E. Roller Award in 2016 from the Dodge Department of Physics and Astronomy.

The national scholarship competition is conducted by the Barry M. Goldwater Scholarship and Excellence in Education Program. This year, 1,280 college sophomores and juniors from 455 institutions competed for the 211 scholarships. 281 students received Honorable Mentions, including OU students Kate Avery, Alex Hamilton and Eli Jergensen. The one- and two-year scholarships cover the cost of tuition, fees, books and room and board up to a maximum of $7,500 per year.

Solar Eclipse Viewing in the South Oval

Lunar Sooners hosted a eclipse watch party on the South Oval to observe the 2017 Solar eclipse in August. It is estimated that around 1,000 students, staff, faculty, and members of the public attended. The last total solar eclipse that could be observed in the continental United States happened in 1918. In Oklahoma, the eclipse was partial, with 15.4 percent of the sun's disk remaining unobscured by the moon. Two solar telescopes, 500 solar glasses, and a few pinhole projectors were set up for public viewing. The solar telescopes revealed several visible sunspots at the time of the eclipse. The event was co-sponsored with the College of Arts and Sciences. In the image on the right, graduate student Alekzander Kosakowski assists the public observe through a telescope. The eclipse occurred right on the first day of classes — a perfect way to greet our incoming students!

Eclipse viewing in the South Oval in August 2017.

Women in Physics Initiative Launched

The Department of Physics and Astronomy now has a vibrant, APS-funded Women in Physics (WiP) group. The group was started in January 2018 following a successful APS grant application, with a grant renewal due in 2020. This puts OU in the company of other universities nation-wide which have seen the growth of similar groups in recent years (see https://www.aps.org/programs/women/ for more information).

The WiP group held two lunch meetings this semester, both attracting a large number of faculty, students (undergraduate as well as graduate), and staff. The first was led by professor Doerte Blume, and the second by incoming professor Ferah Munshi. Audience members enthusiastically shared their perspectives on career development, the pressures of graduate and research life, and strategies for negotiating professional challenges. Professor Munshi's presentation also coincided with the campus visit by new graduate students, many of whom attended the meeting.

Student coordinators of the WiP group include Delaram Nematollahi and Amber Roepe. Kuver Sinha is the current faculty mentor, with Ferah Munshi joining starting this fall. The group has planned several activities in upcoming semesters, including hosting speakers, presenting modules on professional development, forming a website and perhaps planning a field trip.

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Collin Dabbieri: Continued from pg. 6

Collin is a National Merit Scholar from Medina, Ohio. He is working on the SimBAL (Spectral Synthesis for Broad Absorption Line Quasars) project in professor Karen Leighly's group. Last summer, in collaboration with OU graduate students Francis MacInnis and Joseph Hyunseop Choi, he analyzed a sample of FeLoBAL quasars. They found that the outflows are located over a broad range of distances from the quasar central engine, and that the width of the absorption lines is anticorrelated with the distance. He presented this research at the American Astronomical Society meeting in Washington, D.C., in January. Over the summer, he helped professor Leighly supervise REU students Collin McLeod, Ryan Hazlett, and Susannah Brodnitz as they tackled a sample of broad absorption line quasars that feature absorption lines from P+4.

Collin plans to graduate in spring 2020. He hopes to attend a graduate program that integrates astrophysical research with machine learning. In his spare time, he plays ultimate frisbee and competes as a member of OU's Apes of Wrath Ultimate club.

Members of the Homer L. Dodge Department of Physics and Astronomy, May 2018. Photo by Hugh Scott.

Please consider making a donation to the Homer L. Dodge Department of Physics and Astronomy

Your donations to our General Fund are used to support such critical departmental activities as physics and astronomy conferences on the OU campus; high-profile colloquium speakers; programs for women and minorities; outreach; alumni reunions; faculty and student research; postdoctoral fellows; graduate research assistants; and newsletter publication. The two major immediate needs are the building and a buy-in to a national telescope. Remember, what you give to the department stays in the department. Go to https://www.nhn.ou.edu/friends-alumni/donate for details.

Nielsen Hall, home of the Homer L. Dodge Department of Physics and Astronomy

Foucault pendulum, located in the Nielsen Hall atrium, where tea is served each weekday from 3:30 to 4 p.m.