ΦYAST ΦLYER

The Homer L. Dodge Department of Physics and Astronomy

Faculty joined by Robert Lewis-Swann

Robert Lewis-Swann

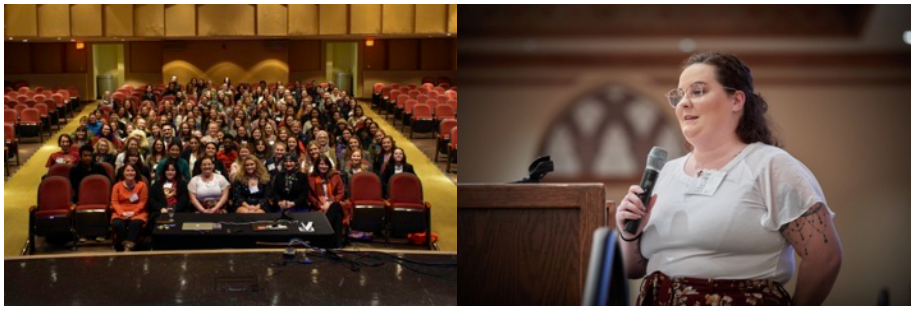
This Fall, Robert Lewis-Swan will join our department as an assistant professor doing theoretical Atomic, Molecular, and Optical Physics. Robert graduated from the University of Queensland (UQ), Australia, in 2011 with an undergraduate degree in physics. In 2015 he obtained his PhD from UQ, working with his supervisor Karen Kheruntsyan on developing new fundamental tests of quantum nonlocality using ultracold atoms. Since 2016 until this year he was a postdoctoral fellow in the group of Ana Maria Rey at JILA (CU Boulder).

At UQ, his work mainly focused on utilizing quantum entanglement and non-classical correlations in large-scale ensembles of ultra-cold atomic gases to propose fundamental tests of quantum mechanics, such as demonstrating violations of a Bell inequality. His work led to several collaborations; including one with the Oberthaler experimental group of Heidelberg University to generate and observe non-classical correlations to build a quantum-enhanced atom interferometer, and another with the Truscott experimental group of the Australian National University, to observe and verify non-classical correlations between pairs of atoms scattered from a collision of ultracold Bose-Einstein condensates.

At JILA, he collaborated extensively on a range of experimental topics, including: trapped ions, cavity-QED, and neutral atoms in optical tweezers. These experimental platforms provide an excellent playground to study novel non-equilibrium many-body phenomena such as dynamical phase transitions and the dynamics of quantum

Continued on pg. 4

Department holds Conference for Undergraduate Women in Physics



Left: Group picture of the Conference for Undergraduate Women in Physics, held in at OU in February 2020. The local organizing committee with 19 members was led by graduate student Amber Roepe (right) and by faculty Doerte Blume.

The department hosted the Conference for Undergraduate Women in Physics (CUWiP) in January 17-19. The conference was attended by about 130 undergraduate students, mostly women, from Oklahoma and surrounding states. Following a formal application to the American Physical Society, which coordinates the conference series, OU was selected as one of 12 sites across the United States to host CUWiP over Martin Luther King Jr. weekend.

Continued on pg. 4

From the Chair

Calendar year 2020 has been a long strange year. The year started with news reports from China about a serious respiratory illness spreading in the city of Wuhan. On January 20, 2020 the first case was reported in the U.S. and on March 6, 2020 the first case in Oklahoma was confirmed. In order to protect faculty, staff, and student, OU decided to cancel all in-person classes after Spring Break and we all learned to work from home. Not only were in-person classes moved online, but research labs were shut down and staff worked from home. New terms entered our lexicon, “Covid-19”, “social distancing”, “masking”, and “Zoom”. Unfortunately for our graduating students (seniors, masters, and Ph.D.) commencement occurred virtually, which did not allow for the celebratory atmosphere that surrounds this momentous event in a student’s life to occur. By the end of the Spring 2020 semester we were all ready to relax and hope for some return to normality.

Before the end of the Spring 2020 semester, OU announced a return to in-person teaching for classes with an enrollment of 40 students or less for the Fall semester and announced a phased return of the research enterprise. With a significant effort by the academic administrator we were able to return to in-person teaching during the Fall 2020 semester with no major incidents and the research enterprise was fully operational. Of course, there was plenty of stress on all but with OU administering vaccines following the State’s phased program, the CDC predicting that most Americans can be vaccinated by the end of Summer 2021, there is some hope of a return to a more normal life by the end of 2021.

Yet all was not bleak and much progress has been made over the last year plus. As stated in this newsletter, Dr. Robert Lewis-Swan (AMO theorist) joined the faculty in Fall 2020. In addition, Dr. Joseph Tischler (condensed matter experimentalist) joined in Spring 2021, Dr. Bihui Zhou (AMO Theorist) and Dr. Madalina Furis (condensed matter experimentalist) will join the faculty in Fall 2021, and Dr. Thirumalai Venkatesan (condensed matter experimentalist) will join the faculty in July 2021 becoming the first Director of the Center for Quantum Research and Technology. We all want to thank Prof. Alberto Marino for serving as interim director for two years and bringing the center to its current nationally recognized status.

As with everything else, the annual awards ceremony for our students did not take place due to Covid-19 restrictions in place at the time, which was a disappointment for students and faculty alike. Students were notified directly of their award. We congratulate the many outstanding students who received awards as listed in this newsletter. Here, I will single out the two students who successfully completed the course of study in our department: Collin Riggert who received the Fowler prize, which is given annually to the outstanding graduating senior in Physics & Astronomy, and Dylan Frizzell who received the Nielsen prize, which is given to Ph.D. recipients who are exceptional among those who have been awarded doctoral degrees from the Department of Physics and Astronomy over the years.

Finally, three faculty members received faculty awards in 2020. They are Professor Karen Leighly who received the Regents' Award for Superior Research and Creative Activity. Professors Alberto Marino and Ian Sellers were the recipients of the Ted S. Webb Presidential Professorship. The award recognizes faculty members who excel in all their professional activities and who relate those activities to the students they teach and mentor.

We look forward to a very busy and productive year. I would like to personally invite any of our alumni and friends to visit with me or any of our faculty.

What Is Where?

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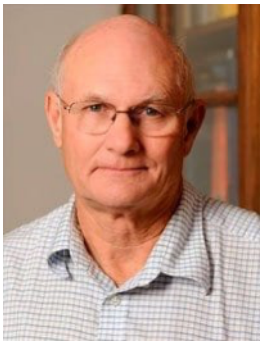
Holland Ford recognized as the 2020 Distinguished Alumni



Holland Ford

Dr. Holland Ford was recently recognized as the 2020 Distinguished Alumni by the College of Arts and Sciences at the University of Oklahoma. The recognition is offered to OU Alumni with outstanding careers in their areas of expertise.

Ford is an astronomer at the Space Telescope Science Institute, and an emeritus professor in the Johns Hopkins' Henry A. Rowland Department of Physics and Astronomy. He graduated with special distinction from OU in 1962, with a bachelor of science degree in mathematics and physics. In 1970, he earned a Ph.D. in Astronomy at the University of Wisconsin. For 40 years, he held multiple positions in various institutions, including professorships at UCLA and the University of Michigan, as a professor and Center Director in the Center for Astrophysical Sciences at John Hopkins University, and as an astronomer and Acting Deputy Director in the Space Telescope Science Institute.

He is the principal investigator for the Hubble telescope's Advanced Camera for Surveys, and assumed a leading role in organizing the Hubble panel that developed the Corrective Optics Space Telescope Axial Replacement. Ford has also played a role in discovering evidence for the existence of supermassive black holes in the cores of most galaxies.

Ford is the recipient of NASA's Distinguished Public Service Medal for his outstanding contributions to the Hubble Space Telescope. This award is NASA's highest form of recognition, and is presented to those who have made a profound impact on the success of a NASA mission. He is also the recipient of the NASA Public Service Medal, the NASA Exceptional Scientific Achievement Award and the NASA Group Achievement award.

OU Alumni identifies "Peter Pan" disks

Steven Silverberg

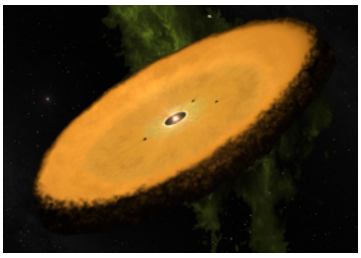
OU alumni and astronomer Dr. Steven Silverberg has recenty observed unusual planetary systems `that refuse to grow'. Silverberg, is a recent PhD graduate of our department and is now a postdoctoral researcher at the MIT Kavli Institute for Astrophysics and Space Research. He and his colleagues have dubbed such star systems as "Peter Pan" discs.

There's something strange about the star J0808, which is a low-mass red dwarf star in the Carina association, over 330 lightyears away. It exhibits an extreme infrared excess. This means that the J0808 system is giving off far more thermal energy than you would expect from its visible brightness. The normal reason for this is that newly formed stars are often still surrounded by a protoplanetary disc of gas and dust, which warms up in the young starlight and emits the extra infrared radiation. The strange thing is that J0808 isn't really all that young. It formed about 45 million years ago.

It was previously thought that any primordial disc of gas and dust ought to have long since dispersed by this time. J0808 had already been recognised as an oddity by its late infrared excess, but now Silverberg's team report on a handful more examples of such Peter Pan discs.

The increasing number of Peter Pan disc discoveries may indicate that they are actually relatively common, but a big mystery remains about why these systems are refusing to grow up.

The study was published in the *Monthly Notices of the Royal Astronomical Society: Letters*.



An artist's impression of the Peter Pan disk around WISE J080822.18-644357.3, a red dwarf located about 331 light-years from Earth in the constellation of Carina. Source: http://www.sci-news.com/astronomy/peter-pan-disks-08526.html

Robert Lewis-Swann: Continued from pg. 1

information, i.e. how quantum correlations and entanglement propagate through a system. Given JILA's close relationship with NIST, much of this research is motivated by trying to better understand how entanglement can be generated in non-equilibrium systems and used as a resource for quantum-enhanced sensors.

Dr. Lewis-Swan's research program at OU will seek to understand how we can harness and/or engineer interactions between atoms, molecules and light to generate, characterize and manipulate entanglement and to form the backbone for schemes to use entanglement in next-generation quantum sensors and devices. The key concepts that are driving the revolution in modern quantum science and new 'quantum-enhanced' technologies are quantum entanglement, correlations and coherence. These serve as the resources from which we power new computing protocols and advanced metrological devices. Devising ways to robustly generate these resources, specifically entanglement, is the key task in the current quantum revolution.

Concerning his approach to these issues, he says, "AMO experimental platforms form the perfect toolkit for a theorist as there are a plethora of intrinsic and mediated interactions available to choose between: from contact interactions in neutral atoms, to dipolar interactions in polar molecules, long-range interactions in Rydberg systems and trapped-ion arrays, and light-matter interactions in composite systems. By better understanding how to use and engineer interactions to generate, characterize and manipulate entanglement, I hope to bring the promise of quantum-enhanced sensors to fruition. This can lead to breakthroughs in a range of scientific fields such as developing new state-of-the-art time and frequency standards, realizing tabletop experiments to search for dark matter, and measuring ultra-weak forces and fields, to name just a few."

Dr. Lewis-Swan was attracted to Oklahoma by the recent effort at OU to create a concentration on quantum technology research. He said, "With the newly created CQRT, OU physics looks to be pushing in the right direction to do great things. Combined with the national push to develop breakthrough quantum technologies, I believe the environment is set for CQRT to take advantage and become a center of excellence for AMO and CM physics."

Outside of physics, he likes to stay active. "As a result of a misspent youth competing at a national level in rowing ('crew'), where I met my wife (who has coached national teams for Australia) I am a very active person. Almost every afternoon in the spring and summer I can be found outside cycling, while in the winter I rack up the miles indoor rowing."

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Women in Physics Conference: Continued from pg. 1

Presenters at the conference. Left: Doerte Blume; right: Ferah Munshi and daughter.

The conference program touched on all aspects of undergraduate students' lives, including the challenges and isolation frequently felt by members from underrepresented minorities. The undergraduate student attendees had the opportunity to visit experimental facilities in Nielsen and Lin Hall, to learn about graduate programs and internships, to enjoy talks by internationally renowned speakers, and to interact with OU alumni who are now pursuing highly successful careers in academia. They also heard about strategies to cope with mental health challenges, and were able to learn about unique challenges encountered by underrepresented minorities and the LGBTQ+ community.

OU's CUWiP was organized under the leadership of third-year physics graduate student Amber Roepe, who spearheaded bringing CUWiP to OU and served as chair of the Local Organizing Committee. Doerte Blume served as the faculty chair of the conference. The majority of the committee was made up of undergraduate and graduate students from the Department of Physics and Astronomy. In addition, several staff and faculty members generously donated their time. The full list of local organizing committee members and the program can be found at https://www.ou.edu/cuwip/loc. The feedback from the student participants and presenters was overwhelmingly positive and suggested that the conference was a great success.

The conference organizers would like to acknowledge the financial support of the conference by the APS, through their NSF and DOE grants; nine OU colleges, departments and offices; EPSCOR Mississippi; as well as individual donors who donated through OU's Thousands Strong crowdfunding efforts.

Student Awards

Due to restrictions imposed by COVID-19, the traditional departmental award ceremony, usually held in May, was cancelled this year. The awards were communicated directly to the recipients.

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
Jamie Boyd	Julianna Voelker	Colin Riggert

J. Clarence Karcher Award

Matthew Welty

Duane E. Roller Award

William McNulty, Kiernan Arledge, and Dorothy He

William Schriever Award

Cora deFrancesco, and Nathan Leiphart

Outstanding Graduating Senior

Lukas Stone, Camron Parker, Samuel Bayliff, Claire Riggs, Hannah Day, Collin Dabbieri, Rayan Hazlett, Collin McLeod

Meritorious Scholarships

Seniors: Samuel K. Bayliff, Jeremiah Buenger, Collin Dabbieri, Hannah Day, Daniel Dobrosky, Aleksia Elmborg, Kazsa Fahrenthold, Grayson Garmaker, John Z. Griffin, Ryan S. Hazlett, George Mau, Collin L. McLeod, Cameron Parker, Collin Riggert, Claire Riggs, Dayna Sloane, Lukas Stone, Matthew Welty, Alexander Yates, Anneliesse Zeller

Juniors: Kiernan Arledge, Robert Beauchamp, Aspen Bell, Travis Casey, John Cox, Nathaniel Gunter, Dorothy He, Willow Kirkpatrick, Gannon Lawley, William McNulty, Latta Miller, Mark Mitchell, Alexander Parsells, Seth Pickle, Aidan Powers, Noah Reidy, Katherine Sloan, Austin Stejskal, Lukas Sturm, Julianna Voelker, Michael Walkup, London Wilson, Christopher Yamashiro,Sara Zych;

*Sophomores:*Bianca Azartash, Isabella Campbell, Anna Marie Conly, Cora DeFrancesco, Jacob Dyke, Kurtis Felker, Nathan Leiphart, Jacob Moser, Sara Paugh, Franklin Rawson, Jaycie Thaemert, Landon Turner, Evelyn Vargas Olmos, Michael Waslo, Zachary Yarbrough;

Freshmen: Ryan Abbott, Bryan Beard, Elisabeth Blazek, Jamie Boyd, Angela Brown, Maddison Burgett, Saige Caffey, Tucker Capps, Dylan DelCol, Megan Firgard, Karson Francis, Theodore Frantz, Harley Hasha, George Hayek, Charlotte Kostecka, Sebastian Lomeli, Adrian Lopez, Jaylen Losh, Simon Lowry, Thomas McGee, Ogechi Okoronkwo, Andrew Olsen, Miles Rex, Aaron Richterkessing, Riley Rose, Gabriel Shulmann Yang, Jacob Sims, Sean Smith, Anna Thomas, Jaqueline Thomas, Emily Tipton, Lydia Verity.

Engineering Physics

J. Clarence Karcher Award

Elijah Robertson

Duane E. Roller Award

Tanner Legvold

William Schriever Award

Rachel Penner

Meritorious Scholarship

Seniors: Alexander G. Grove, Elijah Robertson, Israa Yusuf;

Juniors: Tanner Legvold, Kevin Robb, Omar Robles, Andrew Schramka;

Freshmen: Jacob Coffman, Anjani Gautam, Brigham Godwin, Cameron Goodbar, Noah Gruman, Michael May, Rachel Penner, Sadie Priddy, Natali Raymundi Pinheiro.

Collin Riggert recipient of Fowler Prize

Collin Riggert

This year, Colin Riggert won the Fowler prize for the outstanding graduating senior from the Homer L. Dodge Department of Physics and Astronomy. Colin comes to OU from Trabuco Canyon, CA on a National Merit Scholarship. He originally intended to be an aerospace engineering major, and considers his switch to physics, "the greatest decision I ever made.

Collin excelled in both coursework and research. He completed most undergraduate work before his final year in the program and took a number of graduate courses. In research, he started working with Prof. Brad Abbott in the Vector-Like Leptons group, doing signal and control region optimization. From this research, he found he enjoyed the elements of computational physics. For his first summer REU, he worked with Prof. Francis Robicheaux at Purdue University in Atomic, Molecular, and Optical theory. For his second, he worked with Prof. Kieran Mullen doing numeric studies of topological systems of quantum rings, which evolved into his Capstone research.

This research with Dr. Mullen made Colin decide Condensed Matter theory was where he wanted to direct his career. "This opened my eyes to how interesting modern Condensed Matter theory truly is and shaped my interests in studying topological materials and quantum critical phenomena through techniques that blend analytic and numeric calculations."

Colin will pursue a PhD at the University of Minnesota—Twin Cities. He will build upon the research interests he

Continued on pg. 15

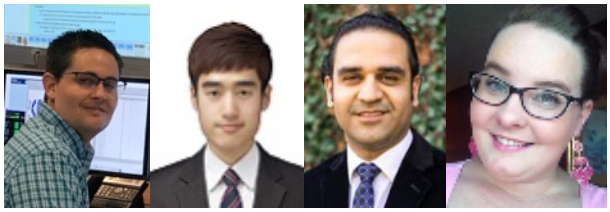
Howell Scholarships go to Kim, Kosakowski, Mishra and Moss

From Left: Saesum Kim, Aleksander Kosakowski, Hora Mishra and Adam Moss.

The Kenneth and Joyce Harwell Scholarship was awarded to graduate students Saesum Kim, Alekzander Kosakowski, Hora Mishra, and Adam Moss. The scholarship provides additional financial support for educational expenses for qualifying students.

Congratulations!

Recipients of the Nielsen Prize, Kalbfleisch Award, Shafer-Ray Award and Dodge Scholarship announced



From left: Dylan Frizzell, Sang Wook Kim, Mahammadjavad Dowran and Amber Roepe.

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 **Dylan Frizzell** for his thesis work "*Observation of single top quark with associated Z boson production at the large Hadron Collider using ATLAS detector*". Frizzell worked under the supervision of Phil Gutierrez.

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 $2,000 check was given to **Sang Wook Kim**, who works with Bruno Uchoa in the theory of strongly correlated quantum fluids.

The *Shafer-Ray award*, which includes $2,000 check, is offered to accomplished students in Condensed Matter or Atomic, Molecular and Optical physics. The award was given to **Mahammadjavad Dowran**. Dowran currently works with Alberto Marino in quantum metrology.

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 **Amber Roepe**, who is advised by John Stupack. Congratulations!

Ph.D.s, Master's Degrees Awarded

Since July of 2019, 11 Physics and Astronomy students have successfully defended their dissertations. Those students who completed their Ph.D. degrees (and their advisers) are: **Kyra Dame** (Killic), **Jin Yang** (Shaffer), **Collin Brown** (Sellers), **David Shope** (Strauss), **Jenna Nugent** (Dai), **Yifan Zhang** (Baer), **Wenxiang Huang** (Santos), **Rishabh Jain** (Kao), **Dibyashree Sengupta** (Baer), **Sang-Wook Kim** (Uchoa), **Mitchell Yothers** (Bumm). Five students also defended their master's thesis: **Rajeeb Sharma** (Kaib), **Andrew Dewalt** (Kao), **Caleb Duff** (Santos), **Coulton Johnson** (Strauss), **Nafisa Amin** (Bumm). 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, had 14 students from different universities as well as from OU. These students help conduct research in the department for two months during the summer. Due to COVID-19 restrictions, the program was attended virtually this year. The OU program is overseen by Brad Abbott and Mike Strauss.

The students and home institutions are: Chaise Heinen (Minnesota Duluth), Shania Wolf (Missouri State), Katelynn Fleming (Drew), Elijah Sheridan (Vanderbilt), Grace Ward (Michigan State), Carolyn Doctor (U. Georgia), Bailey Weakley (Oklahoma Baptist), Cordelia Meixsel (Stetson U.), Julianna Voelker (OU), William McNulty (OU), Andrew Schramka (OU), Tanner Legvold (OU), Kathrine Sloan (OU), Cora DeFrancesco (OU). We hope they had a productive and interesting summer!

Yearly Review of Lunar Sooners

Lunar Sooners had a good 2019-2020 academic year. Unfortunately, our year was cut short due to the COVID-19 pandemic. We had a total of 15 events, including 11 private star parties, 1 Soonertarium, 3 demo events. In 2019, the new observatory on the third floor of Lin Hall finally opened - with 12 new 8" telescopes and one 14" telescope inside the fully functioning dome. We moved our Lunar Sooners events entirely to Lin Hall. The nine permanent mounts for the telescopes were set up on the roof for the Astr 1514 labs, Wednesday public star parties, and Lunar Sooners private events. Lin Hall observatory is wheelchair accessible, while the old observatory on Asp Ave. is still used as a backup venue for Lunar Sooners events.

Back Row (from left): James Derkacy, Nickalas Reynolds, Joseph Choi, Brett Bonine, Evan Rich, Jordan Van Nest, Kellen Lawson Front row: Renae Wall, London Wilson, Hora Mishra, Kyra Dame.

For the second year, Lunar Sooners collaborated with Norman High School, Norman North High School, OKC Astronomy Club to host a Science lecture series, "4 Science: the Cutting Edge", at the Sam Noble Museum of Natural History.
We thank our previous officers for their great work (President: Hora Mishra, Vice-President: Brett Bonine, Engineer: Nick Reynolds, and Treasurer/PR manager: Joseph Choi) in the past year. We can't wait for the next year where we hope to have more amazing events on OU campus and around Oklahoma!

Faculty Research

Astronomy, Astrophysics and Cosmology

Eddie Baron's supernova numerical radiative transfer group is proceeding apace. Postdoc Vera Passegger arrived at the end of October and is well integrated into the group. Fourth year student James Derkacy has been driving our observational effort on APO as well as working on three papers on Type Ia supernova spectra. Sarah Stangl just finished her second year and is working at Los Alamos again this summer. First year student Anthony Burrow is busily trying to finish up his first, first-author paper on various photometric and spectroscopic classifications of Type Ia supernovae using data from the Carnegie Supernova Project I and II (CSP I and CSP II). Undergrad London Wilson is working on modeling so-called super-Chandra Type Ia's using our parameterized SYNOW code. Eddie's group started a pilot project to observe and model very early supernovae of alltypes, CSP II.5. They had lined up two months of telescope time, all over the world, but got exactly one night of observations before everything was shut down due to COVID-19. The simulations and one night of observing were a success. They will try again in October as well as preparing to go forward with CSP III. With luck all the work will be conducted remotely. Hopefully, observatories will begin to open back up in the Fall!

Graduate student Matt Clement, a member of **Nathan Kaib**'s group, completed his PhD and began a postdoctoral fellowship at the Earth and Planets Laboratory at the Carnegie Institution for Science. Kaib's group also wrote a paper demonstrating that highly inclined trans-Neptunian objects discovered recently place tight constraints on the orbit and mass of a distant undetected planet. Graduate student Kalee Anderson is developing this work further. Graduate student Hunter Campbell is studying how trans-Neptunian binaries may constrain a past orbital instabilities within the outer solar system, and graduate student Elizabeth Campbell is studying the stability of exoplanets within binary star systems.

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Bhatiani and Dai News Release: "Planet-mass objects in extragalactic systems,"https://www.sciencedaily.com/releases/2019/12/191212095904.htm

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The SimBAL group lead by **Karen Leighly** has had another active year. Graduate student Joseph Choi published his first paper entitled "Discovery of a Remarkably Powerful Broad Absorption-line Quasar Outflow in SDSS J135246.37+423923.5". Gemini Observatory issued a press release on this result. Undergraduates Collin Dabbieri, Ryan Hazlett, and Collin McLeod graduated, and are looking forward to graduate school at Vanderbilt University, University of Toledo, and University of Pittsburgh, respectively. Several new students are diving into research this summer: Kaylie Green, a graduate student at Western University who just passed her PhD candidacy exam, and OU undergraduates Cora DeFrancesco and Julianna Voelker. Leighly, Choi, Dabbieri, and McLeod all presented virtual posters at the AAS 236th meeting. Leighly and OSU collaborator Don Terndrup will attend the AAPT annual meeting in July to present their experiences teaching data analytics to undergraduates.

Mukremin Kilic's group is using a variety of telescopes in 2020, including our own Apache Point Observatory 3.5m telescope, the Hubble Space Telescope, Keck I 10m telescope, and the twin Gemini 8m telescopes. Our group was awarded 60 hours of Gemini time in 2020. Graduate students Alek Kosakowski and Renae Wall published their first first-author journal papers, and both are already working on their second papers. Adam Moss has received Gemini time to study magnetism in white dwarf stars, and Onder Catmabacak is using machine learning tools to identify variable stars. Capstone student Dayna Sloane (graduated in May) and REU student Shania Wolf worked on identifying variable white dwarfs in the Zwicky Transient Facility and NASA's TESS satellite data. Capstone student Latta Miller and sophomore Jake Dyke are working on using TESS data to measure stellar spin periods. Our group has identified a 20 min period gravitational wave source that will be used as a verification source for ESA's LISA mission, and also published a large paper presenting the analysis of nearly 2,000 white dwarfs within 300 lightyears of the Sun, finding evidence for crystallized white dwarf stars and also discovering a sequence of ultra cool white dwarfs for the first time.

Atomic, Molecular and Optical Physics

Deborah Watson's group studied the dynamic forces during the transition from complex microscopic motion to simple collective behavior as seen in superfluidity. She is investigating the role of the Pauli principle in the creation and stabilization of collective behavior for systems of fermions. Normal modes were found to describe the superfluid behavior of ultracold fermions in the unitary regimen accurately, yielding excellent agreement for thermodynamic quantities with experimental data. Understanding the dynamics behind the emergence of collective behavior increases our ability to produce and control these systems and enhance their use in technology. This work is supported by NSF.

Eric Abraham's group, led by graduate student, Matthew Holtfrerich, who is finishing up his Ph.D. thesis on experiments using ultracold rubidium gases and laser beams with orbital angular momentum. The project studies how using these laser beams can improved experiments in electromagnetically induced transparency. Also last year, Andy Schramka, an OU undergraduate student, has been working on a new project studying classical entanglement in laser fields, joined during the summer by Amirah Townsend from Frostburg State University, as part of the OU REU program.

Arne Schwettmann's group performed experiments on microwave-control of spin-changing collisions in sodium spinor Bose-Einstein condensates. Graduate students Shan Zhong, Qimin Zhang, Isaiah Morgenstern and Hio Giap Ooi investigated atom interferometry for sensing applications. In collaboration with D. Blume's theory group at OU, they verified a newly predicted resonance that causes unexpected spin dynamics. Undergraduate students Tyler Lazarek (CAPSTONE) and Chase Heinen (NSF-REU) designed an ionization spectrometer to investigate Rydberg impurities. The group published two new research articles and presented their progress at DAMOP. The group is funded through an NSF CAREER award and a newly awarded DOD DEPSCOR award.

Doerte Blume's group works on quantum systems. Postdoc Dr. Jianwen Jie leads a theory effort on spinor Bose-Einstein condensates. Jianwen's work guides the experiments conducted by the Schwettmann group. Postdoc Dr. Qingze Guan (moved to Temple University in September 2019), in collaboration with Doerner's group in Frankfurt, completed work on the strong-field control of the weakly-bound helium dimer, discovering a double-slit-like interference pathway. Third-year graduate student Jugal Talukdar made great progress on understanding open quantum systems such as probes or emitters embedded in a photonic crystal. Undergraduate A.J. Yates continued his work on characterizing small helium clusters.

Grant Biedermann's group has been building their new experiment in the fantastic new lab space of Lin Hall. Hoang-Van Do recently joined us for post-doctoral research following her PhD at LENS, Università degli Studi di

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Karen Leighly received the Regents' Award for Superior Research and Creative Activity. Alberto Marino and Ian Sellers were the recipients of the Ted S. Webb Presidential Professorship. Congratulations!

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Firenze. He also welcomed new students in jis lab, including graduates Daida Thomas, Kevin Mack-Fisher, Luke Kraft and Alec Gaddie, along with undergraduates Jacob Sims and Angela Brown. Hugh published a collaborative paper in PRA rapid theoretically exploring a robust quantum gate technique for neutral atoms. Grant also gave two invited talks this year at PQE in Snowbird and Photonics West in San Francisco.

Alberto Marino's group pushes devices beyond their classical limit using quantum resources. His group, currently consisting of six graduate students and one postdoc, Siva Tekuru, who joined the group in January, has partially moved to the state-of-the art laboratory space in Lin Hall. The group published papers in Physical Review A and Optics Letters and has several papers under review, in addition to invited and contributed talks at international conferences, e.g. DAMOP, SQuInT, CQO, FiO, and SPIE Photonics West. Alberto served as the interim director for the Center for Quantum Research and Technology (CQRT) since its inauguration in Fall 2019.

Condensed Matter Physics

Since the Fall of last year, **Bruno Uchoa**'s group has published two papers in Physical Review B and another in Physical Review X, in collaboration with an experimental group at Urbana Champaign. Graduate Student Sang Wook Kim defended his Ph.D. thesis in the summer and has just started a three year postdoctoral position at the University of Vermont. Bruno's group has been working in the subject of quantum hydrodynamics, which addresses the behavior of electronic systems that are so strongly correlated that they behave as viscous fluids. His recent work suggested a class of quantum materials that can behave as perfect fluids, showing possible quantum turbulence. His group has also been working on the subject of incoherent metals, which may be behind the mysterious strange metal phase in high-T_c cuprates.

This has been a particularly productive year for **Ian Sellers**'s group including several high impact publications in scientific journals and group member presentations at various international conferences. Dr. Sellers also presented several invited talks around the US, as well as in Europe at the Technical University of Munich in Germany and the University of Manchester in the U.K. This year has also seen the development of new collaborations with groups at UNSW in Australia and the IPVF in France. Finally, the group has said goodbye to (former) graduate student Collin Brown this year. Collin successfully defended his PhD. thesis, and now works at Intel Corp. in Portland Oregon. We thank Collin for his contributions to the group and wish him luck in his new job!

Mike Santos's research group continues to focus on the epitaxial growth of narrow-gap heterostructures. They are collaborating with Ian Sellers's group on materials for photovoltaic applications, particularly on semiconductor structures that exploit hot electrons. They also grow superlattice structures for projects with Rui Yang's group (in Electrical Engineering) that use a cascade architecture to improve the performance of infrared lasers, infrared photodetectors, and thermophotovoltaic devices. In a collaboration with Amethyst Research, a small company in Ardmore OK, they produce materials for research on infrared photodetectors for gas sensing applications.

High-Energy Particle Physics

Phillip Gutierrez's research group has had a productive year: Postdoc M. Alhroob and graduate student D. Frizzell lead the effort to finish and publish the results of a measurement of electroweak production of a single top quark in association with a Z boson. This analysis formed the core of D. Frizzell dissertation, which he successfully defended during the Fall 2019 semester. The paper has been submitted and is currently undergoing revisions in response to comments from the referees. Postdoc M. Marjanovic and graduate student J. Muse are working on a search for vector-like tau leptons. This work is being performed in collaboration with B. Abbott and his student D. Wilbern. In addition, M. Marjanovic and J. Muse are working on the construction of a new silicon pixel detector to be used during the operation of the upgraded high intensity LHC, as well as the associated production testing facility. Recently, P. Gutierrez and M. Alhroob joined with B. Abbott and his student J. Lambert to measure the cross section for the production of WW + photon and search for anomalous gauge boson couplings.

During the 2019 - 2020 year, **Kuver Sinha** published 12 papers. His work encompassed the following topics: (a) new ideas for detecting axions using X-ray and soft gamma ray radiation from neutron stars, using hybrid accelerator/helioscope experiments and neutrino facilities; (b) probing early Universe cosmology using phase transitions, especially a period of early matter domination motivated by string theory; (c) studies of the string landscape to infer the scale of supersymmetry breaking after Kahler moduli stabilization; (d) complementary studies of the Higgs sector using double Higgs production at the high-luminosity LHC and gravitational waves; and (e) studies of boson stars.

Continued on next page

Kosakowski and Kilic News Release: "Astronomers spot never-before-seen gravitational wave source from binary white dwarf stars," https://www.space.com/white-dwarf-binary-gravitational-wave-source-discovery.html

Continued from previous page

Brad Abbott is continuing his work on the ATLAS experiment at CERN. He and his graduate students Joseph Lambert (resident at CERN) and Daniel Wilbern (resident at Argonne) are currently involved in three different physics analyses. They hope to provide the first discovery of WWW production and WWgamma production at the LHC. In addition, we are searching for vector-like leptons (VLL) and our analysis should provide the world's most sensitive measurement to high mass VLL. Brad is also continuing to help design the next generation pixel detector for the upgraded ATLAS detector.

During 2019-2020, **Howie Baer** and his group continued investigations of consequences of the string theory landscape for collider and dark matter searches. One paper summarized the SUSY mu problem, and how both R-parity and a gravity-safe PQ symmetry-- essential for WIMP and axion dark matter-- emerge from the same discrete R-symmetry. Then they investigated stringy naturalness versus usual naturalness: a 3 TeV gluino is more stringy natural than a 300 GeV gluino. They also proposed a new string landscape solution to the SUSY flavor and CP problems via a mixed quasi-degeneracy/decoupling mechanism. Finally, the state of SUSY phenomenology circa 2020 was summarized in a review article.

Mike Strauss's student, David Shope, graduated with his Ph.D. on a measurement of the production cross-sections of Higgs production via gluon-gluon fusion and vector boson fusion with decays to two W bosons. Mike's other Ph.D. student, Nate Grieser, is also nearing graduation doing a search for other types of higher mass Higgs particles.

John Stupak concluded his term as convener of the ATLAS physics analysis group dedicated to searches for unconventional signatures of beyond the Standard Model physics, during which he shepherded nine analyses to publication. Within the context of the "Snowmass 2021" US high-energy physics long-term planning effort, John was appointed to Chair the Energy Frontier Monte Carlo Task Force. He and postdoc Giuliano Gustavino are finalizing a search for dark matter in the so-called mono-jet topology. In collaboration with graduate student Amber Roepe, they are also developing a novel search for decays of the Higgs boson to long-lived particles, which decay within the ATLAS tracker.

Valley Photovoltaics for Ultra-efficient Solar Cells

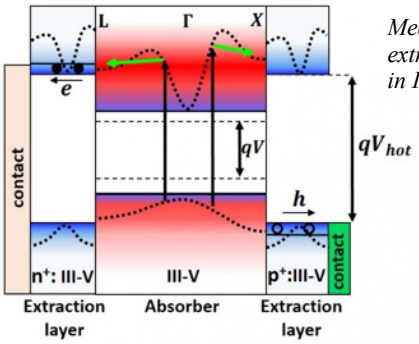
Experimental condensed matter physicists in the Department of Physics at OU have developed an approach to circumvent a major loss process that currently limits commercial solar cells to conversion efficiencies less than 30%. In this new approach recently published in the journal *Nature Energy*, members of the Photovoltaic Materials & Devices Group led by **Ian Sellers** along with theorists at Arizona State University (David K. Ferry), have demonstrated a breakthrough towards the long sought Hot Carrier Solar Cell, a device in which high energy photo-generated charge carriers are extracted prior to heat generation (device losses) with predicted efficiencies in excess of 50%.

Although this device has been the source of a considerable amount of research over the last 10-15 years, the realization of a practical solution has thus far eluded researchers with proof-of-principle demonstrations only presented under unrealistic conditions (low temperature and/or high power laser excitation) or in materials and structures not relevant for solar cell operation, typically mismatched to the solar spectrum.

In the OU-ASU approach, the full band structure of the absorbing semiconductor material is manipulated, and "hot" high energy photo-generated carriers absorbed through a direct transition in the conduction band (G-valley) rapidly transfer to higher energy valleys (L or X) in the conduction band, which provides a route to inhibit carrier thermalization, i.e., heat generation. This new approach has led to the experimental demonstration of hot carrier effects in a simple solar cell structure under conventional solar irradiation conditions at room temperature.

"Although this device has been the source of a considerable amount of research over the last 10 to 15 years, the realization of a practical solution has thus far eluded researchers with proof-of-principle demonstrations only presented under unrealistic conditions or in materials and structures not relevant for solar cell operation," said Sellers.

These results therefore represent significant progress in the realization of the hot carrier solar cell, and the potential for ultrahigh efficiency single semiconductor devices – which would revolutionize the field of photovoltaics and renewable energy generation. See also: https://www.nature.com/articles/s41560-020-0602-0



Mechanism for effective extraction of hot carriers in III-V semiconductors.

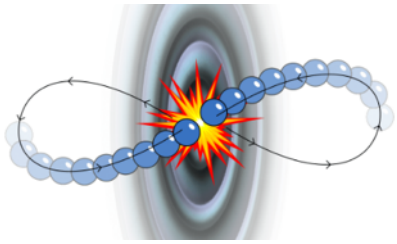
Watching Atoms Bang Together

Collisions between atoms are more complex than those between everyday objects, which typically just ricochet off one another. Thanks to the quirks of quantum mechanics, atoms can intertwine and pass through one another, leading to nonintuitive impact outcomes. To better understand atomic collisions, Qingze Guan of the University of Oklahoma in Norman and colleagues developed a way to watch two atoms crash together in 3D. Their initial experiments reveal the unmistakable hallmarks of quantum collisions. The team says that the setup could be used to monitor run-ins between several particles at a time.

The setup developed by Guan and colleagues consists of two perpendicularly oriented laser traps with different strengths. The team confined two ultracold lithium atoms in the stronger trap, keeping the weaker trap on standby. When they switched off the first trap, the other trap caught the atoms, which began to oscillate, colliding with each other at each excursion. By recording the positions of the atoms over time, the team mapped the paths of the atoms, observing a quantum-mechanical interference pattern.

With the aid of a magnetic field, the team tuned how strongly the atoms felt each other's presence. The interference pattern vanished for noninteracting particles, demonstrating the critical role of interactions in the evolution of the system. The team also calculated that the system never thermalizes; that is, it always "remembers" its starting conditions. Both sets of results agree with predictions.

While these initial experiments were a proof-of-principle, the team says that their successful completion illustrates the possible use of their setup to study more complex atomic interactions. See: https://physics.aps.org/synopsis-for/10.1103/PhysRevLett.122.083401



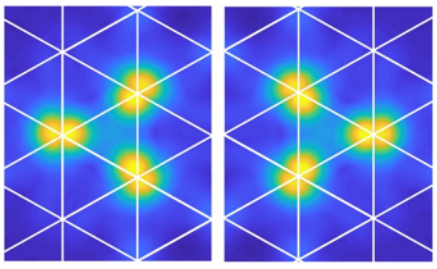
A new experimental setup allows researchers to observe collisions between ultracold atoms while tuning how hard they hit.

Ferromagnetism with a Twist

In a new study published in *Physical Review Letters*, OU postdoc Kangjun Seo and **Bruno Uchoa** have found numerical evidence of a novel Mott state that exhibits ferromagnetism at low temperatures. Recent experiments found that when two sheets of graphene are twisted by a very small angle, dubbed a 'magic angle', the combined system behaves as a very strongly correlated system in ways that remind several of the outstanding properties observed in high temperature superconductors. The new study shows that the Mott state in twisted graphene bilayers departs from other known examples in fundamental ways.

Mott physics has been extensively investigated in the last decades in high-temperature cuprate superconductors, systems that can carry charge currents at relatively high temperature without any dissipation. In the Mott phase, the motion of charge carriers is confined by strong repulsive interactions. That leads instead to insulating behavior and anti-ferromagnetism — antiparallel spin alignment — as a result of the Pauli exclusion principle, which states that two electrons cannot occupy the same quantum state. The new work shows that symmetry restrictions imposed by the lattice of twisted graphene bilayers can strongly favor ferromagnetism, even in the presence of strong repulsive interactions.

This new phenomenon is unheard of in conventional Mott insulators and sheds a conceptual light on the nature of the novel insulating state observed experimentally in twisted graphene bilayers. The new work may also provide profound insights about the spin symmetry in the superconducting phase recently discovered in the metallic regime of this system. See: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.122.246402



Localized orbitals in the superlattice of twisted graphene bilayers near the magic angle. Strong correlations in those orbitals lead to a novel ferromagnetic Mott state.

Gemini detects most energetic wind from distant quasar

The most energetic wind from a quasar has been revealed by a team of astronomers using observations from the international Gemini Observatory, a program of NSF's NOIRLab. This powerful outflow is moving into its host galaxy at almost 13% of the speed of light, and stems from a quasar known as SDSS J135246.37+423923.5 which lies roughly 60 billion light-years from Earth.

"While high-velocity winds have previously been observed in quasars, these have been carrying only a relatively small amount of mass," explains Sarah Gallagher, an astronomer at Western University (Canada) who led the Gemini observations. "The outflow from this quasar, in comparison, sweeps along a tremendous amount of mass at incredible speeds. This wind is crazy powerful, and we don't know how the quasar can launch something so substantial". The colossal energy carried by the quasar outflow is a product of both the speed of the wind and the amount of mass it carries. As well as measuring the outflow from SDSS J135246.37+423923.5, the team was also able to infer the mass of the supermassive black hole powering the quasar. This monstrous object is 8.6 billion times as massive as the Sun — about 2000 times the mass of the black hole in the center of our Milky Way and 50% more massive than the well-known black hole in the galaxy Messier 87.

This result is published in the Astrophysical Journal and the quasar studied here now holds the record for the most energetic quasar wind measured to date, with a wind more energetic than those recently reported in a study of 13 quasars. Despite its mass and energetic outflow, the discovery of this powerhouse languished in a quasar survey for 15 years before the combination of Gemini data and the team's innovative computer modeling method allowed it to be studied in detail.

"We were shocked — this isn't a new quasar, but no one knew how amazing it was until the team got the Gemini spectra," explains **Karen Leighly**, an astronomer at the University of Oklahoma who was one of the scientific leads for this research. "These objects were too hard to study before our team developed our methodology and had the data we needed, and now it looks like they might be the most interesting kind of windy quasars to study."

Quasars — also known as quasi-stellar objects — are a type of extraordinarily luminous astrophysical object residing in the centres of massive galaxies. Consisting of a supermassive black hole surrounded by a glowing disk of gas, quasars can outshine all the stars in their host galaxy and can drive winds powerful enough to influence entire galaxies. The gas feeding a quasar surrenders energy in the form of light as it falls into the central black hole. This emitted light is both the origin of a quasar's luminosity and the source of the energy that drives outflows.

"Some quasar-driven winds have enough energy to sweep the material from a galaxy that is needed to form stars and thus quench star formation," explains Hyunseop (Joseph) Choi, a graduate student at the University of Oklahoma and the first author of the scientific paper on this discovery. "We studied a particularly windy quasar, SDSS J135246.37+423923.5, whose outflow is so thick that it's difficult to detect the signature of the quasar itself at visible wavelengths."

Despite the obstruction, the team was able to get a clear view of the quasar using the Gemini Near-Infrared Spectrograph (GNIRS) on Gemini North to observe at infrared wavelengths. Using a combination of high-quality spectra from Gemini and a pioneering computer modeling approach, the astronomers uncovered the nature of the outflow from the object — which proved, remarkably, to be more energetic than any quasar outflow previously measured. The team's discovery raises important questions, and also suggests there could be more of these quasars waiting to be found.

Source: http://www.gemini.edu/pr/gemini-detects-most-energetic-wind-distant-quasar

Central portion of the galaxy that hosts the quasar SDSS J135246.37+423923.5. Artist's view at infrared wavelengths, as seen by the Gemini GNIRS detector. The thick outflow is transparent, giving a clear line of sight to the quasar.

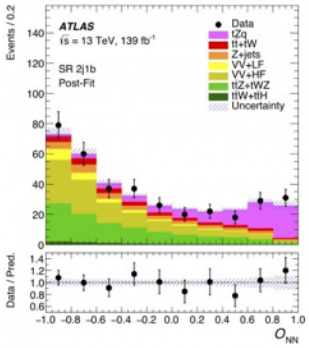
When a top quark partners with the Z boson

A quarter-century after its discovery, physicists at the ATLAS Experiment are gaining new insight into the heaviest-known particle: the top quark. The huge amount of data collected during Run 2 of the LHC (2015-2018) has allowed physicists to study rare production processes of the top quark in great detail, including its production in association with other heavy elementary particles. This measurement was made possible in part due to significant contributions from OU physicists D. Frizzell, M. Alhroob, **P. Gutierrez**, J. Lambert, and **B. Abbott**.

In a new paper released this week, the ATLAS Collaboration reports the observation of a single top quark produced in association with a Z boson (tZq) using the full Run-2 dataset, thereby confirming earlier results by ATLAS and CMS using smaller datasets. To achieve this new result, physicists studied over 20 billion collision events recorded by the ATLAS detector, looking for events with three isolated leptons (electrons or muons), a momentum imbalance in the plane perpendicular (transverse) to the proton beam, and two or three jets of hadrons originating from the fragmentation of quarks (with one jet originating from a b-quark). Only about 600 candidate events with such a signature were identified and, despite strict selection criteria, only about 120 of those are expected to come from the tZq production process.

To best separate their signal from background processes, ATLAS physicists trained an artificial neural network to identify tZq events using precisely simulated data. The neural network provided each event with a score (ONN) that represented how much it looked like the signal process. Using this distribution, the tZq signal was extracted and the rate of such events being produced in the given data sample (i.e. the cross-section) was computed. The uncertainty on the extracted cross-section is 14%. The cross-section was found to be in agreement with the prediction from Standard Model, confirming that even the heaviest particles in the Standard Model still behave as point-like elementary particles.

With the observation of the tZq production process now confirmed, ATLAS researchers can anticipate its study in even greater detail. Measurements of the cross-section as a function of kinematic variables will allow physicists to carefully probe the top quark's interactions with other particles. Will more data unveil some unexpected features? Look forward to seeing what nature is hiding in the top world.

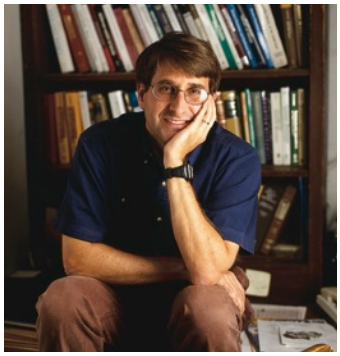


The neural network output (ONN) distribution for one of the signal regions. Data is shown in black. The simulated signal is shown in magenta. Backgrounds are shown in other colors. The high part of the ONN spectrum is dominated by signal events. Source: http://atlas.cern/updates/physics-briefing/single-top-quark-partners-z-boson

Bruce Mason wins APS Physics Education Award

The Open Source Physics project, https://www.compadre.org/osp was awarded the 2020 APS Excellence in Physics Education Award. This project was recognized for: "Sustained commitment to computational physics education through creating and disseminating programming environments, books, software, simulations, and other tools to support computational thinking, and for research establishing the value of these tools and best practices for their use." Associate Professor **Bruce Mason** and OU graduate Lyle Barbato are engaged in several aspects of this project.

The Open Source Physics (OSP) Project is a collaboration of physicists providing high quality computer-based curricular resources to engage students in physics, computation, and computer modeling. The OSP project began in 2002 when Wolfgang Christian and Mario Belloni (both at Davidson College) received an NSF grant to develop interactive web-deliverable curricular material using Java Applets known as Physlets. This work was extended by developing an open−source object−oriented Java code library for computational physics, enabling the development of new educational tools. Douglas Brown (Cabrillo College) created the free, open-source Tracker Video Analysis and Modeling Tool used in



Bruce Mason

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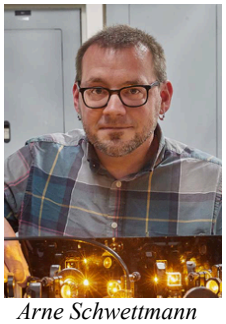
Schwettmann promoted to associate professor


Arne Schwettmann

In the spring of 2020, **Arne Schwettmann** was awarded tenure and promoted to the rank of associate professor. Arne is an experimental physicist in Atomic, Molecular, and Optical Physics and a member of our new Center for Quantum Research and Technology.

His research is in the field of experimental ultracold atomic gases and Bose-Einstein condensation (BEC). His research focuses on spin-exchange collisions and their use in developing new sensors with reduced noise and other devices based on matter-wave quantum optics, as well as studying the effect of Rydberg atom impurities and external perturbations on the ultracold spinor system.

In January 2018, Arne's group created their first sodium spinor Bose-Einstein condensate, the first BEC at OU. Their method—using laser light, magnetic fields, and evaporative cooling—brings a few million atoms from nearly 1000K to the nanokelvin regime in eight seconds. His research program was rewarded with an NSF CAREER award in the amount of $500,000 for five years, starting in June 2019. He was also awarded a DOD DEPSCOR award of $584,814 for three years starting in August 2020, in collaboration with Grant Biedermann.

In his teaching and mentoring, Arne focuses on making the students at OU feel welcome, while ensuring that they learn the necessary skills to be successful in their future careers. He uses diverse and modern approaches to teach scientific reasoning, interpretation and problem-solving skills, scientific thinking, rigorous physics knowledge, hands-on skills in the lab, as well as convey the sense of wonder and excitement he feel for physics to students.

He says he is excited to be at OU and looking forward to the future, "I feel honored to be part of the OU family and to be awarded tenure. I love it here. I was a student here myself and I love being back as a professor."

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Bruce Mason: Continued from pg. 14

many physics lab courses. Francisco Esquembre and Felix Garcia (University of Murcia, Spain) used the library to develop the Easy Java/Javascript Simulations (EJsS) programming and modeling tool. This simplified programming environment, in turn, has enabled educators and programmers from around the world to create simulation-based curricular materials. For example, Bruce Mason used the Bungee Jump Lab as a virtual demonstration and student activity this spring when his class went to remote learning due to COVID-19. EJsS is also used by many students to include computer modeling in class work and independent research.

Dissemination is an essential component of any curriculum development project. In 2008, the OSP developers approached Mason and Barbato about hosting the web and collaboration interfaces in the AAPT-ComPADRE National Science Digital Library. The result is an organized and curated digital library for the OSP Collection that connects the different OSP tools. This Collection currently contains well over 2,000 curricular resources and over 1,000 Physlet pages with interactive student explorations and exercises (https://www.compadre.org/physlets, https://www.compadre.org/pqp). The ComPADRE collections currently serve nearly 250,000 user sessions per year from users all over the world.

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Collin Riggert: Continued from pg. 6

learned in Prof. Mullen's group, commenting, "It equipped me with the computational and conceptual skillset that I hope will let me hit the ground running as a productive graduate student."

While excited to pursue the next phase of his career, he will miss OU, "The department has been wonderful through and through, and the faculty have been endlessly helpful, supportive, and understanding as I explored my interests both in the classroom and in research settings. The opportunities afforded to me here have shaped me immensely as a physicist, and the impact of OU will undoubtedly ripple through the rest of my career."

Members of the Homer L. Dodge Department of Physics and Astronomy, May 2019. 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.