The UNIVERSITY of OKLAHOMA

SPRING 2015

# ΦYAST ΦLYER

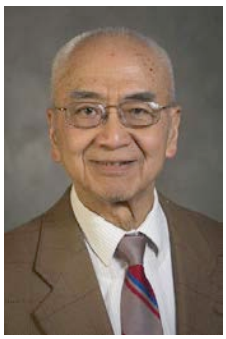
*The Homer L. Dodge Department of Physics and Astronomy*
***Volume 23, Number 1***

## Nathan Kaib Joins OU's Astrophysics Group


*Nathan Kaib*

The Department of Physics and Astronomy is pleased to welcome Nathan Kaib as an assistant professor in the astrophysics group. After receiving his doctorate in 2010 from the University of Washington under the direction of Tom Quinn, Kaib spent two years as a CITA National Postdoctoral Fellow at Queen's University, two years as a CIERA Postdoctoral Fellow at Northwestern University, and one year as a Carnegie Fellow at the Carnegie Institution of Washington's Department of Terrestrial Magnetism. Nathan Kaib's research utilizes numerical simulations to investigate the formation and evolution of planetary systems, including our own solar system as well as those around other stars. In our own solar system he is interested in how the orbital distribution of icy bodies beyond Neptune can constrain the Sun's birth cluster as well as the degree that the Sun has migrated within the Milky Way during its lifetime. In addition, he has been studying how the giant planets' orbits have evolved over the history of the solar system and how this has affected the long-term stability of the inner terrestrial planets. Kaib currently is using numerical simulations to characterize the long-term chaos and stability of the solar system's rocky planets, to determine if such a chaotic, marginally stable state is a natural outcome of terrestrial planet formation. Kaib also is investigating how the evolution of the giant planet orbits early in the history of the solar system affected the formation of the terrestrial planets and whether this process can explain the small mass of Mars. As far as exoplanetary systems are concerned, he has a strong interest in how the presence of a binary stellar companion can affect the formation and evolution of planets. Outside of the office, Nathan is an avid hiker and skier, and has completed two hikes of the full Appalachian Trail.

## Chun Lin Receives Honorary Degree at Commencement


*Chun Lin*

Chun Lin, a member of our department from 1955 to 1968 and chair of our Board of Visitors, was recognized with an honorary degree from OU at Commencement Ceremonies on May 8. The citation by the university reads as follows:

*A consummate professor, Lin has provided educational supervision for over 48 Ph.D. candidates, many of whom went on to achieve prominent positions within the field, including Neal Lane, former Science Advisor to the President of the United States; Donald Johnson, Director of the National Technical Information Service; and Jeff Chilton, Center for Naval Analyses. Lin earned his undergraduate degree at the University of California-Berkeley and his Ph.D. from Harvard in 1955, the same year he joined OU as an assistant professor in physics. While at OU, he initiated a seminal program on electron excitation of atoms in collaboration with Robert M. St. John. He has served as the chairman of the Gaseous Electronics Conference and chair of the Division of Atomic, Molecular, and Optical Physics of the American Physical Society. In 1996, the American Physical Society honored Lin with the Will Allis Prize for his contributions to the study of ionized gases. He is a Fellow of the American Physical Society and a former Alfred P. Sloan Foundation Fellow. He serves as the John and Abigail Van Vleck Professor of Physics at the University of Wisconsin-Madison.*

We congratulate Chun on this wonderful occasion.

# From the Chair

*Greg Parker*

Atomic, Molecular and Optical experimentalist Arne Schwettmann joined our department in August, and currently is teaching and setting up his research laboratory. Theoretical astrophysicist Nathan Kaib will join our department this August. In the past five years, we have hired nine junior faculty to strengthen our department. We hope to advertise, recruit and hire three additional faculty this year. We will miss professors Yun Wang and Barbara Capogrosso-Sansone, who have accepted positions elsewhere. In addition, our graduate recruiting committee admitted 22 new graduate students, bringing the total number of graduate student to more than 86.

With the recent growth of our department, we are totally out of space in Nielsen Hall. Fortunately, donors came to our rescue, and it is my pleasure to announce that we currently are in the design stages of an addition to be built directly to the south of Nielsen Hall, thanks to those gifts and a supportive administration! We sincerely thank those donors who are making this possible. We do need additional funds, so we are requesting your support for the building and a buy-in to a national telescope.

Our alumni reunion on Oct. 24, 2014, was very successful, and we appreciate all who attended. As always, our faculty, postdoctoral fellows, staff and students continue to excel in research, teaching and service. We are indeed fortunate to have a collegial, prestigious, and highly productive department. Our national and international reputation is increasing at a steady rate. We really appreciate our Board of Visitors, close friends and former alumni who are contributing so much to the success of our department!

# Department to Acquire a New Laboratory

The Department is in the initial design phase for a new laboratory building. The building will be located adjacent to Nielsen Hall on the current site of Gittinger Hall. It will house much-needed state-of-the-art laboratories for onsite physics labs and offices for students and faculty. The laboratories are being designed by Miles and Associates of Oklahoma City and HDR of Omaha, Nebraska. HDR has built ground breaking laboratory buildings such as the Advanced Measurement Laboratory at the National Institute of Standards and Technology and the Physical Sciences building at Maryland. The laboratories will have advanced temperature control, vibration and acoustic isolation, and electromagnetic shielding in addition to providing critically needed space. The condensed matter and atomic, molecular and optical faculty will move to the new building once it is completed. The department is grateful for the support from the lead donors for this project. The new physics laboratory will give the department a facility that will be one of the best, if not the best, facility in the world. The facilities will allow the department to provide high-quality laboratories for student research projects, allow us to provide better training for our graduate students, and compete at the top level for grants. There is still time to contribute to this project and help to increase the scope. Contact Department Chair Greg Parker for more information.

## What Is Where?



# Remembering Helmut Fischbeck

Helmut Fischbeck, Professor Emeritus of the department, passed away in Norman on April 11 at age 87. Fischbeck earned his doctorate at Indiana University and was an assistant professor at the University of Michigan before joining the OU faculty in 1966. He served as chair of the Engineering Physics program from 1980 until his retirement in 1993. In 1981, he established the Van De Graaff Accelerator Laboratory for Ion Beam Materials Characterization. The lab sponsored 25 research projects in applied physics and produced four doctoral and five masters degree students. In 1983 Fischbeck and his father, Kurt H. Fischbeck, published the book, *Formulas, Facts and Constants for Students and Professionals in Engineering, Chemistry, and Physics.* Professor Fischbeck's former students are urged to send reminiscences, which we will post on the alumni page of the department website www.nhn.ou.edu. Write to Dick Henry at rhenry@ou.edu.

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 Dick Henry, Howard Baer, Deborah Watson, John Wisniewski and Bruno Uchoa. All photographs are by Robert H. Taylor or photo subject unless otherwise noted. The University of Oklahoma is an equal opportunity institution. www.ou.edu.

# Student Awards

On April 30, the department held its annual awards ceremony to honor numerous undergraduate and graduate students for their excellent work in courses and research. Chairman Greg Parker served as master of ceremonies and was assisted by Mike Strauss, Mike Santos and Kieran Mullen in distributing the awards. Following the event, students and faculty gathered in the atrium outside the first-floor lecture hall to enjoy refreshments and conversation. 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. The graduate awards include the Kalbfleisch Award and Nielsen Prize.

## Homer L. Dodge Departmental Awards

| **Dodge Outstanding Sophomore** | **Dodge Outstanding Junior** | **Fowler Prize** |
|---|---|---|
| Patrick Vallely | Brandon Curd | Hayden Nunley |

## Physics and Astronomy Awards

**J. Clarence Karcher Award**

Li Yang Murphy

**Duane E. Roller Award**

Joseph Altermatt

Stephen Lacina

**William Schriever Award**

Anthony Burrow

**Outstanding Graduating Senior**

Christopher Bender, Hunter Ash, Sagen Cocklin, Stephen Hefner, Catherine Ciampa

**Meritorious Scholarship**

Anthony Burrow, Patrick Vallely, Stephen Lacina, Hayden Nunley, Christopher Bender, Joseph Altermatt, Li Yang Murphy, Brandon Curd, Reza Niazi, Mohammad Niazi, Caroline Buckles, Phillip Collins, Hunter Ash, Sagen Cocklin, Taylor Murphy, Brooke Wade, Jeffrey Terry, Zoe Oer, Sydney Gedman, Dillon Roberts, Ethan White, Steven Hefner, Adam Marrs, Karyssa Johnson, Tarryn Kahre, Sean Bruton, Cody Ray, Jonthomas Box, Alex Dorio, Collin Wade, Miranda Brugman, Lisa Patel, Kyle Yates, Jodi Berdis, Jacob Tice, Hanna Walla, Brian Stephenson, Sam Jones, Anita Bhagat, Matthew Scheffler, Sean Islas, Vincent Rojas, Daniel Barham, Josiah Purdum, Conrad Young, Jacob Whitson, Braden James, Nicholas Vogel, Raymond Barriball

# Engineering Physics Awards

**J. Clarence Karcher Award**

Daniel Grimmer, Alec Forbes

**Duane E. Roller Award**

Nicholas Kantack

**William Schriever Award**

Christopher Brown

**Meritorious Scholarship**

Shuli Liao, Drew Wild, Nicholas Kantack, Christopher Brown, Troy Southard, John Brown, Robert Anderson, Daniel Grimmer, Alec Forbes, Courtney Crawford, Johathan Dasher, Jesse Harter, Olivia Caruthers, Bao Tran, Ryan Griffith, Phan Vu, Russell Hobson, Hannah Harrell, Jocelyn Roberts, Trenton Hamm, Timothy Corbly, Omar Robles, Devon Moseley, Mary Chenot, Chuan Chin, Steven Roberts, Kevin Everly, Daniel Davidson, Madison Jones, Brandon Carson, Seth Hodgson, Patrick Helms, Daren Davis, Jeffrey May

# Brandon Curd, Goldwater Scholar

*Brandon Curd*

Brandon Curd, a junior majoring in astrophysics, received word in late March that he has been awarded a Goldwater Scholarship. Besides the great prestige that the award bestows on the recipient, the scholarship will cover the cost of tuition, fees, books, and room and board up to a maximum of $7,500 during his senior year.

Curd was born in Chicago, lived in Texas for several years, and finally moved to Oklahoma City with his family in 2009. He was home-schooled until he entered OU as a freshman in 2012. His initial interest was game design, but he later began studying orbit simulations, and it was then that he realized that he needed to study physics in order to continue exploring his interests. After finishing his sophomore year in spring, 2014, he spent two months at Cornell University as a student in their astronomy department's REU program, where he worked with Matthew Tiscareno on problems related to the vertical structure of Saturn's rings. Their research was based on data acquired during Saturn's 2009 equinox period. Curd presented a poster on some of their results at the January, 2015, meeting of the American Astronomical Society in Seattle. He also is a coauthor on a publication that appeared in March in the *Monthly Notices of the Royal Astronomical Society*. The article is titled, "Ultracool White Dwarfs and the Age Of The Galactic Disc," and the lead author is Alex Gianninas, a postdoc in the department. In 2014 Curd was presented with the department's William Schriever award as well as the Webb scholarship. This spring he was the recipient of the Dodge Outstanding Junior award.

Currently, Curd is working at OU with astronomer Mukremin Kilic on white dwarf stars, their atmospheres and pulsation modes. He has observed twice on the 3.5 meter telescope at Apache Point Observatory. He also has time on the 8.1 meter telescope at Gemini North, located in Hawaii. Between June and August of this year Curd will travel to the Netherlands to work with Silvia Toonen at Leiden Observatory for two months on the evolution of triple star systems. Curd was first attracted to OU and our department because of the strength of the astrophysics faculty in both theory and observations as well as the cooperation he saw between research groups. His plans for the future include working either as a research scientist or a university faculty member. This year's Goldwater Scholars were selected on the basis of academic merit from a field of 1,206 mathematics, science, and engineering students who were nominated by the faculties of colleges and universities across the United States. Curd's scholarship is one of just 260 awarded nationwide, and he is one of only four Oklahoma students presented with the award.

# Kalbfleisch Award to Bertsche
# Nielsen Prize to Booth and Friesen

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 it was the unanimous vote of the Graduate Studies Committee to give the award and a $1000 check to **Callie Bertsche**.

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 $1000 check for $1000 check and a standing invitation to return in the next year to give a departmental colloquium on a research topic of their choice. For the academic year, fall, 2014 - spring, 2015, the faculty has voted to give the award to two graduating students: **Donald Booth** for "Detection of 'Trilobite' and 'Butterfly' Rydberg Molecules in Cesium with kiloDebye Dipole Moments," and **Brian Friesen** for "Spectrum Formation at Late Times in Type Ia Supernovae."



*Left to right: Callie Bertsche, Donald Booth, Brian Friesen*

# Ph.D.s Awarded

This year, twelve graduate students successfully defined their dissertations. We congratulate these individuals and wish them well in their careers. Those students (and advisers) are: **Tom Akin** (Abraham), **Sara Barber** (Kilic), **Donald Booth** (Shaffer), **Shayne Cairns** (Murphy), **James Coker** (Moore-Furneaux), **Brian Friesen** (Baron), **Sean Krzyzewski** (Abraham), **Dan Mickelson** (Baer), **Stephane Valladier** (Morrison and Parker), **Scarlett Norberg** (Abbott), **Sangeetha Vijeyaragunathan** (Santos), and **Priyangika Wickramarachchi** (Kao).

# Four Departmental TAs Receive Teaching Award

Four departmental teaching assistants were honored for their hard work and dedication to their students. **Aaron Foster**, **Claudia Belard**i, **Michael Whitaker**, and **Lisa Simpson** were presented with the Provost's Certificate of Distinction for Outstanding Graduate Assistant Teaching. These students are part of a larger group of OU TAs who represent the top 10 percent of all graduate assistants across campus, as determined by student evaluations for courses taught during the fall 2014 semester. The students were recognized at a special reception February 12 at the Crawford University Club honoring their outstanding teaching performance.

# Barber to AIP

*Sara Barber*

In April, Sara Barber was notified that she was selected as the 2015-2016 American Institute of Physics Congressional Science Fellow. The AIP annually sponsors one scientist to spend a year providing analytical expertise and scientific advice to Congress. Following a two-week orientation organized by the American Association for the Advancement of Science, Barber will interview with congressional and committee offices to find a placement of her choosing. During her term, she will handle a variety of assignments, both technical and nontechnical, in service to her office. This appointment will enable Barber to broaden her experience through direct involvement with the legislative and political process.

# OU Physicists First to Create New Molecule With Record-Setting Dipole Moment

Jim Shaffer's research group, along with theorists Hossein Sadeghpour at ITAMP and Seth Rittenhouse at Western Washington University, have created a new kind of molecule based on the interaction between a highly excited Rydberg atom and a ground-state atom. A unique property of the molecule is the large permanent electric dipole moment, which reacts with an electric field much like a bar magnet reacts with a magnetic field.

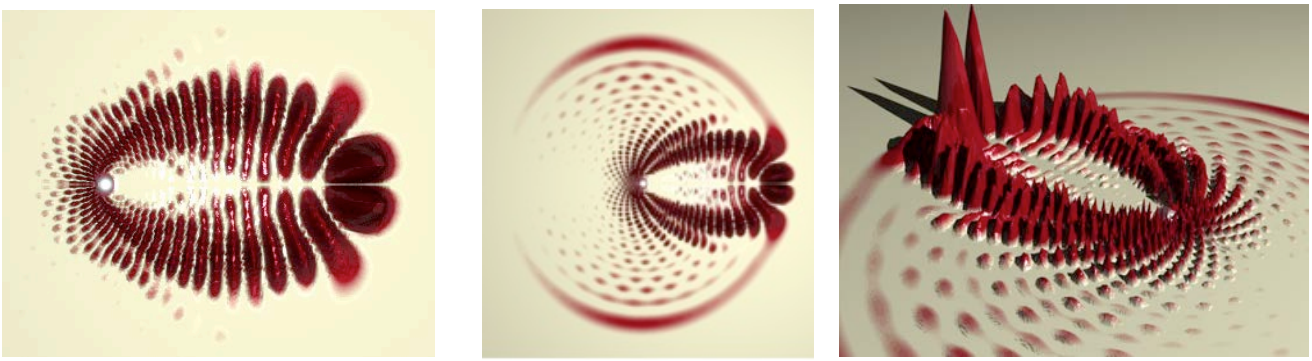
"This is the largest electric dipole moment ever observed in a molecule," says Shaffer. Shaffer and his team want to produce enough of these molecules to carry out future experiments on dipole interactions. Dipole interactions between particles are interesting for a number of reasons, including their role in forming new states of matter and their possible use in constructing scalable quantum computers. One can readily envisage applications for these molecules ranging from ultracold chemistry to studying strongly correlated many-body physics.

Donald Booth, the lead graduate student on this project, says the molecule is formed when an electron from the Rydberg atom grabs onto the ground-state atom. The researchers excite the Rydberg atom using lasers in a cloud of ground-state atoms held at a millionth of a degree above absolute zero, so the Rydberg electron can collide with a ground-state atom and form the molecule.

These exotic states of matter are referred to as trilobite molecules, because their electronic probability distributions resemble the fossilized marine creatures. Theoretically predicted by Chris Greene and co-workers in 2000, they are ultra-long=range molecular Rydberg states where the Rydberg atom has a very large principal quantum number and high orbital angular momenta coupled to a ground state atom of the same species. Due to strong localization of the electron cloud, these molecules are expected to possess huge permanent electric dipole moments, of the order of thousands of Debye, which is quite surprising since homonuclear molecules are symmetric and therefore should not have a dipole moment in the first place.

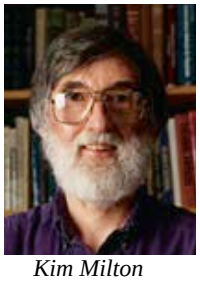
Cesium atoms, due to peculiarities in their low orbital angular momentum energy states, can be bound in a hybrid state with a mixture of high and low orbital angular momentum states yielding permanent electric dipole moments of thousands of Debye. To put this into perspective, the dipole moment of water is 1.85 Debye, and even very polar molecules like sodium chloride have dipole moments of 9 Debye. Creating these molecules adds a new creature to the quantum world's menagerie of exotic states.

A paper by the team on this research has been published in *Science* magazine at news.sciencemag.org, *Science* 348, 99-102 (2015). The work also is being highlighted in a News and Views article in *Nature Physics* in May. The National Science Foundation funded this research project. For more information, contact James Shaffer at James.P.Shaffer-1@ou.edu.



*Calculated electron probability density distributions in cylindrical coordinates for several different Cs trilobite molecules observed in this work. The Rydberg atom core (Cs+) resides in the central position where the spherical ball sits. The ground state atom sits underneath the two large peaks in the probability density distribution, indicating that the electron is piling up around the ground state atom.*

# Milton Elected APS Fellow in 2014


*Kim Milton*

In November 2014 Professor **Kimball A. "Kim" Milton** was elected a Fellow of the American Physical Society. The criterion for election is exceptional contributions to the physics enterprise, e.g., outstanding physics research, important applications of physics, leadership in or service to physics, or significant contributions to physics education. Fellowship is a distinct honor signifying recognition by one's professional peers.

His nomination was in the Forum on the History of Physics, and his citation reads: For studies of the development of quantum field theory in the 20th century, particularly of the contributions of Julian Schwinger. Kim Milton was last in a long line of students supervised by the legendary physicist Julian Schwinger, one of the creators of Quantum Electrodynamics or QED. Schwinger was awarded the Nobel prize in 1965 along with Feynman and Tomonaga.

Milton has written, with Jagdish Mehra, an inspiring biography titled *Climbing the Mountain: The Scientific Biography of Julian Schwinger*. In addition, Milton has collated and adapted many of Schwinger's notes for lecture classes into actual textbooks. These include a graduate text on *Classical Electrodynamics* and also *Electromagnetic Radiation: Variational Methods, Waveguides and Accelerators*. Also, *A Quantum Legacy: Seminal Papers of Julian Schwinger* covers many of Schwinger's most important contributions ranging from Nuclear Physics to QED, quantum field theory and mathematical physics. And, oh yes, Schwinger was in a sense the father of the Standard Model, suggesting a theory based on SU(2)xU(1) symmetry to another of his students, Nobel laureate Shelly Glashow. Along with his historical contributions, Milton spends most of his time these days researching aspects of the Casimir effect and the quantum vacuum.

# Department Alumni Reunion

Many faculty and students, along with several alumni, including the members of the department's Board of Visitors, attended the Department of Physics and Astronomy alumni reunion on October 24, 2014. Among alumni i attendance were Board of Visitors members Chun Lin, Neal Lane, G. Ward Paxton and A.T. Stair. Activities included a welcome from department chair Greg Parker, who announced a significant donation that will be used in the expansion of the current experimental facilities. It also included a special performance by Dr. Indestructo, played by emeritus faculty member Stu Ryan, who for many years had a remarkable role in the dissemination of physics education across the state of Oklahoma. All alumni were invited for a tour of the Galileo exhibit in the History of Science Special Collections, followed by a social gathering in the Nielsen Hall atrium and a special afternoon colloquium featuring short talks by faculty on the current advances in the research in the department. The activities culminated with a banquet at the Embassy Suites and a presentation by the invited keynote speaker Benton Clark, a native Oklahoman and graduate of OU's Department of Physics and Astronomy, who through his career at NASA played an essential role in the advancement of our current knowledge of the Solar System. Following his presentation, the graduate students (formally the Lunar Sooners astronomy outreach group) provided a successful night-time viewing of celestial objects using portable telescopes.

# Ben Clark: OU Physics '59

Ben Clark from the class of 1959 presented the keynote address at the reunion banquet last October. Clark was born and raised in Oklahoma City. He received the bachelor of science degree in physics in 1959 at OU. He was a member of Sigma Xi, Phi Beta Kappa and the Pe-et Honor Society. After earning his master's degree from University of California, Berkeley, he served three years in the U.S. Air Force, where he conducted research in space radiation, including the design of an instrument for the Gemini 6 flight piloted by Oklahoma's Tom Stafford. Clark's doctorate was earned at Columbia University, in biophysics. He then worked on space projects at Avco Corp. in Tulsa before moving on to Martin Marietta in Denver.

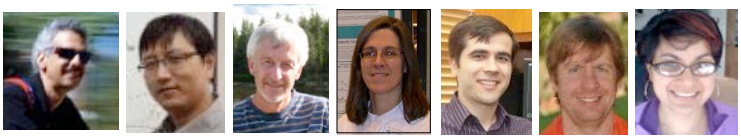
Clark has served on three task groups for the National Science Foundation, and more than a dozen independent Advisory groups for NASA. He developed instrumentation

*Continued on pg. 11*

# Faculty Research Programs

## Astronomy, Astrophysics and Cosmology

**Eddie Baron**'s supernova group had a good year. The group consists of Brian Friesen working on late-time Type Ia supernova spectra; Jeremy Lusk working on core collapse photometry and spectra; Malia Jenks working on metallicity variations in Type Ia spectra; Lisa Simpson, who is in her first year and is just getting started; and undergraduate Patrick Vallely, who worked on SN 2014J and is now working on fast, dim objects. Friesen defended his thesis this semester and has accepted a position as a NERSC Exascale Science Application Program Postdoctoral Fellow at Lawrence Berkeley National Laboratory. New projects in the group include working on interacting supernovae and pushing the computational boundaries.



*Astro l-r: Baron, Dai, Henry, Leighly, Kilic, Wisniewski, Munshi*

**Mukramin Kilic**'s research group includes Alex Gianninas, Sara Barber, Paul Canton, Kyra Dame, Claudia Belardi, Brandon Curd (undergrad) and Matt Scheffler (capstone). Barber defended her dissertation on "Planetary Remnants Around White Dwarfs" in May. Canton and Belardi have been using the Kitt Peak and Cerro Tololo 4m telescopes for their projects. In a recently published paper, Gianninas and Curd have identified 10-billion-year-old white dwarfs in the solar neighborhood, putting a firm lower limit to the age of the Galactic thick disk. Curd has received time on the Gemini 8m telescope in Hawaii, and also was selected for a summer internship at Leiden Observatory in the Netherlands.

**Xinyu Dai**'s research group continues working on areas of extragalactic astronomy, including gravitational lensing, galaxy clusters, and active galactic nuclei. Utilizing the gravitational microlensing technique, with nano-arcsecond resolutions, Dai's group constrained the accretion disk structure and non-thermal emission of quasars. Together with two graduate students, Rhiannon Griffin and Jenna Nugent, Dai's group published a large catalog of X-ray selected galaxy clusters using the Swift satellite. Griffin used the Fermi Gamma-ray Space Telescope to obtain the lowest gamma-ray flux limit for galaxy clusters, and Nugent used the Suzaku X-ray Observatory to constrain the baryon fractions of two poor galaxy groups.

The Gaseous Nebulae group comprises doctoral student Tim Miller, undergraduate Marcus Keil and faculty member **Dick Henry**. They are working with cospatial spectrophotometric data obtained with HST/STIS of eight planetary nebulae (ejected gas from dying low-mass stars) in order to study stellar C and N production. Miller finds no C and N abundance variations within each object. Keil currently is learning to compute photoionization models to study a few of the objects. Henry has computed models of all eight nebulae and finds that the theoretical C and N production predictions comport nicely with observations.

**John Wisniewski**'s research group includes Jun Hashimoto, Jamie Lomax, Mike Malatesta, Evan Rich, Steven Silverberg, Jodi Berdis, Anthony Burrow, Marcus Keil, and Matt Scheffler. Malatesta is leading a paper analyzing the V356 Sgr interacting binary system. Rich submitted a paper on AO imagery of the DoAr 28 transitional disk. Silverberg is writing a paper on the analysis of Kepler observations of the flare star GJ1243. Lomax analyzed multi-epoch AO imagery of the AB Aur system to place constraints on the locations of young exoplanets in the system. Hashimoto found differences in the distribution of small and large dust grains in the PDS 70 transitional disk system, potentially formed by several unseen planets in the system.

**Ferah Munshi**'s research focuses on studying galaxies using N-body + SPH simulations. This year, she has completed some of the highest-resolution dwarf galaxy simulations to date in order to study their star formation histories and dark matter halos. She uses an "apples-to-apples" comparison between simulations and observations by artificially "observing" simulations like data from a telescope. This past summer, Munshi worked with REU student Danny Weller, studying the stellar mass to halo mass relation in dwarfs as a function of redshift. This semester, she is working with OU undergraduate Brian Stephenson as part of his OU Space Grant scholarship.

## Atomic, Molecular and Optical Physics

In the last year, **Eric Abraham**'s group published work on laser modes that carry orbital angular momentum and their interactions with ultracold gases. Led by graduate student Tom Akin, they have now completed more detailed experiments, and Akin recently defended his dissertation. After a long investigation, they also have succeeded in forming molecules from resonant collisions of ultracold atoms using photons. This effort was led by graduate student Sean Krzyzewski, who has now also defended his thesis. They presented preliminary results of this effort at the national DAMOP conference in June.

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**John Moore-Furneaux** began a one-year sabbatical leave in January at the Max Plank Institute for Biophysical Chemistry and the Georg-August-University in Göttingen, Germany, with Samuel Meek, who did his undergraduate research with Neil Shafer-Ray. They are working on ultraprecision molecular spectroscopy of OH for tests of fundamental constants, particularly the ratio of the electron mass to the proton mass. Shafer-Ray's former students are doing well. Sam Meek has a junior professor position in Göttingen with funding from the Otto Hahn Society; Poopalasingam Sivakumar (Siva) has just accepted a tenure track position in the Department of Physics at Southern Illinois University, Carbondale, beginning fall 2015, and Milinda Rupasinghe has just started a post-doc at Williams College.

*AMO l-r: Abraham, Marino, Moore-Furneaux, Schwettmann, Capogrosso, Shaffer, Watson, Parker*

**Alberto Marino**'s interests lie in the field of experimental quantum optics, with particular emphasis on quantum information and quantum metrology. His research focuses on the use of atomic systems to generate and control quantum states of light and on applications of these quantum states toward sensitivity enhancements of devices. Over the past year, he published several papers in journals such as *Physical Review Letters* and *Optics Communication*. He also obtained funding from the W.M. Keck Foundation for the study of "Quantum Enhanced Plasmonics Sensors" with the goal of enhancing the sensitivity of plasmonic based sensors by two orders of magnitude (see related article on pg. 13).

**Jim Shaffer**'s research group had two new students join the group this year, George Chao and Will Whiteneck, and are looking for a few more students again this year! The group has published several papers, one in *Physical Review Letters* and one in *Science*! Shaffer also received a new grant from the Air Force Office of Scientific Research to study quantum hybrid systems and has several other grants pending and a lot of papers in preparation. The group has obtained some exciting results on atom-surface interactions. Don Booth graduated this year and has a postdoctoral position with Mark Saffman at Wisconsin. Shaffer is also working hard on planning the new building and making it come to life. They should start to see real plans in the near future.

**Deborah Watson**'s research into large systems of cold fermions recently achieved some impressive results for ground state energies in the unitary regime, which has relevance to several areas of physics, including superfluid systems and neutron stars, as well as cold Fermi gases. The energies are competitive with recent numerically intensive Monte Carlo results. By using analytic building blocks calculated and stored previously and enforcing the Pauli principle "on paper", the calculation took a few seconds on a work station. Future plans are to obtain excited state energies and to determine thermodynamic quantities.

The **Schwettmann** group has been constructing an apparatus to study spin-changing collisions in an ultracold atomic gas of sodium. While the apparatus is being built, they have been running supercomputer simulations of the collisional spin evolution of the system subject to applied microwave fields. They will present their progress and simulation results at DAMOP 2015. Graduate students Hyoyeon Lee and Qimin Zhang have joined graduate students Delaram Nematollahi and Aaron Foster in the group. Welcome! Together with undergraduate students Kyle Yates (Capstone) and Joseph Altermatt (Honors Research), the group has been making great strides!

## Condensed Matter Physics

In the past 12 months, **Bruno Uchoa**'s group published two papers in *Rapid Communications* and another one in *Physical Review B*. In the spring, his research group was joined by a new graduate student Sang Wook Kim. Uchoa was an invited speaker in different universities, including Columbia University and University of Illinois at Urbana-Champaign. His research currently is funded by an NSF Early Career Award. He has been investigating new ways in which electronic correlations can give rise to novel elusive states of matter. In a recent paper published in Rapid Communications, Bruno and collaborators proposed a novel exotic state that follows from the spontaneous orbital motion of electrons in graphene subjected to the local potentials of a boron nitride substrate. This spontaneous orbital motion breaks time reversal symmetry and describes a novel anomalous Hall effect, that could be detected with magneto optical measurements at low temperature.

**Kieran Mullen** has been studying the unusually electronic and thermal properties of lattices of carbon atoms. These "hyper-honeycomb lattices'' are a hybrid, with many properties similar to that of two-dimensional graphene, but actually existing as three dimensional structures. He has an ongoing collaboration with Dan Glatzhofer to study heat transport in related carbon systems. In his spare time, he has also been helping run an informal theory seminar with **Barbara Capogrosso,** discussing tools needed by theory students and covering such topics as Green functions and the renormalization group.

Recently, **Ian Sellers'** group has published several journal articles including two recent papers in *Applied Physics*

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*Letters*. These projects have been developed in collaboration with his colleagues at CRHEA-CNRS in France and Amethyst Research Inc., in Ardmore. Sellars continued strong collaborative links with the University of Tulsa on a NASA funded energy generation and storage system. He also pursued projects investigating colloidal quantum dot solar cells in collaboration with **Lloyd Bumm** here at OU (OCAST-funded) and with the Watt-Group at the University of Oxford (U.K.). Recently, his group initiated a research program in collaboration with the Naval Research Laboratory in Washington, D.C., and with Virginia Tech to investigate hot carrier dynamics in high-efficiency solar cells. This fall, his group saw the departure of Miwa Fukuda, who graduated with a master's degree from the group. Since departing, Fukuda obtained a research scientist position in the automobile industry in Indiana.

*CM l-r: Uchoa, Bumm, Mullen, Santos, Sellars, Murphy, Johnson, Mason*

**Mike Santos**'s research group continues to focus on the growth of narrow-gap semiconductors by molecular beam epitaxy. They collaborate with **Sheena Murphy**'s group on the study of topological materials and with **Ian Sellers**'s group on antimonide materials for third-generation solar cells. They also work with Rui Yang's (Electrical Engineering) and **Matthew Johnson**'s groups on infrared devices made from antimonide multi-layers. This year's highlights include Sangeetha Vijeyaragunathan completing her doctoral degree and new funding from the Department of Defense for infrared device research.

## High-energy Particle Physics

In 2014, **Howie Baer** completed a review article entitled "Dark matter production in the early universe: Beyond the thermal WIMP paradigm" with Choi, Kim and Roszkowski. This article critiques the usual simplistic picture of WIMP-only dark matter (WIMP=weakly interacting massive particle) and argues as well for the presence of the axion along with non-thermal WIMP production. We make a case that dark matter is composed of a WIMP plus axion admixture and that ultimately both particles should be detected. This article was published in *Physics Reports* 555 (2014) 1. Our group also has been working on naturalness in supersymmetry. We have shown where previous measures of naturalness go wrong. Proper application of the naturalness principle leads to the requirement of light higgsino states of matter with mass not too far from the Higgs mass. These new states are hard to see at LHC but should be detectable at the International Linear e+e- Collider if Japan goes ahead with construction.

*HEP l-r: Abbott, Baer, Gutierrez, Milton, Skubic, Strauss, Kantowski, Kao*

During the year since **Kim Milton**'s return from sabbatical in Paris, he finished up projects initiated there, on thermal corrections to the Casimir force between metal plates, where an experimental/theoretical controversy still ranges after almost two decades, and on negative Casimir entropy. He completed work on effects of three-body forces in situations where Casimir-Polder forces result in geometric repulsion. With his former student and postdoc Prachi Parashar, he re-examined the regulated Casimir self-energy of an anisotropic electromagnetic delta-function sphere. He gave invited talks on these subjects in Virginia and Alabama. He also was a consultant for NASA, on a panel considering the validity of the so-called quantum thruster, and a judge for the Science Media Awards of the Jackson Hole Wildlife Film Festival, where Particle Fever, a film about the discovery of the Higgs at the LHC, won the top prize.

**Mike Strauss** continues to do his research using the ATLAS detector at the LHC. He has been working with three talented graduate students Callie Bertsche, Ben Pearson, and David Shope. Bertsche and Strauss have published a precise measurement of the pole mass of the top quark using its decay rate to leptons and are working on a measurement of jet production in association with top quark production. Pearson and Strauss are searching for a Higgs boson that decays through W bosons to two quarks and leptons with a mass higher than the standard model Higgs already discovered. Shope recently joined the collaboration and will be developing primary vertex finding software and algorithms.

Over the past year, **Brad Abbott** has been continuing to work on the ATLAS experiment. Abbott's student Scarlet Norberg recently defended her dissertation in which she measured the isolated prompt-photon production cross section in pp collisions at sqrt(s) = 7 TeV. His other graduate student, Othmane Rifki, was awarded an Argonne Fellowship and currently is resident at Argonne, and his

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group is getting prepared to perform a SUSY search using the data from the upcoming run. Abbott also is continuing his research on the D0 experiment he has been searching for exotic particles. Abbott's most recent analysis involves searching for a Z_b particle decaying into an Upsilon + a charge pion.

**Phillip Gutierrez** continues his research program as a collaborator on the D0 experiment at Fermilab and the ATLAS experiment at CERN. Gutierrez, with OU postdoc Peter Sviosky, have finished a couple of papers on multi-parton interactions in proton anti-proton collisions and are working on the measurement of the W boson mass, which is an important measurement as it, the top quark mass, and the Higgs boson mass are correlated with each other. On the ATLAS experiment, Gutierrez is supervising the work of graduate students A. Hasib and Q. Wang on top quark-related analyses, which will become the dissertation of these students and will be used to set limits on non-standard Higgs boson models. Finally, Gutierrez has started to work toward the development of new detector components for the high luminosity run of the Large Hadron Collider scheduled for about 2025.

**Pat Skubic** reports that the OUHEP group has had a very productive year. They have made major contributions to the ATLAS experiment at the LHC in the areas of Top Physics, Higgs Physics, and searches for new possible particles predicted by supersymmetry (SUSY) theories. Skubic had the opportunity to present recent ATLAS results on top quark pair production cross sections at the XXII International Workshop on Deep-Inelastic Scattering and Related Subjects, April 28 – May 2, Warsaw, Poland [ATL-PHYS-PROC-2014-060]. Now that the final results from Run 1 of the LHC are being finalized, the group is concentrating on preparations for Run 2 with an increased energy from 8 to 13 TeV in the center-of-mass of the colliding protons. They also have contributed to construction of another layer of pixel detectors that have been installed in preparation for Run 2.This will improve their resolution for reconstruction of secondary vertices during the run.

# CERN Large Hadron Collider Startup With Double the Energy Is Imminent

The CERN Large Hadron Collider, or LHC, is a proton-proton collider operating at CERN, the European Laboratory for Particle Physics, located on the Swiss-French border near Geneva Switzerland. Construction of the LHC was finished in 2008 but an accident having to do with faulty welds in its superconducting magnets delayed actual data taking until 2010. The wait was well worth it! As data accrued from 7 and later 8 TeV pp collisions, evidence for the existence of the long-sought after Higgs boson began to mount. Discovery was claimed on July 4, 2012. The Higgs boson seems necessary if particles are to have any mass at all. Peter Higgs and Francois Englert were awarded the Nobel prize in 2013 for predicting the existence of the Higgs particle.

While the Higgs discovery was indeed amazing, it brings with it a puzzle. The Higgs boson is the only fundamental particle known which carries no intrinsic angular momentum, also known as spin. However, in quantum field theory, spinless particles are notorious in that their mass value is mathematically unstable. In contrast, other particles such as quarks, leptons and gauge bosons all have mass values which are protected by either chiral or gauge symmetries.

In the 1970s, a new quantum symmetry which relates bosons to fermions-- known as supersymmetry-- was discovered. Supersymmetry provides the necessary symmetry to stabilize once-and-for-all the mass of scalar particles such as the Higgs boson. But SUSY also predicts a whole new world of supersymmetric matter states which ought to exist with masses of order 100-1000 times the proton mass. These super-particle states are the next target for possible LHC discovery.

The LHC is scheduled to begin taking data in May 2015 with nearly double its previous energy: 13 trillion electron volts in the center-of-mass! Calculations performed at OU indicate this may be enough energy to produce and ultimately detect the new superparticles. The lightest superparticle may make up at least a portion of the dark matter which pervades the universe. OU experimentalists Pat Skubic, Brad Abbott, Phil Gutierrez and Mike Strauss are all working on the gargantuan Atlas detector at LHC. We are hoping they keep us posted about any first sighting of new states of matter which are produced in high energy LHC collisions! *Howie Baer*

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for numerous space missions, including Viking, the first mission to land on Mars, and for Giotto, a European spacecraft that flew past Halley's Comet. He also led studies of human missions to Mars. He is recipient of the Wright Brothers Award, the Rotary International Stellar Award, the Lockheed Martin Nova Award, and numerous individual and group achievement awards from NASA. The asteroid "benclark" is named for him. In 2007, he was inducted into the Oklahoma Aviation and Space Hall of Fame.

# Sabbatical Reports

## Karen Leighly

*Karen Leighly*

During her sabbatical, Karen Leighly initiated three new research projects and one new research program. The first research project was developed in collaboration with Don Terndrup (Ohio State University), and Sarah Gallagher (University of Western Ontario / Yale University). X-ray observations offer ways to understand quasar outflow geometry. Quasars with broad absorption lines are X-ray weak, perhaps because X-ray absorbing gas is found along the same lines of sight as the UV absorbing gas. The amount of X-ray absorption depends on which UV absorption lines are present, perhaps because the outflow is principally equatorial, with the thick outflows found at the largest angles from the symmetry axis. At the same time, quasars with marginally broad lines, known as mini-BALs, often lack thick X-ray absorption; perhaps thinner, patchy outflows are observed at higher latitudes. This project targets mini-LoBALs – objects that have low-ionization absorption lines, and yet have relatively narrow lines. Will these objects will be X-ray weak, similar to LoBALs, or X-ray strong, like miniBALs? This research project is supported by three accepted proposals, including a Chandra proposal to obtain the information about the X-ray emission of a sample of 10 mini-LoBALs, a KPNO 4m proposal, and an LBT MODS proposal.

A second research project involves a search for NaID absorption lines in quasars. Such lines, originating from neutral sodium, are very rare; only four quasars are reported to have them. Analysis of optical and infrared spectra from Mrk 231 led Leighly et al. 2014 to propose that the absorption lines arise from a typical quasar outflow that impacts the dusty gas produced by a starburst, compressing it, and accelerating it out of the central engine, i.e., feedback in action. The new experiment searches for similar interaction signatures in higher redshift objects using infrared spectra obtained using IRTF SpeX and Gemini GNIRS.

## Howie Baer

*Howie Baer*

Once every seven years, faculty become eligible for a one-semester paid sabbatical — time off from teaching/service duties — for professional renewal and to gain new directions and perspectives in research. For me, this meant traveling to the University of Minnesota in Minneapolis to work within their William I. Fine Theoretical Physics Institute. I was accompanied at FTPI by my postdoc Kyu Jung (KJ) Bae and my grad student Hasan Serce.

The FTPI is chaired by Keith Olive, one of the leading lights in supersymmetry phenomenology and astrophysics/cosmology. Also serving as members are several great Russian theorists who moved to the United States after the collapse of the old Soviet Union. These include Mikhail Shifman and Arkady Vainshtein, two pioneers of the invisible axion theory known as KSVZ. The FTPI provided generous financial support for living in Minneapolis, office space for the three of us and a thriving intellectual environment.

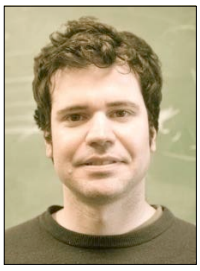
I have been working for the past several years on a theory developed here at OU known as radiatively-driven natural supersymmetry, or RNS for short. This theory clarifies our notion of supersymmetric naturalness, or how we understand the value of the W, Z and Higgs boson masses, in the face of ever-increasing limits from LHC on superparticle masses. At FTPI, I ended up finishing a manuscript on how one might detect the predicted light higgsino states from RNS at the LHC. Also, with KJ, we finished up a paper on mixed gravitino-axion dark matter, and with Hasan and KJ we wrote a beautiful paper on explaining the Little Hierarchy — the growing gap between the weak scale and the sparticle mass scale — via axion physics. On the weekends, I enjoyed hiking and paddling amongst the fall colors with my family, and tending to my daughter, who started attending Northland College on the shores of Lake Superior.

# Murphy – Santos Collaboration

A collaborative effort between **Sheena Murphy** and **Michael Santos** is focused on a relatively new development in Condensed Matter Physics, topological insulators. Long-held wisdom that solids can be divided into only two categories, conductors (metals, semimetals) and insulators (insulators and semiconductors), has been recently overturned with the prediction of a new class of insulators. These new materials are topologically distinct from conventional insulators. This means that there cannot be a smooth continuum at the interface between a topological insulator and a conventional insulator, but the interface must be non-insulating (i.e., a conductor). The conducting states at these interfaces are protected by time-reversal symmetry and hence are immune to weak disorder and display interesting spin and momentum coupling. These surface states have potential applications in spintronics and quantum computing. While many groups worldwide are working on growing high-quality materials, Murphy and Santos are focused on a niche, quantum confined antimony (Sb). Santos is an expert in the molecular beam epitaxy growth of Sb and related compounds in his semiconductor work. The hopes are that by growing sufficiently thin layers of Sb on lattice matched substrates, quantum confinement will suppress the usual semimetallic behavior and reveal the isolated conduction at the interface. Murphy's group is responsible for the sample characterization, nanodevice fabrication and low-temperature measurements, which frequently take her students to the National High Magnetic Field Laboratory in Tallahassee, Florida. So far the collaboration is reporting success in suppressing bulk conduction and evidence for suppressed backscattering, a characteristic of topological states. Stay tuned for future developments.

*Sheena Murphy and Mike Santos*

# Uchoa Wins NSF Early CAREER Award



*Bruno Uchoa*

Bruno Uchoa received the prestigious Faculty Early CAREER Award by the National Science Foundation. The award is a recognition for junior faculty "who exemplify the role of teacher-scholar through outstanding research, excellent education and the integration of education and research, and who demonstrate promise for a lifetime of leadership." The award will fund his research in the topic of "Interactions and quantum effects in nodal materials." The goal of the research is to enhance our fundamental understanding about the physics of correlated quantum systems with nodal Fermi surfaces, and to propose new ways to observe emergent quantum phenomena in those systems. Uchoa's research is motivated by the discovery of an entire new "zoo" of materials showing remarkable quantum properties in low dimensions, including graphene, two-dimensional crystals, and a variety of materials with topological properties.

# Marino Receives $1 Million Grant

*Alberto Marino*

OU assistant professor Alberto Marino, in collaboration with Raphael Pooser (ORNL/ University of Tennessee), was awarded a $1 million grant from the W.M. Keck Foundation. The team will combine quantum optics with devices based on collective electronic excitations in a metal, or plasmons, in order to develop ultra-precise sensors ("quantum enhanced plasmonic sensors") that go beyond the ultimate sensitivity possible with classical resources. The substantially enhanced sensitivity of these sensors could be used to allow earlier detection of diseases and advanced warning of dangerous pollutants or chemicals in the atmosphere.

# Summer Research for Undergraduates

Twelve students from around the country as well as from OU will help conduct research in the department for two months this summer, thanks to the NSF-sponsored Research for Undergraduates program. The OU program is overseen by Mike Strauss, Ferah Munshi and Rhiannon Griffin. The students, home institutions and OU mentors are: Charlotte Wood (Hofstra), Kilic; Joseph Lambert (Eastern Kentucky), Abbott; Joseph Joe (Reed), Mullen; Sydney Duncan (University of Utah), Munshi; Libby Dabrowski (University of Puget Sound), Lomax; Mindy Townsend (Washburn), Dai; Brennan Kerkstra (Central Michigan University), Wisniewski; Tyler Viducic (TCNJ), Kao/Milton (TBD); Anthony Burrow (OU), Wisniewski; Taylor Murphy (OU), Milton; Patrick Vallely (OU), Baron; and Nic Vogel (OU), Bumm. We welcome all of these students and wish them success in their summer work.

# Astronomy Education and Public Outreach Activities

**Back Row**: Shaun Steele, Claudia Belardi, Kyra Dame (Secretary), Jenna Nugent (Treasurer), Rhiannon Griffin (President), Tim Miller (Engineer), Brian Friesen **Front Row**: Steven Silverberg, Paul Canton, Adam Marrs, Erin Cooper, Sara Barber, Evan Rich (Vice President), Michael Whitaker, Mike Malatesta, Brandon Curd

Lunar Sooners (pictured above) had a great start in their inaugural year as an official OU registered student organization. They hosted a variety of large-scale outreach events including, interactive demonstrations, star parties and discussion panels. For example, Lunar Sooners engaged about 200 members of the public at the Science in Action Day at the Sam Noble Oklahoma Museum of Natural History, showing participants how craters form, why the moon has phases, what an element's spectrum looks like and how to make a solar system model scaled to their height. In October, Lunar Sooners were there to show the public a stellar view of the partial solar eclipse from the roof of Nielsen Hall. In addition to their initial $10,000 Creativity in Motion prize, so far Lunar Sooners has raised nearly $2,000 in funds from Majestic Athletics, OU Student Affairs and the OU Office of the President. Looking forward, Lunar Sooners plan to join the NASA Night Sky Network, establish ongoing relationships with local schools, and spread the excitement of scientific discovery by increasing their emphasis on interactive demonstrations. For more information about Lunar Sooners and what they do, check out their website, www.ou.edu/lunarsooners.

# Physics and Baseball

There was an article in last year's newsletter that described the department's annual spring trip to the ballpark to see the OKC Redhawks play. The article included a reference to a blistering foul ball that was caught by Andy Feldt. Alum Mike Fast (EP95) was kind enough to send in the following comments regarding that bit of news:

"I was very interested to read in the spring newsletter an item about the department attending a baseball game at the Oklahoma City Redhawks. The Redhawks are a farm team of the Houston Astros, where I work in the analytical department. I thought you might be interested to learn of a physics application which takes place at every Redhawks game. We have a phased-array Doppler radar that we use to track every pitch thrown and every batted ball hit during Redhawks games. The radar provides us information about the position, velocity, and acceleration of the baseball, as well measuring the spin rate of the baseball using radar reflections off the seams of the ball. The foul ball mentioned as being caught by Andy Feldt was presumably tracked by this radar, and if I knew the inning it occurred or the section in which you were seated, I could presumably identify the speed and trajectory of this foul ball in our database. Anyhow, it warms my heart to read of interactions between physics and baseball, as that is how I spend most of my days."

Editor's note: The OKC Redhawks are history. Our allegiance now shifts to the OKC Dodgers, a triple-A farm club of the LA Dodgers.

# Network News

**by Andy Feldt**


*Andy Feldt*

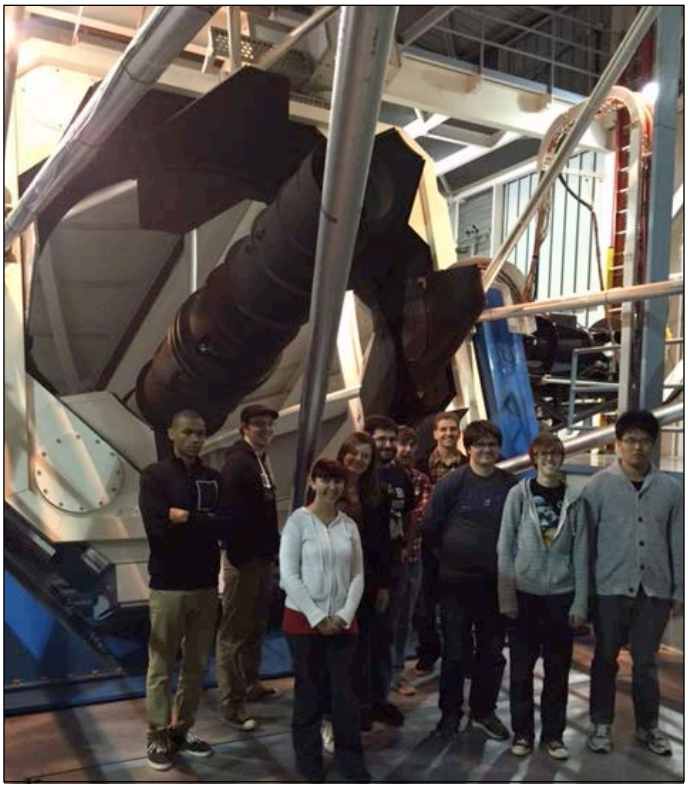
Our last report indicated that we were in the middle of our transition from Sun workstations to those running Red Hat Enterprise Linux (RHEL). We now have no Sun workstations remaining. All of our systems (except one aging IBM AIX system) now run RHEL. The total number of cores available to our Condor batch pool has increased by 50 percent during this time. The amount of disk we back up has tripled since our last report and is beginning to strain our current tape-based capacity. We are gradually dropping support of our own mail server and see a drop in volume as this occurs. We have also had a major overhaul of our web services and, with the help of a professional web designer, completely redesigned our web pages. Surprisingly, this has coincided with a drop in both the number of page hits and bandwidth used. For those who like numbers, a few are given here:

- 46 - RHEL workstations on NHN
- 47 - total workstations on NHN
- 152 - total cores in our workstations
- 231 - IP addresses assigned on our subnet
- 4.1 - terabytes of backed up data
- 3300 - e-mails/day initiating connection
- 1400 - e-mails/day actually delivered after filtering
- 8000 - hits/day to our web server
- 3 - gigabytes/day served by our web server

# Students Observe at Apache Point Observatory

The astronomy group entered into its second year of a three-year lease arrangement with the Apache Point Observatory 3.5m telescope consortium. Access to OU's share of observing time on the 3.5m telescope has been distributed amongst many research groups in the department, and has provided data used in two refereed papers (plus one submitted) and one Ph.D. thesis to-date. A group of 10 undergraduate and graduate students visited the observatory in April for a three-day on-site observing run as part of Professor Wisniewski's Advanced Observatory Methods class. All students gained hands-on experience using the 0.5m and 3.5m telescopes, and each is now qualified to run the telescope remotely from Nielsen Hall. The astrophysics group continues to pursue funding to become a permanent member of the APO 3.5m consortium.

Members of the Observatory Methods class who traveled to APO in April are shown in the photo to the right with the 3.5m telescope in the background. Pictured from left are: Brandon Curd, Marcus Keil, Kyra Dame, Tarryn Kahre, Steven Silverberg, Matt Scheffler, Mike Malatesta, Evan Rich, Jodi Berdis, and Xiaoxian Duan.




*Members of the Homer L. Dodge Department of Physics and Astronomy, April, 2015. Photo credit, Hugh Scott, OU.*

## 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.

To make a donation, go to www.nhn.ou.edu/donate/

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

*Foucault pendulum, located in the Nielsen Hall atrium*