

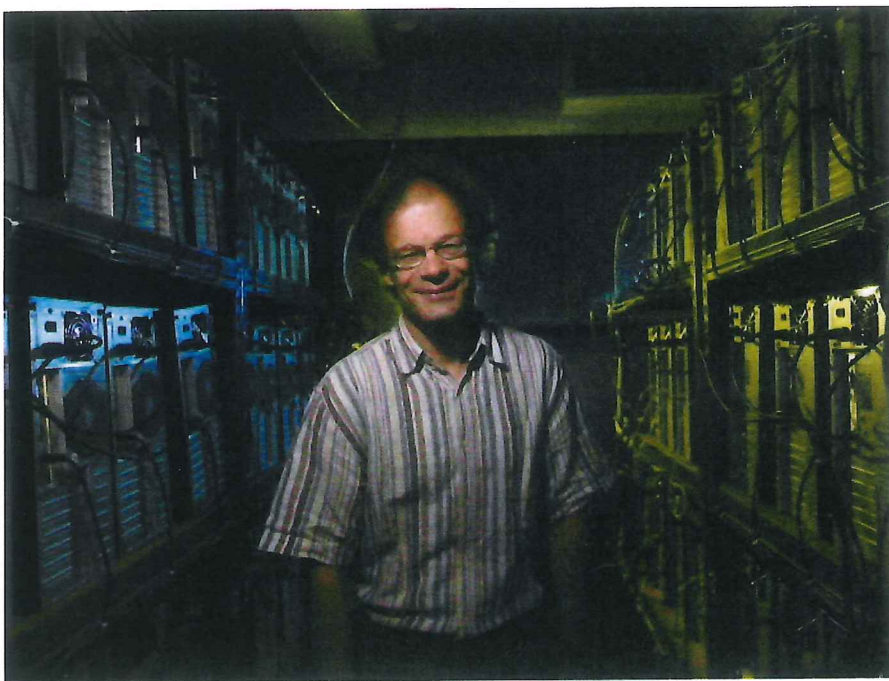
For alumni, friends, faculty, and staff of the MSM-UMR-Missouri S&T Physics Department

## Vojta Elected Fellow of APS

**Thomas Vojta**, Professor of Physics at Missouri University of Science and Technology, has been named a Fellow of the American Physical Society.

Vojta was nominated by the society's Division of Condensed Matter Physics for his "innovative analyses of quantum phase transitions in the presence of strong disorder." His work in theoretical physics focuses on how changing the chemical compositions of materials can lead to new states of matter, for example superconductors that have the ability to transfer electricity without any loss. So far, materials need to be cooled to almost absolute zero temperature to become superconductive, but his goal is to find this state of matter at room temperature.

APS Fellowship is an honor that demonstrates the recognition of one's professional peers. It also represents outstanding physics research, important applications of physics, leadership in or service to physics, or significant contributions to physics education. Fellowship is limited to no more than half of one percent of APS membership.



Vojta joined the Missouri S&T faculty as an assistant professor in January 2002. He was named an associate professor in 2006 and full professor in 2011. Prior to his work at S&T, Vojta served as Heisenberg Fellow in the department of theoretical physics at University of Oxford in Great Britain.

Vojta earned a Ph.D. in physics from the University of Chemnitz in Germany in 1994. His research interests include quantum and classical phase transitions, critical behavior, and superconductivity and transport in disordered materials. In January of 2016 he was awarded a \$339,000 NSF grant for the study of "Unconventional quantum phase transitions." Since joining Missouri S&T in 2002, Thomas has received four major NSF grants totaling over \$1,400,000, including a CAREER award in 2004. This level of funding for a theorist is remarkable, and the Physics Department is fortunate to have Thomas as one of its faculty.

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## Contact S&T Physics

If you would like to contact us, you can reach us by phone at (573) 341-4781 and by e-mail at [physics@mst.edu](mailto:physics@mst.edu). You might also be interested in checking out our web page, <http://physics.mst.edu>.

## Memo from the Chair

This past year was one of change and accomplishment for the Physics Department. Long time faculty member **Bob Dubois** retired, moving to Oregon with his wife **Kay**. We wish them all the best in their future endeavors. The department also hired its third new faculty member in the past two years. Dr. **Alex Chernatynskiy** joins the department as part of the University's Best-In-Class program targeting focused hiring in four areas in which the campus intends to achieve best-in-class or signature status as a research university. Alex joins us from the University of Florida where he was a post-doc working in computational condensed matter physics with emphasis on thermal and electron transport. He joins the best-in-class group working on Materials for Extreme Environments.

Our faculty continue to garner recognition for outstanding scholarly and teaching performance. Notable this year was Prof. **Thomas Vojta's** election a Fellow of the American Physical Society. In addition Prof. **Greg Story** won another Outstanding Teacher Award, and **Ulrich Jentschura** won a Faculty Research Award.

Our students also continue to perform admirably. Undergraduate and graduate enrollments remain strong, and the quality of students is excellent. Approximately 2/3 of our majors graduated with honors this past year. For the second year in a row we welcomed a student with a perfect ACT score into the department. One of our incoming graduate students received the prestigious new Chancellor's Distinguished Fellowship (one of nine awarded and the only one awarded in the College of Arts Science & Business), and two were awarded Dissertation Completion Fellowships.

The department was also able to expand its teaching lab capabilities thanks to generous donations from both Colleges, from the Provost, and from our alumni. These donations have allowed us to supply an additional undergraduate laboratory, and to increase the number of students that attend these labs by up to 50%. I thank all of you for your continued and dedicated support.

The department remains a vital and thriving unit due to the quality and dedication of our faculty, students, staff, and alumni. I know that we can continue to count on the generous support of our alumni. It is clear that the department's ability to provide a quality education to our students would be hampered without your dedication and support.

– Dan Waddill



## Planned Giving:

### Leaving a Legacy to Missouri S&T

Many alumni and friends have realized that a future gift – one arranged through their will or trust – allows them to give back to their alma mater more than they ever thought possible. With careful planning, charitable estate giving can reduce your estate tax liability or transfer assets to your family at a lower gift tax cost.

Making a planned gift shows your loyalty to Missouri S&T, an institution that played a significant role in shaping your future. For more information about giving a current or planned gift, contact the Office of Development at 1-800-392-4112 or email [giving@mst.edu](mailto:giving@mst.edu).

## Faculty Funding

**Julia Medvedeva** received continued funding from Northwestern University for her work on “*Multifunctional nanoscale materials structure*” through the Center of Excellence for Materials Research and Innovation.

**Don Hagen** was awarded grants from Shell Exploration and Production Company for “*Assessment of non-volatile PM emissions of TRS-18 micro turbine engine burning alternative fuel blends,*” and from the US Department of Transportation for “*Centre of excellence for aerospace particulate emissions reduction research,*” and “*Non-volatile PM emissions measurements for the variable response in aircraft nvPM testing.*”

**Don Madison** received a new 3-year NSF award for “*Theoretical study of few body processes.*”

**Yew San Hor** is co-PI on a NSF Major Research Instrumentation grant for “*Acquisition of an electron-beam lithography system for nanofabrication and nanoscience research and education.*”

**Thomas Vojta** is PI of a new three year NSF grant for the study of “*Unconventional quantum phase transitions.*” Thomas is also co-PI on an Interdisciplinary Intercampus Research Program award to work with University of Missouri-St. Louis faculty on “*Phase transitions in silico and in vivo.*”

**Cihan Kurter, Ulrich Jentschura, and Daniel Fischer** all received University of Missouri Research Board awards in 2015. Cihan will be working on low temperature transport of superconductor/topological insulator junctions. Ulrich was funded for “*Antimatter, atomic physics, and gravity,*” and Daniel will study “*Control and analysis of atomic few-body systems.*”

**Allan Pringle** is a co-PI on “*Science education and quantitative literacy: an inquiry based approach,*” funded in 2015 for another year by the Missouri Department of Higher Education.

## Physics Department Awards 2015-2016 Scholarships and Fellowships

The following scholarships have been endowed through the generous gifts of the friends of the Missouri S&T Physics Department. Please contact the Physics Department if you would like to add to the endowment fund of these scholarships or would like to establish a new one.

The *Dr. John R. and Patty Rogers Endowed Scholarship* provides scholarships to academically proficient physics majors who demonstrate financial need. The 2015-2016 Rogers scholarships, with values ranging from \$1250 to \$1950, were awarded to **Jacob Cook** from Willard, Missouri; **Ife Siffre** from Kansas City, Missouri; **Nathan Hock** from St. Louis, Missouri; and **Rachel McCormick** from Maryland Heights, Missouri.

The recipient of the *Burke H. Miller Memorial Scholarship* was **Jacob Hume** from Lake Saint Louis, Missouri. This \$500 endowed scholarship was established by the Miller family to commemorate the academic achievements of their son, **Burke**, who graduated with a bachelor's degree in physics in 1969 and later died during the Vietnam War. The award is for promising and dedicated students in physics.

**Rachel Birchmier** from Kansas City, Missouri; **David Gillcrist** from Kansas City, Missouri; **Alexander Mark** from Manchester, Missouri; **Sawyer Scheer** from Hamilton, Ohio; **Owen Smith** from Saint Louis, Missouri; and **Skye Tackkett** from Kansas City, Missouri were awarded the *Ed and Mary Sue Sickafus Endowed Scholarship/Fellowship*, established by **Ed** (BS '55, MS '56) and **Mary Sue Sickafus** in conjunction with the Ford Motor Company. This \$500 to \$1000 scholarship is awarded to physics students on the basis of their performance at Missouri S&T.

The *Richard W. Hannum Endowed Development Fund* was established through a bequest by **Richard Hannum** (PhD '66). The fund is currently used to provide scholarships for outstanding students in Physics. **Rachel McArthur** from Independence, Missouri received the \$1000 Hannum Scholarship for 2015-2016.

**Jason Mao** from Springfield, Missouri and **Juan Remolina** from Saint Charles, Missouri received the *Leon E. Woodman Memorial Scholarship*. This \$1000 scholarship was established by the Woodman family in honor of Dr. **L. E. Woodman**, Chair of the Physics Department from 1919 to 1948. It is offered to students in physics who are of good moral character, maintain a satisfactory grade point average, and are in financial need.

The *Richard Anderson Scholarship Fund* is an endowment established in memory of Dr. **Richard Anderson**. **Sara Newman** from League City, Texas received the \$1000 Richard Anderson Scholarship for 2015-2016.

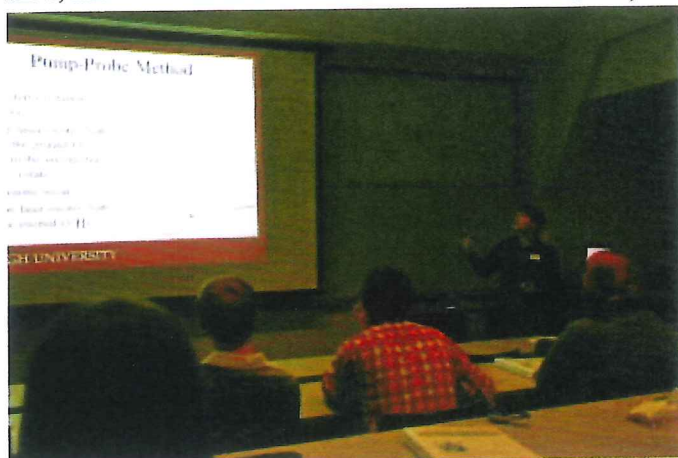
In addition to endowed scholarships, which are usually awarded to juniors and seniors, the department awards special *Physics Department Scholarships*, funded from the annual phonathon and development fund, to students who earn a grade point average of 3.5 or higher. This past year, these \$500 to \$2000 scholarships were awarded to **Rachel Birchmier** from Kansas City, Missouri; **Albert Chua** from O'Fallen, Missouri; **Brian Ford** from Louisville, Kentucky; **Jacob Hume** from Lake Saint Louis, Missouri; **Dawson Huth** from Ballwin, Missouri; **Aaron Lemmermann** from Raytown, Missouri; **Alexander Mark** from Manchester, Missouri; **Joshua Maxwell** from Saint Robert, Missouri; **Kathryn McNabb** from Kirkwood, Missouri; **Mathew Pollard** from Fenton, Missouri; **Juan Remolina** from Saint Charles, Missouri; **Nocona Sanders** from Poplar Bluff, Missouri; **Josey Stevens** from Wooldridge, Missouri; **Joshua Sutter** from Florissant, Missouri; and **Skye Tackkett** from Kansas City, Missouri.

The department also awards *Physics Scholarships for Academic Access*, funded by a group of alumni and faculty donors. These are needs-based awards to Missouri resident students in Physics. For 2015-2016 these \$500 to \$1000 scholarships were awarded to **Robert Branson** from Butler, Missouri, and **Joshua Maxwell** from Saint Robert, Missouri.

## Report from the SPS

2015 began with election of new officers for the spring semester. **Josey Stevens** was re-elected President, **Cory Karle** was elected Vice President, **Josh Sutter** treasurer, and **Rachel McCormick** continued as secretary.

SPS ran several events at the regional Science Olympiad competition in February. The highlight of the semester was a trip to St. Louis for the Spring 2015 SPS Zone 12 meeting. **Philip Markarian**, **Kent Gorday**, **Cory Karle**, **Caleb Hughes**, **Rachel McCormick**, **Skye Tackkett**, **Rachel McArthur**, **Josey Stevens**, **Ian Ramsey**, **Jason Hancock**, and **Zach Miller** all represented Missouri S&T. Josey gave a talk on “*Theoretical calculations of rotationally inelastic collisions of He with NaK.*” Josey’s talk (see picture below) was based on the work that he did at Lehigh University in the summer of 2014 with Dr. **Peet Hickman** as part of an NSF-funded REU, and was selected best student talk of the meeting.



During spring SPS meetings, S&T Physics faculty **Cihan Kurter** and **Greg Story** gave talks about their research, and Dr. **Josh Rovey** of the Mechanical and Aerospace Engineering Department gave a presentation on his Aerospace Plasma Lab.

The fall 2015 semester began with the now-mandatory liquid nitrogen ice cream party, followed by officer elections. **Rachel McCormick** was elected president, **Nikita Gahr** became vice president, **Philip Markarian** was elected secretary, and **Kent Gorday** was voted treasurer.

In addition to movie and GRE review nights, fall SPS meetings included Professor **Dan Waddill**'s annual talk on “*How to get into graduate school.*” SPS heard talks by Mathematics Professor **David Grow** on “*What classes physics majors should take,*” and **Sean Siebert**, Columbia College professor and founder and CEO of “*Invent Yourself*” on “*How physics can prepare you for the business world.*” In addition, new Physics faculty **Alex Chernatynskiy** and **Daniel Fischer** gave presentations on their research plans.

The members of SPS would like to thank alumni who have made events like the trip to the Zone 12 meeting possible through their donations at the annual Physics phonathon.

## Come Back for Homecoming

The Missouri S&T Physics Department warmly invites you to return to Rolla for **S&T Homecoming 2016** on **October 14-15, 2016**. On Friday afternoon, October 14, the department will hold an open house and special programs for its alumni and friends. Tours of laboratories and educational facilities will be offered and there will be opportunities for interaction with current Missouri S&T physics students. Come see what we have done since you received your degree.

In keeping with a long-standing tradition, an S&T alum will deliver the Homecoming 2016 Physics Colloquium at 4 PM. on Friday, October 14. Contact us at [physics@mst.edu](mailto:physics@mst.edu) for specific information about physics department activities, or [alumni@mst.edu](mailto:alumni@mst.edu) for general homecoming information. Come home to your college roots, and help us celebrate our past as MSM-UMR, even as we work to dig deeper into our future as Missouri S&T!



Professor **Ulrich Jentschura** ran in the 2015 Kansas City Marathon and went an extra mile for his Faculty Research Award, Missouri Research Board grant, and NSF grant, mentioned elsewhere in this newsletter. Ulrich completed the marathon in 3:29:01 for 139<sup>th</sup> place out of 1295 finishers.

## Templeton Honored for Teaching Excellence

Two Missouri S&T graduates were honored in 2015 by the Missouri Association for Colleges of Teacher Education (MACTE) for excellence in teaching.

**Spencer Templeton**, a 2013 physics graduate who teaches physics and Project Lead The Way in the Ferguson Florissant School District, was named Outstanding Beginning Teacher during MACTE's spring conference on March 6, 2015.

A total of 61 outstanding teachers, selected from recent graduates of Missouri's institutions of higher education, were recognized for their excellence in serving children during their first two years of service in school districts across Missouri.

Award recipients were selected based on evaluations completed by their college or university, and recommendations from the school district which deemed the teacher as highly effective in their first two years in the classroom.

Each recipient was awarded an engraved plaque to display in their classroom. MACTE recognizes the contribution of these fine teachers, as well as all of our excellent, highly qualified teachers throughout Missouri's who serve and educate our students.



Spencer (above left) was presented his plaque by Dr. **Jana Neiss** (center), Director of S&T's Teacher Education Program. Also pictured is fellow award winner and 2013 biological sciences graduate **Andrew Lott** (right).

What do a logging job, a year-long bicycle tour of the US, and a vow to never see the inside of a school again have to do with a career in physics? Read the article about **Greg Story** that begins on page 7 of S&T's Center for Educational Research and Teaching Innovation's Fall 2015 newsletter at <http://goo.gl/PMpDVfto>.

## Congratulations to S&T's 2015 Physics Degree Recipients!

May 2015

### *Bachelor of Science*

Zachariah Erik Burgdorf  
Michael Scott Christopher  
Clayton Patrick Craig  
Patricia Leigh Huestis  
Cory Michael Karle  
Frank Edward Marshall  
Mason Louis Proffitt  
Nelson Eugene Shreve  
Alyson Paige Smith  
David Allen Caleb Wilkerson

### *Master of Science*

Chandra M. Adhikari  
Christian Kenneth Dzurny  
Nicholas Ryan Hugenberg

December 2015

### *Bachelor of Science*

Jack Russell Crewse III  
Sheldon Wayne Harper  
Philip George Markarian  
Russell Scott Reckman Jr.  
Joshua Mathew Sutter  
Brandon Dean Yokeley

### *Master of Science*

Sadek Mohamed Fituri Amami  
Basu Ram Lamichhane  
Susmitha Akula

### *Doctor of Philosophy*

Hari Hara Kumar Chaluvadi  
Amrita Roy Chowdhury  
Dawn Michelle King  
Jonathan Howard Noble  
Dongxao Zhao

Congratulations to **Uttam Chowdhury**, who received his PhD from Missouri S&T in 2012. Uttam's name was not listed in our 2013 newsletter among those who received doctorates that year. Apologies to Uttam for our omission.

## New Faculty Alex Chernatynskiy

**A**leksandr Chernatynskiy was born in Perm, Russia, a large industrial center on the border between Europe and Asia. After receiving his BS degree in Physics at Perm State University, he moved to Louisville, KY in 1999 where he completed his MS and PhD degrees in physics at the University of Louisville. His PhD work was focused on atomistic simulations of material properties, a theme that is pervasive in his work to this day.

Following graduation, Alex decided that Kentucky's climate is way too warm, and moved to Minneapolis. There, at the University of Minnesota's School of Physics and Astronomy, he continued to work on the development of the advanced simulations methods and their applications. Of particular interest was the



“overpotential problem” in catalytic reaction of water dissociation on a platinum catalyst. This problem prevents an efficient splitting of oxygen molecules into individual oxygen atoms and their subsequent reaction with hydrogen to form water. This reaction releases energy that could be used to power automobiles, with the only exhaust product being pure water. Alex developed a tight bounding model for platinum that contained relativistic effects up to the level of spin-orbit interactions.

After three years in Minnesota, Alex was up to another change of scenery, but more importantly, to the change of scientific focus. He moved to Gainesville, Florida, to the department of Materials Sciences and Engineering at the University of Florida. There, he stated to work on the thermal transport properties of materials and simulations of those properties from first principles. He was particularly interested in thermal transport in nuclear fuels. A reactor is basically a giant water boiler. The thermal conductivity of the nuclear fuel determines how efficiently the energy of a nuclear decay can be extracted to produce electric power.

Thermal transport in nuclear fuels is an inherently multiscale problem and at each scale appropriate simulation tools need to be applied. Fundamentally, lattice vibrations, or phonons, are responsible for the thermal transport and in an ideal crystal, ab-initio methods can be applied to elucidate the transport details with

high fidelity. Real fuel is far from single crystal, and all sorts of defects need be taken into account, such as point defects, gas bubbles, grain boundaries and dislocations. These are best addressed by molecular dynamics methods with classical potentials. Finally, an actual fuel element is too large to be tackled by the atomistic approach and continuum methods have to be applied. Connecting between different size scales and ensuring that atomistic level calculations are appropriately integrated into larger size scales is a fundamental problem in materials simulations.

In August 2015, Alex became an assistant professor in Missouri S&T's physics department. Alex was brought to campus as part of a focused hiring campaign in “*Enabling Materials for Extreme Environments*.” He intends to pursue studies of the thermal transport and other materials properties in the extreme environments at the fundamental level, as well as in industrial applications, such as nuclear energy, geophysics and others.

## Observatory Open For Viewing Again

**A**fter a couple of years of inactivity, the S&T Observatory opened its doors for public viewings in September, 2015.

Undergraduate student **Ken Goss** evicted the army of spiders who had taken residence in the 16-inch telescope, made a few repairs, and sponsored a viewing of the constellation Cygnus on September 21. Cygnus, or “the swan,” is one of the most recognizable constellations in the northern hemisphere sky during the summer and autumn.

Additional public viewings included the conjunction of Jupiter and Mars on October 18, the Pleiades on November 9, and the Great Orion Nebula on February 10, 2016.

Built in 1973, the Missouri S&T Observatory is adjacent to the university's Stonehenge replica. It is used this semester by students in the Physics Department's astronomy laboratory course.



## New Faculty Daniel Fischer

**D**aniel Fischer was born and grew up in Western Germany a few miles south of Karlsruhe. After studying Physics in Freiburg im Breisgau, Daniel obtained his PhD degree 2003 in Heidelberg. For two years, he was postdoc in Stockholm, Sweden, and came back to the Max Planck Institute for Nuclear Physics in Heidelberg. Starting in 2009, he held an independent group leader position funded by the German Research Foundation. In January 2015 he arrived and settled in Rolla together with his wife **Didi**, a school teacher, and his two sons **Sebastian** and **Jakob**.



Daniel's earlier research activities were mainly focused on the investigation of the dynamics of ion-atom collisions. He was performing experiments at large accelerator facilities like the GSI in Darmstadt, Germany. He also had lively collaborations with some S&T physics faculty that lasted more than a decade, resulting in many joint publications. Daniel's most significant experimental achievement was the development of the so-called MOTReMi (magneto-optical trap reaction microscope). This apparatus allows researchers to cool lithium atoms with laser radiation to temperatures of few milli-Kelvin. After ionizing the atoms in a collision with a projectile ion, the particles' momentum vectors are mapped which provides detailed insights in the collision dynamics. This unique combination of laser cooling and momentum imaging has never been done before, and helps us understand the most fundamental dynamic mechanisms of atomic break-up processes.

In Rolla, Daniel wants to change his research focus and study interactions of single excited and polarized atoms or ultra-cold and quantum-degenerate ensembles of atoms with intense femtosecond ( $1 \text{ fs} = 10^{-15} \text{ s}$ ) laser pulses. He is presently furnishing a laser lab for advanced light sources that allow to cool, trap, manipulate, and ionize lithium atoms with an unprecedented level of control. The aim is investigating few-body effects of atomic quantum systems that are of high relevance not only in atomic physics but also in many other research fields and in numerous technical applications including materials science, quantum chemistry, biological science, and information processing.

## Vojta Searches for New States of Matter

**B**y studying how materials transform at ultra-low temperatures, a Missouri S&T theoretical physicist hopes to discover new states of matter.

Funded by a \$229,000 grant from the National Science Foundation, Dr. **Thomas Vojta**, professor of physics at Missouri S&T, is researching how slight changes in the chemical composition of materials can dramatically change their properties.

"My research looks at quantum phase transitions – transformations of materials occurring near absolute zero – and how they take place," says Vojta. "In connection with these transformations, exotic new quantum states of matter can appear – for example, superconductors that can carry electric current without any losses."

Until recently, it was believed that materials had to be cooled to temperatures below negative 400 degrees Fahrenheit – close to absolute zero – in order to transmit electric current with no loss, an effect known as superconductivity. Current research shows that some materials can become superconducting at warmer temperatures. But to reach room-temperature superconductivity – where the effect would have enormous technological impact – new kinds of superconducting states may be required. Once they are discovered, researchers could continue to improve the materials' superconductivity, leading to lower costs and faster advances in the field, Vojta says.

His research in quantum phase transitions could be one method of finding new states of superconductivity in certain materials.

"Quantum property phase transitions are similar to the changes that occur when you boil water," says Vojta. "These abrupt transformations directly affect superconductivity, and we want to find out exactly how and why."

Vojta uses a supercomputer he built with his colleagues and students to model these quantum phase transitions and to compute various materials' properties. Called the Pegasus IV High-Performance Computing Cluster, the homemade PC cluster is made up of 156 quad-core computer nodes that are used for computational research in condensed matter and statistical physics.



Vojta, whose research interests include quantum and classical phase transitions, critical behavior, superconductivity, and transport in disordered materials, joined the S&T faculty in 2002 and was named a full professor in 2011. Prior to his work at S&T, Vojta served as Heisenberg Fellow in the department of theoretical physics at University of Oxford.

## Outstanding GTA's

This past year we again presented graduate teaching awards to honor the outstanding accomplishments of our graduate teaching assistants. The awards are determined by a combination of student evaluations and teaching performance assessed by the faculty overseeing the teaching laboratories. The 2015 winners were **Sam Lee** and **Chandra Adhikari**. Congratulations to the winners for helping to advance the department's commitment to excellence in teaching.



*Sam Lee (left) and Chandra Adhikari (right) receiving awards from Dan Waddill*

### Endowments: Gifts that Continue to Give

Many generous donors have found that creating an endowment, a fund established with cash, securities or other assets which provides income in perpetuity, offers a significant, long-term impact on Missouri S&T. Endowments can be unrestricted or restricted for a specific purpose such as scholarships, department programs, faculty support, etc. Endowments can be started with as little as \$15,000 and additional funds can be added at any time in the future.

## Faculty Honored

Professor **Ulrich Jentschura** received a Faculty Research Award during a February 22, 2016 ceremony on campus. This award recognizes faculty members who have demonstrated excellence in research and scholarship. Awards are given based on the significance of the contributions of the individual in the preceding two years, as well as the long term impact of the individual's research. Eight S&T faculty received this award in 2015. The award includes a \$1,000 stipend funded by industry and alumni contributions.

Professor **Greg Story** was selected yet again as one of Missouri S&T's outstanding teachers. Greg was one of 41 S&T faculty to receive an Outstanding Teaching Award, which was presented at an awards ceremony on November 30, 2015. This award is based on student teaching evaluations. Every year it gets harder to count this high, but we believe this is the thirteenth consecutive year that Greg has received this award.

Professor **Yew San Hor** was named a 2015 Thomson Reuters Highly Cited Researcher. Thomson Reuters analyzed citation data over an 11-year period to identify highly cited researchers. This is the second year in a row that he has received the honor. He is also listed in Thomson Reuters "World's most influential scientific minds." for 2015.

The Missouri S&T Physics Department has several donors that have been adding to their endowment for several years, including endowments established by **Ed and Mary Sue Sickafus**, and by the estates of **Richard Anderson** and **Richard Hannum**. Our most recent endowment came from **John and Patty Rogers**.

The ongoing nature of an endowment provides a way to support your alma mater and give them the financial strength to do things that might not otherwise be possible. If you want to learn more about the Missouri S&T endowment program and how you can participate, please call 1-800-392-4112, or e-mail [giving@mst.edu](mailto:giving@mst.edu).

## Congratulations to 2015 Physics Academic Scholars

*Students who maintain at least a 3.50 GPA for twelve hours or more of coursework are honored for their outstanding accomplishment by being named Academic Scholars.*

### Spring Semester 2015

Rachel Birchmier, Robert Branson, Michael Christopher, Albert Chua, Clayton Craig, David Gillcrist, Kent Gorday, Patricia Huestis, Jacob Hume, Dawson Huth, Jason Mao, Alexander Mark, Joshua Maxwell, Kathryn McNabb, Sara Newman, Mathew Pollard, Mason Proffitt, Juan Remolina, Nocona Sanders, Sawyer Scheer, Nelson Shreve, Owen Smith,

Paul Somers, Jason Summers, Joshua Sutter, Raylynn Swift, Skye Tackett, David Wilkerson.

### Fall Semester 2015

Abdulahman Alharbi, Rachel Birchmier, Robert Branson, Bryce Cahill, Albert Chua, Jacob Cook, Brian Ford, Kent Gorday, Nathan Hock, Jacob Hume, Dawson Huth, Aaron Lemmermann, Jason Mao, Alexander Mark, Philip Markarian, Brady Martin, Mikeelie Martin, Joshua Maxwell, Rachel McCormick, Scott McCumber, Kathryn McNabb, Sara Newman, Mathew Pollard, Austin Powell, Brendan Ramsey, Juan Remolina, Nocona Sanders, Logan Smith, Owen Smith, Paul Somers, Josey Stevens, Jason Summers, Raylynn Swift, Skye Tackett, Lawrence Thompson, Charlie Winborn, Matthew York.



## Bob DuBois Retires

**B**ob DuBois retired at the end of February, 2015. His primary area of research at S&T was funded by the National Science Foundation and centered on highly differential measurements of ionization resulting from positron and electron impact, where the



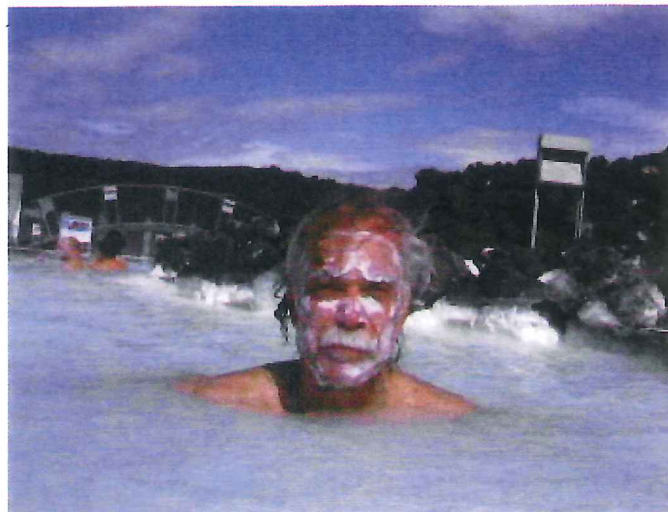
goal was to study kinematic effects associated with the direction of the Coulomb field between the incoming particle and the target atom. For electron impact, such studies have been performed for many decades whereas for positron impact Bob's studies represent the majority of the experimental information currently available.

Bob's other area of research involved measurements of electron loss by very fast, heavy, low charge state ions. This research began with a grant from the Department of Energy to provide information to aid in a proposed heavy ion fusion project. Many of the experiments were done at the GSI Helmholtz Center for

Heavy Ion Research in Germany where the interest was in improving ion beam lifetimes in storage rings.

Bob joined the Physics department in 1995. Prior to coming to Rolla, he spent many years at the Pacific Northwest National Laboratory, was a visiting scientist at Kansas State University, the University of Frankfurt, the Hahn Meitner Institute in Berlin, the University of Aarhus (Denmark), and was a Fulbright Fellow at the University of Freiburg and GSI. In addition he collaborated with scientists in Hungary, Brazil, and Mexico. Upon retirement, Bob and his wife Kay moved to Oregon.

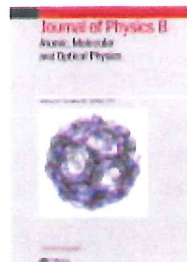
Bob's retirement party and reception was held at the Public House in Rolla. All guests agreed that this was the Best Retirement Reception, Ever.



## Esam Ali Recognized For Outstanding Paper

**A** paper by S&T graduate student **Esam Ali** has been selected by the editorial board of the Journal of Physics B: Atomic, Molecular and Optical Physics for inclusion in the journal's "*Highlights of 2015*" collection. The paper "*Experimental and theoretical study of electron-impact ionization plus excitation of aligned  $H_2$* " was chosen due to "its outstanding quality and impact within the field of AMO physics."

Esam is advised by Professor Don Madison. Congratulations, Esam!



### Journal of Physics B Atomic, Molecular and Optical Physics

**This is to certify that the article**

Experimental and theoretical study of electron impact ionization plus excitation of aligned  $H_2$   
**Esam Ali, XueGuang Ren, Alexander Dorn, Chuongang Ning and Don Madison**

has been selected by the Editors of Journal of Physics B: Atomic, Molecular and Optical Physics for inclusion in the exclusive "Highlights of 2015" collection. Articles are chosen on the basis of relevance, endorsement, novelty, scientific impact and broadness of appeal.

# The Physics Department gratefully acknowledges the support of the following alumni and friends.

## Donations over \$100:

Harro Ackermann  
 Gary D. Bickel  
 Robert E. Caldwell  
 Ross O. Carnes  
 James M. Carter  
 Daniel Chitwood  
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 Marsha S. Evans  
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### Physics Department Acknowledges Corporate Support

The Physics Department gratefully acknowledges the support of the following corporations:

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### Lab Upgrades Supported

Last year with generous donations from our alumni and from the Chancellor we were able to upgrade equipment in our teaching laboratories. This year, in response to increasing enrollment, we received generous contributions from both Colleges and from the Provost to expand our instructional laboratory offerings. The contributions have allowed us to increase the teaching laboratory capacity by up to 50%, and these changes have been implemented this spring. Your continued support will be crucial in keeping these new facilities adequately equipped and up-to-date.

## Missouri University of Science and Technology Students & Alumni: In Press

The following journal articles which appeared over the last year feature work by Missouri S&T undergraduate students,<sup>1</sup> graduate students,<sup>2</sup> or alumni<sup>3</sup> under the supervision of Missouri S&T faculty.

“*Theoretical and experimental ( $e,2e$ ) study of electron-impact ionization of laser-aligned Mg atoms,*” S. Amami,<sup>2</sup> A. Murray, A. Stauffer, K. Nixon, G. Armstrong, J. Colgan, and D. H. Madison, *Phys. Rev. A* **90**, 062707 (2014), Erratum: *Phys. Rev. A* **91**, 069906(E) (2015).

“*Kinematically complete study of low-energy electron-impact ionization of neon: internormalized cross sections in three-dimensional kinematics,*” X. Ren, S. Amami,<sup>2</sup> O. Zatsarinny, T. Pflugger, M. Weyland, W. Y. Baek, H. Rabus, K. Bartschat, D. H. Madison, and A. Dorn, *Phys. Rev. A* **91**, 032707 (2015).

“*Experimental and theoretical study of electron-impact ionization plus excitation of aligned  $H_2$ ,*” E. Ali,<sup>2</sup> X. Ren, A. Dorn, C. Ning and D. H. Madison, *J. Phys. B* **48**, 115201 (2015).

“*Interference effects for intermediate energy electron-impact ionization of  $H_2$  and  $N_2$  molecules,*” Z. N. Ozer, Hari Chaluvadi,<sup>3</sup> D. H. Madison and M. Dogan, *Journal of Physics: Conference Series* **601**, 012003 (2015).

“*Observation of two-center interference effects for electron impact ionization of  $N_2$ ,*” Hari Chaluvadi,<sup>3</sup> Z. N. Ozer, M. Dogan, C. Ning, J. Colgan and D. H. Madison, *J. Phys. B* **48**, 155203 (2015).

“*Evidence for unnatural-parity contributions to electron-impact ionization of laser-aligned atoms,*” G. S. J. Armstrong, J. Colgan, M. S. Pindzola, S. Amami,<sup>2</sup> D. H. Madison, J. Pursehouse, K. L. Nixon, and A. J. Murray, *Phys. Rev. A* **92**, 032706 (2015).

“*Comparison of experimental and theoretical electron-impact-ionization triple-differential cross sections for ethane,*” E. Ali,<sup>2</sup> K. Nixon, A. Murray, C. Ning, J. Colgan, and D. H. Madison, *Phys. Rev. A* **92**, 042711 (2015).

“*Electron- and photon-impact ionization of furfural,*” D. B. Jones, E. Ali,<sup>2</sup> K. L. Nixon, P. Limão-Vieira, M.-J. Hubin-Franskin, J. Delwiche, C. G. Ning, J. Colgan, A. J. Murray, D. H. Madison, and M. J. Brunger, *J. Chem. Phys.* **143**, 184310 (2015).

“*Ultrarelativistic decoupling transformation for generalized Dirac equations,*” J. H. Noble<sup>3</sup> and U. D. Jentschura, *Phys. Rev. A* **92**, 012101 (2015).

“*Dirac equations with confining potentials,*” J. H. Noble<sup>3</sup> and U. D. Jentschura, *Int. J. Mod. Phys. A* **30**, 1550002 (2015).

“*Composition-dependent structural and transport properties of amorphous transparent conducting oxides,*” R. Khanal,<sup>2</sup> D.B. Buchholz, R. P. H. Chang, and J. E. Medvedeva, *Physical Review B* **91**, 205203 (2015).

“*Role of composition in structural properties of amorphous In-based oxides: ab-initio molecular dynamics study,*” R. Khanal,<sup>2</sup> J. E. Medvedeva, *Vacuum*, Special issue on Transparent Coating Materials **114**, 142 (2015) (Front cover).

“*Strong-randomness phenomena in quantum Ashkin-Teller models,*” H. Barghathi,<sup>2</sup> F. Hrahsheh,<sup>3</sup> J.A. Hoyos, R. Narayanan and T. Vojta, *Physica Scripta* **T165**, 014040 (2015).

“*Using geometry to manipulate long-range correlation of light inside disordered media,*” R. Sarma, A. Yamilov, P. Neupane,<sup>2</sup> H. Cao, *Phys. Rev. B* **92**, 180203(R) (2015).

“*Applicability of the position-dependent diffusion approach to localized transport through disordered waveguides,*” P. Neupane,<sup>2</sup> A. Yamilov, *Phys. Rev. B* **92**, 014207 (2015).

“*Critical states embedded in the continuum,*” M. Koirala,<sup>2</sup> A. Yamilov, A. Basiri, Y. Bromberg, H. Cao, T. Kottos, *New J. Phys.* **17**, 013003 (2015).

“*Exploring new aspects and practical applications of capillary guiding of charged particle beams,*” M. Alshammari, K. Alshammari, A. Cudd,<sup>1</sup> R. D. DuBois, and K. Tokési, *Nucl. Instrum. Meth. B* **354**, 20 (2015).

“*Separation of single- and two-center interference in ionization of  $H_2$  by proton impact,*” T. P. Arthanayaka,<sup>2</sup> S. Sharma,<sup>3</sup> B. R. Lamichhane,<sup>2</sup> A. Hasan, J. Remolina,<sup>1</sup> S. Gurung,<sup>2</sup> and M. Schulz, *J. Phys. B* **48**, 071001, Fast Track Communication (2015).

“*Influence of the post-collision interaction on interference effects in ionization of  $H_2$  by proton impact,*” T.P. Arthanayaka,<sup>2</sup> S. Sharma,<sup>3</sup> B.R. Lamichhane,<sup>2</sup> A. Hasan, J. Remolina,<sup>1</sup> S. Gurung,<sup>2</sup> L. Sarkadi, and M. Schulz, *J. Phys. B* **48**, 175204 (2015).

## Medvedeva Invited to Workshop in Japan

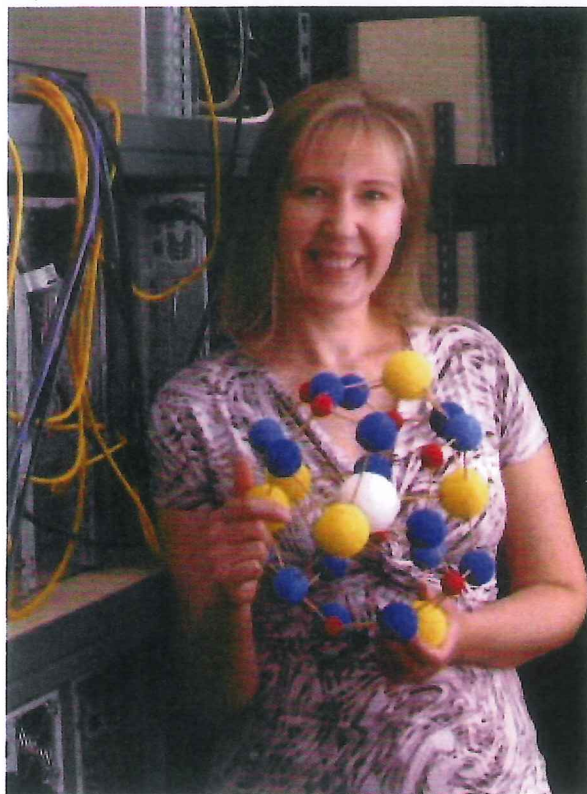
**D**r. **Julia Medvedeva**, an associate professor of physics at Missouri University of Science and Technology, joined a panel of experts at the first “*U.S.-Japan Materials Genome Workshop*” to discuss the best ways to produce low-cost, efficient manufactured products.

The workshop, held June 23-24 in Tsukuba, Japan, brought together an interdisciplinary group of researchers from the United States and Japan to collaborate on ways to use predictive theory and modeling, combined with machine learning and data mining to create industrial products. By developing this collaborative framework, the workshop aims to promote greater research partnerships and a shared database of research materials.

The event featured five keynote speakers and 30 distinguished researchers leading five separate discussion sessions. As an expert in the field of computational condensed matter physics and materials science, Medvedeva was invited to serve on a panel of experts who discussed topics such as materials design and synthesis, data mining, and infrastructure needs for materials development. The event was sponsored by the Japan Science and Technology Agency in collaboration with the National Institute of Standards and Technology, part of the U.S. Department of Commerce, and the National Science Foundation.

“We are trying to create a large database of information to more efficiently create materials,” says Medvedeva. “By using big data and collaborating, not just interdisciplinary-wise but internationally, we hope to bridge the gap between academia and industry to optimize materials research.”

The workshop covered both scientific and engineering challenges in materials, with topics including metals, polymer composites and ceramics. Structural materials that are central to physical infrastructure and have potential applications in aerospace and power generation were also discussed.



“There is a lot of interest not just in the U.S. or Japan, but around the world in expanding researcher toolsets and broadening the distribution of research results,” says Medvedeva. “This is part of the Material Genome Initiative of the White House – ‘to discover, develop and deploy new materials twice as fast,’ and Dr. **Lloyd Whitman**, assistant director of nanotechnology in the Office of Science and Technology Policy, is excited about the workshop. It is a great opportunity to find new research partners and learn how researchers can better share results.”

## Phonathon 2016

**L**ast year's Phonathon continued a trend of increased giving from our alumni. Phonathon donations have nearly doubled in the past five years, and your dedication and generosity has allowed us to increase teaching laboratory capacity by up to 50%.

In addition, your donations help make it possible to continue to attract quality undergraduate and graduate students in our department. Currently we have approximately 80 undergraduates and 30 graduate students, and we have a goal of growing these numbers to 90 and 40 respectively by 2020. Every dollar

you can give for scholarships and graduate fellowships will greatly assist the department in its aggressive recruitment plan, and will be greatly appreciated.

Alumni and other donors committed \$44,759 in donations to the MSM-UMR-Missouri S&T Physics Department last year. Last year's fundraising Phonathon raised \$42,251 with an average gift of \$335 from 126 donors. The department greatly appreciates your generosity, which helps to support scholarships and student activities like the Society of Physics Students.

## Frontiers in Physics Colloquium Series

The Spring 2015 *Frontiers in Physics Colloquium Series* was coordinated by Professor **Julia Medvedeva**. The series began with a talk on “*Filling the world with new light: Physics Nobel Prize 2014*” by Professor **Thomas Vojta** from our own department.

The February colloquia were presented by candidates interviewing for a Physics faculty position offered under the focused hiring campaign in “*Enabling Materials for Extreme Environments*.” **Aleksandr Chernatynskiy** from the University of Florida gave a talk on “*Thermal transport at extreme environments from atomistic simulation*,” and **Handan Yildirim**, from Purdue University, followed with his presentation “*Atomistic scale modeling of materials for applications in electrochemical energy storage*.” The third candidate, **Liping Yu** from the University of Colorado-Boulder, discussed “*Computational design of new materials for energy applications from first principles*.”

In March, **Ian Ferguson**, representing S&T's College of Engineering and Computing, spoke on “*Beyond nano: spinning; dazed and confused!*”

During April, **Mark Lusk** from the Colorado School of Mines described “*Energy pooling upconversion in organic molecular systems*,” **Claudia Ojeda-Aristizabal** from the University of California-Berkeley lectured on “*Graphene: quantum phenomena and layered heterostructures*,” and **Heng Pan** from S&T's Mechanical Engineering department reported on “*Electronics manufacturing with laser processing of nanoscale materials and fundamentals*.”

The Spring Colloquium Series concluded in May with poster presentations by undergraduate Physics majors at the Forty-Fourth Annual **Harold Q Fuller Prize Colloquium**. Details of the Fuller competition appear in a separate article on page 15.

## Vojta Visits Brazil

Faculty member **Thomas Vojta** spent 4 weeks lecturing and researching in Brazil, funded by a travel grant from the Brazil-U.S. Exchange Program sponsored by the Sociedade Brasileira de Física and the American Physical Society. He first spent two weeks at the Federal University of Minas Gerais in Belo Horizonte and after that two weeks at the Institute of Physics in Sao Carlos.

At both universities, Thomas delivered a lecture series on “Phases and phase transitions in disordered quantum systems.” He also started a new research collaboration with **Ron Dickman** in Belo Horizonte and continued his work **José Hoyos** in Sao Carlos.

Of course, the trip would not have been complete without some hiking in the mountains. Thomas spent a weekend exploring the many waterfalls of the Serra da Canastra National Park, including the famous 800 Ft high Casca d'Anta (pictured to the right).

Professor **Ulrich Jentschura** took charge of the *Frontiers in Physics* series for the Fall 2015 semester. **John Rogers** from the University of Illinois, Urbana-Champaign kicked off the semester with “*Semiconductor nanomaterials for transient electronics and 3D circuits*.” John is the son of an Dr. **John R. and Patty Rogers**, who sponsor an endowed scholarship for academically proficient physics majors. The Physics Department was honored by a visit from both son and parents.

In October, **Peter Mueller** of Argonne National Laboratory presented “*Searching for 'New Physics' at the micro-Kelvin Scale*” and **Fateme Rezaei**, from S&T's Chemical and Biochemical Engineering department, reviewed “*CO<sub>2</sub> capture on amine-functionalized polymer hollow fiber sorbents in rapid temperature swing adsorption*.”

We heard from three speakers in November. **Giovanni Vignale**, Curators' Professor at the University of Missouri-Columbia, presented “*Many-body effects in graphene*,” our own Thomas Vojta described the work that led to the 2015 Nobel Prize in Physics, and **Bernold Feuerstein**, of the European Severe Storms Laboratory/MPIK, Heidelberg, told us about “*Tornado and severe weather research in Europe*.” We learned that they have tornadoes in Europe too!

Frontiers in Physics 2015 concluded in December with a talk by **Paul Rulis** of the University of Missouri-Kansas City on “*Amorphous molecular solids: modeling and fabrication challenges*,” and finally with presentations by five finalists at the Twenty-Second Annual **Laird D. Scheerer Prize Competition**. Details of the Scheerer competition are in the article on page 14 of this newsletter.



## 22<sup>nd</sup> Annual Schearer Prize Competition

The Twenty-Second Annual *Laird D. Schearer Competition for Graduate Research*, established by the family of Dr. **Laird D. Schearer** to recognize research performed by a graduate student, was held on December 10, 2015.

The annual competition is held in memory of Laird Schearer, the department's first Curators' Professor of Physics. In keeping with Professor Schearer's longtime interest in enhancing the quality of research performed at the university, the Schearer Prize rewards graduate students of the Department of Physics for outstanding research performed during the course of their graduate study.

The 2015 Schearer Prize Committee, Professors **Aleksandr Chernatynskiy**, **Daniel Fischer**, **Paul Parris**, chaired by **Cihan Kurter** selected five finalists who gave oral presentations about their work in a departmental colloquium. The finalists this year were **Esam Ali**, advised by Professor **Don Madison**; **Hatem Barghathi**, advised by Professor **Thomas Vojta**; **Thusitha Arthanayaka**, advised by Professor **Michael Schulz**; **Jonathan Noble**, advised by Professor **Ulrich Jentschura**; and **Seng Huat (Sam) Lee**, advised by Professor **Yew San Hor**.

During the colloquium on December 10, Mr. Ali discussed "*Ionization of aligned molecules by electron-impact*," Mr. Barghathi talked on "*Contact process on generalized Fibonacci chains: infinite-modulation criticality and double-log periodic oscillations*," Mr. Noble presented "*High energy tachyons are attracted by gravity*," Mr. Lee described "*Detection of 2D Dirac electron in  $Fe_xBi_2Se_3$  magnetic topological insulator*," and Mr. Arthanayaka talked about "*Fully differential study of projectile coherence effects in atomic fragmentation processes*." All students gave excellent talks.

After considering the finalists' contribution to the research, knowledge of the area and presentation effectiveness the committee awarded first prize and \$1000 to Jonathan Noble, and second prize and \$500 to Hatem Barghathi. The Schearer Prize committee would like to congratulate Jonathan and Hatem on the excellent quality of their oral presentations and thank all five finalists for participating in the Schearer Prize competition. The cash awards were made possible by the generous donations of the Schearer family. Following the presentations, the finalists and numerous faculty members had a wonderful dinner at a local restaurant.

### Alumni Notes

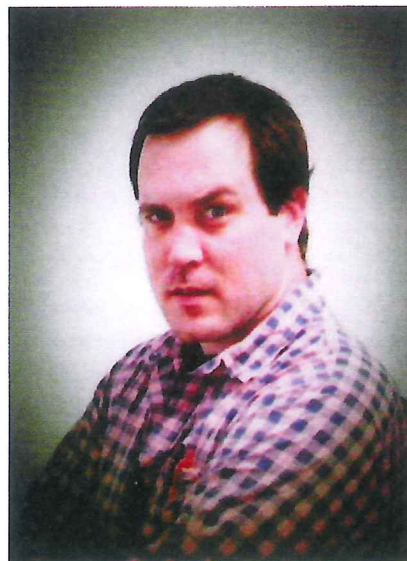
We need your stories to liven up our newsletter!

Please send us your stories, pictures, and musings for our 2017 newsletter. The best way to do this is by email to [physics@mst.edu](mailto:physics@mst.edu).

### From Schearer Prize Winner Jon Noble

The Twenty-Second annual Schearer Prize Competition was held a few short weeks before my graduation ceremony, and was probably the last big thing I did as a student. And I won. I think it was awesome that I was able to end a lifetime of being a student on such a high note.

In my research I found that, contrary to the classical result, in the high energy limit, tachyons (particles traveling faster than the speed of light) are attracted by gravity. To obtain this result we draw inspiration from the Foldy—Wouthuysen transformation and develop the ultrarelativistic decoupling transformation. We then apply this transformation to the gravitationally coupled Dirac equation for a superluminal particle. The resulting transformed Hamiltonian clearly shows this surprising result.



Allow me to wrap all this up by acknowledging a number of people, starting with the other participants in the 22<sup>nd</sup> Annual Schearer Prize Competition; each of you did an amazing job and gave a fantastic talk. To the prize committee: that must have been an incredibly difficult decision, and I thank you for providing the platform for presenting my research. I'd also like to thank the Schearer family for making this competition possible. It is an awesome opportunity for us, as students, to practice giving talks about our work; one that I took advantage of on three occasions. Thanks to all of the faculty and staff here in the physics department for teaching, advising, helping, and generally putting up with me. Last, but certainly not least, let me thank my thesis advisor, Dr. **Ulrich D. Jentschura**, for all his guidance.

## Faculty Notes

**Ulrich Jentschura** was promoted to Professor of Physics in 2015. Ulrich was also selected to receive a 2015 Faculty Research Award.

Congratulations to **Thomas Vojta** who has been elected a Fellow of the American Physical Society!

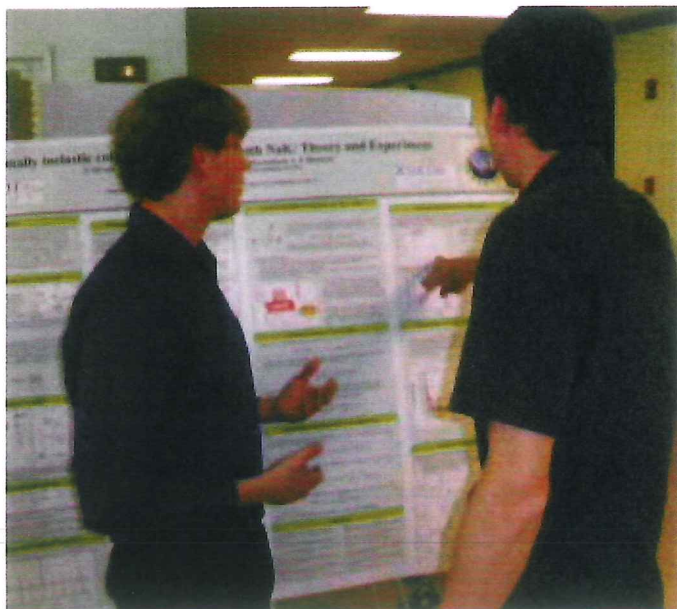
The last three articles reporting the research coming out of Missouri S&T's Laboratory for Atomic, Molecular and Optical Research, directed by professor **Michael Schulz**, were highlighted in one form or another (invited labtalk, interview in J Phys+, invited video abstract) by the Journal of Physics B, where they were published.

In addition, Michael was recently featured on the Journal of Physics website for his J. Phys. B journal article "*Influence of the post-collision interaction on interference effects in ionization of  $H_2$  by proton impact.*" In an interview for this feature, he answers questions about his research, what problems science needs to solve, and his advice for young scientists. The interview is published here: <http://goo.gl/HgZfHm>.

Michael was also awarded the "*President's International Fellowship for Visiting Scientists*" by the Chinese Academy of Sciences.

Congratulations to Thomas Vojta, **Paul Parris**, and **Barbara Hale** who received S&T Outstanding Teaching Commendations for 2014-2015.

**Julia Medvedeva** received the 2015 *Gilbert R. Speich Award* from the Association for Iron and Steel (AIST). The award is presented to the author of a physical metallurgy technical paper judged to be the best of class by the AIST. Julia co-authored the paper "*Developing a third-generation advanced high-strength steel with two-stage TRIP behavior.*"



## 44<sup>th</sup> Annual Fuller Research Seminar

**N**ine undergraduate students presented posters about their research projects at the 44<sup>th</sup> annual **Harold Q Fuller Undergraduate Research Competition**, held on April 30, 2015.

The posters were judged by the Fuller Prize Committee, Dr. **Daniel Fischer** and Dr. **Barbara Hale**, chaired by Dr. **Cihan Kurter**.

The Fuller Awards are given to the students whose projects are judged to be the most outstanding on the basis of accomplishment, presentation, and response to the questioning of the judges. The presenters were **Alexander Mark**, **Paul Somers**, **Brandon Yokeley**, **Josey Stevens**, **Nocona Sanders**, **Tyler Jacquin**, **Jason Mao**, **Mat Pollard**, and **Nicholas Spitznagel**.

The four research projects were "*Creation and analysis of thin film  $MoSe_2$ ,*" by Alexander Mark, Paul Somers, Brandon Yokeley, advised by Dr. **Yew San Hor**; "*Investigation of rotationally inelastic collisions between NaK and helium,*" by Josey Stevens, a summer research project advised by Dr. **A. Peet Hickman** of Lehigh University; "*Role of stoichiometry and chemical composition in the properties of amorphous indium-based oxides*" by Nocona Sanders, advised by Dr. **Julia Medvedeva**; and "*Wave motion in a restoring medium as a classical analogue to the Higgs mechanism,*" by Tyler Jacquin, Jason Mao, Mat Pollard, Nicholas Spitznagel, advised by Dr. **Greg Story**. The judges commented "We have been extremely impressed by your work...we applaud your efforts!"

Josey Stevens was awarded first place and received a \$400 prize. The other three posters were judged very impressive and were each awarded second place, with a \$200 prize going to each of the competing teams. Congratulations to the winners!



Above: *Mat Pollard (facing camera)*

Left: *Josey Stevens talking to Daniel Fischer*

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### So What's News with You?

We hope you enjoyed this year's edition of **Matter 'n Motion**. We enjoy keeping you informed about what is going on at Missouri S&T, but we'd also like to know what's new with you, both personally and professionally. Any information you send will be circulated in the department and, if appropriate, inserted in the next physics newsletter unless you request otherwise.

Please print or type your information, and include your mailing address so that we can update our records. Mail to: **Physics Department, Missouri University of Science and Technology, 1315 N. Pine St., Rolla MO 65409-0640**. Or, if you would prefer, you can e-mail us your comments at **physics@mst.edu**. Thanks for keeping in touch. It's always good to hear from old friends.

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