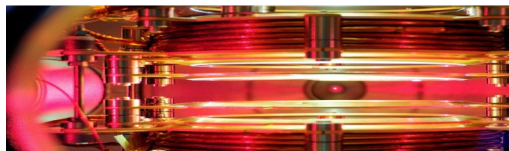


Matter 'n Motion

January 2022



Missouri University of
Science and Technology
PHYSICS DEPARTMENT

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



Michael Schulz Retires



In September, the physics department celebrated the retirement of Curators' Distinguished Professor **Michael Schulz** after 31 years at the university. Over the course of his career, he wrote more than 150 journal articles, mentored 16 PhD students and won grants totaling more than \$4.5 million.

Michael will continue to teach part-time and keep the accelerator laboratory going. We thank him for his years of service and wish him the best in his future endeavors.

Pam Crabtree Celebrates 30 Years



We celebrated **Pam Crabtree's** 30th Anniversary with the Missouri S&T in September. Pam joined the physics department in 1991 as a secretary and has been the lead administrative staff member since 2012. During her time at UMR/Missouri S&T, she has worked with 5 chairman, 7 chancellors, over 500 graduate students and too many undergraduates to count.

Pam truly is the backbone of the physics department!

Memo from the Chair

The year 2021 was another challenging one overshadowed by the Covid-19 pandemic. During the spring semester, the campus operated under social distancing requirements and occupancy limits in the classrooms. The resulting hybrid classes in which a few students attended in person while the rest participated online via Zoom were tough for students as well as teachers. We returned to full classrooms and a resemblance of normal campus life for the fall semester.

2021 also brought significant changes to the physics department. As you may have seen on the front page, Prof. **Michael Schulz** retired in August after 31 years in the department including 15 years as a Curators' Distinguished Professor. I would like to thank Michael for his dedication to the department and wish him all the best for the future. For now, he will continue researching and teaching part-time as a Chancellor's Professor. The department also said goodbye to Prof. **A.T. Le** who left Missouri S&T to move to Connecticut. We were sad to see him leave but happy that he was able to move closer to his children.

I am happy to report that, after years of faculty losses, we are welcoming two new colleagues this year. Profs. **Halyna Hodo-vanets** and **Hyunsoo Kim** are both condensed matter experimentalists. Halyna will be growing crystals for novel quantum materials, and Hyunsoo will investigate the properties of quantum materials at temperatures near absolute zero. Read more about Halyna and Hyunsoo elsewhere in this newsletter.

In September 2021, the department celebrated **Pam Crabtree's** 30 year work anniversary. She joined the physics department of what was then the University of Missouri-Rolla in September 1991. Our department would not run without Pam, and I hope she stays another thirty years.

Despite the challenges, the physics faculty continue to be successful in their teaching and research endeavors. Prof. **Alex Chernatynskiy** was promoted to Associate Professor with tenure, and Prof. **Alexey Yamilov** to Full Professor. Prof. **Julia Medvedeva** is part of a \$2 million project on solar cells funded by the US Department of Energy. She also received a major National Science Foundation grant, as did Profs. **Ulrich Jentschura** and **Thomas Vojta**. Prof. **Ulrich Jentschura** completed an 800-page monograph on quantum electrodynamics.

Prof. **Alex Chernatynskiy** received a Teaching Award from the college. Prof. **Julia Medvedeva** won a campus Faculty Research Award, Prof. **Greg Story** received his 19th Outstanding Teaching Award, and Prof. **Agnes Vojta** won a campus Faculty Achievement Award. Prof. **Ulrich Jentschura** was elected a Full Member of Sigma Xi, The Scientific Research Honor Society. Profs. **Marco Cavaglia**, **Yew San Hor**, **Ulrich Jentschura**, **Julia Medvedeva**, and **Thomas Vojta**, as well as emeriti **Bob Dubois**, **Don Madison**, and **Ron Olson** were listed in a database featuring the top 2% researchers in their field.

The enrollment in our department's undergraduate and graduate programs continues to be healthy. We have currently about 80 undergraduates and 27 graduate students. Just like last year, we managed to attract top new students including National Merit finalists **Jason Thurow** and **Andrew Sante**. In 2021, 13 students graduated with a B.S degree, and 7 students received a Ph.D. degree. Two of our undergraduates, **Steven Karst** and **Anthony Lonsdale**, won prizes at the 2021 S&T Undergraduate Research Conference. Two of our graduate students established a Women in Physics group with a grant from the APS. These and more stories about the success of our students can be found in this newsletter.

As always, I would like to close by thanking our alumni and friends for their dedication and generous donations without which the department's success in teaching, research, and service would not be possible. I know that we can count on your continuing support. Thank you very much!

Please keep in touch! I hope that 2022 is the year we leave the pandemic behind so that you can visit us in Rolla to see the exciting things happening in the physics department and to tell us what you have been doing since graduation.



Thomas Vojta

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, contact the Office of Development at 1-800-392-4112 or email giving@mst.edu.

Physics Department Awards 2021-2022 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** recipients were **Gabriel Riddle** from Kidder, MO; **Samuel Hunt** from Weatherby, MO; and **Kathryn Zychinski** from Saint Louis, MO.

The **John L. & Betty L. McDaniels Scholarship** was awarded to **Colton Helms** from Fredericktown, MO.

The **Gerrie Fletcher Endowed Scholarship in Memory of Dale Shull** was awarded to **Kaylee Denbo** from Rolla, MO.

The **Richard Anderson Scholarship** recipients were **Mason Toombs** from Arnold, MO and **Zachary Szatkowski** from Saint Louis, MO.

Recipients of the **Harold Q Fuller Scholarship-Loan** were **Andrew Niiro** from Hermann, MO and **Cole Rischbieter** from Barnhart, MO.

The recipients of the **Burke H. Miller Memorial Scholarship** were **Winston Penrod** from Kansas City, MO and **Jordan Stevens** from Bonne Terre, MO.

The **Ed and Mary Sue Sickafus Endowed Scholarship/Fellowship** was awarded to **Sean Anderson** from Warrensburg, MO; **Steven Karst** from Ballwin, MO; **Charles Kropp** from Chesterfield, MO; **Chase Lenahan** from Joplin, MO; **Keith Miller III** from Malden, MO; **Zachary Miller** from Saint Peters, MO; **Emily Richardson** from Saint Peters, MO; **Nicholas Theodorou** from Saint Louis, MO; and **Kathryn Zychinski** from Saint Louis, MO.

The **Richard W. Hannum Endowed Development Fund** recipient was **Mcgowan Toombs** from Arnold, MO.

The recipients of the **Leon E. Woodman Memorial Scholarship** were **Reece Beattie-Hauser** from Wildwood, MO and **Andrew Janes** from O'Fallon, MO.

The **Allan Pringle Endowed Scholarship** recipient was **Mason Labrot** from Park Hills, MO.

Pringle Miner MO Merit Match Money was awarded to **Sean Anderson** from Warrensburg, MO; **Reece Beattie-Hauser** from Wildwood, MO; **Joshua Dalton** from Saint Charles, MO; **Colton Helms** from Fredericktown, MO; **Andrew Janes** from O'Fallon, MO; **Steven Karst** from Ballwin, MO; **Charles Kropp** from Chesterfield, MO; **Chase Lenahan** from Joplin, MO; **Zachary Miller** from Saint Peters, MO; **Keith Miller III** from Malden, MO; **Andrew Niiro** from Hermann, MO; **Winston Penrod** from Kansas City, MO; **Emily Richardson** from Saint Peters, MO; **Cole Rischbieter** from Barnhart, MO; **Jordan Stevens** from Bonne Terre, MO; **Zachary Szatkowski** from Saint Louis, MO; **Nicholas Theodorou** from Saint Louis, MO; **Mason Toombs** from Arnold, MO; **Mcgowan Toombs** from Arnold, MO; and **Kathryn Zychinski** from Saint Louis, MO.

The **Physics Scholarships for Academic Access** recipients were **Jose Padron** from Springfield, MO and **Paul Haynes** from Saint Charles, MO.

DONATIONS 2021

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 27 graduate students, and we have a goal of growing these numbers in 2022. 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.

In addition, your continued generosity has allowed us to increase teaching laboratory capacity by up to 50%.

Last year's fundraising raised \$15,425 from 81 donors.

We greatly appreciate your generosity in helping us support scholarships and student activities such as the Society of Physics Students.

Congratulations to 2021 Physics Degree Recipients

May 2021

Bachelor of Science

James C. Bearden
Joseph Lee Franz
Samuel Ian Halladay
Jodie K Hermann
Taylor J Lindenbusch
Joshua Riley Macchler
Nicholas J Razo
Elijah D Stafford
Seth William Stubblefield

Doctor of Philosophy

Kentaro Mogushi
Mohammad Saki
Chathuri Chandani Silva



Top left to right: James Bearden, Joseph Franz, Samuel Halladay; bottom left to right: Jodie Hermann, Elijah Stafford, Seth Stubblefield.

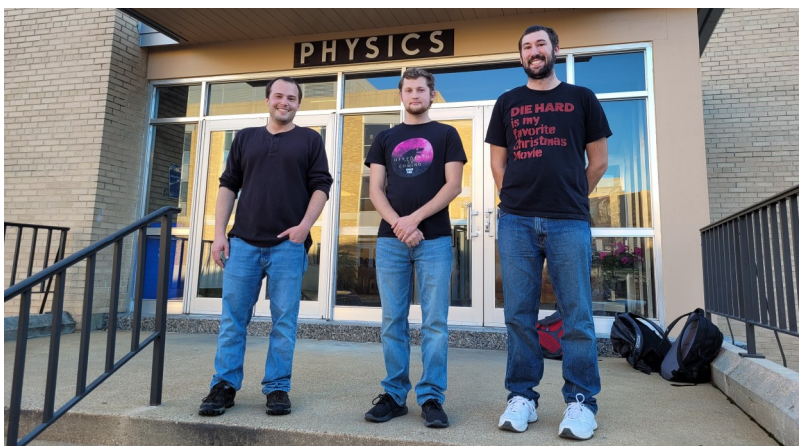
December 2021

Bachelor of Science

Zachary Driemeyer (Aug)
Noah Baden
Joshua Dalton
Brock Hinton
Ethan Hisle

Doctor of Philosophy

Bishnu Acharya
Dripta Bhattacharjee
Philip Chrostoski
Stephen Walter Ordway



Left to right: Brock Hinton, Ethan Hisle, and Joshua Dalton.

Congratulations to the 2021 Physics Academic Scholars

Students who maintained at least a 3.50 GPA for twelve hours or more of coursework

Spring 2021: Sean Thomas Anderson, James C. Bearden, Reece Beattie-Hauser, Joseph Franz, Samuel Ian Halladay, Jodie K. Hermann, Ethan Hisle, Steven Raymond Karst, Charles Benjamin Kropp, Mason Thomas Labrot, Chase Lenahan, Taylor J. Lindenbusch, Avery Jordan Lyons, Keith Edward Miller III, Matthew B. Miller, Zachary Angelo Miller, Emily K. Richardson, Brandon Clovis Robinson, Jordan B. Stevens, Seth William Stubblefield, Zachary Daniel Szatkowski, Nicholas G. Theodorou, Mason Toombs, McGowan Turner Toombs, Kathryn Grace Zychinski

Fall 2021: Zachary N. Alton, Harold Joseph Baker, Reece David Beattie-Hauser, Erin M. Brady, Benjamin A. Brown, Kenzie Lynn Byrum, Michael Patrick Colletti, Joshua N. Dalton, Colton A. Helms, Ethan Hisle, Samuel Hunt, Elias Chalmer Hyatt, Andrew Calvin Janes, Gavin Nathaniel Jones, Steven Raymond Karst, Charles Benjamin Kropp, Mason Thomas Labrot, Logan Richard Lorts, Dillon P McNamara, Keith Edward Miller III, Zachary Angelo Miller, Amelia Nora Nenninger, Huy Q Nguyen, Andrew Kozo Arthur Niir, Kristin Malinda Nyenhuis, Ethan Nguyen Pham, Gabriel Riddle, Cole R. Rischbieter, Joshua M. Santy, Samuel David Schrader, Kshitij Sharma, Jordan B. Stevens, Nicholas G. Theodorou, Jason Frederick Thurow, Jeppe Pagaard Thybo, Mason Toombs, McGowan Turner Toombs, Landon B. Viers, Kathryn Grace Zychinski

Meet New Faculty: Hyunsoo Kim and Halyna Hodovanets



We welcomed two new assistant professors who are starting in January 2022. **Dr. Hyunsoo Kim** and **Dr. Halyna Hodovanets** are both condensed matter experimentalists joining us from Texas Tech University.

Dr. Kim received his PhD from Iowa State University and DOE Ames Laboratory. He was as postdoctoral research associate at the University of Maryland-College Park before joining the faculty of Texas Tech as a Research Assistant Professor. His current research activities focus on quantum materials research and low-temperature experiment by utilizing various techniques including transport and thermodynamic. He hopes to utilize quantum matters such as topological insulators and superconductors to the new information technology that includes quantum devices and quantum computers.

Dr. Hodovanets received her PhD from Iowa State University, did postdoctoral training and was promoted to Assistant Scientist at the Maryland Quantum Materials Center at the Department of Physics, University of Maryland. Before joining us, she was an Assistant Professor at Texas Tech.

Her research interests are the synthesis and discovery, characterization, and optimization of novel quantum materials in a single crystalline form. She investigates exotic electronic and quantum states of matter that are realized in quantum materials and can be tuned with chemical substitution, magnetic field, or application of pressure.

The couple have two sons: Richard was born in Iowa and Harry was born in Maryland. We welcome their family to our department.

Julia Medvedeva Improves Solar Cells

Dr. Julia Medvedeva received funding from the Department of Energy to improve solar cells. Julia works alongside researchers from Arizona State University, University of California San Diego, National Renewable Energy Laboratory, and Hanwha Q-CELLS company to study the role of hydrogen in the performance and long-term stability of high-efficiency silicon solar cells and modules. The \$2 million project has received funding from the Office of Energy Efficiency and Renewable Energy at the US Department of Energy for three years. The lead investigator of the project, Professor Mariana Bertoni from ASU, is a long-time collaborator of Julia.



The Yamilov-Medvedeva family visiting Dr. Mariana Bertoni's lab at Arizona State University in 2018.

Despite high levels of conversion efficiency of over 25%, silicon heterojunction and other Si-based solar cell architectures show degradation issues that have been linked to hydrogen incorporation and defect kinetics during cycles of device operation.

In close collaboration with growth and characterization experimentalists, Julia will perform ab-initio modeling to determine the structural and electronic properties of hydrogen-related defects at the interfaces between amorphous silicon and transparent conducting oxide layers and will develop the fundamental understanding behind evolution of hydrogen under external stressors intrinsic to photovoltaic operation (such as temperature and light) as a function of hydrogenation conditions.

Ulrich Jentschura Has another Successful Year

In 2021, Dr. **Ulrich Jentschura** finished a book project with colleague Greg Adkins from Franklin and Marshall College in Lancaster, Pennsylvania that had been in the making for 15 years. The 808-page book titled “Quantum Electrodynamics: Atoms, Lasers, and Gravity” will be published by World Scientific, one of the world’s leading publishing houses in science.

Ulrich was elected a Full Member of Sigma Xi, The Scientific Research Honor Society, for noteworthy achievements as an original investigator in a field of pure or applied science. Sigma Xi has been a cornerstone of academic support of students in the U.S. for decades. Ulrich is in the good company of Albert Einstein and Enrico Fermi, who were members of the same honor society.

Another highlight of the year was that one of Ulrich’s recent collaborators, Professor Giorgio Parisi from Rome, received the Nobel Prize. With Giorgio Parisi and Jean Zinn-Justin from CEA Saclay, Ulrich studies methods to overcome the predictive limits of perturbative quantum field theory on the basis of so-called large-order expansions. In the 1950s, physicists Richard Feynman and Sin-Itiro Tomonaga developed mathematical methods to describe the interactions of quan-

Quantum Electrodynamics: Atoms, Lasers and Gravity

Ulrich D. Jentschura and Gregory S. Adkins

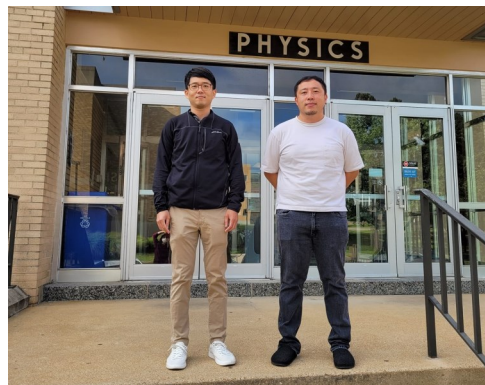


[Picture by the authors. Taken in Switzerland (Canton Wallis).]

tum fields (for example, the interaction of a bound electron’s quantized radiation field onto the energy levels) using Feynman diagrams. However, once the order of perturbation theory is increased, the Feynman diagram calculations become much more involved, with diminishing returns. The new approaches come from the other side because, counter-intuitively, Feynman diagram calculations become easier at infinite order of perturbation theory. Ulrich’s calculations could lead to better predictions for critical exponents of phase transitions which describe, among other things, the behavior of the specific heat of helium when it becomes superfluid.



Yi-Kuan Chiang Visits Shun Saito



Dr. **Yi-Kuan Chiang** visited from Ohio State to work on research with Dr. Shun Saito and to present a colloquium.

Chandra Adhikari

Former graduate student, Dr. **Chandra Adhikari** (PhD 2017), has accepted a faculty position at Fayetteville State University. Congratulations!!



Report from the SPS

The year 2021 in SPS was certainly an eventful one, given the adjustment of student life to the pandemic. Despite that, our organization was able to make a return to some semblance of normalcy. In the spring semester, we held regular virtual meetings and returned to in-person meetings in the fall.

I would also like to thank the SPS officers that helped get us through the year. Spring semester, officers were Vice President Sean Anderson, Secretary Cole Rischbieter, and Treasurer Talon Clay. In the fall semester we had Vice President Logan Sowadski, Secretary-Nicholas Theodorou, Treasurer Jacob Thiel and Historian Dillon McNamara. Zachary Miller, was President for both semesters.

Given the pandemic restrictions in the spring semester, very little of note occurred in the organization beyond presentations from the nuclear, physics and mathematics departments. However, with the return to in-person meetings in the fall, SPS membership was finally able to grow as a new wave of freshmen and sophomores joined the organization and we had more opportunities to connect with each other socially.

I look forward to seeing SPS recover from the pandemic and return as the bastion for all students interested in physics.

Zachary Miller

Promotions



Dr. **Aleksandr Chernatynskiy** was promoted to Associate Professor with tenure. Dr. **Alexey Yamilov** was promoted to Full Professor. Congratulations to both!

New Telescope for Observatory Donated by Joseph Marcus



The physics department is very grateful to **Dr. Joseph Marcus** for the donation of a 10-inch cave telescope for use in outreach activities, research, and demonstrations.

Faculty member Marco Cavaglia and graduate student Dripta Bhattacharjee rented a U-haul truck and traveled to St. Louis to retrieve the 10-inch Cave Astrola Newtonian. They hauled it back to Rolla where it now resides in the Observatory.

Dr. Marcus calls it the “Slaton-Cave” telescope. The telescope had been significantly upgraded by Jon Slaton, a past member of the St. Louis Astronomical Society (SLAS).

The picture shows Dr. Marcus, Dripta, and Dr. Cavaglia (left to right) in Dr. Marcus’ garage, picking up the instrument.

We hope that we can go back to regular public viewing nights at the observatory this year!

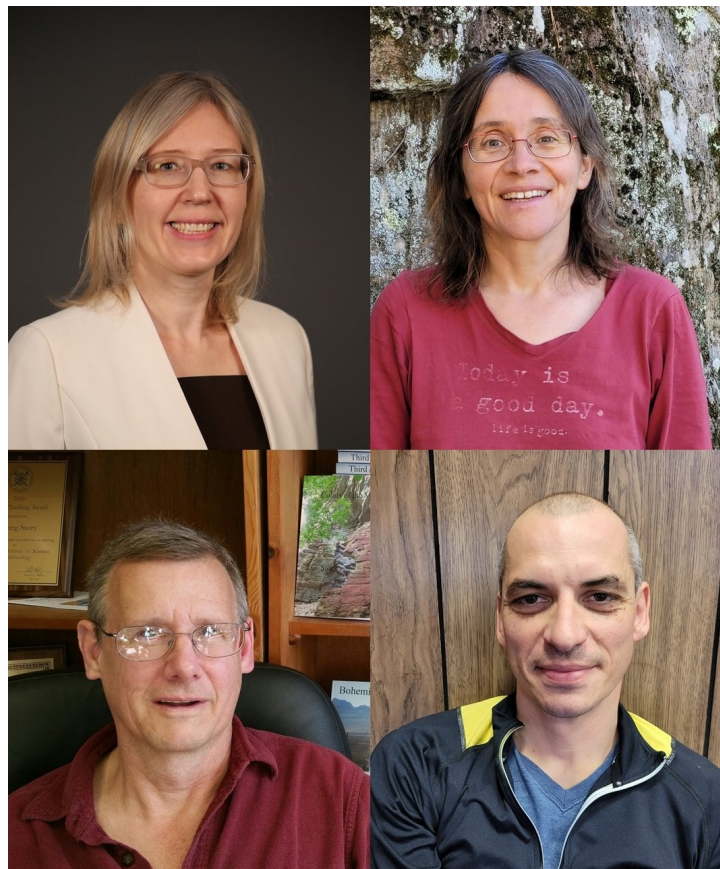
Faculty Awards

Julia Medvedeva (top left) received a 2021 campus Faculty Research Award, recognizing faculty members who have demonstrated excellence in research and scholarship during the last two years.

Agnes Vojta (top right) received a 2021 campus Faculty Achievement Award. This award recognizes non-tenure track faculty who have demonstrated sustained excellence in teaching or research or service, or a combination thereof.

Alex Chernatynskiy (bottom right) won a 2021 College of Arts, Sciences, and Business Teaching Innovation Award which honors innovations in teaching by CASB faculty.

Greg Story (bottom left) received his 19th Outstanding Teaching Award given by the Committee for Effective Teaching based on student evaluation scores.



Women in Physics Group Established

PhD students **Dripta Bhattacharjee** and **Yanyan Zheng** won a Women in Physics Group Grant from the American Physical Society to establish a Women in Physics Group at Missouri S&T. WiP@MST is a student organization aimed at encouraging more women to pursue a career in physics. Projects include journal club sessions, graduate student talks, outreach activities, and social events. **Marco Cavaglia** serves as the faculty advisor of the group.



The Women of Physics Group organized an event featuring **Astronaut Sandra Magnus** ('86 physics alumna, center). Thanks Sandra for visiting the department!!



The Missouri S&T Women in Physics held their first Journal Club meeting at the park welcoming new women students to the department.

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

CORPORATE:

Baker Hughes
Boeing Company
Shell Oil Foundation

Donations under \$100:

Bruce C. Anderson
Derek Anderson
Dwight Carmichael
Madhav Dhital
Sarah Elizabeth Eyermann
Patricia L. Huestis
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Carolyn R. Johnson
Jerry G. Johnson
J. Daniel Jones
William A. Lindgren
Havva Malone
Steven A. Mezines
Scott Miller
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Charles Williams
Gary G. Wooley

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Gary D. Bickel
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George Caudle
Daniel Chitwood
George A. Colgrove
Delmar A. Dobberpuhl

Donations \$100-\$249 (cont.):

Kevin B. Edwards
Suzanna Edwards
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Arthur L. Nickless
Daniel Payton III
Andrew Richard Prideaux
Kathy A. Rages
Carrie L. Rule
Ryan Rule
Gary S. Sammelmann

Donations \$100-\$249 (cont.):

Gary K. Woodward
John J. Zenor
Wei Zhao
James G. Smith
Robert Stovall
Robert E. Thurman

Donations \$250-\$499

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Donations \$500-\$999

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Michael Noble
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Nancy Stepp
Gregory E. Upchurch

Donations \$1,000 -\$2499

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Ulrich D. Jentschura
Gary S. Kovener
Kevin Moll
Charles W. Myles
Donald Packwood
Agnes Vojta
Thomas Vojta
Gerald Wilemski

Donations \$2500 and over

WinWin Than
Padetha Tin
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 \$25,000 and additional funds can be added at any time in the future.

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, John and Patty Rogers, John and Betty McDaniels, L.E. Woodman** and by the estates of **Richard Anderson** and **Richard Hannum**. Our most recent endowment was established in memory of **Dr. Oran Allan Pringle**.

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 email giving@mst.edu.

New Graduate Students



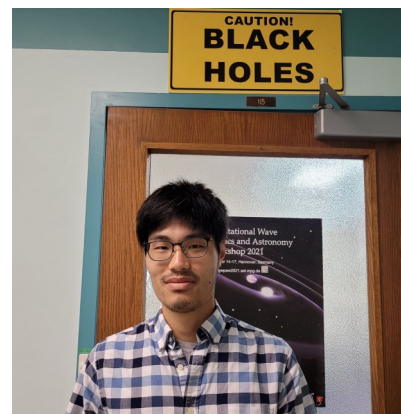
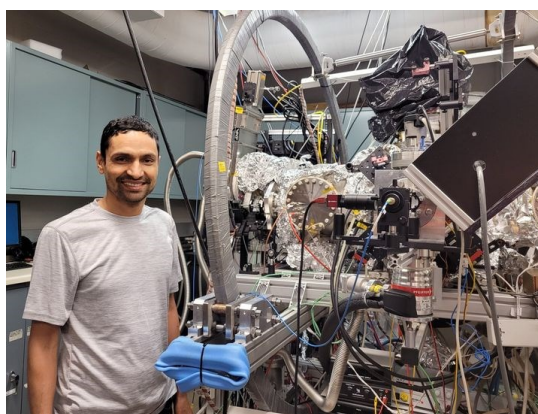
Clockwise from top left: Syeda Nasim, Dylan Ruzbasan, Emma Lockyer, Pablo Jara Palacios.

New Postdoc



Dr. Hasti Khoraminezhad joined our astrophysics group to work with Dr. Saito. Hasti received her PhD from the Scuola Internazionale Superiore di Studi Avanzati (SISSA) in Trieste, Italy.

Three Graduate Students Defend PhD Theses



Congratulations to Bishnu Acharya, Dripta Bhattacharjee and Kentaro Mogushi who successfully defended their PhD theses.

Bishnu Acharya: “Complete experiment on multi-photon ionization of ultra-cold and polarized atoms” (Advisor: Dr. Daniel Fischer). He will start a post-doc position through the National Institute of Standards and Technology (NIST) Professional Research Experience Program in Gaithersburg, Maryland.

Dripta Bhattacharjee: “Reduced calibration uncertainties for the global network of gravitational-wave observations and the impact on sky localization of burst-like sources” (Advisor: Dr. Marco Cavaglia). Dripta continues as a postdoc at Kenyon College.

Kentaro Mogushi: “Improving the data quality in gravitation-wave detectors by mitigating transient noise artifacts” (Advisor: Dr. Marco Cavaglia). Kentaro returned to his native Japan to work for a pharmaceutical company in Tokyo.

Frontiers in Physics Colloquium Series

Physics Colloquium Series in Spring 2021 (some colloquia were held in person and some on Zoom):

Dr. Sarah Morrison (Missouri State University) “Unearthing the formation histories of the inner planets in extrasolar systems”

Dr. Aleksandr Chernatynskiy (Missouri S&T) “Ab initio thermal transport: Boltzmann Transport Equation and beyond”

Dripta Bhattacharjee and Yanyan Zheng (Missouri S&T Graduate Students) “You can be a woman physicist”

Dr. Jeffery S. Hazboun (University of Washington-Bothell) “Searching for Nanohertz Gravitational Waves with a Galactic-Scale Detector”

Dr. Anh-Thu Le (Missouri S&T) “Progress in probing molecular structures with ultrafast intense laser pulses”

Dr. William D. Philips (NIST) “A New Measure: The Revolutionary Quantum Reform of the Metric System”

Dr. Christopher Verhaaren (University of California-Irvine) “A New Force from the ATOMKI Anomalies”

Dr. Eun-ah Kim (Cornell University) “Interpretable Machine Learning of Quantum Emergence”

Dr. Oskar Vafek (National High Magnetic Field Laboratory) “Correlated electron phases in graphene moire structures: reality born in imagination”

Virtual poster session for the 50th Annual Harold Q Fuller Prize Competition

LAMOR Seminar by Dr. Basu Lamichhane “Sterile neutrino search using Heavy Unseen Neutrinos from Total Energy-Momentum Reconstruction (HUNTER)”

Fall colloquium series continued with in-person and Zoom presentations:

Dr. Ulrich Jentschura (Missouri S&T) “Quantum Electrodynamics: Monograph with a Textbook Component”

Dr. Kazunori Akiyama (Research Scientist at Haystack Observatory, MIT) “Photographing Black Holes and Magnetic Fields with the Event Horizon Telescope”

Dr. Halyna Hodovanets (Texas Tech University) “Weyl semimetals: the case of CeAlGe”

Dr. Yi-Kuan Chiang (OSU) “Probing the Cosmic Energy Density Inventory with Tomographic Intensity Mapping”

Homecoming speaker, Dr. Shella Keilholz (Georgia Tech) “Physics on the Brain”

Dr. Carsten Ullrich (Univ. of MO-Columbia) “Excitons: from basic concepts to first-principles theories”

Dr. Patrick E. Hopkins (University of Virginia-Charlottesville) “Ultrafast electron, phonon and infrared polaritonic coupled thermal transport across thin films and interfaces”

Dr. Zohar Nussinov (Washington University) “Are supercooled liquids and glasses related to conventional fluids and solids”

Dr. Thomas Vojta (Missouri S&T) Public Lecture “Hidden patterns in complex systems: The 2021 Nobel Prize in Physics”

28th Annual Laird D. Scheerer Prize Competition

Dr. Kenrick Smith (Perimeter Institute-Canada) “FRB science results from CHIME”

2021 Homecoming Speaker—Shella Keilholz



The Physics Department welcomed back alumna **Dr. Shella Keilholz** (BS 1997) to present the 2021 Homecoming Colloquium in the Physics Department. The title of her talk was “Physics on the Brain”.

After graduating from UMR in 1997, she attended graduate school at the University of Virginia where she was granted a PhD in Engineering Physics in 2001.

Shella spent several years as a postdoc at the NIH in the laboratory of Alan Koretsky. Shella then accepted a faculty position in the joint biomedical engineering department at Emory University and Georgia Institute of Technology. Shella’s work extends using functional MRI to detect networks of activation in the anesthetized rat to develop and characterize functional connectivity mapping with MRI for the rodent. She is currently interested in elucidating the neural underpinning of the signal correlations used to map functional connectivity within brain networks using simultaneous imaging and multisite microelectrode recording. Her other area of focus involves detecting and characterizing the dynamic aspects of network activity in the brain with MRI using novel analysis techniques.

28th Annual Schearer Prize

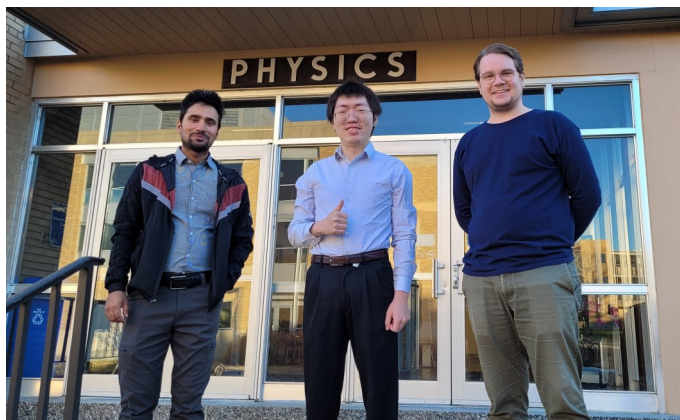
The Twenty-Eighth Annual *Laird D. Schearer Competition for Graduate Research* was held on December 2, 2021.

The competition is held in memory of Laird D. 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 Prize, established by the Schearer family, rewards graduate students of the Department of Physics for outstanding research.

The 2021 Schearer Prize Committee, **Dr. Alexandr Chernatynskiy** (Chairman), **Dr. Daniel Fischer** and **Dr. Shun Saito** (Judges) selected three finalists who gave oral presentations about their work in a departmental colloquium:

- **Sujan Bastola** advised by Dr. Michael Schulz, "*Fully Differential Investigation of Two-Center Interference in Dissociative Capture in $p + H_2$ Collisions*"
- **Jack R. Crewse** advised by Dr. Thomas Vojta, "*Localization of the Higgs mode near the superfluid-Mott glass quantum phase transition*"
- **Xuecheng Ye** advised by Dr. Thomas Vojta, "*Stripe order, impurities, and symmetry breaking in a diluted frustrated magnet*"

The committee awarded a first place (\$600) to Jack Crewse. Second place (\$400) was awarded to both Sujan Bastola and Xuecheng Ye. The cash awards were made possible by the generous donations of the Schearer family.



Sujan Bastola, Xuecheng Ye and Jack Crewse (left to right).

From the Schearer Prize Winner

As I am nearing the end of my Ph.D process, being honored as the Schearer Prize winner feels especially significant. The work presented is a culmination of all the time and energy that has been poured into my PhD work both by myself and others who have supported me along the way. I thank my advisor, Thomas Vojta, who has not only provided me with the support and guidance necessary to study such subject matters, but also the tools necessary to communicate it clearly and concisely. I also want to thank the faculty of the physics department in general for mentorship, motivation and inspiration. Lastly, but certainly not least, I must thank my loving wife Shay, for the seemingly infinite support she has provided me in these long years of research.

The work I presented in this year's prize investigates the 'Higgs' mode near the superfluid-Mott glass quantum phase transition. Recent experiments in superconductors, ultra-cold lattice bosons, and antiferromagnetic systems has spurred interest in the Higgs mode, the condensed matter analog of the well-known 'Higgs boson'. We set out to determine how the Higgs mode in condensed matter systems may be affected by disorder (i.e. site-vacancies, doping, lattice imperfections). To this end, we consider the superfluid-Mott glass quantum phase transition using a model of interacting bosons on a diluted lattice.

Using large-scale Monte Carlo methods we compute the scalar susceptibility of the superfluid order parameter, from which we can calculate the spectral density that is closely related to many experimental probes. Whereas the Higgs mode in the clean system is a sharp, well-defined excitation that softens as the quantum critical point (QCP) is approached, the diluted case shows a much different behavior, with broad peaks in the spectral density which are not sensitive to the distance from the QCP. These observations indicate strong evidence for the localization of the Higgs mode in response to the dilution. Our findings indicate that 'unconventional' dynamical behavior (i.e. localization) may be exhibited in diluted systems despite underlying 'conventional' thermodynamic behavior.

Thank you to the Schearer family as well as the members of the Schearer prize committee for making such a competition possible!

Jack Crewse

Alumnus Note

Brian G. Millburn (BS'1975) lives in Colorado Springs, CO. He retired in November 2018 for good at the age of 65. His first retirement was from United States Air Force as a Lieutenant Colonel in September 1996. He then continued to perform operations research on helicopter; missile warning; battle management; command control, and communications; space surveillance, missile defense, satellite and cyber systems as a member of ANSER Corp. (3 years) and The Aerospace Corp. (19 years) until his final retirement. He now supports his church and Boy Scouts of America and travels extensively to see family, beautiful sites and museums.

50th Annual Fuller Research Seminar

Six undergraduate students presented posters about their research projects at the 50th *Annual Harold Q Fuller Undergraduate Research Competition* on May 6, 2021 via Zoom.

- “*Fractional Brownian Motion in Confined Geometries*” by **Samuel Halladay**, advised by Dr. Thomas Vojta.
- “*Higgs mode in a diluted classical magnet*” by **Reece Beattie-Hauser**, advised by Dr. Thomas Vojta.
- “*Machine Learning Optimizes a Survey of Dark Energy*” by **Steven Karst**, advised by Dr. Shun Saito.
- “*Irradiating AIN and the effect on its dielectric properties*” by **Sean Anderson**, advised by Dr. Aleksandr Chernatynskiy.
- “*Do Baryon Acoustic Oscillations and Big Bang Nucleosynthesis Independently Confirm the Hubble Tension*” by **Noah Baden**, advised by Dr. Shun Saito.
- “*Aharonov-Bohm Conductance Oscillations in terms of Transmission Eigenchannels*” by **Charles Knopp**, advised by Dr. Alexey Yamilov.

The posters were judged by the Fuller Prize Committee: **Dr. Jim Musser** (Chair), **Dr. Shun Saito** and **Dr. Dan Waddill**.

Steven Karst (left) and Samuel Halladay (center) were awarded first prizes and received \$400 each. Charles Knopp (right) won a third prize of \$200.



From the Fuller Prize Winner Steven Karst

I am so honored to be one of the winners of the 50th Annual Fuller Competition. I would like to thank Dr. Saito for his dedication in mentoring my research, the coordinators of the National Merit Semifinalist Scholarship Package for their funding and support, the Fuller Prize Committee for setting up the competition, and the Fuller family for their generous support.

The aim of my research project was to utilize machine learning algorithms to select galaxies with peaks in their (O||) emission lines given measurements along five photometric bands. This was to help in the target selection phase of the Subaru Prime Focus Spectrograph (PFS) by locating constraints that would maximize the amount of measurable high-redshift galaxies collected while minimizing the amount of non-target galaxies. During the project, I received opportunities to speak with several diverse groups such as the PFS Target Selection Group, the Institute for Multi-Messenger Astrophysics and Cosmology, and the Midwest Cosmology Journal Discussion Group, all of which provided extremely helpful feedback and criticism.

This experience was a fantastic introduction to cosmological research. As a result, I plan to continue this type of research as I proceed through my undergraduate career. I highly recommend that every undergraduate also finds something they like and conducts research about it. In my experience, the successes feel awesome, the failures are genuinely interesting, and presentations such as those in the Fuller Competition tie everything together.

Steven Karst

S&T Undergraduate Research Conference Winners

Congratulations to physics majors **Steven Karst** (left) and **Anthony Lonsdale** (right) for their success at the Missouri S&T Undergraduate Research Conference.

Steven won 1st prize for his presentation “Machine Learning Optimizes a Survey of Dark Energy” (Advisor: Dr. Shun Saito).

Anthony won 2nd prize for his project “Thermal Conductivity in Ferromagnetic Materials Using MD Simulations” (Advisor: Dr. Aleksandr Chernatynskiy).



Marco Cavaglia Has Productive Year

Dr. Marco Cavaglia had a very busy year. His LIGO group published 37 papers, he delivered about a dozen talks at workshops, conferences, and colloquia, and he graduated two PhD students: Dripta Bhattacharjee and Kentaro Mogushi. Marco also helped establish the Women in Physics Group at S&T, and he was re-elected co-chair of the LIGO Scientific Collaboration “Burst Sources Group”.

Marco spent the fall semester as a visiting professor at the Institute of Pure and Applied Mathematics (IPAM) at the University of California, Los Angeles and co-organized a long symposium on “Mathematical and Computational Challenges in the Era of Gravitational Wave Astronomy” there. It consisted of four workshops, one tutorial session and a culminating retreat. Marco spent the fall semester at IPAM, together with graduate student **Yanyan Zheng** and postdoc **Ryan Quitzow-James**.

In November, he co-organized the workshop “Detection and Analysis of Gravitational Waves in the era of Multi-Messenger Astronomy: From Mathematical Modeling to Machine Learning” in Oaxaca, Mexico.



Ryan Quitzow-James, Marco Cavaglia, and Yanyan Zheng attending the symposium "Mathematical and Computational Challenges in the Era of Gravitational Wave Astronomy" at UCLA.



Ryan Quitzow-James and Yanyan Zheng in discussion with 2017 Nobel Prize winner **Barry Barish** who gave one of the opening talks at the IPAM symposium.

Faculty Notes

Ulrich Jentschura was awarded a major grant from the National Science Foundation for his project “Precision Low-Energy Quantum Electrodynamical Theory and Fundamental Processes”.

Julia Medvedeva is a co-PI on a new major National Science Foundation award "Designing Efficient Electrocatalysts for Selective Reduction of CO₂ to Carbon-Rich Products" with Dr. Manashi Nath, associate professor of chemistry.

Thomas Vojta won a major National Science Foundation award in the Computational Neuroscience program entitled “Stochastic Axon Systems: From Spatial Dynamics to Self-Organization” together with Dr. **Skirmantas Janusonis** from UCSB.

Dr. **Yi-Kuan Chiang** visited from Ohio State University to collaborate with **Shun Saito**.

Research findings by **Julia Medvedeva** and her colleagues from Northwestern University, have been published in the prestigious [*Proceedings of the National Academy of Sciences*](#).

Ulrich Jentschura serves as a guest editor of the special issue “[The fundamental role of precision atomic-physics measurements in modern science](#)” of the journal *Atoms*.

In October, researchers from Stanford University and Elsevier published an updated [database](#) of the top 2% of scientists in many fields based on a composite citation metric. Physics faculty members Drs. **Cavaglia**, **Hor**, **Jentschura**, **Medvedeva**, and **Vojta** as well as emeriti Drs. **DuBois**, **Madison**, and **Olson** are listed in this database.

Outreach



We are excited that we can finally do in-person outreach events again!

On September 22, physics faculty and students participated in the Equinox Fest at the S&T Stonehenge, a half-sized replica of the famous monument in England. They performed astronomy demonstrations and opened the observatory for the public. Thanks to the S&T Astronomical Research Society and the Society of Physics Students.

In November, faculty members Drs. **Jim Musser** and **Yew San Hor** and graduate students **Ali Sarikani** and **Mat Pollard** performed physics demonstrations for second-graders from the Newburg School on their field trip to S&T. The activity was organized by the Kummer Center for STEM Education. Pam Crabtree's granddaughter, Louella, is pictured on the left enjoying the demos!



Emeritus Robert Bell Passed Away



Robert John Bell, age 86, passed away on Sunday, May 8, 2021 in San Antonio, TX. Robert Bell received his education of B.S. in Physics at Virginia Polytechnic Institute in 1956; his M.S. in Physics at Rice University in 1958, and his PhD in Physics at Virginia Polytechnic Institute and State University in 1963. He was a professor of physics at UMR/Missouri University of Science and Technology.

Dr. Bell's research included studies in biophysics and geophysics. He was a member of Phi Kappa Phi, Sigma Pi Sigma and Omicron Delta Kappa leadership and scientific societies. His professional activities included 1 book, 4 book chapters, 58 refereed papers, 13 published conferences papers, and one patent. His research resulted in a published book, R.J. Bell (with R.W. Alexander, Jr.), *Introductory Fourier Spectroscopy* (Academic Press, New York, 1972).

He was preceded in death by, his parents, Mason & Amoret Moore Bell; his daughter, Sarah Elizabeth Bell; and brothers, Mason & Frank Bell. Robert is survived by his wife, Carolyn Wine Bell; son, Robert R. Bell (Terri); grandsons, Ian Bell, Brendan Bell, Dylan Bell, beloved dog Rosie; sisters Betty Montgomery, Amoret Bunn, Mary Ellen Haefner, and numerous nieces and nephews, family and friends.

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Come Back for Homecoming 2022

The Missouri S&T Physics Department warmly invites you to return to Rolla for the **S&T Homecoming 2022 on October 21 & 22, 2022**. On Friday afternoon, October 21st, 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, Bernard Fendler (BS 2002, MS 2004) will deliver the Homecoming Physics Colloquium at 4 PM on Friday, October 21, 2022.

Contact us at physics@mst.edu for specific information about physics department activities, or alumni@mst.edu for general homecoming information. Come home to your college roots, and help us celebrate our past as MSM-UMR, as we work to dig deeper into our future at Missouri S&T!

So What's News with You?

We hope you enjoyed this year's edition of **Matter 'n Motion**. We would like to know what is happening in the lives of our alumni to include in next year's newsletter. Send us stories, pictures and musings by mail to the **Physics Department, Missouri University of Science and Technology, 1315 N. Pine St., Rolla MO 65409-0640** or e-mail at physics@mst.edu. Thanks for keeping in touch. It's always good to hear from old friends. If you would like to contact us, you can reach us at (573)341-4781. You might also be interested in checking out our web page, <http://physics.mst.edu> and our facebook page *SandT Physics*.