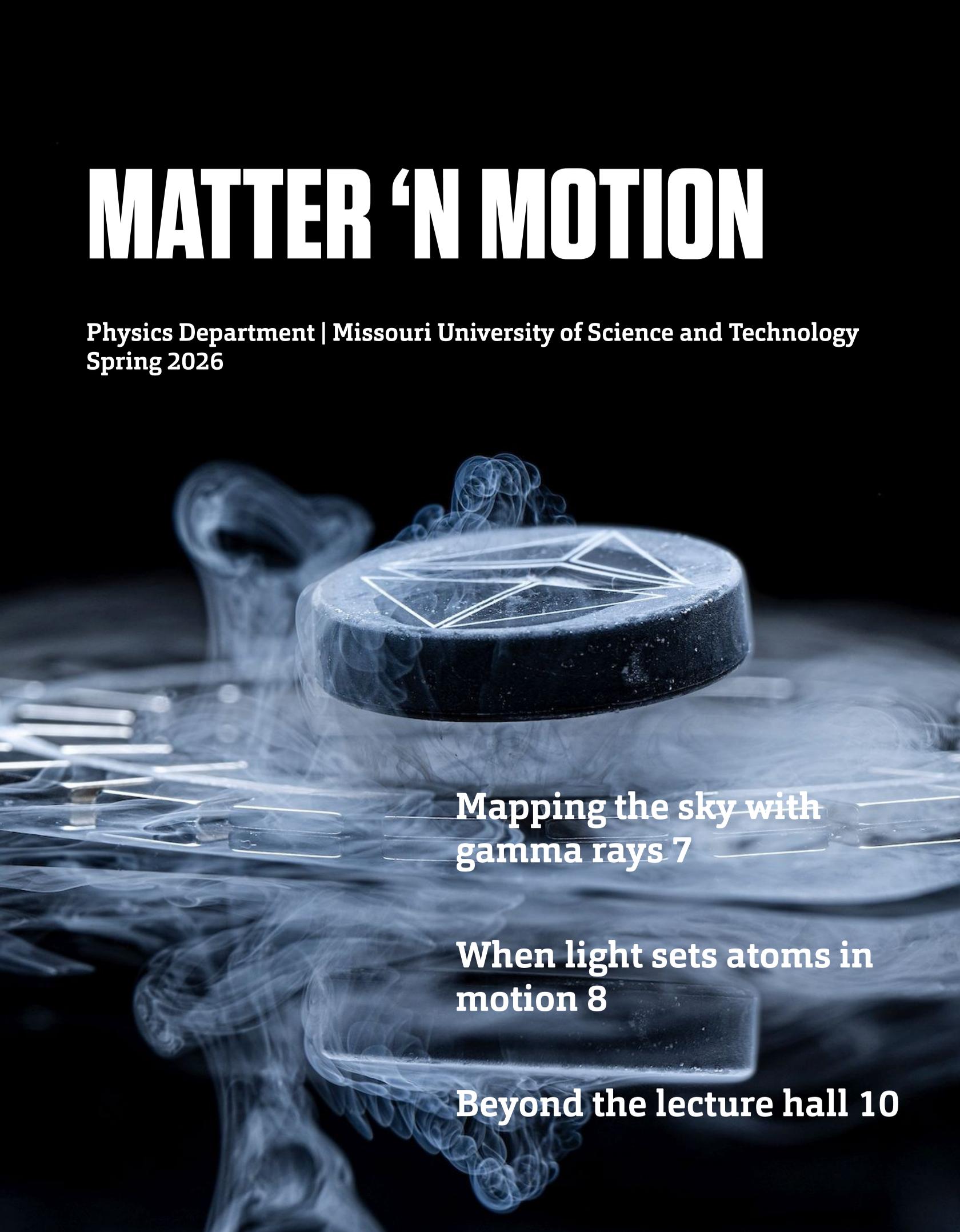


MATTER 'N MOTION



Physics Department | Missouri University of Science and Technology
Spring 2026

Mapping the sky with
gamma rays 7

When light sets atoms in
motion 8

Beyond the lecture hall 10

ENDOWMENTS: GIFTS THAT CONTINUE TO GIVE

We are grateful for the generosity of the donors who funded the following endowed scholarships and prizes that helped so many students this academic year.

Dr. Richard Anderson

Dr. Harold Q Fuller

Dr Gary and Sharon Kovener

Burke H. Miller

Dr. Donald and Lona Packwood

Dr. Stephen P. Reed

Dr. Laird D. Schearer

Richard and Linda Thom

Leon E. Woodman

Gerrie Fletcher

Dr. Richard W. Hannum

John L. & Betty L. McDaniels

Dr. Charles W. and Barbara J. Myles

Dr. Oran Allan Pringle

Dr. John R. and Patty Rogers

Ed and Mary Sue Sickafus

Dr. Gerald Wilemski

We are particularly grateful for the following sizable donations in 2025:

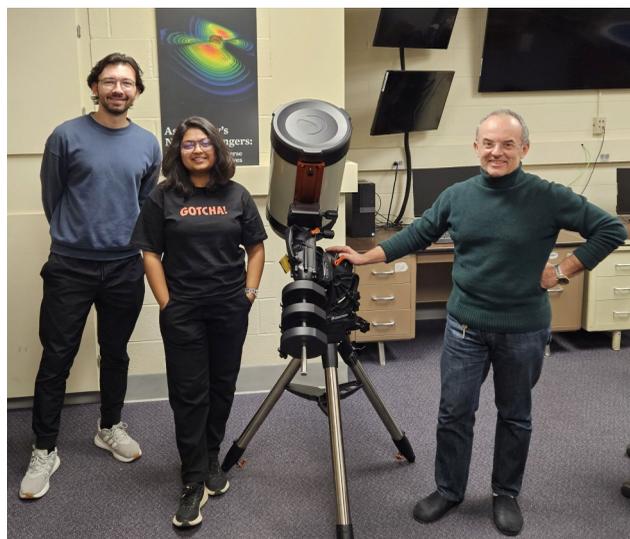
Dr. **Gerald Wilemski**, professor emeritus of physics, added \$ 50,000 to his Graduate Research Fund.

Dr. **Gregg Adams (PhD 1983)** donated \$25,000 for research which will provide summer funding for graduate students.

Dr. **Stephen Christiansen** made another donation of \$40,000. His gift last year enabled us to upgrade the equipment for the Advanced and Intermediate Laboratories; more about that on pg. 10.

State-of-the-Art Telescope

We received another generous \$22,000 gift from **Kul and Charlotte Basin** for an upgrade of our astronomy laboratory. This allowed us to purchase an 11 inch aplanatic, flat field Schmidt-Cassegrain reflector telescope for sharp wide fields of view with large CCD chips. The optical configuration is designed to produce aberration-free images all the way to the edge of the field of view with no field curvature and off-axis star coma. The tube is supported by a computerized mount that allows for high-precision tracking. Together with the telescope we also bought an impressive 61.2 megapixels full-frame CCD low-noise cooled camera. We will complete the set-up with an a computerized filter wheel, autofocus, a control hub, additional accessories, and a professional H-alpha filter for solar observations. This instrument will become the most advanced and powerful system for astronomical observations that S&T has ever had, surpassing the capabilities of the campus observatory, and approaching the power of a professional research instrument.



DEAR ALUMNI AND FRIENDS,

I am happy to report that the physics department continues to thrive, not least because of your generous support for our students and faculty.

At the beginning of the 2025 fall semester, we welcomed a new assistant professor, Dr. Xiaojie Wang. She is an astrophysicist and a member of the HAWC (High-Altitude Water Cherenkov Observatory) Collaboration. Learn more about her and her work on pages 2 and 7 of the magazine.

Our faculty continues their excellent work in teaching and research in 2025. Dr. Shun Saito was promoted to associate professor with tenure. Drs Marco Cavaglia, Ulrich Jentschura, and Shun Saito were recipients of Missouri S&T Faculty Research Awards. Dr. Alexey Yamilov was honored with a college Research Award, and Dr. Agnes Vojta received an S&T Faculty Service Award. Ulrich and Alexey also received Post-Tenure Review Excellence Awards.

Drs Ulrich Jentschura and Shun Saito won new major NSF grants, and Shun also received additional funds for his grants from DOE and NASA. 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 newest edition of the Stanford database of the top 2% cited scientists in their fields.

Our undergraduate enrollment continues to be strong. We currently have 87 undergraduates (plus another 8 students who are double majors with physics as

their secondary subject) and 26 graduate students. In 2025, 11 students graduated with a BS degree, and we awarded 4 PhDs and two MS degrees.

More than half of our first-year physics majors participated in the First Year Research Experience (FYRE) program of the college, and the department's Fuller Competition for undergraduate research saw a record number of entries. Several of our current students and recent graduates were the first authors, respectively, of articles published in prestigious physics journals in 2025: undergraduate Jonathan House and graduate students Farhana Bristy, Sharma Chaudhary, Pablo Jara, Gaurav Khairnar, Kevin Romans, and Qi Zhang.

On the following pages, you can read more about the accomplishments of our faculty and students. On pages 10 to 12, we highlight how our undergraduates gain practical experience that prepares them for their research careers.

As always, I would like to thank you for your dedication and generous donations without which the department's success in teaching, research, and service would not be possible. We are enormously grateful for several sizable donations that the department received in 2025. They allow us to support promising undergraduate and graduate students and upgrade the teaching laboratories for physics majors.

Warm Regards,
Thomas Vojta



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Front cover:
Demonstration of the Meissner effect using a magnet track and a superconductor cooled with liquid nitrogen. Dr. Kim's low-temperature lab. Photo credit: Michael Pierce, Missouri S&T.

NEW FACULTY: Xiaojie Wang

At the beginning of the fall semester, we welcomed Dr. **Xiaojie Wang** who joined our faculty as an assistant professor. Dr. Wang received her Ph.D. from the Institute of High Energy Physics, Chinese Academy of Sciences, where she worked on the Large High Altitude Air Shower Observatory (LHAASO) experiment. Prior to joining Missouri S&T, she held a Research Assistant Professor position at Michigan Technological University.

Xiaojie works on very-high-energy and ultra-high-energy gamma-ray astrophysics, using wide-field observatories such as the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC), and the upcoming Southern Wide-field Gamma-ray Observatory (SWG0). Her research focuses on uncovering the origins of cosmic rays by studying particle acceleration around galactic accelerators like supernova remnants, pulsar wind nebulae, and binaries. She also leads several multi-wavelength and multi-messenger programs in partnership with NASA missions, including Fermi, Chandra, XMM-Newton, and NuSTAR. Read more about her research on page 7.



SHUN SAITO PROMOTED

Dr. **Shun Saito** was promoted to associate professor of physics, effective September 2025. Dr. Saito is a theoretical astrophysicist working on observational cosmology and galaxy evolution, focusing on galaxy redshift surveys. He is the chair of the Cosmology Science Working Group in the Hobby Eberly Telescope Dark Energy Experiment (HETDEX), a co-I of the Project Infrastructure Team in Nancy Grace Roman Space Telescope, and a lead of the Halo Occupation Distribution Tropical Group in the Dark Energy Spectroscopic Instrument.

Annual Giving Day:
April XX

Please consider donating at
give.mst.edu

A GENEROUS GIFT TO PHYSICS STUDENTS:

Gene Gowins establishes \$2.1 million endowment

Gene Gowins, who studied physics at Missouri S&T in the early 1960s, has established a \$2.1 million permanent endowment to help physics students succeed, a gift he says was inspired by both the values he learned growing up during the Great Depression and his passion for physics.

“I love physics,” he says. “To me, physics is man’s effort to create a mathematic model that identifies some of nature’s secrets.”

Gowins earned two master’s degrees in physics at Missouri S&T, one specifically for teachers. His thesis was on the piezoelectric properties of thallium nitrate. He says it was the encouragement of two S&T professors that moved him to give back.

Dr. Harold Q. Fuller was a physics professor who served as department chair from 1948 to 1970, when he became founding dean of the College of Arts and Sciences. He was also on the board of education in Rolla, and helped Gowins obtain a teaching position, which made it possible for him to pursue his studies.

Dr. Franklin Pauls breathed life into the subject as the primary teacher of Physics I. He also became the first director of Missouri S&T’s nuclear reactor, the first operational nuclear reactor in the state of Missouri.

“I’ll never have the kind of impact they had on me, but I’m pleased to be able to make it possible for students to worry less about expenses and focus more on physics,” Gowins says.

As a Boeing employee, Gowins worked on the Nuclear Engine for Rocket Vehicle Application (NERVA) program and simulations for the Saturn V rocket. Following his time with Boeing, Gowins worked on advanced sensors, specifically laser and infrared-guided missiles, with the U.S. Army Missile Command.

Post-retirement, Gowins is careful with his investments and sees his good fortune in the market as a signal that it’s time, in his words, to pay it back. “I want to invest where I think it will do the most good,” he says. “For me, supporting Missouri S&T is a win-win for the students, the university, and our country.”



This article by Patrick Collins was first published online in the S&T news on October 6, 2025. The image was provided by Gene Gowins.

ALUMNI SPOTLIGHT: RAY VANDIVER

It is always a pleasure to welcome our alumni back to campus and find out what happened in their lives. Our 2025 homecoming speaker was Dr. **Ray Vandiver**, president and CEO of the St. Louis Science Center, who earned his PhD from our department in 1994. He gave a fascinating talk with the title “Physics Beyond the Lab: Building Wonder through Museums.”

Inspired by visiting the Science Center and the James S. McDonnell Planetarium in his hometown St. Louis, Ray Vandiver discovered his interest in physics as a child. But it was not until completing his PhD at UMR that he decided to make his career building museums. He moved to the small town of Malden, MO and established the Bootheel Youth Museum in an abandoned Pepsi bottling plant. He moved on to become the Vice President of the Center for Learning Experiences at the Oregon Museum of Science and Industry (OMSI) and the founding Executive Director of Discovery Lab in Tulsa, Oklahoma. In 2025, he returned to St. Louis as the president and CEO of the Science Center.



FACULTY AWARDS

Dr. Alexey Yamilov received a Faculty Research Award of the College of Arts, Science, and Education. Drs. Marco Cavaglia, Ulrich Jentschura, and Shun Saito were honored with Campus Faculty Research Awards, and Dr. Agnes Vojta received a Faculty Service Award.



FULLER PRIZE 2025

The Fuller Prize Competition for Undergraduate Research honors the memory of Dr. Harold Q. Fuller, former chair of the physics department.

1st prize: Harshit Agarwal

Development of a Novel AC Magnetic Measurement Technique with a Transistor-Powered Colpitts Self-Oscillator for Quantum Materials Research (advisor: Dr. Hyunsoo Kim).

2nd prize: Jacob Harl

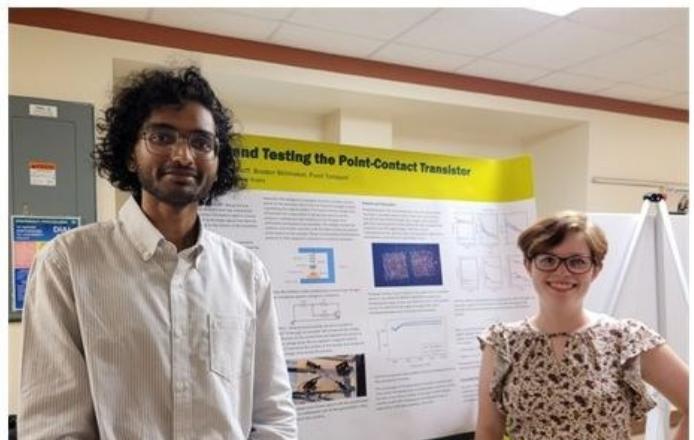
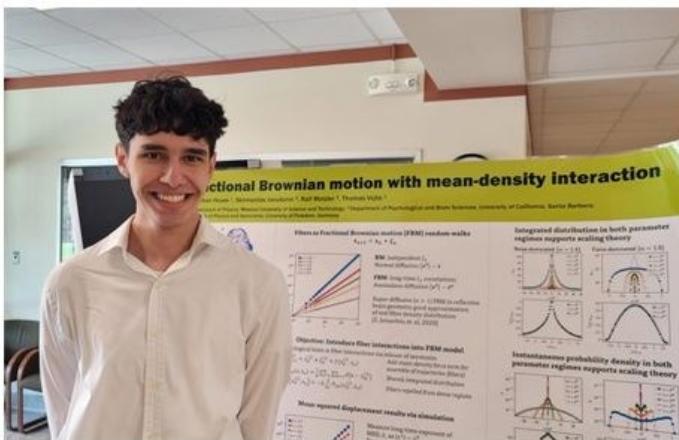
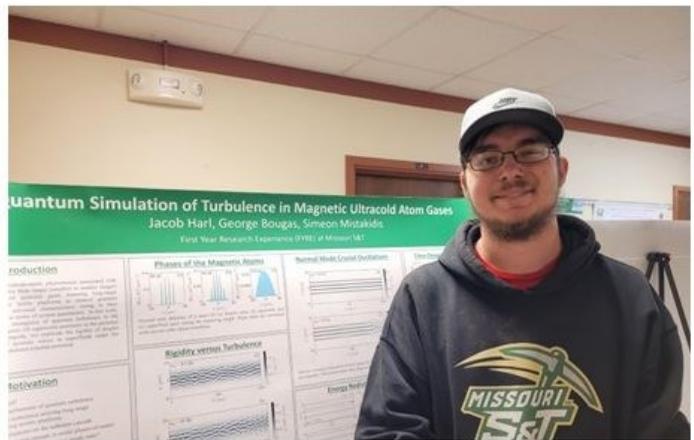
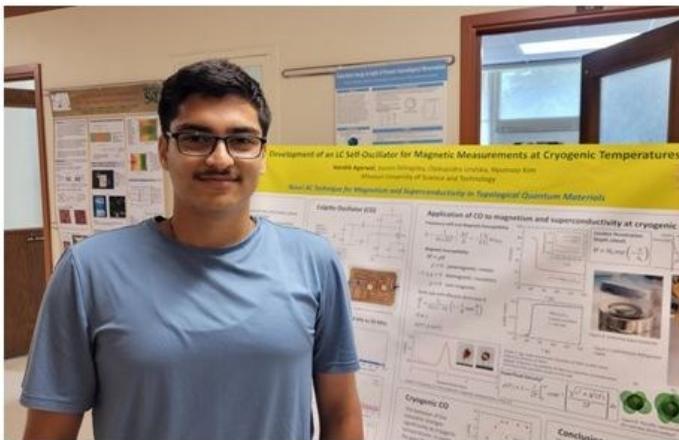
Quantum Simulation of Turbulence in Long-Range Interacting Magnetic Ultracold Atom Gases (advisor: Dr. Simeon Mistakidis).

3rd prize: Jonathan House

Fractional Brownian Motion with Mean-Density Interaction (advisor: Dr. Thomas Vojta) and

Lana Herkenhoff and Punit Turlapati

Replicating and Testing the Point-Contact Transistor (advisor: Dr. Hyunsoo Kim).



SCHEARER PRIZE 2025

The Schearer Prize Competition for graduate research is held in memory of Laird D. Schearer, the department's first Curators' Professor of Physics, and rewards graduate students for outstanding research performed during the course of their graduate study.

First prize: Kyle Foster

"Time-Resolved 3D Momentum Spectroscopy in Continuous Wave Atomic Photoionization Experiments" (advisor: Dr. Daniel Fischer)

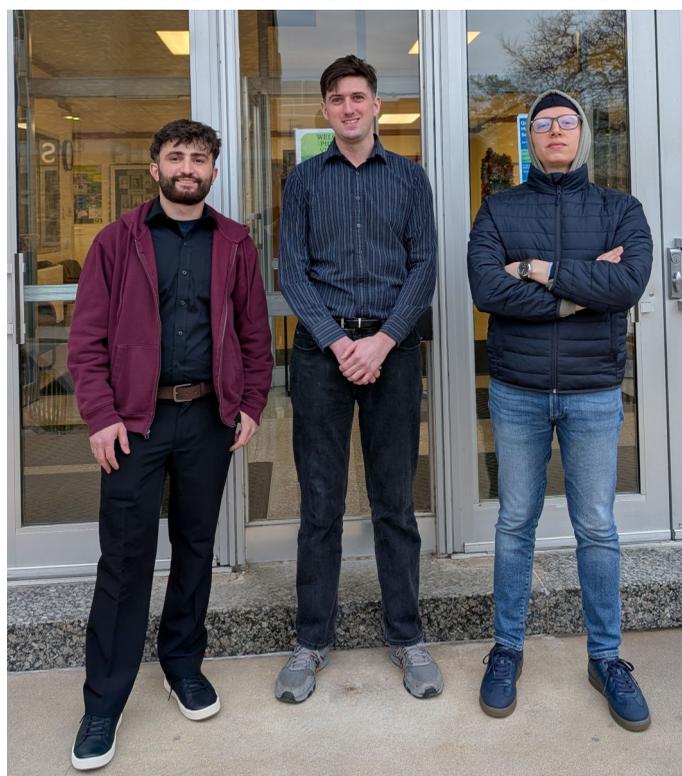
and

Pablo Jara

"Harnessing coherent-wave control for sensing applications" (advisor: Dr. Alexey Yamilov)

Second prize: Rashad Bakhshizada

"Fractional Brownian Motion with Mean-Density Interaction: A Myopic Self-Avoiding Fractional Stochastic Process" (advisor: Dr. Thomas Vojta)



Rashad Bakhshizada, Kyle Foster, and Pablo Jara

From Schearer Prize winner Pablo Jara:

It is my honor to be among the winners of the 32nd Schearer Prize competition. I would like to thank the Schearer family for making this competition possible. I am also very thankful to my advisor Dr. Alexey Yamilov who continuously has supported me through my PhD research. I would also like to thank the committee for giving me the opportunity to present my work.

The research I presented focuses on optical sensitivity, which describes how local variations in a medium affect measured signals and enable image reconstruction in diffuse optical imaging. Diffusion theory models sensitivity as a random walk but neglects interference and therefore fails under coherent control with sample-specific input wavefronts. Using a microscopically exact description of wave propagation, we derive a sensitivity formulation valid under both coherent control and random illumination. We predict—and experimentally and numerically confirm—that sensitivity enhancement equals remission enhancement, establishing a rigorous foundation for integrating coherent control into diffuse optical imaging and enabling deeper, more sensitive biomedical diagnostics.

From Schearer Prize winner Kyle Foster:

I am truly honored to have been selected to present and to be chosen as one of the Schearer Prize winners. I would like to thank Dr. Daniel Fischer, as well as the graduate students and faculty of the department, for their tremendous support over the years in helping me reach this point. I am also grateful to David Keenan for sitting through multiple iterations of my presentations and for being a consistent source of encouragement.

Lastly, I would especially like to thank Shruti Majumdar, whose invaluable help in conducting research and encouragement to apply for the Schearer Prize made this achievement possible.

MAPPING THE SKY WITH GAMMA RAYS

13,500 feet above sea level, three hundred large metal tanks sit on the flanks of the Sierra Negra volcano in the Mexican state of Puebla. Each tank is 7 m wide and 5 m high and contains 188,000 liters of purified water. These tanks form the main array of High-Altitude Water Cherenkov (HAWC) gamma ray observatory. HAWC detects electromagnetic radiation created by high energy cosmic rays or gamma rays that hit the Earth's atmosphere.

When the rays interact with the atmosphere, they produce cascades of secondary particles. Those charged particles enter the HAWC tanks at speeds faster than the speed of light in water and produce blue Cherenkov radiation which is detected by photomultiplier tubes on the bottom of each tank. Using the differences in arrival times at different tanks allows scientists to measure the direction of the particles. Since gamma rays are not affected by electromagnetic fields and travel in a straight line, they can be traced back to their source and used to map the sky.

Dr. **Xiaojie Wang** uses HAWC to study some of the most powerful natural “particle accelerators” in our galaxy, such as pulsar winds nebulae, star clusters, supernova remnants, and black holes, that boost particles to energies far beyond what human-made accelerators like the Large Hadron Collider can reach. These extreme environments produce gamma rays, the most energetic form of light. Dr. Wang is interested in finding out where the main sources of galactic cosmic rays are, how particles propagate through the Milky Way once they are accelerated, how they could be accelerated to such high energies, and how these processes connect to what we observe in other wavelengths such as X-ray and radio.

A recent highlight of her work was the discovery of a large bubble of ultra-high-energy gamma rays around the microquasar V4641 Sagittarii. Located about 20,000 light-years from Earth in the constellation Sagittarius, V4641 Sagittarii is a binary system that consists of a black hole of 6-10 solar masses and a type B companion star. It has an orbit period of 2.8 days and produces some of the brightest and most intense X-ray outbursts in our galaxy. The gamma rays observed have energies up to 200 TeV, i.e. 100 trillion times the energy of visible light. This result, published in *Nature*, shows that such systems can accelerate particles to extreme energies and reshape their surroundings.

Scan the QR code to read the article.



WHEN LIGHT SETS ATOMS IN MOTION:

Watching atomic spins evolve in real time

Light and atoms interact in remarkably rich and subtle ways. By carefully shaping light—its color, polarization, timing, and spatial structure—researchers can not only observe atomic behavior but actively steer it, controlling how electrons move and how quantum states evolve. This ability to manipulate light-matter interactions lies at the heart of atomic, molecular, and optical (AMO) physics and supports emerging fields such as quantum communication, quantum computation, and quantum sensing. In the experimental atomic physics laboratory at Missouri S&T, Dr. Daniel Fischer and his research group focus on studying these interactions in their simplest form: individual atoms cooled to near absolute zero and exposed to precisely tailored laser fields. By combining laser cooling, ultrafast femto-second laser pulses, and momentum-resolved detection, the group seeks to uncover fundamental atomic dynamics .

A recent publication by the group illustrates this approach by showing how light can set atomic angular momentum in motion—and how that motion can be observed in real time. In the experiment, an ultrafast laser pulse prepares a lithium atom in a quantum state whose magnetic moment is tilted relative to an external magnetic field. The atom then behaves like a tiny spinning compass needle, undergoing a well-defined magnetic precession. Instead of probing this motion with additional laser pulses, the atoms are continuously illuminated with light from an optical dipole trap, which both confines and ionizes them. By extending a powerful detection technique known as COLTRIMS, the researchers reconstructed the timing of the ionization events and directly observed the atomic spin dynamics on nanosecond time scales. This work demonstrates how continuous light fields can track coherent quantum motion beyond traditional pulsed methods.

The project was driven by student contributions at all levels. PhD students Kevin Romans, Kyle Foster, and Shruti Majumdar led key aspects of the experiment and analysis. They were joined by master's student Mason Toombs and undergraduate researchers Harshit Agarwal and Aslan Merioles.

Read the article in Phys. Rev. A, <https://doi.org/10.1103/5fzd-g7qn> .



Graduate student Shruti Majumdar working in the Laser lab.
Photo credit: Michael Pierce, Missouri S&T.

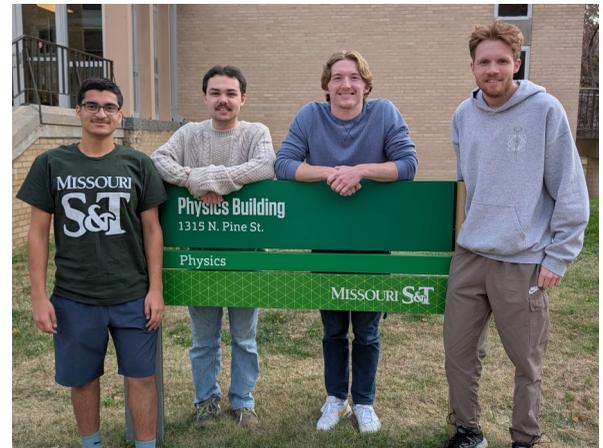


CONGRATULATIONS TO OUR 2025 GRADUATES

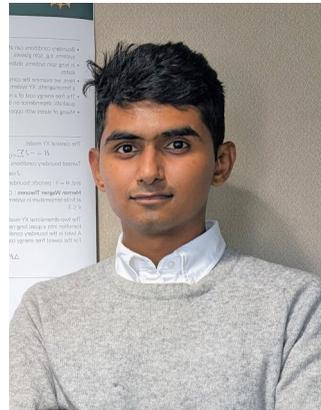
Bachelor of Science in Physics:

Spring 2025 (left): Evan Blake, Joshua Santy, Michael Colletti, Jonathan House, Elias Hyatt, and Jackson Marlett. Four of our graduates also completed a double-major: Joshua and Jackson in Applied Mathematics, Jonathan in Computer Engineering, and Michael in Economics.

Fall 2025 (right): Harshit Agarwal, Caden Huffines, Nicholas Mertens, Kyle Kruel, and Alexander Meadows (not pictured)



PhD in Physics: Sushant Sharma Chaudhary, Mat Pollard, Gaurav Khairnar, Kapil Sharma



MS in Physics:

Angela Rayle
Logan Sowadski

BEYOND THE LECTURE HALL:

Training Students for Cutting-Edge Research

Advanced Laboratory

With two semesters of Advanced Lab, all of our physics majors get to experience real research as part of their required curriculum. A-Lab serves as our capstone course and is a favorite class for many of our students.

In A-Lab, students form teams and choose their own project that they will work on throughout the semester. Under the guidance of faculty members Drs. **Daniel Fischer** and **Hyunsoo Kim**, they design their experiments, build the apparatus, and perform the measurements. Presenting their results at mid-term and finals gives the students the opportunity to develop their public speaking skills.

The students use state-of-the-art equipment in the research labs. One group studied the topological superconductor $\text{Cu}_x\text{Bi}_2\text{Se}_3$ and used a Teslatron, a research refrigerator, to investigate transport properties at temperatures as low as 1.5K. In another project, students used photolithography and magnetron sputtering techniques to fabricate Josephson junctions which are key components of a superconducting circuit quantum computer.

This spring semester, Nick Mertens, Andrew Miget, and Braden Stillmaker recreated the Rutherford Gold Foil Experiment. This project combined extensive mechanical work, vacuum technology, and electronics. The students designed and built a particle detector using low-cost, off-the-shelf photodiodes and made excellent use of the new lab equipment. Their efforts paid off with impressive results that successfully recreated the classic Rutherford scattering experiment.



The upgrade of our laboratory equipment was made possible through generous gifts from Stephen Christiansen and Kul and Charlotte Basin.

Computational Physics Laboratory

In recent decades, the research landscape in physics has changed dramatically. An increasing part of research is nowadays performed via computational means. In Dr. **Julia Medvedeva's** Computational Physics Laboratory (C-Lab), students can develop their skills by working on an individual, semester-long, computational research project.

Dr. Medvedeva guides the students through the project from the starting point of posing a scientific question all the way to the final presentation of the results. Each student learns to formulate a scientific problem that can be solved numerically via computer simulations. The projects span a broad range of topics from materials science to astrophysics. Students have visualized ultracold atoms, classified supernovae events, computed fractal dimensions of LIGO data, and predicted the atomic structure of high entropy borides. Once the students have identified their topic, they develop a research plan, carry out literature search, select appropriate computational tools, perform the simulations, and analyze the data.

Students with any level of programming skills are welcome to take this class. They develop their knowledge about computational methods, run programs on a high-performance cluster, and use AI tools. Weekly individual consultations with the instructor are augmented by lectures on computational research, data analysis, and visualization.

C-Lab attracts not only physics majors, but also students from chemistry, materials science, mechanical engineering, and computer science. Several students presented their projects at the Fuller Competition for undergraduate research, and some of the class projects lead to publishable results. Currently, five manuscripts resulting from C-Lab projects are in preparation for submission to high-quality refereed journals. Our students may be published authors before graduation!

In his C-Lab project, Elias Hyatt simulated the H_2 formation on interstellar grains. In interstellar space, H_2 primarily forms on the surface of dust grains. Elias modeled the grain surface of amorphous $Mg_{1.8}Fe_{0.2}SiO_4$ using ab initio liquid-quench molecular dynamics simulations. The atomistic structure profile revealed possible locations where hydrogen atoms get trapped by under-coordinated metal or oxygen atoms at the surface, which then attract a second hydrogen atom, leading to H_2 desorption.

Elias says: "I enjoyed C-Lab because I was able to use Linux for the first time and see how it could be applied to research. I also had the opportunity to analyze simulation data in a way that I was previously unfamiliar with using a 3D visualization program." Elias is now a Masters student in our department.

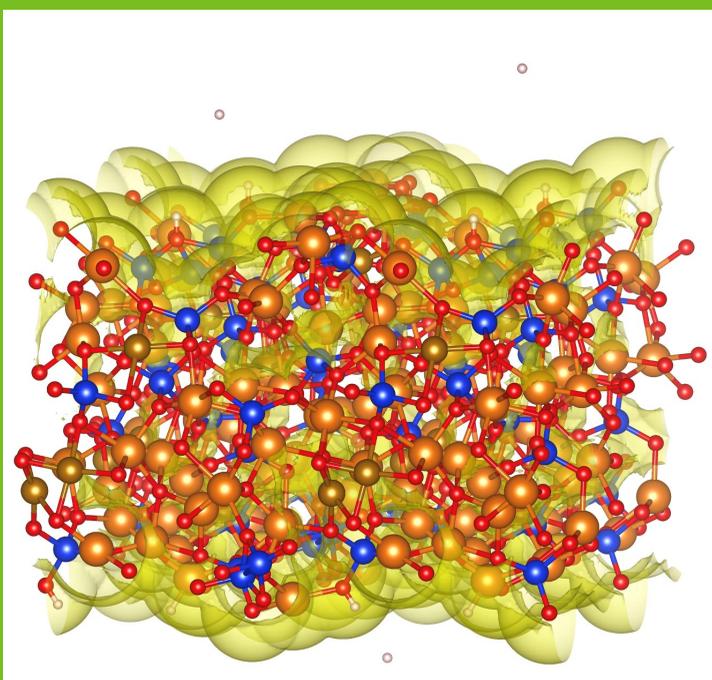




Photo: Gabriel Duncan working in the glove box in Dr. Hodovanets's lab.
Photo credit: Michael Pierce, Missouri S&T.

First-Year Research Experience

The First-Year Research Experience (FYRE) of the College of Arts, Sciences, and Education pairs students with faculty for one-on-one mentoring. Faculty design research projects specifically for first-year students. More than half of our majors who started in the fall of 2025 participated in the program.

Students are matched with their mentors in November and can begin working on the research project right away. They have the opportunity to present their results at a showcase event in May, and several students have posters in the department's Fuller competition for undergraduate research.

The projects span the a variety of theoretical and experimental research topics. Gabriel Duncan, a first-year student from Simpson, Illinois, worked with Drs. Hodovanets and Kim on the project "High-Temperature Electrical Transport in Topological Semimetals". Doing hands-on work in the lab, he grew single crystals of the topological semimetal YPtBi and measured their electrical resistance as a function of temperature. He learned to use the high-temperature flux single crystal growth technique, calculate and weigh out the amounts of Y, Pt, and Bi needed for the growth, and shape the crystal into the resistivity bar for the resistivity measurements. Gabriel says about his experience:

"I couldn't believe that amazing research opportunities this big are given to freshman students. Participating in FYRE not only solidified my goal of going to graduate school, but also pursuing research as a career."

We are grateful for the support of these alumni and friends in 2025:

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Physics Consultants
Shell Oil Company Foundation

Over \$ 5,000

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Charlotte A. Bhasin
Kul Bhasin
Stephen Christiansen
Gary S. Kovener
Gerald Wilemski

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Thomas M. Jordan
Xiaoqian Liu
Kevin Daniel Moll
Amy Leigh Jones Morriss
Casey Patrick Morriss
Michael Lee Noble
Timothy J. Sommerer
Agnes and Thomas Vojta

\$500 - \$999

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Michael J. Mochel
Emmett R. Redd, PhD
Morgan P Slusher



SPOOKY SCIENCE TAKES A VILLAGE

We are always looking for opportunities to bring science fun to the community. The week before Halloween, more than thirty physics department members hosted a Spooky Science event at Kaleidoscope Discovery Center in Rolla. Fully costumed, physics professors, postdocs, undergraduates and graduate students provided hands-on experiments, demonstrations, and planetarium shows for over two hundred visitors from Rolla and the surrounding area.

Whether it's at Sci Fest at the St. Louis Science Center, at the State Fair in Sedalia, or at the Kummer STEM Days on campus, our faculty and students are happy to share their passion for physics.



The 2025 physics department Outreach Award which recognizes outstanding contributions to outreach activities that promote physics to children, S&T students, and the general public, went to graduate student Cole Rischbieter and Academic Specialist Jason Summers.



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Keep in touch!

Drop us an email at physics@mst.edu, visit the campus when you are in town, or plan a special trip for Homecoming 2026. We would love to show you what we have accomplished

Tell us what you're doing with your physics degree, and what you've been up to since you left Rolla. We love to hear from our graduates!

You can follow us on facebook at **SandTPhysics** or on LinkedIn at

<https://www.linkedin.com/company/missouri-s-t-physics/>

Our website is physics.mst.edu

