INTERACTIONS THE DEPARTMENT OF PHYSICS AND ASTRONOMY WINTER 2021

It has been a year of *giant leaps* for **Dr. Laura Pyrak-Nolte**. Read about her accomplishments and an example of her research inside on pages 8 and 9.



NOTE from the HEAD Greetings Boilermakers! Well, what a The last time I wrote you was at the end of 2019. We had a nice holiday season, and I was on the road in early 2020 visiting and touching base with some of you. Then, BANG, the

pandemic kicks in and we all go into some form of lockdown. We had several events planned where we could meet and share our reflections, the march APS meeting in CO and the April APS meeting in DC, but both meetings were canceled. They were 2 of the early casualties and I must admit I was shocked when news of the march APS meeting being canceled was shared as it is the largest society meeting we have in our business. Well, needless to say, this has been a challenging year for all of us in many ways. At Purdue we have managed to get through 2 semesters with students on-campus for the fall. It was a bumpy ride but we got through it without any major hang-ups. always meeting with you, our alums, to hear your Despite the pandemic we still managed to move the department forward and our faculty, postdocs and students continue to be recognized for their achievements.

Prof. Laura Pyrak-Nolte was the recipient of the Reginald Fessenden Award from the Society of Exploration Geophysicists, became a fellow of the American Geophysical Union, and was elected a fellow of the American Association for the Advancement of Science. Good year Laura! Chris Boiler Up! Greene was the winner of the Herbert Newby

McCoy Award, the highest honor in the sciences awarded by Purdue. Prof. Manfra was promoted difference a year makes. to a distinguished professor. Well done all and kudos to all the faculty as our research portfolio continues to grow.

As we enter a new year, and a vaccine is becoming available, I think I can see a glimmer of light at the end of the tunnel. It is reasonable to assume that we will be back to normal by 2022 and travel bans and group restrictions will become but a memory. That will afford me the opportunity to meet more of you at some of our scheduled events

ever, these are never easy negotiations, and they can drag on for a long time. Therefore, I will not sign off as if this is my last note as it may not be. If it is my last time writing you I cannot over state how much it has been my pleasure to serve the department in this capacity. The highlight is stories and share with you the progress we are making in the department. I have always been impressed with the passion you all have displayed for Purdue Physics and Astronomy. So, I bid you adieu and hope to see you down the road. You may now imagine a picture of me riding off into the sunset with music playing softly in the background, or not.

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Department of Physics and Astronomy at Purdue University Department Head: John P. Finley **Physics and Astronomy Designer and Editor:** Cheryl Pierce, pierce81@purdue.edu For a digital version, go to: physics.purdue.edu/interactions **Contact Information:** Department of Physics and Astronomy 525 Northwestern Ave. West Lafayette, IN 49707-2036 physics.purdue.edu n 765-494-3000 Interactions is an annual publication Photos included have been provided by either Purdue Marketing and Communications or from persons mentioned.

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FACULTY AWARDS AND HONORS



Chris Greene ► Herbert Newby McCoy Award



Dan Milisavljevic Outstanding Contributions to Undergraduate Teaching by an Assistant Professor, Purdue University College of Science



Yulia Pushkar Showalter University Faculty Scholars



Laura Pyrak-Nolte

- American Association for the Advancement of Science fellow
- American Geophysical Union 2020 fellow
- Society's Reginald Fessenden Award from the Society of Exploration Geophysicists
- National Academy of Engineering (NAE) Member







Michael Manfra Distinguished Professor of Physics and Astronomy



Tongcang Li Promoted to Associate Professor with tenure



DEPARTMENT AWARDS



Paul Muzikar Buth and loel

Spira Award, Outstanding Graduate Teaching



David Nolte Ruth and Joel Spira Award Outstanding Undergraduate Teaching



Tongcang Li Excellence in Graduate Advising





Jay Melosh - 9/11/2020



Jay's research career spanned five decades and his research interests were diverse and influential. His work on the geophysics of impact processes revolutionized understanding of not only the impact processes themselves, but the important roles impacts have played in the evolution of the solar system, Earth, and the development of life.

Sergio Rodriguez - 6/30/2020

Sergio joined the faculty of the Physics Department at Purdue University in 1961 and retired as Full Professor in 2000. He received many honors for his work in theoretical physics and published over 200 peer-reviewed articles and several books.



FACULTY PROMOTIONS/PROFESSORSHIPS



Yulia Pushkar Promoted to Full Professor



Kyoungsoo Lee Promoted to Associate Professor with tenure



Yeona Kim - 6/25/2020

Yeong had a deep love of science and physics. He was a professor of Physics at Purdue University for 47 years, group leader of the Purdue Nuclear and Many-Body Theory Group, and director of the Center for Sensing Science and Technology at Purdue University. As a theoretical nuclear physicist, he published over 200 technical articles.



Donald Duane Carmony - 1/14/2021

Donald Duane Carmony, accomplished scientist, naturalist and beloved family member, passed away on Jan, 14 due to Covid-19. He was 85. A research scientist in the field of particle physics, Duane also taught and mentored many students in physics and engineering at Purdue University during his tenure on the faculty from 1966 to 2002.

PHYSICS & ASTRONOMY WELCOMES NEW FACULTY

DR. MIA LIU Fall 2020 new faculty member



Dr. Mia Liu brings with her a substantial catalog of works that will help unlock the mysteries of the universe. She will use her extensive knowledge to teach physics and also further her investigative research at Purdue University.

"I am passionate about advancing our capabilities in studying nature's secrets: I led the testing and commissioning of the forward pixel detector Phase 1 upgrade, that is a 'camera' sitting at the 'heart' of the CMS detector providing the most precise 3D measurements," says Liu. "My current endeavor is to apply machine learning techniques in our trigger and data acquisition system, in order to unleash the physics potential of the LHC/High-lumi LHC data."

In her persistent pursuit of the secrets of nature, Liu has worked with cutting edge technology that furthers modern physics. She has worked with the Large Hadron Collider for her recent research.

"My research is focused on understanding the fundamental particles and forces with colliders," says Liu. "I use the data collected by the Compact Muon Solenoid (CMS) detector at the Large Hadron Collider (LHC) to search for the unknown particles such as those predicted in the supersymmetry theories, and stringently test the current theory: the Standard Model by measuring very rare and challenging processes with multiple bosons. At Purdue I will continue with these explorations, with a focus on novel ways to measure the Higgs potential."

Liu obtained her undergraduate degree in China, then came to the United States for graduate school. She obtained her PhD at Duke University in 2015. The Department of Physics and Astronomy is excited that Liu will be taking her next giant leap onto the West Lafayette campus and looks forward to seeing her vision unfold.

DR. JUKKA VAYRYNEN *Fall 2020 new faculty member*



Dr. Jukka Vayrynen comes to the Vayrynen is interested in solving

Purdue campus at West Lafayette from a post-doc researcher position at the Microsoft quantum group in Santa Barbara, California. theoretical physics problems related to developing future quantum devices, with a particular focus on condensed matter physics approaches to quantum information science.

When he isn't busy solving the mysteries of physics, he enjoys fishing and has been enjoying the local fishing areas in the Greater Lafayette area. He is also a private

DR. PAUL DUFFELL Spring 2021 new faculty member



physics.

"My primary field of research is in computational fluid dynamics, with applications spanning a wide range of topics in astrophysics," says Duffell. "I have worked on planet formation, supernovae, gamma ray bursts, black hole binaries and neutron star mergers. I am also generally interested in fluid instabilities."

When Duffell isn't busying himself with astrophysics and computational fluid dynamics, he enjoys baking and creating stained glass windows.



pilot.

"Although it's been too many years since the last time I was in the left seat," says Vayrynen "perhaps I'll get current again here at Purdue!"

Vayrynen received his PhD from Yale University after doing his undergraduate studies in Finland (BSc University of Oulu, MSc University of Helsinki). The Department of Physics and Astronomy is excited that Vayrynen will be teaching the next generation of Boilermakers.



Dr. Paul Duffell is teaching PHYS/ ASTR 562 — High Energy Astro-

Duffell received his BS in Physics from the University of Washington in Seattle in 2001, then received his PhD in Physics from New York University in 2014. Between undergraduate and graduate school Duffell says he took time off and worked a wide range of jobs, including a record store, a coffee shop, and a pizza place. After his PhD, he pursued a Postdoctoral **Research Fellow at UC Berkeley** from 2014-2018 and then a Postdoctoral Research Fellow at the Harvard Center for Astrophysics from 2018-2020.

Chattering dust allows scientists to see how fluids flow through rock

The modern energy economy and environmental infrastructure rely on the flow of fluids through fractures in rock beneath the Earth' surface where it may be out of sight but never out of mind. The human race relies on the availability of fresh water to drink, the power of fossil fuel to drive our machines, and geothermal resources to heat and cool our homes. But finding what direction these fluids take underground is hard because the fractures they follow are invisible inside opaque rock. Now, scientists at Purdue University are applying a different sense than sight to the problem. What if, instead of seeing the flow of fluids, they hear them?

Dr. Laura Pyrak-Nolte of the Department of Physics and Astronomy at Purdue University along with a team of scientists, including undergraduate Alan Wright, and Dr. David Nolte, also from Physics and Astronomy, have published an article in Nature Communications where they test "chattering dust" to chart the path of liquids as they flow through fractures. Chattering dust? That's right. This dust "speaks" to the scientists and tells them where the liquids are flowing.

This team of scientists applied chattering dust, or chemically reactive grains of sucrose containing pockets of pressurized carbon dioxide gas, to



Volume (Cubic micrometers)

397.21 1,276,131.67 2,551,866.13 3,827,600.59 5,103,335.05 6,379,069.51 7,654,803.97

3D X-ray tomographic reconstruction of a subregion of a single "chattering" dust grain showing bubbles of compressed gas. The red bubble has a diameter of 243 micrometers (~0.0096 inches). This figure is adapted from publication.

study rock fractures. As the grains of the dust dissolve in the liquid that is carrying it, the pockets carrying the compressed gas burst open and emit acoustic signals. These signals can be detected using ultrasonic sensors outside the fracture allowing the movement to be tracked throughout the fracture systems. This dust is able to be heard with sensors when visual opportunities are not possible.

The speed of the "chatty" dust grains not only tells the scientists about the map of the fracture flow paths, but also how quickly the liquid is flowing. This provides information about the rock's internal fracture geometry, and any bottlenecks that may be present in the flow paths. With current fracture monitoring systems, these bottlenecks remain unseen and cost time and money. Therefore, the chattering dust may create great savings in this modern energy economy while being kind to the environment.

"In the past, the dream for subsurface characterization was the idea of 'smart' dust- sensors that would flow through a rock formation and change in response to pressure or fluid chemistry as they flowed between boreholes," says Pyrak-Nolte. "While 'smart' dust would demonstrate that two boreholes were connected, they provided no information on how they traveled between the boreholes. So instead of 'smart' dust, I thought we needed 'chattering' dust- dust that 'speaks' or makes 'noise' to tell us where it is as it travels."

According to the publication titled "Probing Complex Geophysical Geometries with Chattering Dust," "chattering dust takes advantage of the well-developed field of acoustic emission and induced seismicity, hence using chattering dust for laboratory experiments on rock enables more complex systems to be studied than is possible using X-ray or optical imaging. Currently, there are no other methods that can determine the flow field lines in opaque materials such as rock or the direction of flow through more complicated fracture networks in rock cores or other geotechnical laboratory samples."

Using this chattering dust has distinct advantages over other commonly used practices. One common practice is to use chemical sensors, but these chemical sensors must be collected after the testing. With chattering dust, there is no need to collect the dust after use because it simply dissolves away to nothing. Another common method uses passive tracers like dyes that can only say whether two fractures are connected. Chattering dust is preferable to these passive tracers because it charts the actual transport path of the fluids to say how the fractures are connected.

Pyrak-Nolte states, "the next step for us is to go bigger." Their team believes that the work they have conducted in the lab has been so successful that chattering dust has the potential to scale up quickly in size. Chattering dust is now ready to be tested on civilian infrastructure.



She was also named an American Association for the Advancement of Science (AAAS) 2020 Fellow. AAAS Fellows are elected each year by their peers serving on the Council of AAAS, the organization's member-run governing body. The title recognizes important contributions to STEM disciplines, including pioneering research, leadership within a given field, teaching and mentoring, fostering collaborations, and advancing public understanding of science. She received a rosette pin (pictured) for the Section on Physics designation for outstanding contributions to understanding the physics of fractures in rocks and their interactions with fluids and seismic waves.

Most recently, she was elected as a member of the National Academy of Engineering (NAE) for advances in understanding of the processes that link the mechanical, hydraulic, and seismic properties in discontinuities. Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature" and to "the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

For the latest news in research at the Purdue University Department of Physics and Astronomy, visit physics.purdue.edu/news



GIANT LEAPS

This year has marked giant leaps for Dr. Laura Pyrak-Nolte. In addition to getting works published throughout the year, she was also elected as a 2020 American Geophysical Union (AGU) Fellow. The AGU Fellows program, established in 1962, defines fellows as external experts, capable of advising government agencies and other organizations outside the sciences. Fellows are named as members who have made exceptional contributions to Earth and space science through a breakthrough, innovation, or discovery in their field. Since, 1962, fewer than 0.1% of the AGU members are elected to this prestigious group.



A Glimpse at Our Past

By Ken Ritchie

It is the fall of 1926/27 academic year. Calvin Coolidge is the President of the United States. Prohibition is in full swing. A. A. Milne publishes his timeless classic Winnie-the-Pooh. Fritz Lang is preparing to release the science fiction film classic Metropolis. Henry and Martha Berry give birth to a son named Chuck who would go on to change the world of popular music. In sports, the St. Louis Cardinals win the World Series, defeating the NY Yankees with the final out on Babe Ruth as he tries to steal second base.

In the world of physics, the Nobel Prize is awarded to Jean Baptiste Perrin "for his work on the discontinuous structure of matter, and especially for his discovery of sedimentation equilibrium". Erwin Schrodinger publishes his treatise on the wave theory of quantum mechanics [1]. Wolfgang Pauli uses the recently publishes matrix theory of quantum mechanics of

Werner Heisenberg [2] to derive the observed emission spectrum of hydrogen [3].

In West Lafayette, the Department of Physics (as it was called then) was headed by Prof. Ervin S. Ferry and was housed in the original physics building (where the new Class of 50 building currently resides). The department had a faculty of 12 and presented 38 one-semester courses. It was into this that a young George Rupel Walz (BSME. 1931) entered Purdue as a freshman undergraduate student.

Mr. Walz grew up in South Bend, Indiana (born in 1910), the youngest of three children. During high school, Mr. Walz was a flutist, being chosen as a member of the National High School Orchestra, and an avid amateur photographer. Mr. Walz entered Purdue seeking a degree in Mechanical Engineering and, as most freshmen engineers do, took an Introductory Physics Lab course.

We have been fortunate that Mr. Walz's daughter, Marilyn Walz Taylor, recently

found his freshman lab book and has graciously All-in-all, freshman did 38 labs over the first two sent it to the department so we could see the labsemesters. The curriculum consisted of fluid meoratory course taken by the incoming class in our chanics, classical mechanics and thermodynamdepartment over 90 years ago. The lab instructor ics in the first semester and optics, electricity and was a Mr. Bush, presumably the TA for the course magnetism and sound in the second semester. as he was not a member of the faculty in 1926. From the due dates of the labs we can see that The lab book contains all the handouts to the the first semester ran from September to January students for the labs of the first semester and all and the second from February to the end of May. Also note that lab 16 was due on Dec 22 while lab of Mr. Walz's reports for the fall and spring semesters. All the handouts to the students were typed 17 was due on Jan 4, so one must conclude winter (and presumably copied, most likely by the mimbreak was minimal at that time.

eograph) and served as the location for raw data While many of the labs are standard, even in collection. Each lab report consisted of a title, purtodays curriculum, some do show the times they pose, equipment, answers to the questions asked were created in. One such obvious lab is # 14 from in the handout, a hand drawn figure of the appathe second semester, "Operation of a telegraph" ratus used, and the data collected (see figure). pictured in this article. The report includes the

The labs that a freshman student performed during their freshman year were as follows. Note that the first two labs of the first semester were listed as for a course named Science VII while labs 3-18 were listed for Physics I. The second semester labs were all for a course named Physics II.

List of experiments in Physics I

- Correct method for the use of the 1. Balance (no due date recorded)
- 2. Water Pressure (Thu. Sept 30, 1926)
- 3. Vernier Caliper (Thu. Oct 7, 1926)
- Specific Gravity (Tue. Oct 12, 1926) 4.
- 5. Density (Tue. Oct 19, 1926)
- 6. Boyle's Law (Thu. Oct 21, 1926)

7. Resistant forces (Tue. Oct 26, 1926) 1927)

- 8. Parallel Forces (Tue. Nov 2, 1926)
- Pendulum (continued in lab 10) 9.
- 10. Pendulum (Mon. Nov 8, 1926)
- Friction (Wed. Nov 24, 1926) 11.
- 12. Levers (Mon. Dec 6, 1926)

1927)

- 13. Levers (Fri. Dec 10, 1926)
- 14. Pulley (Tue. Dec 14, 1926)
- 15. Inclined Plane (Fri. Dec 17, 1926)
- Expansion (Wed, Dec 22, 1926) 16.
- 17. Specific Heat (Tue. Jan 4, 1927)
- 18. Heat of Friction (Mon. Jan 10, 1927)

- latest developments in telegraphy such as the use
- of a dynamo instead of gravity cells. It also addresses a problem we still face today using modern communication methods, data security. Recall that this lab was given in the middle of the roaring
- twenties when the stock market was rising rapidly only to crash a few years later. One question on

List of experiments in Physics II	
1.	Photometry (Thu. Feb 3, 1927)
2.	Reflection (Tue. Feb 8, 1927)
3.	Concave Mirrors (Mon. Feb 14, 1927)
4.	Refraction (Thu. Feb 17, 1927)
5.	Convex Lens (Fri. Feb 25, 1927)
6.	Focal Length (Mon. Feb 28, 1927)
7.	Magnets and Magnetic Fields (Mon. Mar 14,
	c c x <i>y</i>
8.	Static Electricity (Fri. Mar 18, 1927)
9.	Galvanic Cell (Tue. Mar 22, 1927)
10.	Electromagnet (Tue. Apr 5, 1927)
11.	Operation of a Doorbell (Fri. Apr 8, 1927)
12.	Electrolysis and Electroplating (Tue. Apr 12,
13.	Storage Cell (Battery) (Fri. Apr 15, 1927)
14.	Operation of a telegraph (Tue. Apr 19, 1927)
15.	D'Arsonval Galvanometer (Mon. Apr 25, 1927)
16.	Voltmeter and Ammeter (Wed. Apr 27, 1927)
17.	Induced Currents (Tue. May 3, 1927)
18.	Dynamo (Mon. May 9, 1927)
19.	Motor Efficiency (Thu. May 12, 1927)
20.	Velocity of Sound (Thu. May 26, 1927)



Shown are pages from George Rupel Walz's freshman lab book. Walz was a freshman student of 1926 who took our introductory physics labs.

Continued from page 9

the lab report asks how stock reports transmitted on telegraph lines can be kept secure. Mr. Walz's response was to encrypt the data, a solution we still use today.

Mr. Walz successfully completed his introductory physics lab course and went on to graduate from Purdue in 1931, right in the middle of the Great Depression. Unable to find a job, he worked on the family farm in South Bend. Keen to the significance of the time, he collected all of his rejection letters from that time in a binder for later generations to see. As the depression came to an end, Mr. Walz joined Minneapolis Honeywell as their Washington, DC representative. He later went on to form his own company, the George R. Walz Company.

Mr. Walz passed away at his home in September 1986. As his daughter wrote "A member of the Greatest Generation (along with Jimmy Stewart), Mr. Walz had lived A Wonderful Life."

I would like to thank Marilyn Walz Taylor for lending the department her father's freshman lab book and for providing information on the life of George Rupel Walz. A short reflection on the life of Mr. Walz written by his daughter can be found online

geoway

Experiment no.14. Due april 19,1927 George Rupel Walz.

EXPERIMENT NO. 14. Apparatus: Telegraph autfit consisting of two cells, two keys, Object; The operation of the telegraph. Discussion: (1) A relay is necessary to strengthen the local two relays, and two sounders. current and make louder signals at the sounders. (2) The sounder is desirable because the sound that it makes is an easy and accourate method for measages to be received. (3) A relay which always works on a low current has an electro magnet containing several thousand turns of wire, which is to make up for the weak amperage. The armsture is made very light since it is used merely to close the local circuit which is ran by a local battery and sounder. When a current is sent thru the relay coll, it closes the circuit with the sounder and local battery which causes a loud sharp (4) Duples telegraph = a system by which two messages may be sent of once over a single wine by use of differently wound soils. (5) The public could be was from more the start more (5) The public could be kept from knowing the stork reports by the stock exchanges having an individual code to be sent thru telegraph. Frequent ohanges in the code would prevent anyone from decipher (6) The Synamor generator has taken place of the gravity ing the code dells for telegraph use.

on the following pages.

1. Schrödinger. E. 1926. Quantisierung als Eigenwertproblem. Ann. d. Phys. 79:361–376, 489–527; 80:437–491; 81:109–140.

2. Heisenberg, W. 1925. Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen. Z. Physik 33:879–893.

3. Pauli, W. 1926. Über das Wasserstoffspektrum vom Standpunkt der neuen Quantenmechanik. Z. Physik 36:336–363.





George Rupel Walz BSME in 1931

Reflections on the life of George Rupel Walz

as recalled by his daughter Marilyn Walz Taylor / January 2021

It is a pleasure to try to reconstruct some high points of the life of our father, George Rupel Walz, to accompany his physics lab notes from over 90 years ago.

Mr. Walz was born in South Bend, Indiana, in 1910, the third and youngest child of Nellie Rupel Walz and George Henry Walz. Though he guickly grew to be 6'3" tall, in South Bend he was always known as "Little George."

He graduated from South Bend High School in 1927. While there, he was among those chosen by Joseph Maddy, founder of Interlochen (Michigan) Music Camp, as part of the National High School Orchestra performing at the Department of Superintendence, National Education Association's March (1927) conference in Dallas, Texas. Playing flute and piccolo, Mr. Walz enjoyed being regularly introduced as "the biggest man in the orchestra, playing the smallest instrument."

He was an amateur photographer and visual artist as well. Many imaginative photos and beautifully framed items (as well as the lab notes) still bear witness his fine eye for order and beauty.

Once Mr. Walz had earned his degree in Mechanical Engineering at Purdue (Class of 1931), he immediately faced the Great Depression. Though he had received many job offers during his senior year at Purdue, by the time he'd actually graduated he had been repeatedly "fired." In a threering notebook, he saved those many "reject letters," all with essentially the same message (paraphrased here):

Mr. Walz, though your qualifications are excellent, due to the current economic situation, we must release even long-term employees and therefore cannot in good conscience hire anyone new. We wish you the best in your professional endeavors...etc.

That book became a great treasure in our eyes, a testament to perseverance.

Armed with a fresh degree from Purdue but no job, Mr. Walz returned to South Bend where he worked on the family farm (parenthetically now an historic landmark -- for other reasons! -- 59449 Keria Trail) and also became a test driver for Studebaker, then manufactured in South Bend. Always an excellent driver, he taught us that practical skill and included many tips not in the typical drivers ed. manual. One example: carefully observe what's in front of you and when you see a patch of oil on the road, you know a bump is coming up ... why's that, Daddy? ... because a drop of oil falls from every car as it hits that bump and over time, drop by drop, that oil becomes visible even when you cannot see the bump itself.

As economic conditions improved, Mr. Walz was hired by Minneapolis Honeywell as a manufacturer's representative and moved to Washington, DC. Our mother [Lois Mildred Fitz], likewise a native of the Midwest (Nebraska), had also moved to the DC area and very soon caught the attention of Mr. Walz who remarked with a smile that "something new has been added" to the young adult group at Foundry Methodist Church. They were married in1938. Four years later they moved to Minneapolis having become by then parents of a daughter, aged four months. Mother's recently-discovered diaries from that time reveal how hard they both worked ("George still at work till 7:00 pm" -- or later -- was a common refrain) while maintaining an active social life, raising a small child, handling rationing ("looked for meat at the store again today - no luck") and the ever-changing notifications from the draft board.

In 1945 they returned to the Washington DC area just in time for the birth of their second daughter, one month after they purchased their first house. Because it had quickly come to light that "George can fix anything," he was called upon to do that quite often in that hastily built wartime house and elsewhere. Tasks such as rehanging doors, straightening out quirky electrical hook-ups (the front porch light was originally and illogically controlled by a light switch upstairs, which took a while to discover), and shoveling coal into the cantankerous furnace in the Once, when one of his rulings was deemed just too, too strict, basement were common at home, while "call Mr. Walz" became he received this exasperated retort: "Well all right, you are the go-to solution discovered by many, including our elementathe king!" At that spirited, totally unexpected insurrection, he ry school principal in the brand-new school building. Because hesitated just a moment, then burst out laughing -- along with our father habitually encouraged us to tag along on his sales all who had witnessed this exchange. The story spread, and he and service calls, the furnace room at school became almost as was affectionately known as "King" throughout our extended familiar to me as my grade two classroom. family for the rest of his life.

He later formed the George R. Walz Company, representing several heating and air conditioning companies including Barber-Colman, Mid-Continental Metal Products, and Indeeco (Industrial Engineering and Equipment Company / St. Louis). This resulted in decades of mutual professional respect and friendship with the founders and clients. (The Indeeco founder's son, who, as a young boy, first met our father, shared several warm-hearted memories at his funeral.)

Throughout his professional career, Mr. Walz was talented not only in solving many varied technical mechanical/engineering dilemmas, but also in treating others with honesty, respect, and

He loved his family greatly and showed it in many ways, some empathy. ("Remember Marilyn, every person you meet is carryrather surprising for a large, strong man, so often the master of huge machinery. With a steady hand and great patience, for ing a heavy load.") He and our mother were very hospitable and civic-minded. many months Mr. Walz was the only one entrusted with trim-They went door-to-door gathering donations to establish the ming the tiny fingernails of his newborn grandson (the mother local hospital in Arlington, Virginia. They served on the PTAs of was too scared to try it). In time, he trained his daughter (the our schools at every level, and my father was the first PTA presmother) in this additional practical skill, eventually giving her ident at Yorktown High School when it opened in 1960. He also his special nail-trimming scissors to do the job correctly. (She served as president of the Arlington YMCA and the Arlington grew confident, took over the job, and still has the scissors. The Outdoor Education Association. Active in the Cherrydale Methgrandson grew up healthy and unscathed.) odist Church beginning in the 1940s, Mr. Walz became a mem-In our parents' house of nearly 60 years, it was fun to disber of the finance committee, chairman of the Board of Trustees, cover these ancient lab notes and, as adults, to appreciate the precision and detail of them. In hindsight, the genesis of our and an enthusiastic bass in the choir. (He and the choir director, an Indiana University alumnus, enjoyed ongoing light-hearted childhood familiarity with blueprints all over the house is evirivalry.) As in other areas of his life, Mr. Walz was often called dent. Mr. Walz's attention to detail was evident when he was a upon to cajole the church heating/ventilating system into action. student and reflected the fine training he received. That quality He also served as a member of the Arlington County (Virginia) remained with him throughout life and was complemented by Planning Commission, and as president of the local Rotary Club. He always seemed tickled to be of service and rather surprised hard-working and fair-minded businessman with an artistic eye, that these honors came his way. an ear for music, and a kind heart.

Serious when that was needed, he also had a great sense of humor -- even when the joke was on him. This was tested mightily one memorable evening in 1956 when, after a long day on the road, our family stopped at the Missouri home of longtime friends for dinner. The story became a classic for our two families (and possibly for other observers of the scene). Years later, the host recounted it thus:

Our house was full of people - too many for the dining room and we were eating all over the place. This was a great trial for our two dogs, who were at odds to determine who was the likeliest touch for a surreptitious handout. At the height of the confusion, just as the dogs had unsuccessfully worked through two rooms full of people and entered the living room, a big tall guy (6'3"), sitting unsteadily on a too small chair at an even smaller TV table (not quite big enough for his somewhat overloaded plate), heartily dug his fork into his precariously balanced meal, flipping the whole thing onto the floor. The resulting pandemonium as the two dogs tore into that pile of food appeared to come from forty snarling beasts. George is a great guy and a great practical joker, and this was the only time I ever saw him beaten and speechless.

Mr. Walz set high standards for himself and his children.

Mr. Walz loved animals and we housed many stray pets. Persia, a female kitten who came into heat before we were prepared, received some remarkable TLC from him one memorable night when, sensing her condition, many howling tom cats circled round and round our house in full amorous voice. Mr. Walz spent that entire night on the floor with little Persia (understandably straining to heed the energetic courting just outside), trying to distract her -- with limited success -- by calmly stroking and talking to her until a bit after sunrise when we could take her to the vet to be spayed. Going the extra mile was his habit.

- his caring for others and his conscientious work ethic. He was a

Our mother observed that of all his varied activities, "he was proudest of his associations with other people. In every activity he participated in, everybody loved him, and he loved them."

In summary, Mr. Walz, whom today we might call "the HVAC Whisperer," used his engineering knowledge to make his living as a manufacturer's sales and service representative for heating and ventilating equipment. He made his life through hard work, honest and caring treatment of his associates, many long and faithful friendships, and knowing how to see the humorous side of life, even near its end.

- Recovering from open-heart surgery in 1983, he was asked to fill out lots of paperwork while in the hospital. When he noticed that the pen his nurse had handed him was from "Murphy's Funeral Home," he laughed out loud, humorously accusing that flustered young lady of "sending him a message." He refused to return the pen and delighted in sharing it and a hearty laugh with his subsequent hospital visitors.
- Our parents had planned a short road trip for a sunny Saturday in September 1986. Instead, Mr. Walz died at home in bed early that very morning at the age of 76. A member of the Greatest Generation (along with Jimmy Stewart), Mr. Walz had lived A
 - Wonderful Life. WINTER 2021 INTERACTIONS / 15



UNDERGRADUATE STUDENT AWARDS

Ramdas Award

Nicholas Hilgert

The Ramdas Award award was establish in 2018 by Anant K. Ramdas, the Lark-Horovitz Distinguished Professor of Physics and his wife, Vasanti Ramdas. The purpose of the Ramdas Award is to recognize an exceptional senior who has completed a unique project in the Department of Physics and Astronomy.

Frederik J. Belinfante Scholarship in Physics

Matthew Schulz

This scholarship recognizes outstanding physics upperclassmen. The scholarship is possible due to the generosity of Dr. Robert Newcomb (BS 1955).

Lijuan Wang Memorial Award

Rachel Lee

YuXin Dong

The Lijuan Wang Memorial award is given annually to one or more outstanding undergraduate physics majors who promote the gender diversity of the depart ment through participation in Women in Physics. Lijuan Wang was a graduate student in the department from 1989 until her untimely death in 1992.

Richard W. King Award

Braden Buck | Outstanding Junior

Nicholas Hilgert | Outstanding Senior

The Richard W. King Award recognizes the Department's outstanding physics junior and senior. Prof. King joined the Department of Physics in 1955 as an assistant professor, was promoted to associate professor in 1958, and to professor in 1961. He served as Department Head from 1966 to 1969. During his years at Purdue, Professor King gained a reputation as an inspiring teacher and sympathetic friend of students. He served for many years as the counselor for undergraduate physics majors. With other students he often took the opportunity to promote the value of a broad science background for students pursuing careers such as teaching, law, journalism, and medicine. Following his untimely death in August 1969, Prof. King's family, friends, and colleagues established this award.

Shalim and Paula Sargis Memorial Scholarship

YuXin Dong

Danny Kim

The Sargis Scholarship recognizes a physics upperclassman from outside the state of Indiana who also graduated from a U.S. high school. This scholarship is made possible due to the generosity of Dr. James Sargis (BS 1958).

David G. Seiler Physics Scholarship

Mackenzie Geckler

The Seiler Scholarship recognizes an outstanding physics upperclassman who is involved in Women in Science or Women in Physics programs. This scholarship is possible due to the generosity of Dr. David G. Seiler (PhD 1969).

Arthur N. Pozner Memorial Scholarship

Kaustub Anand

This scholarship recognizes outstanding physics upperclassmen. The scholarship is possible due to the generosity of the Arthur N. Pozner Trust.

Kenneth S. and Paula D. Krane Physics Scholarship

Darrell Fischer

Allison Earnhardt

The Krane Scholarship recognizes outstanding physics upperclassmen. The scholarship is possible due to the generosity of Dr. Kenneth S. (PhD 1970) and Mrs. Paula D. Krane.

Margie and Don Bottorff Undergraduate **Physics Scholarship**

Faith Bergin

Andrew Burgess

Rachel Lee

Nicholas Spano

The Bottorff Scholarship is made possible by a gift from Ms. Celeste Bottorff (MS 1975). The scholarship is a 1-year award made to outstanding physics upperclassmen.

Purdue Physics and Astronomy Departmental Awards

Robert Gustafson Grace Bowling Gozde Iloglu William Casey Moira Andrews Ethan Zweig

College of Science Honors Convocation Student Honorees

Darrell Fischer - Freshman Allison Earnhardt - Sophomore Matthew Schulz - Junior Andrew Santos - Senior



2020 Raman Prize

The Raman Prize recognizes a Ph.D. student or recent alumni for their outstanding dissertation. The award was made possible through the generosity of Anant K. Ramdas, the Lark-Horovitz Distinguished Professor of Physics and Astronomy (emeritus), and his wife Vasanti Ramdas.

Katherine Schreiber

Katherine Schreiber completed her PhD at the Purdue Physics and Astronomy Department in May 2018. She was nominated by her PhD Advisor, Dr. Gábor Csáthy, and Dr. Yuli Lyanda-Geller, and Rui-Rui Du, Prof. of Physics and Astronomy at Rice University.

Zhujing Xu | Karl Lark-Horovitz Award

Our Department's most prestigious graduate student honor, the Lark-Horovitz Award recognizes outstanding research accomplishments. The award is possible through the generosity of the faculty as well as the family, friends, and associates of Prof. Lark-Horovitz in memory of his great contribution to the growth and development of the Department of Physics and Astronomy.

Francis F. Walz | Gabriele F. Giuliani Award

Established in 2013 in memory of Prof. Gabriele F. Giuliani, this award honors excellence in teaching by first- or second-year graduate students. These graduate students show dedication and dependability, and, like Professor Giuliani, demonstrate a passion for physics that contributes to a rich learning environment.

Rui Xiao | George W. Tautfest Award

This award honors outstanding physics graduate students in high energy particle physics, high energy nuclear physics, or astrophysics. Prof. Tautfest was the leader of the Purdue High Energy Physics group until his death in 1967 at age 41. The award was established in 1969 by his colleagues and the Purdue Alumni Foundation.

Tzu-Han Chang | H.Y. Fan Award

The Fan Award recognizes outstanding graduate research in condensed matter physics, biological physics, or AMO physics. The award was established in recognition of Prof. Fan's many contributions to condensed matter physics, particularly in the area of infrared studies of semiconductors, and to the Department of Physics and Astronomy.

Yang Cao | Charlotte Ida Litman Tubis Award

The Charlotte Ida Litman Tubis Award was established in her memory by her husband, Prof. Emeritus Arnold Tubis, to promote clear and concise communication of scientific ideas beyond the physics and astronomy community.

Alireza K. Ravari | **Dr. Warner Black Award**

The Black Award recognizes graduate students whose research has the potential to bring physics to the people and to help them improve their lives by using a deep knowledge of fundamental and applied physics to make practical and useful inventions that have a real and lasting impact.

Michael D. Higgins | Edward S. Akeley Award

This award recognizes outstanding physics graduate students in theoretical physicists. The Akeley Award is made possible through the generosity of Instructor Emeritus Anna M. Akeley.

GRADUATE STUDENT AWARDS

Amanda O. Harrison | Akeley-Mandler Award for **Teaching Excellence**

The Akeley-Mandler Award recognizes exceptional graduate student teaching assistants who excel beyond the mere requirements of the job, investing their effort to ensure that they provide the best education possible to their students. This award is made possible thanks to a gift made by Instructor Emeritus Anna Akeley in memory of her husband, Prof. Edward S. Akeley, and brother. Kurt Mandler.

Trang T. Nguyen | Lijuan Wang Memorial Awards

The Lijuan Wang Memorial award is given annually to one or more outstanding graduate student majors who promote the gender diversity of the department through participation in Women in Physics. Lijuan Wang was a graduate student in the department from 1989 until her untimely death in 1992.

Rolf Scharenberg Graduate Fellowship

The Rolf Scharenberg Graduate Fellowship was established in 2017 through the generosity of Wendell and Nancy Lutz. The fellowships allow first- or second-year graduate students to work with a research advisor for a summer prior to joining a research group permanently.

> Kiran Dixit Xinchao Zhou Jijun Chen Andrew J. Wildridge

Bilsland Dissertation Fellowship

The Bilsland Dissertation Fellowship provides support to outstanding Ph.D. candidates in their final year of writing.

> Rui Xiao Alireza Bavari Karbkhsh Shivam Gupta Tingting Shen



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FOLLOW ALONG WITH PHYSICS AND ASTRONOMY

Faculty of Purdue University have created ways for people at home to take in pieces of their favorite sciences throughout the year. The Department of Physics and Astronomy has something for every age group to ensure that the persistent pursuit of our physical world is within reach.

Saturday Afternoon **Astrophysics (SMAP)**

The Department of Physics and Astronomy has a dedicated K-12 outreach program. One of the charter programs for outreach is Saturday Morning Astrophysics (SMAP), which is a monthly on-campus program for middle and high school students. Because of the pandemic, SMAP had to change course from in-person to remote learning. For this reason, David Sederberg, created a youtube channel (youtube.com/channel/ UCCfaznZ8tJONEItYH8GBQNg) and a twitter account (@PhysAstroK12). These will both help teachers and students who have been forced by to stay home stay connected with physics and astronomy.





SMAPShots - Saturday Morning Astro at Purdue



Quantum Coffeehouse

Are you in need of a coffee break and quantum physics broken down into bite-sized nuggets? Then look no further than the Quantum Coffeehouse by Dr. Erica Carlson, 150th Anniversary Professor of Physics and Astronomy. Check out her youtube channel created for the Purdue Quantum Science and Engineering Institute that presents quantum physics lessons, special guest speakers, and novel examples of quantum mechanics at voutube.com/QuantumCoffeehouse.





For the latest news in research at the Purdue University Department of Physics and Astronomy, visit physics.purdue.edu/news



2020 ALUMNI AWARDS



Yok Chen Distinguished Alumni 2020 1966 PhD

Yok Chen is a retired program manager with the Department of Energy, Office of Basic Energy Sciences and the Division of Material Science. He also worked at Oak Ridge National Laboratory and since 1972, an APS Fellow. Other accomplishments include 240 peer-reviewed publications, 6 patents related to crystal growth, edited two books, co-discoverer of positronium hydride. His research interests include: radiation effects; laser materials; high-temperature materials; redox effects; and spectroscopy and transport of hydrogenic isotopes in oxides; crystal growth; fission and fusion materials; optical spectroscopy (absorption and luminescence); electron paramagnetic resonance; and defect structures. Invited guest of the Academy of Sciences of the USSR (former), Bulgaria, Siberia, Spain, Taiwan, China and Mexico.

Yok Chen is proud to have been the graduate student of Karl Lark-Horovitz (July 20, 1892 – April 14, 1958), an American physicist known for his pioneering work in solid-state physics that played a role in the invention of the transistor. Yok is assumed to be the last person to have spoken with Karl before he passed away at his desk one night at Purdue. Yok also remembers AK Ramdas as a post-doctorate student and then assistant faculty member.



Bruce Schechter

Distinguished Alumni 2020 1980 BS

Bruce Schechter is an advisor, consultant or investor in a variety of technology startups, including Life360, BigML, Illumeo, SHIFTMobility, 3PointData, and Treasury Curve. He is a member of the Band of Angels, Silicon Valley's oldest organized Angel investor organization. Bruce began his career at Intel Corporation in 1980 and there he served a 17 year tenure in a variety of roles including Fab Process Engineering, Microprocessor Product Management, Technical Assistant to the Sr VP of Corporate Strategy, and Director of Online Marketing in the Corporate Marketing Group. Bruce was on the founding team of Pandesic LLC, a pioneer eCommerce application service provider, where he served as Director of Operations Management and then Director of Strategic Alliances. Bruce is active in mentoring student entrepreneurs at both Stanford University and Purdue University, and is active in non-profit work, including his role as founder and President Emeritus of the Intel Alumni Network and as co-founder and past co-chairman of Purdue SVBIG (Silicon Valley Boilermaker Innovation Group). He received a BS in Physics and Math from Purdue University, where he graduated with Highest Honors and Phi Beta Kappa, and MUCH later he received an MS in Computer Science from Stanford University.

Physics and Astronomy welcomes Directory of Development Star Murray

Howdy!

I'm so very excited to join Physics and Astronomy! My official duties as director of development began on March first and I'm eager to learn about and collaborate with our alumni.

My first career after attending Northern Michigan University was in pre-college and early-college programing. Getting to witness young students transition into young adults was life-changing for me. There isn't quite another time in a person's life such as the time in undergrad or grad school. The academic and personal growth, away from parents and other familiar comforts, is exponential. The ability to watch that growth first-hand was remarkable. Although my career has taken me down a different path, the absolute best thing about this job is getting to hear alumni share their stories of that time in their life.

As I begin the amazing journey in Physics and Astronomy, I'd love to hear about your time in the dorms, in your labs, the best professors, the best place to grab a coffee and study, and how Purdue helped you grow as a person. I hope you are willing





Mario J. Paniccia

Ph.D. Physics '94

Mario Paniccia has been elected into the National Academy of Engineering (NAE). He is the CEO of Anello Photonics, which focuses on developing a new type of sensor for the autonomous market based on silicon photonics. He was elected to the academy in recognition of his contributions to ingerated silicon photonic devices and their commercialization.



to share your story. I'm eager to listen. Feel free to email me any time at *ssmurrary@prf.org*.

Boiler Up! - Star







The science of painting cats

By Cheryl Pierce

A life's journey in science can branch out into many avenues. Mary Clark, Purdue Physics alumna, graduated in 1959 with a major in Physics and minors in Math and Chemistry. This education gave her a solid foundation for a long and rewarding career in science. She spent 40 years in the computer industry with a career spanning programming, systems operation, database maintenance, web design, and graphic design. All of these avenues prepared Clark for her latest career highlight: painting cats.

Clark was gifted in the sciences. After all, she was granted a Westinghouse Science scholarship from her high school. These scholarships could identify a budding scientist and help them pay their way through to a college degree. But she was also a gifted artist. At the time she attended Purdue, senior skirts and cords were especially popular. Students painted them so that each senior had a unique memento of their stay at Purdue.

Mary drew on her artistic ability to draw and paint skirts for friends and "dorm gals." She was often paid for her talent and this plus her scholarship and a part time job helped her pay her way through her undergraduate degree. Now, after a life-long rewarding career in the computer industry, Clark has circled back to her love of artistry, and it all started by painting those skirts. Now she paints whimsical cats and commissioned pet portraits.

"My first job out of college was at Lockheed in Burbank, CA doing programming related to their aircraft. I then transferred to Lockheed's Space Program in Sunnyvale and programmed. I always did some type of mathematical programming -with the space program, for IBM in San Francisco when they introduced the first disk drive (it was huge!), at UC Berkeley, Lockheed Marietta and more!" says Clark. "After I married, my husband changed jobs to move 'up the ladder' and I moved along, finding jobs in the computer field. Often I was the only woman programmer. Eventually, I ended up learning to setup and maintain databases and websites. Along the way, I obtained two Master's degrees: Marriage and Family Counseling and Leadership and was a Marriage and Family Counselor for a few years; eventually going back to computers."

It's interesting that Clark ended up in a computer programming field. At the time she attended Purdue, the university did not yet have a computer. But an education at Purdue can take a student a long way in the interview

process.

"I feel my education at Purdue is what encouraged Lockheed to hire me and train me as a programmer," says Clark. "I love detail and solving problems, so the job was perfect for me. I feel very fortunate to have worked almost 40 years in the computer field; it gave me a sense of confidence with many computer programs."

Clark always had an appreciation for art, even though it wasn't encouraged at home as a child. She has two adult children and always found ways to work arts and crafts into her parenting. Soon she was helping the neighborhood kids with projects. It was a passion that did not conflict with her career in science, it complimented it.

"I use is my computer skills to perhaps draw up an idea in Photoshop or to play with colors in Paint or other programs," says Clark. "I feel very fortunate to have worked almost 40 years in the computer field; it gave me a sense of assurance with many computer programs."

Her scientific training also lent her an eye for detail. Because of her scientific background and interest in painting, Clark obtained a certificate in Botanical Art and Illustration from the Denver Botanic Gardens in 2008. Botanical art is highly detailed plant paintings that are required to be scientifically accurate. After painting botanicals for a few years, her eyes had changed and the detail work added ocular stress so she switched to oil painting, and painting cats.

"A friend talked me into to taking classes at Park Hill Art Club," says Clark. "In my first class, we were to paint ten to twelve paintings in a series. At the time, I was volunteering at a large animal shelter so I choose to paint twelve shelter cats. The rest is history. I am an oil painter and paint primarily cats: whimsical, abstract, and realistic." She still volunteers at the animal shelter and sees cats come in who weren't wanted or left outside as people move. At first, she was mainly painting those shelter cats. According to Clark, she paints cats to encourage people to see cats other than a throw away object.

Now Clark paints all sorts of animals. Her art has been featured in many shows. She has taken part in many art fairs and she currently belongs to a gallery and several art guilds. Though the pandemic has slowed the galleries and shows, Clark's art can be seen in her online gallery, paintingcats.com. She still paints shelter cats in addition to commissioned portraits.

Clark's experience teaches that, though a person may have a variable skill set, it is all connected. Her scientific initiative and artistic talents compliment one another with each whimsical brush stroke.



Mary Clark, Purdue Physics alumna, graduated in 1959 with a major in Physics and minors in Math and Chemistry. Photos provided by Mary Clark.





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BOILER UP!



DEGREE RECIPIENTS DECEMBER 2019 - AUGUST 2020

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Ali T. Al-Keldi, Bachelor of Science Nathaniel R. Essington, Bachelor of Science Andrew J. Fahrenbach, Bachelor of Science Adam M. Guerin, Bachelor of Science Jacob M. Laster, Bachelor of Science Yang Cao, Master of Science Amanda L. Depoian, Master of Science Zhenyu Xu, Master of Science Fan Zhang, Master of Science Haotian Zhou, Master of Science Xiaoling Zhai, Doctor of Philosophy Xuhui Zhou, Doctor of Philosophy

Spring 2020

James L. Allan, Bachelor of Science Michael E. Anderson, Bachelor of Science Sandeep Baskar, Bachelor of Science Ashton A. Bitters, Bachelor of Science Katherine E. Broad, Bachelor of Science Mitchell D. Brown, Bachelor of Science JiaSheng Cao, Bachelor of Science Rebecca A. Carmack, Bachelor of Science Agamdeep S. Chopra, Bachelor of Science Ryan M. Coffman, Bachelor of Science Brody K. Conner, Bachelor of Science Alexander A. Couturier, Bachelor of Science Farhad De Sousa, Bachelor of Science Frank M. DiBartolomeo, Bachelor of Science Matthew A. Doniere, Bachelor of Science Sean C. Egloff, Bachelor of Science Diana M. Forbes, Bachelor of Science Nicholas J. Hilgert, Bachelor of Science Yuchen Kan, Bachelor of Science Surkhab Kaur, Bachelor of Science Hosam Khalifah. Bachelor of Science Arman S. Kumar, Bachelor of Science Kehan Liu, Bachelor of Science Brian H. Long, Bachelor of Science Ray S. Mattes, Bachelor of Science George A. Mitchell, Bachelor of Science Andrew D. Santos, Bachelor of Science



DEGREES

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Summer 2020

Jacob L. De Souza, Bachelor of Science Kui Zhang, Master of Science James R. Nakamura, Doctor of Philosophy **Dohyung Ro**, *Doctor of Philosophy*

Fall 2020

Kira N. Graves, Bachelor of Science Cara J. Brookins, Bachelor of Science Connor M. Mohs, Bachelor of Science Hunter C. Small, Bachelor of Science Nicholas C. Spano, Bachelor of Science Simran S. Gurdasani, Master of Science Simitrios Krommydas, Master of Science Xiaobing Shi, Master of Science Sayan Basak, Doctor of Philosophy Teng Bian, Doctor of Philosophy Jian-Yu Chan, Doctor of Philosophy Alireza Karbakhsh Ravari, Doctor of Philosophy Antoine P. Martin, Doctor of Philosophy Troy A. Seberson, Doctor of Philosophy Rongxin Xia, Doctor of Philosophy **Zhenyu Xu,** *Doctor of Philosophy*

CONGRATULATIONS

TO OUR NEWEST ALUMNI!



Because of the pandemic, the way we teach changed all over Purdue University. Because we are Boilermakers, we kept going. Members of the PRIME Lab masked up to Protect Purdue and we were still able to teach and learn remotely and in-person during a year marked with challenges.

Pictured left to right: Lan Luo, Post-doc, Allie Koester, graduate student, Tom Woodruff, Head of Tandem Operations, Professor Marc Caffee, and Angus Moore, graduate student.



Department of Physics and Astronomy

525 Northwestern Avenue West Lafayette, IN 47907-2036 (765) 494-3000 | physics.purdue.edu **Purdue University College of Science**