2024 AAPT
WINTER MEETING

JANUARY 6-9 NEW ORLEANS, LA

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Facebook/Twitter at Meeting

We will be posting updates to Facebook and Twitter prior to and during the meeting to keep you in the know! Participate in the conversation on Twitter by following us at twitter.com/AAPTHQ or search the hashtag #aaptwm23. We will also be posting any changes to the schedule, cancellations, and other announcements during the meeting via both Twitter and Facebook. Visit our Pinterest page for suggestions of places to go and things to do in the Portland area. We look forward to connecting with you!

Facebook: facebook.com/AAPTHQ **Twitter** twitter.com/AAPTHQ **Pinterest:** pinterest.com/AAPTHQ

Katherine Mack Recognized as 2024 Recipient of the Richtmyer Memorial Lecture Award

Katherine (Katie) Mack

Dark Matter: The Cosmic Mystery at the Heart of Particle Physics

Monday, January 8
11:30–12:20 p.m.

St. James - 3rd Floor

Katherine (Katie) Mack has been selected to receive the 2024 Richtmyer Memorial Lecture Award. She is recognized with the award for outstanding contributions to physics and for effectively communicating those contributions to physics educators. The following citation from the Awards Committee will be used for the award:

"For significant efforts in promoting the interest in and understanding of cosmological research and discovery, and for creating innovative, accessible connections with physics educators, Dr. Katie Mack is hereby named as the recipient of the 2024 Richtmyer Memorial Lecture Award."

Mack is a theoretical astrophysicist who studies a range of questions in cosmology, the study of the universe from beginning to end. She currently holds the position of the Hawking Chair in Cosmology and Science Communication at the Perimeter Institute. Throughout her career, she has placed an emphasis on sharing science with the broader public. A scientist whose research relies on public funding, she considers it part of her job to share her knowledge and expertise with people outside the world of science and academia. As part of her role, she frequently takes part in outreach activities (public lectures, school visits, mentoring events, videos, podcasts, etc) and makes herself available for interviews.

As @AstroKatie, she has amassed a Twitter following of more than 400,000. Her popular writing (https://www.astrokatie.com) has appeared in major publications including Scientific American, Slate, Sky & Telescope, Cosmos, BBC Science Focus, The New York Times, and The Wall Street Journal. In 2020, she released her first book "The End of Everything (Astrophysically Speaking)" which examines five ways the universe could end and the mind-blowing lessons each scenario reveals about the most important concepts in cosmology. It was named a New York Times Notable Book of 2020 and continues a storied tradition of science communication of which Hawking himself is perhaps the most known example.One of Mack's nominators noted, "[Dr. Mack]..deftly breaks down complex topics and uses simple wording and analogies to help them understand. Because of this, many physics teachers (both high school and post-secondary) and physics students follow her on Twitter."

Named for Floyd K. Richtmyer, distinguished physicist, teacher, and administrator and one of the founders of AAPT, the Richtmyer Memorial Lecture Award recognizes those who have made outstanding contributions to physics and their communication to physics educators. The recipient delivers the Richtmyer Lecture at an AAPT Winter Meeting on a topic of current significance and at a level suitable for a non-specialist audience and receives a monetary award, an Award Certificate, and travel expenses to the meeting.

Mike Florek and Saara Naudts Will Receive 1st Barbara Wolff-Reichert Travel Grants

Sunday, January 7
6:20–6:30 p.m.

St. James - 3rd Floor

The first recipients of the Barbara Wolff-Reichert Travel Grant have been selected.

Mike Florek is finishing his seventh year as a high school physics teacher with Roanoke County Public Schools. His primary school is Glenvar High School in Salem, VA, but he travels to teach classes at William Byrd High School (Vinton, VA) and Glenvar Middle School (directly connected to the high school). His course load each year has included AP Physics (which he teaches as a hybrid of AP 1 and AP C: Mechanics) and a General Physics course. He has also taught: Geometry, Advanced Geometry, College-Bound Chemistry, and 8th Grade Physical Science. Florek's education career began as a summer camp educator with the Science Museum of Western Virginia in Roanoke, VA, which turned into museum education and outreach, a brief stint running planetarium shows, and eventually graduate school for a classroom teaching license. Prior to this, he trained and worked (briefly) in civil engineering. He earned a B.S. and an M.S. in Civil Engineering – Water Resources focus from the University of Nebraska at Lincoln and an M.A. in Teaching – Secondary focus from Hollins University.

Saara Naudts was born and raised in Belgium. Her father always encouraged her to think outside the box. After high school, she moved to Canada and continued to pursue her interests in STEM. In 2004, Saara started teaching physics in the Peel District School Board in Ontario, Canada and has been passionate about Physics Education Research (PER) and advancing the teaching of physics ever since. Naudts is the incoming president of the Ontario Association of Physics Teachers (OAPT) and works with the Perimeter Institute for Theoretical Physics (PI) Outreach Team as the Teacher Network Regional Coordinator for Ontario. Throughout the years, these outreach involvements have allowed her to facilitate many PER related workshops, review PI's award-winning resources, and be part of an international network of teachers who, in turn, reach millions of students worldwide. This year, Naudts chaired the annual OAPT conference, an exciting 3-day event connecting science educators from all over Ontario. She was also selected to facilitate PI's Einstein Plus, a one-week intensive workshop for Canadian and international high school teachers that focuses on modern physics including quantum physics, special relativity, and cosmology. Naudts is a lifelong learner as demonstrated by completing a Master of Education degree with a focus on PER in 2021, for which she received a Medal of Academic Excellence. She has big ideas and loves learning from physics teachers around the world about best practices to get students interested in physics and STEM fields.

Laura H. Greene

Physics Education Beyond the Classroom

Sunday, January 7
11:30 a.m.–12:30 p.m.

St. James - 3rd Floor

2024 Oersted Medal Awarded to Laura H. Greene

Laura H. Greene is the 2024 recipient of the prestigious Hans Christian Oersted Medal. The Oersted Medal recognizes her outstanding, widespread, and lasting impact on the teaching of physics.

Greene is Chief Scientist at the National High Magnetic Field Laboratory and the Marie Krafft Professor of Physics at Florida State University. She was previously the Swanlund and the Center for Advanced Study Professor of Physics at the University of Illinois at Urbana-Champaign. Her undergraduate studies were at The Ohio State University, and after receiving her PhD at Cornell University, she was a post doc at Bell Labs then a member of staff at Bellcore.

In September 2021 Greene was appointed by President Joseph R. Biden to serve as a member of the President's Council of Advisors for Science and Technology (PCAST), which directly advises him on matters of science and technology including STEM education.

As a leading advocate for diversity in science, a champion for women in science and engineering, science diplomacy, ethics, and human rights, she has held leadership roles in many science organizations nationally and internationally, including the 2017 president of the American Physical Society (APS), the Board of Directors for the American Association for the Advancement of Science (AAAS), and is the Vice President for Ethics and Outreach of the International Union of Pure and Applied Physics (IUPAP). She has been a member of the State Department-supported COACh team, and continues to promote the success and impact of women and minority scientists, particularly in developing countries, through their workshops which include negotiation, leadership, networking, publishing, and communication skills.

Greene's own research is on quantum materials, focusing on the fundamental studies of novel materials and their synthesis, and the mechanisms of unconventional superconductivity. She has co-authored over 200 publications and has presented over 700 invited talks.The scientific community has recognized Greene's scientific excellence with many awards and honors. She is a member of the National Academy of Sciences and the American Academy of Arts and Sciences and is a fellow of the Institute of Physics (U.K.), the AAAS, and the APS. She received the Tallahassee Scientific Society Gold Medal Award and the American Physical Society Five Sigma Physicist Award for Advocacy in Science Policy has been a Guggenheim Fellow, was awarded the E.O. Lawrence Award for Materials Research from the U.S. Department of Energy, the APS Maria Goeppert-Mayer Award, and the Bellcore Award of Excellence.

Named for Hans Christian Oersted, the Oersted Medal recognizes those who have had an outstanding, widespread, and lasting impact on the teaching of physics. The recipient delivers an address at an AAPT Winter Meeting and receives a monetary award, the Oersted Medal, an Award Certificate, and travel expenses to the meeting. The award was established in 1936.

Sanlyn Buxner

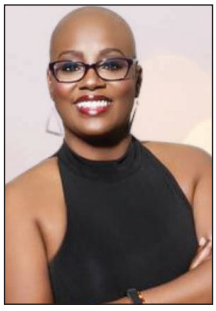
Tuesday, January 9
9 a.m.–9:50 a.m.

St. James - 3rd Floor

2024 Winter Meeting Plenary Speaker Sanlyn Buxner

Sanlyn Buxner is a Senior Research Scientist and Senior Education and Communication Specialist at the Planetary Science Institute in Tucson, Arizona. She is also an Associate Research Professor in the Department of Teaching, Learning, and Sociocultural Studies at the University of Arizona where she serves as a director of graduate studies. She serves as the Public Engagement Lead for the SSERVI TREX node and the Director of Broader Impact for the NASA SHIELD DRIVE Science Center. She is an active science education researcher, her research areas include: investigating the impact of research experiences on K-12 teachers and students and undergraduate students; understanding and improving of undergraduate experiences and outcomes in general education and major-level STEM courses; supporting and diversifying graduate students in STEM; supporting K-12 students and teachers in out of school informal education spaces; and understanding the role of supporting community science on empowering communities. She is the co-chair of the AAS Education Committee, recent past Education Officer of the Division for Planetary Sciences, and serves on the Education Executive Committee of the American Geophysical Union. She has co-authored over 40 peer-reviewed journal publications as well as numerous conference papers and presentations, and book chapters, and co-authored and edited several books in astronomy education.

Winter Meeting Plenary Speaker K. Renee Horton



K. Renee Horton

Sunday, January 7

5:30–6:20 p.m.

St. James - 2rd Floor

K. Renee Horton is a native of Baton Rouge, Louisiana, and a lifelong lover of science and NASA. A graduate of Louisiana State University with a B.S. in Electrical Engineering with a minor in Math in 2002 and a Ph.D. in Material Science with a concentration in Physics, becoming the first African American to graduate from the University of Alabama in 2011 in this area.

K. Renee Horton currently serves as the Electrified Powertrain Flight Demonstrator Project (EPFD) Airworthiness Deputy at NASA's Michoud Assembly Facility in New Orleans. She worked for NASA, first as a student from 2009 to 2011, and then started her career as a mechanical test engineer in 2012.

In 2016, Renee was elected President of the National Society of Black Physicists (NSBP) as the second woman to hold the office. She has served the physics community abroad as a member of the International Union of Pure and Applied Physics (IUPAP) Women in Physics Working Group and currently serves on several advisory boards dedicated to a more diverse inclusion in physics. In 2017, she was elevated to a Fellow in the NSBP, which is the highest honor bestowed upon a member.

Renee has been an invited speaker for the first International Women and Girls Day at the United Nations, Essence Power Stage, March for Science – New Orleans, and recently the LSU Engineering Spring Commencement. She has spoken all over the world including South Africa, Brazil, South Korea, Canada, Mexico, and the beautiful Virgin Islands. She is the author of Dr. H Explores the Universe, Dr. H and her Friends, and Dr. H Explores the ABCs.

Exhibitors at the Meeting

- AAPT Membership
- AAPT Nominating Committee
- AAPT Publications
- AFM Workshop, Inc.
- Digitalis Education Solutions
- Kudu
- LIGO
- PASCO scientific
- Society of Physics Students
- Vernier Science Education
- Wiley

Homer L. Dodge Citations for Distinguished Service to AAPT

Sunday, January 7 • 6:20–6:30 p.m. • Location: St. James – 3rd Floor

Tatiana Erukhimova

Tatiana Erukhimova

Tatiana Erukhimova, a member of AAPT since 2015, Erukhimova has served in various roles on the Committee on Science Education for the Public and chaired this committee in 2020. She is an Instructional Professor and inaugural holder of Marsha L. and Ralph F. Schilling Endowed Chair in the Department of Physics & Astronomy, Texas A&M University, College Station, TX. Erukhimova exudes the AAPT enthusiasm for the study of physics through her numerous avenues of informal science outreach, including most recently being a TikTok and YouTube physics video maven. Her videos have attracted over 500 million views on departmental social media. She has supported the AAPT mission through her efforts to make physics accessible to all those interested in learning. As a physics education researcher, she has made efforts to quantify the impact of student engagement in physics educational outreach programs and has developed a robust set of course materials and student resources. Nominators noted "[she] has shown incredible enthusiasm and dedication to educating Texas A&M undergraduate students and providing them opportunities to grow outside of the classroom. These efforts also have had immeasurable benefits for graduate students, those in the surrounding community of Texas A&M, and beyond.

Jennifer Blue

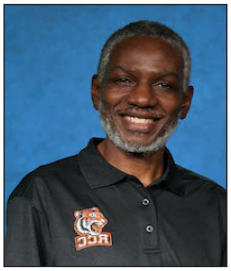
Jennifer Blue

Jennifer Blue has been a member of AAPT since 1995; she has served on the Committee on Women in Physics, the Nominating Committee, the Committee on Professional Concerns, the Programs Committee, and as a leader of the Southern Ohio AAPT Section. Regarding her selection to receive this citation, Blue said, "This is a great honor. AAPT has been my professional home since I was in graduate school, and I'm happy to be part of the great work the organization is doing."Blue is currently the Associate Dean, College of Arts and Science, and Professor of Physics at Miami University, Oxford, OH. Her work has impacted physics education and physics educators for over three decades. As a physics education researcher, she has supported the mission of AAPT by working diligently to enhance diversity, equity, and inclusion (DEI) in physics education with her research work and in service on AAPT committees. She is also active in the AAPT Southern Ohio section. Her work has been pivotal in inviting physicists in all stations to examine the state of DEI in the physics community.

Juan Burciaga

Juan Burciaga

A member of AAPT since 1992, **Juan Burciaga** has served on the Committee on Physics in Undergraduate Education, the Publications Committee as Book Editor, and the Books Committee. Burciaga is currently an adjunct at The Colorado College in Colorado Springs, CO. He has made significant contributions to the AAPT mission through his active engagement in moving forward the AAPT commitment to Diversity, Equity, and Inclusion, with special attention to Hispanic Serving Institutions, as an active member of the National Society for Hispanic Physicists. Burciaga has also devoted much of his work in AAPT to working to build the Physics for the Life Sciences (IPLS) area with his strong interest in the scholarship of teaching and learning. Nominators noted "It is hard to capture all Juan has done for physics education. His efforts have had a major impact and have connected different organizations – most notably the National Society of Hispanic Physicists and AAPT."; "Juan truly embodied inclusive actions throughout this process [creation of inclusive curriculum in physics classes]. Students and significantly junior people were involved in the planning; throughout the workshop organizing, Juan worked to make sure these individuals were truly included in organizing the workshop without overburdening them."



Anthony Mwene Musumba

Tony Musumba

Tony Musumba is an Assistant Professor of Physics as Riverside City College in Riverside California. He earned his BSc and MPhil. in Physics at Moi University and his PhD in Physics at The University of Texas at Dallas (UTD). He has contributed to the mission of AAPT in a variety of areas aimed at professional development of physics educators around the country. A member of AAPT since 2008, Musumba became a member of the Committee on Diversity in Physics in 2014 and has been active in the Committee on Two Year Colleges. He is on the Editorial Board for The Physics Teacher through December 2025. He served as North Dakota Section Representative from 2013-2023 and served as a member of the AAPT Nominating Committee in 2017.

The Homer L. Dodge Citation for Distinguished Service to AAPT was established in 1953, was renamed in 2012 to recognize the foundational service and contributions of Homer Levi Dodge, AAPT's first president. The Homer L. Dodge Citation for Distinguished Service to AAPT recognizes AAPT members for their exceptional contributions to the association at the national, section, or local level.

Committee Meetings at Winter Meeting

All interested attendees are invited and encouraged to attend the Committee meetings with asterisks (*).

Friday, January 5

AAPT Board Meeting I	4–8 p.m.	Fulton
Finance Committee	8–9 p.m.	Fulton

Saturday, January 6

AAPT Board Meeting II	8 a.m.–12 p.m.	Fulton
Awards Committee	1–2 p.m.	Ascot
Meetings Location Committee	1–2 p.m.	Fulton
Meeting Planning Committee	2–4 p.m.	Fulton
Nominating Committee I	2–4 p.m.	Ascot
Publications Committee	2–4 p.m.	Royal
ALPhA Open Meeting	3–4 p.m.	Magazine
Membership and Benefits Committee	3–4 p.m.	Royal
MPC and Amp 24	3–4 p.m.	Fulton
Review Board	4–7 p.m.	Fulton
Section Representatives and Officers	4–5:30	Camp
Area Committee Leadership	8:30–9:30 p.m.	Fulton
Governance Structure Committee	8:30–9:30 p.m.	Ascot

Sunday, January 7

Graduate Education in Physics *	7:45–8:45 a.m.	Churchill C2
Physics in High Schools*	7:45–8:45 a.m.	Churchill A1
Physics in Undergraduate Education*	7:45–8:45 a.m.	Churchill B2
Space Science and Astronomy *	7:45–8:45 a.m.	Churchill A2
Teacher Preparation*	7:45–8:45 a.m.	Churchill B1
Interests of Senior Physicists*	7:45–8:45 a.m.	Churchill C1
Women in Physics*	7:45–8:45 a.m.	Churchill D
PERLOC*	7:45–8:45 a.m.	Acot

Monday, January 8

Apparatus*	7:45–8:45 a.m.	Churchill C2
Contemporary Physics*	7:45–8:45 a.m.	Churchill A2
International Physics Education*	7:45–8:45 a.m.	Churchill C1
Physics in Pre-High School Education*	7:45–8:45 a.m.	Ascot
Physics in Two-Year Colleges *	7:45–8:45 a.m.	Churchill A1
Research in Physics Education *	7:45–8:45 a.m.	Churchill B2
Physics Bowl Advisory	7:45–8:45 a.m.	Churchill D
PTRA Oversight Committee	7:45–8:45 a.m.	Churchill B1
Investment Advisory Committee	5–7 p.m.	own room
Bauder & Venture Fund	7–8 p.m.	Royal
History & Philosophy in Physics*	7–8 p.m.	Churchill C2
Diversity in Physics*	7–8 p.m.	Churchill B2
Educational Technologies*	7–8 p.m.	Churchill A1
Laboratories*	7–8 p.m.	Churchill C1
Science Education for the Public *	7–8 p.m.	Churchill A2
PERTG Town Hall *	7–8 p.m.	St. James

Tuesday, January 9

Programs Committee II	7:45–8:45 a.m.	Commerce

Exhibitor Listings

St. Charles – 3rd Floor

Saturday, 5:30–7 p.m.
Sunday, 10 a.m.– 5:30 p.m.
Monday, 10 a.m.–5 p.m.

AAPT Membership

AAPT® is a strong professional physics science society dedicated to the pursuit of excellence in physical science education. Want to know more about AAPT's mission, history, goals, and organizational structure? Stop by our booth to learn more and get involved!

AAPT Nominating Committee

The AAPT Nominating Committee strongly encourages interested AAPT members to submit a nomination for any Board of Directors or Area Committee position at any time during the year. Please stop by the booth to visit us and learn more!

AAPT Publications

AAPT® publishes two peer-reviewed journals and many other publications in both print and online. The *American Journal of Physics*® is geared to an advanced audience, primarily at the college level. *The Physics Teacher*® focuses on teaching introductory physics at all levels. AAPT eNNOUNCER is an online-only publication that summarizes recent news from the association, its members, its partners, and from the physical sciences world in general.

AFM Workshop, Inc.

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- Research-grade optics
- NI LabVIEW architecture
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- Easily interchanged scanners (15 µm, 50 µm; 100 µm)
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- Noise floor <35 pm
- Extensive AFM training and education resources for students and all users

AFMWorkshop offers the highest performance-to-price ratio in the industry! Over 300 labs around the world utilize our AFMs. Full systems can be purchased for less than $70,000.

Digitalis Education Solutions

Digitalis started the affordable digital planetarium revolution back in 2003. We are now the leading global manufacturer of these immersive simulators. A digital planetarium allows you to travel anywhere through time and space, making spatial concepts much easier to teach. Despite the name, you are not limited to astronomy topics. Using a fixed or portable dome, you can create mind-expanding shared immersive experiences for entire groups—no VR goggles required!

LIGO

LIGO, the Laser Interferometer Gravitational-wave Observatory funded by the National Science Foundation, achieved a groundbreaking milestone in 2015 by directly detecting gravitational waves, which led to a Nobel prize in physics in 2017. Beyond its scientific achievements, LIGO is dedicated to educational outreach. High school teachers are invited to learn about live virtual tours and upcoming professional development opportunities. University educators can use our open data sets, and undergraduates are welcome to apply for research opportunities. Visit LIGO's booth to discover these exciting opportunities, play with an interferometer, and more!

KUDU

Kudu creates high-quality learning materials integrated into a versatile learning platform and provides them at a fraction of the cost of available alternatives. We offer digital textbooks supplied with an auto graded online homework that includes AI hints and problems, high-quality videos and a 'clicker.' The courses are well aligned with modern teaching practices, making it easy for instructors to engage students in active learning. The digital 'textbooks' are fully editable, and professors can either use the content provided by Kudu or edit and customize any segment of the learning materials. Kudu is committed to supporting the academic ecosystem by offering student fellowships, sponsoring research conferences and other academic activities. We are committed to keeping up with modern teaching techniques including AI capabilities. If you want to join us in the development of modern, high-quality, low-cost learning materials, we look forward to hearing from you.

PASCO scientific

Students need modern tools and technology to succeed in STEM. At PASCO, we have been creating and manufacturing award-winning, hands-on science education tools and datalogging solutions since 1964. With our unique blend of dedication and experience, we think no one combines innovative, easy-to-use products with world-class support like we do.

Society of Physics Students

The Society of Physics Students (SPS) is a professional association explicitly designed for students and their advisers. Membership, through collegiate chapters, is open to anyone interested in physics. The only requirement for membership is that you be interested in physics. Besides physics majors, our members include majors in astronomy, chemistry, computer science, engineering, geology, mathematics, medicine, and other fields. SPS is open to everyone. Within SPS is housed Sigma Pi Sigma, the national physics honor society, which elects members on the basis of outstanding academic achievement. This unique two-in-one society operates within the American Institute of Physics, an umbrella organization for ten other professional science societies.

Vernier Science Education

We are a science education company dedicated to providing high-quality solutions for today's STEM classrooms. Our comprehensive solutions include hardware, software, content, assessment, professional development, and technical support. Together, they form the Vernier STEM Classroom.

Wiley

With a legacy spanning more than two centuries, Wiley is one of the world's largest publishers and a global leader in scientific research and career-connected education that is delivering on its mission to unlock human potential. Wiley works to fuel the global economy, advance society, and make a true impact on the lives of people around the world with industry-leading content, platforms, and knowledge networks. Today over 80% digital, Wiley continues to innovate to make knowledge and learning accessible and serve its customers' ever-changing needs. Its impact and investments toward the future include helping to solve social, economic, and environmental challenges.

2024 AAPT SUMMER MEETING

BOSTON, MA
JULY 6–10

SHARE YOUR IDEAS.

Join colleagues at the 2024 AAPT Summer Meeting in Boston, Massachusetts. This is your chance to surround yourself with physics educators from around the globe, while attending sessions and workshops, as well as participating in special activities designed with you in mind. Don't miss your opportunity to learn from and network with leaders in the field.

AAPT PHYSICS EDUCATION®

LEARN MORE AT: https://aapt.org/Conferences/SM2024/

Phone: 301-209-3311 Email: programs@aapt.org

Saturday, January 6, 2024 8 a.m.–12 p.m.

WK-01 Inclusive Astronomy Education: Bridging Gaps for Diverse Learners}

The NSF-supported Big Astronomy project has developed an extensive catalog of freely available resources tailored to serve both formal classroom and informal learning environments. Additionally, in keeping with our commitment to inclusivity, we have expanded our focus to encompass research and resource development for the Deaf/Hard-of-Hearing (DHH) and Blind/Low Vision (BLV) communities. This hands-on workshop will supply educators with effective strategies for engaging and instructing diverse learners. The workshop will explore themes such as inclusive astronomy pedagogy, evidence-based best practices for engaging DHH & BLV learners, teaching multiwavelength astronomy, and promoting diverse STEM careers to improve STEM identity among a broad spectrum of individuals. All participants will receive a carefully curated selection of tactile and hands-on activities, supplemented by a wealth of digital resources. Join us and gain the resources needed to foster a more inclusive learning environment, promote equity, and kindle a passion for astronomy among a wider array of students. For further insights into our initiatives and available resources, please visit Bigastronomy.org.

Organizer(s}: Tiffany Stone Wolbrecht, Renae Kerrigan

Location: Churchill A1

WK-02 Learning how to use Augmented Reality Simulations in your Physics Courses

In this workshop, you will learn about various strategies to incorporate both Augmented and Virtual Reality in the Physics classroom. We highly recommend you bring a laptop and a phone that you can download apps on. Some of these simulations are in the process of being created so you will have a chance to input what you think would make a good simulation while others are existing programs/simulations available. You will also learn how to enhance your own lessons through Augmented reality so bring a lesson you would like to enhance.

Organizer(s): David Rosengrant, Garret Matthews

Location: Churchill A2

WK-03 LHC Physics in the Classroom

Students who complete an introductory physics course may be under the impression that physics somehow "stopped" in the late 19th or early 20th century. Of course, this idea could not be further from the truth, as physicists today continue to work on addressing an ever-growing list of unsolved questions: Where has all the antimatter gone? What is dark matter? What is dark energy? (What questions have we not thought of yet?) Physicists from all over the world work to address these and many other questions at the Large Hadron Collider (LHC) at CERN, on the border of Switzerland and France. This workshop will focus on how teachers can tap into the excitement of LHC physics to both motivate students and provide a contemporary context for them to engage with topics and practices covered in introductory physics courses, including (but not limited to) conservation laws, data collection, organization, and analysis, and making claims based on evidence. Participants in this workshop will alternate between "student mode" and "teacher mode", will analyze authentic LHC data, and will get a chance to work through some activities from QuarkNet's Data Activities Portfolio. The workshop will conclude with a discussion on classroom implementation. Some of the activities will be computer-based, so please bring along a laptop!

Organizer(s): Shane Wood

Location: Churchill B1

WK-04 Preparing for the Great American Eclipse

Hands-on guided inquiry activity to help students and teachers understand the geometry of solar eclipses in preparation of the Great American Eclipse of April 2024.

Organizer(s): Tony Musumba, Rod Milbrandt

Location: Churchill B2

WK-05 Quantum Computing: What's the Buzz?

Are you interested in learning more about Quantum Computing? Have you been asked to teach it or introduce some of the concepts into courses you are already teaching? What's the state of the field anyway? Do you just want to be more informed about this fascinating, relatively new field? Should it be taught in Physics or Computer Science or Chemistry or Math or all of them!? If you find yourself interested in these questions, this workshop is for you. We will give an overview of the present state of the field, present an introduction to Quantum Computing, including discussion of our experiences learning the topics and teaching them, course coverage, format, and learning materials, research we have done on student strengths and difficulties in learning quantum computing topics, and the development of evidence-based materials to teach the course. We will share information on freely available online resources, our own evidence-based materials, and possible texts. We will focus on an undergraduate course, but it will be relevant for classes above and below that level, too. Participants should bring their own internet-enabled laptop.

Organizer(s): Beth Thacker, Tunde Kushimo

Location: Churchill C1

Saturday, January 6, 2024 1–5 p.m.

WK-06 Writing for and Contributing to the Living Physics Portale

The Living Physics Portal (LPP) is an effort by the physics and biology faculty and PER/BER researchers to design, develop, and disseminate new curricular materials for the courses in introductory physics for the life sciences. The first part of the workshop will focus on finding, adapting, and using curricular resources on the LPP. Several sample key resources will be identified and studied. The last part of the workshop is designed to introduce the concepts, practices, and standards of educational scholarship. Faculty who adopt curricular resources from the LPP or other sources will therefore be better able to offer insightful critiques to the developers of the curricular resources. Interested faculty may also learn how to develop curricular materials for their own classrooms for use by the LPP community. Attendees will find having a laptop useful but not required.

Organizer(s): Juan Burciaga

Location: Churchill A1

WK-07 PICUP: Integrating Computation in Introductory Physics Courses

In this workshop, we will show you some ways in which computation can be integrated into your introductory courses. The PICUP partnership has developed a variety of computational activities for introductory physics, and we will show you how you can take these PICUP materials and adapt them to fit your needs. PLEASE BRING A LAPTOP COMPUTER. In this workshop, we will focus on computational activities using spreadsheets and web-based "Trinkets" so you do not need to have any specialized software installed.

Organizer(s): Aaron Titus

Location: Churchill A2

WK-09 AP Physics Course Revisions for Fall 2024

The 2024-25 school year will introduce a new, common, exam format for all AP physics courses, as well as some curricular modifications for each course. This includes a smaller set of science practices, consistent across all four courses. The workshop will familiarize teachers with the new curricula. It will take a deep dive into the key features and major differences between the new curriculum and its predecessor, focusing on science practices. Attendees will develop skills to adapt and implement the new curriculum in their classrooms. The revised exams will be reviewed and participants will work through case studies with sample questions tied to each science practice. Strategies to prepare students will be discussed and modeled.

Organizer(s): Amy Johnson, John Pinizzotto, Jesse Miner

Location: Churchill B2

WK-08 Equity in STEM: Exploring the Underrepresentation Curriculum (1-4 p.m.)

Over the last few years, there has been a push to integrate computational modeling in the introductory physics curriculum. This is a workshop The Underrepresentation Curriculum is a free, open, modular, teacher-created resource that supports high school and college science instructors in empowering students to examine issues of equity, identity, and justice in society and in STEM. This workshop will introduce the curriculum by engaging participants themselves in the learning activities (e.g., discussing the role of objectivity and subjectivity in science and analyzing data about disparities in representations of certain groups of people). The workshop will familiarize participants with the support materials available and make space for exploration. Finally, participants will have the opportunity to discuss how the curriculum can be implemented in their classrooms, and collaborate with other instructors to create viable actions beyond the workshop.

Organizer(s): Elissa Levy, Abigail Daane

Location: Churchill B1

Saturday, January 6, 2024 8 a.m.–5 p.m.

WK-10 Phenomenon-Driven Inquiry in OpenSciEd HS Physics

This workshop introduces physics teachers to the OpenSciEd HS Physics model through an experience in "student hat" of an anchoring phenomenon, followed by an overview of what it means for a storyline to be coherent from a student's perspective in physics. The curriculum we would use is completely free and open-source (available at openscied.org). Participants are asked to show up ready to engage with their peers. No advanced preparation is needed. A $20 organizer fee has been added to help cover the cost of workshop materials.

Organizer(s): Zoe Buck Bracey, Diego Rojas-Perilla, Laura Zeller, Whitney Mills, Kate Henson

Location: Churchill C2

WK-11 Robotic Telescope Labs for Survey-Level Undergraduates

Participants should bring their own computer. In this workshop, participants will be given accounts on both the Skynet global telescope network and the image processing and analysis software, Afterglow Access, as well as observing credits on Skynet. We will learn how to queue observations on Skynet, and will carry out multiple OPIS! (Our Place in Space!) and MWU! (MultiWavelength Universe!) observing experiences throughout the day. OPIS! is built around the cosmic distance ladder, which serves as an organizing principle in many introductory astronomy courses/sequences, and as such, it reinforces students' classroom experiences. The goal of OPIS! is to move beyond laboratory experiences in which students learn how to use a telescope for its own sake to instead use it to do science - the same science that they are learning in class. MWU! is for students who have already completed OPIS!, and is able to provide this smaller group of students with more telescope time per student, making possible color- and radio-mapping, inquiry-based explorations. MWU! currently consists of ten explorations, with more being developed, and uses both Skynet's optical and radio telescopes, as well as archival infrared data, to study the solar system, stars, and galaxies. The curriculum also focuses on light-producing mechanisms, and astrophotography serves as its "hook"..

Organizer(s): Rachel Freed, Dan Reichart

Location: Churchill D

ASTRO Posters (6–7 p.m., Saturday)

SAT-POSA-201 | Poster Presentation Traditional | Radio JOVE 2.0: Radio Astronomy at a Small College

Presenting Author: Nicole Gugliucci, Saint Anselm College
Additional Author | Michael Rochette, Saint Anselm College

The Radio JOVE project allows students, educators, and citizen scientists to contribute observations of the Sun and Jupiter at low frequencies (15-30 MHz). Traditionally, Radio JOVE telescopes have measured only one channel in a narrow range of frequencies, but Radio Jove 2.0 introduces a wide-band receiver consisting of a commercially available software defined radio. At Saint Anselm College, we are deploying Radio JOVE 2.0 at our observatory site over the fall semester. This presentation will showcase the construction of a more stable, steel-based dual-dipole to replace the PVC constructed version, the testing and deployment of the wide-band receiver, and a first look at the wide-band RFI environment and telescope sensitivity. Students at Saint Anselm College have used the original Radio JOVE in an afterschool high school program to teach students the fundamentals of radio astronomy using the published educational materials. We will give an update on our progress assessing this telescope and new data collection process in light of that, with the goal of developing projects for undergraduate students and activities that can be used at the high school level.

SAT-POSA-205 | Poster Presentation Traditional | The Animations for Physics and Astronomy Project at Penn State Schuylkill

Presenting Author: Michael Gallis, Penn State Schuylkill

The Animations for Physics and Astronomy Project has been producing short visuals for key topics in introductory courses for over 20 years. Materials are released as Open Education Resources under a Creative Commons license. As a measure of impact, the project YouTube channel has garnered over 6 ½ million views in the channel's 18-year history. In this poster we will present a brief history of the project and its products as well as some recent work. We will also discuss some opportunities available through evolving and in emerging technologies. Finally, we will outline some future efforts to enhance accessibility of the project's creations.

SAT-POSA-207 | Poster Presentation Traditional |Using Real LVK Data for Gravitational Wave Education

Presenting Author: Logan Selph, University of North Carolina at Chapel Hill
Additional Author | Daniel E Reichart, University of North Carolina at Chapel Hill

Analyzing the structure of merging binaries is a very computationally expensive task involving thousands of different models being fit to datasets produced by the LVK interferometers. These models allow us to calculate many different characteristics of binary black hole and neutron star systems, including total mass, merger mass, mass ratio, spin, and distance. Our gravity plotting tool allows students to conduct their own smaller version of the LVK gravitational wave search with real data taken from the interferometers. This is done using a smaller library of pre-generated models, which students can fit to both frequency and time domain merger data, letting them calculate the system merger time, total mass, mass ratio, and distance. This tool produces results consistent with the findings posted in the GWOSC database and is designed to be used within the Multi-Wavelength Universe! (MWU!) curriculum designed by Skynet.

SAT-POSA-209 | Poster Presentation Traditional | Clustermancer: A Web-based Analysis Tool for Education and Research of Star Clusters

Presenting Author: Ruide Fu, University of North Carolina at Chapel Hill
Additional Author | Daryl Janzen, University of Saskatchewan
Additional Author | Daniel E Reichart, University of North Carolina at Chapel Hill

A star cluster's age, metallicity can be measured by fitting an isochrone model to its Herzsprung-Russell (HR) diagram which is calculated from its color-magnitude diagram with interstellar reddening and distance. The cluster tool of the Astromancer suite is a web application succeeding the Cluster Pro Plus of the Skynet Plotting tools for robust and sophisticated cluster analysis. Users can either upload observational photometry or query the archives from the tool, then remove field stars and fit isochrones interactively to estimate any star cluster's age, metallicity, distance, reddening, number of stars, and radius. The tool is effective for teaching stellar evolution intuitively, and provides measurements on par with results in literature. It's designed to be a part of the Multi-Wavelength Universe! (MWU!), using student's own observational data from the Skynet Robotic Telescope Network.

SAT-POSA-211 | Poster Presentation Traditional | Teach Students Critical Thinking Skills—Comparing the Big Bang Model and the Exponential Expansion Model

Presenting Author: Peter Xinya Zhang, Columbia College Chicago

College-level courses should not only provide up-to-date knowledge to students but also help them gain critical thinking skills. By comparing competing models and searching for evidence supporting each model, students learn to draw conclusions with favoring evidence. As one example, the Big Bang model was developed based on Hubble-Lemaître law. But mathematically, there is an alternative model (the Exponential Expansion model)—the distance of every galaxy expands exponentially with the same Hubble constant H, i.e., r(t)=r0*exp(H*t), where r0 is the distance of this galaxy at time zero. This model is also consistent with Hubble's observation, but is of course not favored. Taking a journey to find evidence to support the current favored model will help students understand the history and limit of our knowledge, and thus help them establish critical thinking skills.

DEI Posters I (6–7 p.m., Saturday)

SAT-POSC-601 | Poster | Investigating the Impact of Equity-Based Teaching on Implicit Biases in STEM Students

Presenting Author: Izabela Taylor, Gustavus Adolphus college

Co-presenting Author | Darsa Donelan , Gustavus Adolphus college

Additional Author | Jessica Stadick, Gustavus Adolphus college

This study, conducted under an HHMI Inclusive Excellence Grant, sought to understand the influence of equity-based teaching modules on implicit biases among students majoring in STEM disciplines, with a focus on Physics. Led by Principal Investigator Izabela Taylor (Psychological Sciences major), in collaboration with faculty sponsors Darsa Donelan (Physics) and Jessica Stadick (Nursing), this pilot study aimed to shed light on the potential for equity-focused coursework to interrupt implicit biases in the classroom. Participants, comprising 25 prospective physics majors, were randomly assigned to either an Equity Module or a Student Skills Module. Both groups completed pre- and post-surveys, including an implicit bias test. The Equity Module aimed to raise awareness about biases, stereotypes, and the importance of diversity in physics education, fostering a more inclusive learning environment. The Student Skills Module focused on enhancing study and learning techniques for students from diverse backgrounds. Results from this research hold significance in the pursuit of racial equity within STEM fields. The study's findings contribute to the ongoing dialogue on the importance of inclusive teaching practices and their potential to interrupt biases, ultimately fostering more equitable and supportive learning environments.

SAT-POSC-603 | Poster | Gender Gap in Confidence in the Force Concept Inventory

Presenting Author: Asuka Hamada, Hiroshima University, Japan

Co-presenting Author | Shuji Munejiri, Hiroshima University, Japan

Additional Author | Takashi Umeda, Hiroshima University, Japan

Additional Author | Izumi Nomura, Chubu University, Japan

Additional Author | Jun Saito, Obihiro University of Agriculture and Veterinary Medicine, Japan

Additional Author | Yoshihiko Shoji, University of Hyogo, Japan

Gender gap in the relation between Force Concept Inventory (FCI) score and confidence of their responses was investigated. The FCI survey was conducted among 294 first-year students at a university in Japan. Respondents were asked to indicate their level of confidence in their answers when answering each of the 30 questions on the FCI. Confidence was rated on a 4-point scale: (1) I don't know so I'm just guessing, (2) I rely more on my feelings than evidence, (3) I'm not sure, but I have a reasonable basis, and (4) I have a solid theoretical basis and I am confident. The sum of these numbers was used as each respondent's confidence score. The relation between FCI score and confidence score was analyzed using linear regression analysis. We found that when male and female students have the same FCI score, females have lower self-confidence. Additionally, no gender gap was found within the same group selected through the entrance exam.

SAT-POSC-605 | Posterl | Gaining Power and Shaping Space through "helping" in intro Physics Classrooms

Presenting Author: Lauren Bauman, Western Washington University

Additional Author | Amy D. Robertson, Seattle Pacific University

Additional Author | Verónica N. Vélez, Western Washington University

A major goal of Physics Education Research is to increase diversity, equity, and inclusion in physics classrooms. Our project approaches this goal by using classroom video and student interview data to understand how power shapes space in introductory physics classrooms. Frequently in our data,, white students position themselves as helpers. In this role, they moderate group dynamics by setting pace, monitor peers' learning, explain content without being asked to, and control the use of supplies (e.g., lab materials). We claim that in this role, helpers are positioned as powerful, both claiming and shaping classroom space. Thus, understanding the helper persona is critical to understanding how power operates in the classroom and to intervening to create more equitable learning environments. Supported by grant numbers 2201930 & 2201929

SAT-POSC-607 | Poster Presentation Traditional | Equity-Minded Physics Questions

Presenting Author: Kristine Washburn, Everett Community College

Physics is an ideal place for equity and social justice work. Connecting our content to issues of equity and social justice is easier than you might think, and can promote greater inclusivity in our classrooms and broaden the impact our students can have in the world. I created a year-long set of weekly homework problems that connect topics from first year Physics to larger issues of equity and social justice. Examples are presented, as well as feedback from students and tips for implementation.

Intro & Beyond Posters I (6–7 p.m., Saturday)

SAT-POSB-401 | Poster | A Different Pedagogical Approach to Teaching Quantum Superposition

Presenting Author: Michael Zheng, St. John's University

Explaining wave-particle duality conceptually in an introductory quantum mechanics class can be a daunting task, especially to non-science majors. In the single photon double slit experiment, it is meaningless to ask what is going through the apparatus, which makes it difficult for students to appreciate its intricacies. Inspired by the Bloch Sphere that rotating angles(theta) and φ(phi) can transform from bit basis to sign basis, or vice versa, and that the same qubit can be represented using different basis sets, we demonstrate connections between quantum objects and real world objects through a rotating framework that helps visualizing similar behaviors without causing confusions or conflicts, even "meaningless" quantum objects have a place in real world. We further corroborate an artist's view that beauty is indeed in the eye of the beholder. Initial feedback from students is positive.

SAT-POSB-403 | Poster Presentation Traditional | Introductory Mechanics as a "Research" Program

Presenting Author: Douglas Kurtze, Saint Joseph's University

I present an approach to teaching introductory mechanics driven by taking data on dynamics-cart collisions. First, a sequence of increasingly complicated collisions leads the students to formulate the principle of momentum conservation in greater and greater generality. As a side issue, they also note that for magnet-to-magnet collisions the relative velocity of the carts reverses during the collision; we save this observation for future investigation. Later we revisit these collisions to investigate whether total momentum remains constant throughout the collision or changes, returning to its original value as the collision finishes. The former is the case; this leads to Newton's laws, with "force" defined as "that which changes an object's momentum". Later still, for magnet-to-magnet collisions we show that mathematically combining momentum conservation with reversal of relative velocity leads to conservation of kinetic energy. We then find that during these collisions, total kinetic energy decreases and then increases again to its original value. Plotting kinetic energy vs. separation then reveals that at a given separation, the kinetic energy deficit is the same when the carts are approaching and when they are moving apart. This motivates the idea of potential energy.

SAT-POSB-405 | Poster Presentation Traditional | Reflecting on Two Summative Activities in Conceptual Physics

Presenting Author: Timothy McCaskey, Columbia College Chicago

We have designed our Conceptual Physics course to be accessible to a diverse group of art and media-focused students. The final weeks of the course contain two summative activities: (1) the presentation of a creative project connected to whatever physics topic in or out of class the student prefers and (2) a final exam that is not mathematical but focuses on qualitative results, demos, and in-class activities. This poster will outline some of the latest creative ideas put forth by our students in their artistic projects. It will also show some data on students' approaches to the final. My earlier work has looked at student "notecards" or "cheat sheets," which in more traditional courses had the potential to be formula-centered. But in a course with less material presented mathematically or formulaically, on what do the students focus their exam preparation?

SAT-POSB-407 | Poster Presentation Traditional | How Stuff Works: A Course on the Physics of Everyday Technologies

Presenting Author: Evan Halstead, Skidmore College

Many traditional physics courses are set up to present concepts first, then applications later (if at all). As a result, some students come away wondering how physics is relevant to their lives. Here I will present the design of an introductory lecture/lab course called How Stuff Works that is structured around applications rather than concepts. Each unit focuses on a particular piece of everyday technology and the physics concepts that make it possible. Students then create their own versions of the technology in the makerspace and perform lab experiments with their creations. Topics are flexible based on student interest, and the fact that equipment is constructed rather than purchased makes it easy to do on a budget.

SAT-POSB-409 | Poster Presentation Traditional | Geometrical Optics Study of the Magnifying Glass

Presenting Author: Salvador Bosch

Additional Author | Santiago Vallmitjana, 1Universitat de Barcelona, Dep. Física Aplicada, Martí i Franqués 1, 08028 Barcelona

Additional Author | Ignasi Juvells, 1Universitat de Barcelona, Dep. Física Aplicada, Martí i Franqués 1, 08028 Barcelona

The magnifying glass is probably the most simple visual instrument for the observation of small objects. It consists of a converging lens placed between the object and the eye. The mutual distances between the elements and the accommodation state of the eye have an important role in the final magnification obtained. In the present work we analyze all the relevant details in terms of the geometrical optics theory. Some interesting results are found and explained.

SAT-POSB-411 | Poster Presentation Traditional | Using VR for Visualizing Difficult Ideas in Introductory Physics: A Proof of Concept

Presenting Author: Patrick Johnson, Georgetown University

When teaching electromagnetic fields in introductory physics, one of the greatest challenges is visualizing what is going on. When encountering electromagnetic fields, though, students struggle to picture what it actually looks like. Working together with an undergraduate student, a virtual reality tool was created to help students experience the visuals of electric fields. Students can walk around a virtual space designed to look like the learning lab at Georgetown, and with the click of a button, they can place positive or negative charges. As charges are added to the room, arrows in the room are added/updated to indicate the direction of the electric field. This was designed as a proof of concept tool that can be expanded to eventually include moving charges, magnetic fields, and more. Separately, a secondary VR tool for understanding rotations was developed where students were tasked with picking up one of three objects and rotating them 90 degrees about a given axis. When the experience begins, a poster on the wall instructs the student to pick up either a sphere, cylinder, or box and rotate it about the x, y, or z-axis. Upon lifting it, a set of axes superimposes itself on the object. When rotated correctly, it turns green.

K-12 Posters (6–7 p.m., Saturday)

SAT-POG-01 | Poster Presentation Traditional | From Tests to Testing: Guided Inquiry Learning Through Hands-On Projects in The Ap Physics 1 Curriculum

Presenting Author: Naren Krishna Jegan, Mission San Jose High School

The guided inquiry model catalyzes student-driven discussions and proposals originating from a central problem. At Mission San Jose High School, we have implemented the guided inquiry model to apply the concepts covered in our AP Physics 1 classes to real life. Specifically, we have challenged students in the design, construction, and testing of a precision-engineered candy launcher aimed at launching projectiles (golf balls) to a predetermined length and height. Our method of facilitating student-led discussions and proposals is designed to provide creative freedom to develop a launcher collaboratively using available materials and tasking them with deriving the initial conditions such as velocity, angle, or spring length, then

using tracker analysis to refine and improve upon their design. In this poster, we will apply the principles of guided inquiry to connect the theory of physics concepts covered in the AP Physics 1 curriculum to bridge student application of physics to real-life concepts. We aim to provide insight into emphasizing student creativity and research to create innovative solutions, strengthen their fundamentals, and facilitate collaborative decision-making through engineering design and scientific method processes.

Labs/Apparatus Posters I (6–7 p.m., Saturday)

SAT-POSD-501 | Poster Presentation Traditional | Manufacture of a Solar Oven: Project for Community Development

Presenting Author: Carmen del Pilar Suarez Rodriguez, Autonomous University of San Luis Potosí

Co-presenting Author | Fátima María Isabel de los Santos Garcia, Autonomous University of San Luis Potosí

Learning physics under a STEM approach considers responding to problems in the students' immediate context or providing a solution to a real problem, with the intention that they apply the physics concepts they learned in the classroom. At the same time, they develop skills such as critical thinking and the management of resources and tools. It is also important that they awaken sensitivity about energy consumption and its optimization. This work presents the methodology for implementing a project for the manufacture of a vegetable drying oven, with engineering students, but which can be adapted with high school students. A description of the manufacturing process and the analysis of the process in terms of the attitudes, knowledge and skills of the students, as well as recommendations for the teacher who wishes to reproduce the classroom experience, are made.

SAT-POSD-503 | Poster Presentation Traditional | Magnetic Resonance with Damping

Presenting Author: Patrick Polley, Beloit College

This experiment expands on earlier work1 to provide students with an investigation of a classical analog to magnetic resonance as well as damped harmonic motion. A compass is aligned in a magnetic field provided by two stacks of ceramic disk magnets. The compass is subjected to a oscillating magnetic field perpendicular to the field supplied by the ceramic disk magnets and the amplitude of oscillation of the compass needle is measured. Plotting the amplitude of the response against the frequency of the oscillating field allows the determination of the damping constant of the oscillating needle. This constant is compared to a constant calculated from observations of the motion of the compass needle as it decays over time when an external field is applied to the needle and then suddenly removed.

(1) "Exploring Magnetic Resonance with a Compass" E. Cookman, D. Nelson, M. Anderson, D.L. McKinney, I. Barsukov The Physics Teacher 57 9 (2019) 633-635

SAT-POSD-505 | Poster Presentation Traditional | Hands-On Lecture Activities for Diverse Adult Students of College Physics

Presenting Author: Virginia Card, Metropolitan State University - St. Paul MN

The algebra-based college physics course at Metropolitan State University in St. Paul Minnesota serves a diverse group of mostly adult students majoring in biology and environmental science. A series of lecture activities was developed to introduce and instantiate abstract concepts and build physical intuition. Similar in subject to lab activities, lecture activities differ in being simpler, safer, and ungraded, with the student results used in example problems in lecture. Activity designs make use of household tools, toys and materials. The activities include kinematics with toy cars, Newton's Laws with fishing lines and sinkers, free-body diagrams with shoes, static electricity with party tricks, and circuits with flashlight and batteries (etc.). The effectiveness of the activities was assessed by student survey, instructor survey, and analysis of student achievement on the associated learning objectives. A summary of the activities and their evaluation, along with detailed description of the one judged best in Fall 2023, will be presented.

SAT-POSD-507 | Poster | Measuring the Adiabatic Index of Gases Using an Ultrasonic Sensor

Presenting Author: Matthew Brynteson, University of Lynchburg

Co-presenting Author | Hayden Deans, University of Lynchburg

In an introductory thermodynamics course, one of the common topics introduced to students is that of the adiabatic index of a gas. Herein, we present a new apparatus capable of measuring the adiabatic index of a gas over a range of temperatures which can be implemented into an undergraduate laboratory course investigating such topics. To accomplish the desired objective, an ultrasonic sensor is used to determine the speed of sound in the gas inside a closed cell. While many previous methods use various techniques to measure the speed of sound with a similar objective, many of them require additional knowledge that many introductory students do not possess. Rather, a direct measurement of the speed of sound is far more intuitive to an introductory student, and an understanding of the experimental methodology is more readily achieved. In addition, we present the results for carbon dioxide over a temperature range which enables students to investigate the effect of molecular vibration on the adiabatic index.

SAT-POSD-509 | Poster | Physics By Inquiry: A Lab-Only Class

Presenting Author: Mark Rupright, Birmingham-Southern College

I outline an Honors course that inroduces students to scientific methodolgies through laboratory-based inquiry. Instead of introducing underlying physical theory, the course requires students to discover concepts of motion and force through direct measurement. They are not allowed to discuss any concepts not directly inferred and justified through experimentation. Because the focus is on methodology, there is no set curriculum. It's not clear what directions their inquiry will take them. I will discuss successes and challenges with this approach.

SAT-POSD-511 | Poster | Polarimetry as a Gateway to Careers in Optics

Presenting Author: Adam Green, University of St. Thomas

Over the past two decades, we have found polarimetry to be an effective topic for attracting students to optics and training them for careers. They appreciate applications of polarized light to a wide range of fields such as biology, medicine, environmental sensing, and materials science. Here, we showcase ways to incorporate polarimetry into the undergraduate curriculum, from simple measurements for first-year students to the construction of polarimeters at the senior level.

SAT-POSD-513 | Poster | Design and Construction of a Low-Cost Raman Spectrometer for Undergraduate Experiments With Graphene

Presenting Author: Mate Garai, University of the South

Co-presenting Author | Randolph S. Peterson, University of the South

Additional Author | Johnny Davenport

Additional Author | Eugene Donev, Austin Peay State University

We present the design and tested construction of a low-cost Raman spectrometer with an integrated 500X magnification microscope tailored for the analysis and characterization of graphenic materials. Such materials have garnered substantial attention due to their remarkable electronic, mechanical, and thermal properties, requiring the availability of a cost-effective analytical tool, such as a Raman spectrometer. The system is built with a budget of less than $10,000 by utilizing readily available components, including a 532 nm 200 mW laser, a Thor Labs-inspired microscope for image acquisition, and an Ocean Optics USB 4000 spectrometer with a highly customizable, open-source LabView app. The integration of a high-magnification microscope enables precise sample observation and positioning, enhancing the accuracy of graphene identification from Raman measurements on microscale samples. Results from commercial and exfoliated graphene, as well as other inorganic carbon materials, will be presented.

SAT-POSD-515 | Poster Presentation Traditional | A Tool for Developing Proper Tone Among Music Students

Presenting Author: Gerald Ruch, University of St. Thomas

Co-presenting Author | Chris Kachian, University of St. Thomas

We present a tool to help music teachers train students to recognize the difference between good and poor tone. Tone, or timbre, is the quality of a musical note that is separate from pitch or volume and is difficult for a music student to practice without the presence of a trained instructor. Becaused such practice is limited to sessions with the instructor, progress can be quite slow. We have devised a way of quantifying the timbre of a played note through an analysis of the note's harmonics. We then built an app that runs on a smart phonem, performs the analysis in real time and presents a numerical score. Using the app, a student can get feedback on their tone in real time between sessions with a trained instructor thereby speeding up the time that it would normally take to develop good tone.

SAT-POSD-517 | Poster Presentation Traditional | The Wave-on-a-Spring Laboratory: Broadening Applicability and Enhancing Accuracy

Presenting Author: Paul French, SUNY Oneonta

The wave on a spring or a string is a standard context for the introduction of traveling and standing waves. This presentation shows how this wave demonstration or lab exercise has been used in a variety of university settings, ranging from the general education curriculum (Physics of Sound) to the intro and intermediate level in the physics major (General Physics, Vibrations and Waves). Benefits including better qualitative understanding and intuition, improved student engagement (fun!), and impressive quantitative challenges and results are described. In addition, the investigation into a second-order correction to the spring's tension and length for the standing wave is summarized.

SAT-POSD-519 | Poster Presentation Traditional | Escape Experience Aeroseum: On Design Goals and Educational Applications

Presenting Author: Sebastian Kilde Löfgren, Department of Physics, University of Gothenburg

Additional Author | Merel Wevers, University of Twente

Additional Author | Magnus Karlsteen, Department of Physics, Chalmers University of Technology

Additional Author | Jonathan Weidow, Department of Physics, Chalmers University of Technology

Additional Author | Jonas Enger, Department of Physics, University of Gothenburg

Designing informal physics education activities outside the classroom can be a meaningful way to increase public awareness of the importance of science in their everyday lives. In line with the growing interest in escape rooms in educational settings, an educational escape room has been developed at the Aeroseum in Gothenburg, Sweden. The Escape Experience Aeroseum presents a series of challenges, including up to five physics puzzles that focus on classical mechanics. The intended goal of the game, which is a twist on classical escape rooms, is to highlight connections between physics, everyday life, and aviation. It is also designed to be visited by groups of students. Escape Experience Aeroseum can thus allow both high school and undergraduate students to learn about concepts such as motion diagrams, pendulums, gears, moment and pulleys, and friction in a hands-on and playful setting.

Physics Education Research (PER) Posters I (6–7 p.m., Saturday)

SAT-POSE-701 | Poster Presentation Traditional | Using AI to Analyze Qualitative Research Data? The case for utilizing AI apps as part of your PER Qualitative Research

Presenting Author: Liam McDermott, Rutgers University

Additional Author | Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education

Everywhere you turn these days, it seems we are inundated by news about Artificial Intelligence (AI). There are so many reports on AI, that you question the veracity of them all, and may be confused or simply do not know if AI is a good thing or if it is a bad thing. One thing remains certain: AI is changing the world and how we interact with it. This includes how Physics Education Researchers collect and analyze their data.

Often, PER data sets consist of lengthy verbal narratives from student interviews. This sheer volume of qualitative data often takes years to collect, transcribe, and analyze. In this poster, we explore how AI-driven natural language processing techniques, such as ChatGPT, can streamline and enhance both data collection and thematic analysis of qualitative data. Thus, providing researchers with a more efficient means of analyzing qualitative data. By presenting examples of AI-generated themes alongside manually identified ones, this research demonstrates the transformative potential of AI in advancing our understanding of physics education and Physics Education Research.

SAT-POSE-705 | Poster Presentation Traditional | Preliminary Results from the Fluids Conceptual Evaluation (FCE) Pilot Test

Presenting Author: Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education
Additional Author | Dedra Demaree, Blue Ridge School
Additional Author | Liam McDermott, Rutgers University
Additional Author | Mary L Urquhart, University of Texas Dallas
Additional Author | James Vesenka, University of New England
Additional Author | DJ Wagner, Grove City College

The FCE, a currently under development research-based conceptual learning assessment (RB-CLA), will evaluate post-secondary life science majors' understanding of fluids in their introductory physics course utilizing a two-tier multiple-choice instrument comprised of a conceptual item (Tier I) and an item assessing test takers reasoning behind their choice (Tier II). Currently, the FCE has 67 Tier I items. In Fall 2023, we initiated the pilot test of the FCE to assess the suitability of its Tier I conceptual items and participants' reasoning. Data from this pilot test will inform the development of approximately 30 final two-tier FCE items. Using Qualtrics, the pilot test participants each completed 14 randomly selected current FCE items online within a 30-minute timeframe. This process will be repeated for up to 250 responses per item. This poster shows the evolution of the original 65 FCE Tier I items evolution to two-tier multiple-choice items. Supported by NSF Award # 2021273

SAT-POSE-707 | Poster Presentation Traditional | Adapting Tutorials in Introductory Physics for Large-lecture Environments

Presenting Author: Dean Bretland, University of Washington
Additional Author | Peter Shaffer, University of Washington
Additional Author | Paula Heron
Additional Author | Taylor Gurreithun, University of Washington
Additional Author | Charlotte Zimmerman, University of Washington

The University of Washington has been developing tutorials to be used in small classroom sections over the course of many years. However, many universities find it challenging to create small classroom sections, due to high enrollments and/or a lack of resources available to them. At the University of Washington, we face such challenges in the algebra-based introductory sequence. Therefore, we are in the process of developing tutorials designed for an interactive, lecture-style classroom. These tutorials have been implemented in the introductory, algebra-based physics courses at the University of Washington for the last several years. In this presentation, we will describe the efforts that went into mirroring a small classroom experience in a large lecture hall, and present some of the materials that have been developed for other instructors to use in their courses. We will also share dissemination plans. This work is supported by the National Science Foundation, under grant No. DUE-1821032.

SAT-POSE-709 | Poster Presentation Traditional | A Mechanics Course without Grades for Assignments

Presenting Author: Shuji Munejiri, Hiroshima University, Japan
Additional Author | Aishi Yamamoto, Hiroshima Institute of Technology, Japan
Additional Author | Syuma Yasuzuka, Hiroshima Institute of Technology, Japan

The effect of not giving grades for assignments was investigated in a calculus-based mechanics course at a Japanese engineering college. About 100 students take this course, randomly divided into two classes according to student ID number. Each class was taught by a different faculty member, but with the same material and the same assignments. In one class, assignments were graded. If its content did not meet the standards, it was required to be resubmitted. If it was not resubmitted, no submission points were given. In the other class, only submission points were given for the assignment and no grade was given for the content and only feedback was given. Final exam scores were higher in the class where assignments were not graded. Significant differences were found, especially in the group of students who had lower scores on the pretest.

SAT-POSE-711 | Poster Presentation Traditional | Year Two of Lecture/Studio at the University of South Carolina

Presenting Author: Alice Churukian, University of South Carolina
Additional Author | David J. Tedeschi, University of South Carolina

Over the last several years, the Physics and Astronomy Department at the University of South Carolina has been working to improve the learning gains of the students enrolled in both introductory physics sequences. We have adopted the Lecture/Studio format and are in the process of adapting the materials developed at the University of North Carolina at Chapel Hill to meet the needs of our students. Starting with the calculus-based sequence, we are rolling out one new course per year. Fall 2022 saw the implementation of the first semester course and this Fall we expanded into the second semester course. In this poster we will evaluate the new program thus far including student and faculty perceptions and leaning gains based on FCI and CSEM performance. We will also discuss our experience with the expansion into the second semester course and ongoing room renovations.

SAT-POSE-713 | Poster Presentation Traditional | An Examination of Two Professional Learning Communities of Physics Teachers Developing Culture-Based Approaches to Instruction

Presenting Author: Clausell Mathis, Michigan State University
Co-presenting Author | Andrea L Wooley, Michigan State University
Additional Author | Mathilda Smith, Michigan State University
Additional Author | Maria Horak, Michigan State University
Additional Author | Maya Patel, Michigan State University
Additional Author | Lauren Collins, Michigan State University

Understanding how to make physics instruction more equitable has been an ongoing challenge for teachers. We highlight the work of two professional learning communities (PLCs) of physics instructors who have attempted to incorporate culture-based teaching approaches in their classrooms. The first PLC focuses on the critical examination of physics ideas and recognizing non-Eurocentric contributions to physics as a discipline. The second PLC focuses on developing curricula that identify students' cultural resources and incorporate them into physics curricula. We will describe our methodology and findings from the analysis of PLC meetings around developing and enacting culture-based physics instruction. We also will highlight the different types of lessons, artifacts, and statements from teachers on what challenges and affordances they had in participating in the PLC.

SAT-POSE-715 | Poster Presentation Traditional | Using Factor Analysis to Gauge Validity of a Laboratory Exam

Presenting Author: Ari Kaye, University of Northern Colorado
Additional Author | Jennifer Delgado, University of Kansas
Additional Author | Christopher Fischer, University of Kansas
Additional Author | Keita Todoroki, University of Kansas

We present initial validation of an assessment evaluating student understanding of experimental uncertainty in undergraduate physics laboratory courses. This assessment arranges multiple-choice problems in a nested system linking a set of "minor" questions to a "major" question with a common focus. Factor analysis of student responses to this assessment verifies this linking while revealing the correlational network connecting "minor" questions to one another. Isolating each skill needed to answer problems in experimental uncertainty as separate "minor" questions identifies specific pitfalls in student understanding–providing insight for future instructional changes in laboratory courses.

SPS Poster Session (6–7 p.m.) Saturday

SAT-SPS-101 | Poster Presentation Traditional | Baseline: Looking For the Cosmic Ray Moonshadow

Presenting Author: Aitak Mosen Harzandi, New Trier High School
Co-presenting Author | Garrett Chong, New Trier High School
Co-presenting Author | Benjamin Baronofsky, Ida Crown Jewish Academy
Co-presenting Author | Jedidiah Marcus, Ida Crown Jewish Academy
Additional Author | Nathan A. Unterman, New Trier High School

Using multiple detectors set at different angles of elevation, the schools in the collaboration observed a large portion of the sky, collecting muon data to look for the moon's cosmic ray shadow. Each school used one of four angles of elevation, each producing their own sets of data and graphs for each day. These graphs were combined into monthly, then yearly averages. These four graphs were then analyzed and compared to find a consistent dip in muon count, which would hint at the presence of a cosmic ray shadow. The data are consistent with no signal, so an upper limit was determined to guide future experiments.

SAT-SPS-105 | Poster | Method for Measuring Low-Energy Cosmic Rays Using Time

Presenting Author: Ash Eliaser, Rochelle Zell Jewish High School
Co-presenting Author | Miriam Bush, Rochelle Zell Jewish High School
Co-presenting Author | Dalya Frank, Rochelle Zell Jewish High School
Co-presenting Author | Dory Marshall, Ida Crown Jewish Academy
Additional Author | Nathan A. Unterman, New Trier High School
Additional Author | Allen Sears, Ida Crown Jewish Academy

A collaboration of high school students set up cosmic ray detectors to measure low-energy cosmic rays using time with the goal of locating the moon's cosmic ray shadow. The detectors were arranged at different elevation angles aiming south to capture the moon's passage each day. As Earth rotates, the detectors swept the sky daily. Lower energy primary cosmic rays bend more due to magnetic fields and should be found as a shadow well before the moon crosses the meridian. The shadow was not expected after the moon passed the meridian since there are almost no anti-protons in the primary rays. Experiment methods are discussed in this poster.

SAT-SPS-107 | Poster | How Spatial Disorder Affects Quantum Eigenvalue Statistics

Presenting Author: Noah Koch, Berry College
Additional Author | Todd K Timberlake, Berry College

The objective of this project is to illustrate the role of spatial disorder in determining statistical properties of the energy spectrum for a quantum system. We investigate the distribution of energy level spacings in a simple quantum system consisting of several Dirac delta barriers placed

inside an infinite square well potential. A version of this model with irregularly spaced barriers was studied previously and the distribution of level spacings was found to depend on the probability T that a particle can tunnel through one of the delta barriers. This disordered model showed a Poisson-like spacing distribution for T near 0, GOE-like spacing distribution for T around 0.5, and Gaussian spacing distribution as T approaches 1. We will first examine this model with evenly spaced barriers, which should lead to level spacings that do not fit any standard distribution. We will then shift the barriers using displacements drawn from a Gaussian distribution with mean 0 and pre-set standard deviation, so that the standard deviation serves as a measure of spatial disorder. As the standard deviation is increased, we expect to see the level spacing distributions shift so that they approach those seen previously for the disordered system.

SAT-SPS-109 | Poster | DC Magnetron Sputtering of Indium Thin Films: Crystallographic and Morphological Investigations

Presenting Author: Ashish Vasandani, Berry College

Co-presenting Author | Jacob D Sylvie, Berry College

While studies involving magnetron sputtering of indium-oxide-based material systems are well represented in the literature, magnetron sputtering of elemental indium is not well documented likely as a result of experimental difficulties linked to the low melting point of indium. In this study, DC magnetron sputtering was used to deposit indium thin films atop glass substrates under various experimental conditions. An argon background gas was ionized and confined near an indium target via a ring magnet stack which resulted in formation of an indium/argon plasma. Glass slides were mounted inside the sputtering chamber at various positions relative to the indium target which resulted in deposited indium thin films. The effects of varying the sputtering power and target/substrate separation on the crystallographic and morphological properties of resulting films were investigated via x-ray diffraction and scanning electron microscopy.

Two Year College Posters (6–7 p.m. Saturday)

SAT-POSF-301 | Poster | Continuing Professional Development Workshop Program

Presenting Author: Thomas O'Kuma, Lee College

Co-presenting Author | Paul J. Heafner, Independent Scholar

Co-presenting Author | Kristine P.H. Lui, AAPT

OPTYCs is The Organization for Physics at Two-Year Colleges (https://optycs.aapt.org). Part of the OPTYCs mission is to provide Continuing Professional Development Workshops (CPDW) and Tandem Meetings for TYC physics faculty across the country. In this poster, we will summarize workshops that have already occurred, workshops at the current meeting, and future workshops. We will also invite TYC physics colleagues and others to submit ideas for workshop content. CPDW are open to all with an emphasis for TYC faculty. OPTYCs is supported by NSF-DUE-2212807.

SAT-POSF-303 | Poster | Surveying Student Attitudes Towards Learning Before and After COVID-19 Emergency Learning Experience

Presenting Author: Andrew Morrison, Joliet Junior College

Additional Author | Cathleen Dobbs, Joliet Junior College

Joliet Junior College is nearing the end of a five-year NSF-funded project to award scholarships to highly qualified students intending to complete a STEM-related major. These scholarships were awarded to students with demonstrated financial need and were also intended to target students from traditionally underrepresented groups in STEM. Students in the program were asked to keep a reflective journal that they discussed regularly with an assigned faculty mentor. Activities throughout the academic year included: introductions to student support offices, information sessions on transfer options, working on summer research applications, invited speakers on campus, and field trips to museums, national laboratories, and industry partners. The project ran for two years before the COVID-19 emergency. We will share the results of our research component of this project comparing the student attitudes towards learning before COVID-19 and after returning from online-only learning.

SAT-POSF-305 | Poster | Student Experiences with Course-based Undergraduate Research Experience in an Introductory Physics Course at a Community College

Presenting Author: Wayne Manrakhan, Harford Community College

Course-based undergraduate research experiences (CUREs) have been identified as a means of positively impacting students' interest and retention in the sciences, with the additional benefits of accessibility and impacting large numbers of students. During the Spring 2023 semester, a CURE based on a previously reported design [1], was implemented in a terminal introductory physics class at Harford Community College. A pre-survey was completed to gauge student's prior experience with laboratory experience and research, as well as their opinions on science. After completion of the CURE, a post-survey was conducted to evaluate student's perspective of gained experience and potential benefits of the CURE. Although the small sample size restricts useful statistical inference about the benefits of CUREs in general, all students self-reported benefits and growth. These included increased tolerance for obstacles faced in the research process and increased readiness for more demanding research. Students also felt more self-confident and reported a large improvement in skills required for oral and written presentations. I will also discuss how students' experiences during their research project impacted their perceived growth on completed the CURE.

[1] Wayne Manrakhan, Implementing a CURE in Terminal Introductory Physics Course, Poster presented at AAPT Winter Meeting 2023.

SAT-POSF-307 | Poster Presentation Traditional | Supporting New TYC Faculty with OPTYCs New Faculty Development Series (NFDS)

Presenting Author: Krista Wood, University of Cincinnati Blue Ash

Additional Author | Brooke Haag, Pathstream

Additional Author | Dwain M. Desbien, Estrella Mountain Community College

Additional Author | Tom O'Kuma, Lee College

The Organization for Physics at Two-Year Colleges (OPTYCs) and American Association of Physics Teachers (AAPT) present a 16-month experience designed specifically for Two-Year College (TYC) Physics Faculty in their first six years of TYC teaching. This New Faculty Development Series (NFDS) will support new TYC physics faculty incorporating student-centered active learning, and research-based instructional strategies. NFDS is an exceptional opportunity that provides new TYC Physics Faculty (1) a foundation in Physics Education Research (PER) with online discussions, (2) a 3-day Immersion Conference to engage in PER-based instructional and inclusive strategies, (3) online mentoring throughout the implementation phase, and (4) a 2-day Commencement Conference in conjunction with a National AAPT Conference. Cohort 2 will be Spring 2025 – Summer 2026. This NSF-funded program provides a community to support you and travel funding for the Immersion and Commencement Conferences! Supported by NSF-DUE-2212807

SAT-POSF-309 | Contributed Talk | "Circuit-Algorithm-Math-Physics (CAMP): A Novel Integrated Model to Assess the Educational Goals of Associate of Science (AS) Degree Program in Quantum Literacy"

Presenting Author: ANIL PYAKURYAL, University of District of Columbia -Community College
Additional Author | Abed Sami Almala, University of District of Columbia-Community College
Additional Author | Peter Ploude, University of District of Columbia-Community College
Additional Author | Souheil Ghannouchi, University of District of Columbia-Community College
Additional Author | Bushra Ahmad Saeed, University of District of Columbia-Community College
Additional Author | Marilyn Hamilton, University of District of Columbia-Community College

With advent in modern technologies, Quantum discoveries have been incorporated into our foundational understanding of science leading to tremendous impacts on our everyday lives. University of District of Columbia-Community College is preparing to launch an Associate of Science (AS) Degree program in Quantum Literacy (QL), a unique model designed to promote elementary education in Quantum Information Science and Technology (QIST), and its applications. Primary objective of the program is to support University's critical mission on work-force development by preparing skillful technical specialists to close the gaps in the emerging technology in Quantum and its applications. Such specialists require broader knowledge in cross-disciplinary fields to perform the tasks efficiently. Quantum education is an important need to overcome the anticipated crisis of the technical work-force in several applications of Quantum Technology. Curricula for QL are designed in such a way that students can prepare themselves in the diverse field by learning technical skills through courses and industrial trainings. In order to assess the efficacy of such program, a CAMP model has been proposed. This model employs a series of signature assignments in cross-disciplinary fields in order to evaluate the fundamental understanding and knowledge of the learners in diverse disciplines in consistent with the program student learning outcomes.

Session SUN-AA: Frontiers in Space Science Sunday, Jan. 7, 9 –10 a.m. Commerce - 3rd Floor

Moderator: Darsa Donelan Sponsor: Committee on Space Science and Astronomy

SUN-AA-01 (9:00 to 9:24 AM) | | NASA'S Return to the Moon: Overview and Challenges of the Artemis Program.

Presenting Author: Alicia Dwyer Cianciolo, NASA Langley Research Center

NASA's Artemis program plans to land the first woman and first person of color on the Moon this decade. Unlike the Apollo missions of the past, NASA is designing Artemis to be a sustained presence on the Moon. This presentation will provide an overview of the first Artemis missions, as well as the motivations for and challenges associated with landing at the lunar south pole.

SUN-AA-02 (9:24 to 9:48 AM) | | Pulsars: Timekeepers of the Cosmos

Presenting Author: Maura McLaughlin, West Virginia University

Pulsars are neutron stars that are formed in supernova explosions following the collapse of massive evolved stars. These exotic objects are more massive than the Sun, and can spin over 700 times a second. They have extremely high magnetic fields - over a trillion times the Earth's! These properties make them energetic sources of radio waves, which are beamed along their magnetic axes. We detect a "pulse" of radio emission once every pulsar rotation period, in a similar manner to a lighthouse. The rotation periods of pulsars can be measured incredibly precisely, making these "cosmic clocks" excellent laboratories for fundamental physics experiments. In this lecture, I will give an overview of pulsars and their properties and describe how we are using a network of these cosmic clocks to search for gravitational waves from the most massive black holes in the universe. I will also discuss how high-school teachers and students can get involved in pulsar research through the Pulsar Science Collaboratory program.

Session SUN-AB: Hybrid Physics Instruction–Part 1 Sunday, Jan. 7, 9 –10 a.m. Camp - 3rd Floor

Moderator: Joseph Ganem Sponsor: Committee on Physics in Undergraduate Education

SUN-AB-01 (9:00 to 9:24 AM) | | Hybrid Teaching: A Tale of Two Populations

Presenting Author: Wolfgang Bauer, Michigan State University

Additional Author | Gerd Kortemeyer, ETH Zürich, Switzerland

Additional Author | Wade Fisher, Michigan State University

We offered a partially flipped, hybrid introductory physics course where students had a free choice between attending any lecture session in person, or via video conferencing, or asynchronously via watching the recorded lectures. In line with the "no significant difference phenomenon," correlations between exam scores and participation choices were weaker than correlations with, for example, prior knowledge as evidenced by pretest scores. Overall, in terms of correlations, participation, and assessment attributes clustered together, respectively, with clicker questions being a connecting attribute between the clusters. Performance aside, we found two populations in the course, which, divided along the line of above and below average in-class attendance, exhibited other distinct behavior attributes mostly related to investment of time and effort in the course.

SUN-AB-02 (9:24 to 9:48 AM) | | Solving the Problem of Low-Enrolled Physics Courses with Hybrid Teaching

Presenting Author: Joseph Ganem, Loyola University Maryland

Additional Author | Heidrun Schmitzer, Xavier University

Low-enrollment in upper-level physics courses is a prevalent problem that threatens the sustainability of many undergraduate physics programs. Hybrid teaching can solve this problem by facilitating remote student exchanges between multiple institutions for low-enrolled courses. We report on a pilot program to share students and instruction in upper-level physics courses across multiple institutions. The pedagogy, logistics and administrative details, as well as the financial and legal implications will be discussed. Our exchange program between Loyola University Maryland and Xavier University has now run four years. It has succeeded in reducing the number of low-enrolled sections at both institutions, alleviated some of the stresses on our physics programs, and been formalized at an institutional level. Our student exchange via hybrid instruction could serve as a model for maintaining the viability of physics programs at other institutions, as well as for programs in other disciplines facing similar stresses.

Session SUN-AC: Physics Labs Beyond the 1st Year Sunday, Jan. 7, 9 –10 a.m.

Royal - 3rd Floor Moderator: Troy Messina Sponsor: Committee on Laboratories

SUN-AC-01 (9:00 to 9:12 PM) | Contributed Talk | Cosmic Ray Muon Detection in a Simple Hand-Held Device

Presenting Author: Aaron Pilarcik, Massachusetts Institute of Technology

Co-presenting Author | Sean P Robinson, Massachusetts Institute of Technology

A simple yet in-depth experiment to measure cosmic ray muons with an inexpensive, hand-held device, the Cosmic Watch. Primary cosmic rays, often streaming thousands of light-years across the galaxy, create an airshower upon hitting Earth's atmosphere, which can now be measured in the lab and classroom with a simple handheld detector. In this presentation, we demonstrate the diverse capabilities of this amazing device for an incredible array of experiments.

SUN-AC-02 (9:12 to 9:24 AM) | Contributed Talk | Takeaways from BFY4 Advanced Labs: Transformative Hubs for STEM Careers

Presenting Author: Joseph Kozminski, Lewis University

Additional Author | Eric Ayars, California State University Chico

Additional Author | Daniel Borrero Echeverry, Willamette University

The Fourth Conference on Laboratory Instruction Beyond the First Year of Physics (BFY4), which took place in Chico, CA, prior to the 2023 AAPT Summer Meeting, highlighted laboratory experiences that help students develop skills that they can transfer to graduate school and the STEM workforce. This conference was centered on hands-on workshop experiences designed to introduce instructors to new laboratory experiences that they incorporate in their labs, but also provided plenary talks, breakout sessions, poster sessions, and an advanced lab demo show. Networking opportunities allowed for dialog and community building with the hope that discussions started during BFY4 would continue beyond the conference. This talk will provide an overview of the conference and of the post-conference survey results.

SUN-AC-03 (9:24 to 9:36 AM) | Contributed Talk | A Laboratory Curriculum Accompanying an Introductory Course in Fundamentals of Quantum Information Science

Presenting Author: Narendra Jaggi, Illinois Wesleyan University

Additional Author | Wanda L. Lindquist, Illinois Wesleyan University

Additional Author | Henry P. Evans, Illinois Wesleyan University

At IWU, we teach an introductory sophomore/junior level course titled Fundamentals of Quantum Information Science. We have recently acquired a number of commercially available Quantum Control (QC) stations from TeachSpin, and are in the middle of designing, debugging and creating documentation for a laboratory component to accompany this course when it is offered next Fall. These QC instruments are compact and moderately priced tabletop NMR experiments that lend themselves to be adapted to the vocabulary and concepts that are now standard in QIS. Our early experience with these QC instruments suggests that we will be able to design a complement of six experiments that explore the following con-

cepts: single qubit states, Unitary quantum gates (X,H, Z and P), measurement in the computational basis, longitudinal and transverse correlation times, the Bloch Sphere and the Bloch Ball. We will report the status of our work in progress.

SUN-AC-04 (9:36 to 9:48 AM) | Contributed Talk | Millikan's Oil Drop Experiment as a Smartphone Lab?

Presenting Author: David Kordahl, Centenary College of Louisiana

Robert Millikan's classic experiment for determining the elementary charge is infamous to generations of undergraduates who have left the laboratory, eyes aching, with a newfound appreciation for the suffering of their predecessors. Could this lab be reconfigured to be less tedious? I have tried to retool the oil drop experiment as a video analysis lab – with mixed results. In theory, one might shift student efforts from time observing droplets toward time analyzing videos, given the ability of programs like Tracker to follow multiple particles in a single frame. In practice, though, the lab remains frustrating.

Session SUN-AG: Physics of Jazz–Part 1

Sunday, Jan. 7, 9–10 a.m.

Fulton - 3rd Floor **Moderator: Sam Sampere** **Sponsor: Committee on the Interests of Senior Physicists**

SUN-AG-01 (9:00 to 9:24 AM) | | The Harmonica in Jazz and Blues

Presenting Author: Gordon Ramsey, Loyola University Chicago

The harmonica has been around since the early 19th century. It is typically used in blues, jazz, country, rock and folk music. These genres are somewhat similar in structure and form, and often borrow ideas from each other. The harmonica is appropriate as a backup to a main vocal melody and instruments due to its rich harmonic structure and subdued intensity. The ability to apply vibrato and gradual slurs make it a perfect instrument to achieve a "bluesy" sound. In addition, the design allows the player to include melody, harmony and rhythm to serve as a stand-alone instrument. At Loyola, we investigated the physical properties of the harmonica to determine factors that lead to various sounds appropriate to blues and jazz. This talk includes an overview of these unique properties and the use of the harmonica in blues and jazz.

SUN-AG-02 (9:24 to 9:48 AM) | | Steelpan Use in Jazz Music

Presenting Author: Andrew Morrison, Joliet Junior College

The steelpan originated from the Caribbean islands of Trinidad in Tobago in the early 20th century. The physics of the steelpan's vibration explains the unmistakable timbre of this instrument. When building tenor steelpans, tuners generally attempt to tune the first three resonances of each note harmonically. When successful, the tuning results in neighboring notes sharing the same frequency for the first two harmonics of each note on the outer ring of the steelpan. The sympathetic excitation of the neighboring notes is believed to contribute significantly to creating the steelpan's characteristic sound. Although often associated with calypso or reggae music, the steelpan has been used in a wide range of music genres including jazz. This presentation will highlight not only the physics of the steelpan but also the origins of the steelpan and how the instrument came to be used in jazz music.

SUN-AG-03 (9:48 to 10:00 AM) | Contributed Talk | The Physics of the Electric Guitar: Learning about Waves, Electromagnetism, Circuits by Building an Electric Guitar

Presenting Author: William Fenton, The Hotchkiss School

I will descibe a high school physics elective that teaches students about waves, electromagnetism and circuits through the building of an electric guitar. As students set out to design and build a guitar, they ask questions such as: How can I make the guitar string vibrate at a particular frequency?, How can I turn that signal into and electrical signal?, How can I change I modify that electrical signal, How can I amplify that electrical signal, and finally, How can I create sound waves? These questions will motivate students in their experiments to develop models for waves on strings, electromagnetic induction, R-C circuits, transistor circuits and sound waves in air. At the end of the semester students have a firm grasp of the physics of the electric guitar and a pretty cool guitar to take home. http://guitarbuilding.org

Session SUN-AD: Practical DEI for Teaching–Part 1 Sunday, Jan. 7, 9 –10 a.m. Magazine - 3rd Floor

Moderator: Kay Peli Sponsor: Committee on Diversity in Physics

SUN-AD-01 (9:00 to 9:12 AM) | Contributed Talk | Revolutionizing Grades: An Enlightening Spin on Equity in AP Physics

Presenting Author: Phillip Stewart, Hopkins School

This presentation describes research in an AP Physics C classroom, exploring a shift in grading practices to align with the articulated standards. Traditionally, grading categories (e.g., homework, assessments, reports) dominate; this approach structures grading around content strands through three large AP content-aligned units. Adhering to Grading for Equity principles (Feldman, 2019)—Accuracy, Bias-Resistance, Motivation—this method allows students to earn grades representing true mastery of content and skills rather than assignment types. This approach offers students the higher of either the unit test grade or the average of their other unit assessment grades. Provisions for unit test retakes (different test, same material), contingent upon completion of experimental work, emphasize learning and mastery over punitive grading. A Pearson's R statistical test, conducted on final grades and AP scores, yielded $R=0.6988$ ($p<0.01$, $N=23$), despite limitations like small sample size and lack of control group. These results hint at the potential for enhanced learning and equity experiences in physics through Grading for Equity, creating the potential for students to see learning as a progression towards mastery rather than an unyielding race where every performance feels high-stakes. Future inquiries will explore qualitative aspects, including student attitudes and motivations in physics, as well as increasing statistical power with a larger sample size.

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SUN-AD-02 (9:12 to 9:24 AM) | Contributed Talk | Gender and Early Success as Predictors of Student Retention in Physics

Presenting Author: Jason Harlow, University of Toronto Physics

This study investigates the correlation between gender and early test scores in introductory physics with retention rates in more advanced physics courses. Students who study introductory physics courses remain in physics for a number of reasons, including interest, self-efficacy, early success on summative assessments, and feelings about whether they belong in the field. We investigate two large introductory physics courses at a large Canadian university, one algebra-based with 700 students, 54% female, and the other calculus-based with 250 students, 30% female. Both courses satisfy prerequisites for second-year physics courses and admission to the physics programs. While there is no significant overall gender-gap in the drop rates, we find that students with higher scores on early tests are more likely to leave physics if they identify as women. Conversely, women with lower scores on early tests are more likely to continue in physics than their male counterparts with lower test scores who drop the course.

SUN-AD-03 (9:24 to 9:36 AM) | Contributed Talk (12 Minutes) | Race, Identity, and STEM - A Short Course Aimed at Empowering Marginalized Students

Presenting Author: Toni Sauncy, Texas Lutheran University

Additional Author | Jennifer Mata, Director-Diversity, Equity, Inclusion, and Accessibility - City of San Antonio (former TLU Faculty)

As part of an NSF Improving Undergraduate STEM Education (IUSE) in Hispanic Serving institutions award, researchers at TLU created a co-curricular module for student professional development focused on navigating systemic racism and other marginalizing experiences students may encounter when pursuing STEM careers. The 8-week short course invites students to examine their cultural, social, and familial identities, and look at so-called barriers to their participation in STEM, including engaging their childhood care-givers in conversation about their dreams and goals. Curriculum is designed to help students shift their mindset as they examine how societally-defined "barriers" can actually be leveraged as strengths in their academic and scientific pursuits. Students are encouraged to share their experiences either in writing or in group discussion, which can lead to uncomfortable, but necessary conversations that have positively impacted their resilience and ability to persist, based on evidence from student feedback. This is a challenging outside-area-of-expertise teaching endeavor for a physics professor, but one which has been truly rewarding and inspiring.

This work is funded by NSF IUSE: HSI Award #1953561

SUN-AD-04 (9:36 to 9:48 AM) | Contributed Talk | History of Physics/Science

Presenting Author: Azida Walker, University of Central Arkansas

Most of modern-day physics is built on what Newton himself called "On the shoulders of Giants" when he referred to the work done by the great thinkers before his time. The twist is that in current day Physics, Isaac Newton finds himself in superstardom status, being one of Physics' greatest scientists. If the general public is asked about physicists they know and recognize perhaps among them Newton, Einstein, Faraday, Watts, Joules, and Pascal, may make the list and it may keep going. One may say what about women? The answer will be a resounding Marie Curie then the list

is silent. The point is, that there have been women scientists contributing with male colleagues to scientific progress but faced with the inevitable gender bias at the time, were left out of the records, conversations, and recognition for their work. It is time we focus on some of these women, and add their names to the list of giants that we stand on. The talk will focus on a new course developed at the University of Central Arkansas that gives students a chance to recognize these women and add to the list of women who have made a significant contribution to the field of Physics.

SUN-AD-05 (9:48 to 10:00 AM) | Contributed Talk | Adapting a Calculus-based Physics Course for a Blind Student

Presenting Author: Abigail Bogdan, Seton Hill University

Introductory physics is a gateway science course for many students, and, as such, there has been an increased emphasis on improving the accessibility of physics courses. However, there are few publication or resources available for adapting physics courses for students who are blind or visually impaired. This presentation will describe the adaptation of a Calculus-based introductory physics lecture and lab for a legally blind student at a small liberal arts college, a setting not often studied by PER researchers. Challenges as well as resources in this particular setting will be discussed.

Session SUN-AE: Quantum in HS–Part 1 Sunday, Jan. 7, 9 –10 a.m. Jackson - 3rd Floor

Moderator: Karen Jo Matsler Sponsor: Committee on Physics in High Schools

SUN-AE-01 (9:00 to 9:24 AM) | | Application of Mathematical Concepts Using Inquiry-based Quantum Activities

Presenting Author: Maajida Murdock, Morgan State University

When you think about teaching quantum mechanics at the high school, do you immediately think of AP physics lessons? All students need to be exposed to key concepts in quantum mechanics (QISK12). Some quantum mechanics concepts can be taught in all academic subjects, including math! With guided questions through inquiry-based activities, high school students can understand the application of mathematical concepts to quantum. Students can conceptualize some of the mathematical concepts and skills taught in the classroom to explain the relationship between simple quantum experiments and quantum technologies.

SUN-AE-02 (9:24 to 9:48 AM) | | The Quantum for All Professional Development Model

Presenting Author: Ramon Lopez, The University of Texas at Arlington

Quantum information science (QIS) is of growing importance to economic and national security, commerce, and technology. The logical venue for exposure to basic ideas in quantum science might be a high school physics course, or even a physical science course if a full physics course is not offered. Professional development (PD) for educators typically includes 1-2 weeks of intensive instruction, usually in the summer. Teachers are then expected to remember what they learned and implement it several months after the PD. However, little research has been done as to how much they actually implement. For the past three years, we have been engaged in a project funded by the US National Science Foundation to build mechanisms (materials and PD strategies) for educating a quantum-ready workforce. Our PD model is based on pedagogical techniques used in classrooms, specifically the components of learn then practice in order to avoid cognitive overload. Instruction is more effective when the learners (teachers or students) are given opportunities to actively engage in the learning process through interaction/collaboration with peers, exploring challenges, and practicing what they have learned. This paper will share the overview of our PD model and some initial results.

SUN-AE-03 (9:48 to 10:00 AM) | Contributed Talk | Training Teachers to Introduce Quantum Information Science in K-12 Classrooms

Presenting Author: Luis Mendoza, Fermilab

Additional Author | Amanda Early, Fermilab

Quantum Information Science (QIS) is a developing multidisciplinary field that uses the laws of quantum physics for storing, transmitting, manipulating, processing, and measuring information. QIS is very likely to impact society in significant ways. To aid in the development of this field it is important to start introducing concepts and ideas of QIS in K-12 classrooms. Starting quantum education in K-12 provides a larger, more diverse pool of students the opportunity to learn about this field so that they can become future leaders in this rapidly growing field, to achieve this, teachers have to be given the resources to introduce QIS concepts in the classroom. With this goal in mind Fermilab hosted a QIS Institute in Summer 2023. Over four weeks we had six K-12 teachers come to learn the basics of QIS, this included lectures, talks, panels, and laboratory tours. The teachers were then tasked with developing lesson plans and activities to include QIS concepts in their classrooms, which will be implemented in the 2023-2024 school year. In this presentation we give a detailed overview of the 2023 QIS Institute and the materials developed by the teachers, alongside teacher testimonials and students responses when exposed to QIS content.

Session SUN-AF: Panel– Reading 'Round Science: K-5 Science with Kiddie Lit Sunday, Jan. 7, 9 –10 a.m.

Canal **Moderator: Nina Morley Daye** **Sponsor: Committee on Physics in Pre-High School Education**

This panel will share K-8 books that teachers connect to a physics lab, demo or activity. Panelists will have books to show and activities, often tied directly to NGSS. Come learn about how to include children's books in your classroom.

Panelists include: *Nina Morley Daye, Jan Mader, Janie Head, Ann Robinson, and Richard Gelderman.*

Session SUN-BA: 21st Century Astronomy and Physics in the Classroom–Part I Sunday, Jan. 7, 10 –11 a.m.

Commerce - 3rd Floor **Moderator: Shane Wood** **Sponsor: Committee on Contemporary Physics**

SUN-BA-01 (10:00 to 10:24 AM) | | LIGO and Gravitational Waves: Eight years later

Presenting Author: Amber Strunk, LIGO/Caltech

In the eight years since the Laser Interferometer Gravitational-wave Observatory's (LIGO) initial ground-breaking detection the field of gravitational wave astrophysics continues to intrigue students, scientists, and the public alike. The exciting nature of the field and the wide range of science and engineering concepts needed for success provides many opportunities to bring LIGO into your classroom. In this talk I will give you the information you need to share this new field with students from how the detectors work to what we have learned from over one hundred gravitational wave events. I will also touch on resources available through the LIGO Laboratory and the broader gravitational wave community to not only teach students about gravitational waves but ways to connect LIGO to the classical physics you already teach.

SUN-BA-02 (10:24 to 10:36 AM) | Contributed Talk | Not Your Typical General Education Survey: A Citizen Science Astronomy Course

Presenting Author: Julia Kamenetzky, Westminster University

A traditional general-education science survey course often prioritizes breadth over depth of content. In this new "Citizen Science Astronomy Research" course, students and I reversed the priorities and dove in-depth into the technique of aperture photometry and the field of exoplanet transit timing monitoring. Referred to as a CURE (Course-Based Undergraduate Research Experience), this type of course gives students an authentic research experience with no pre-requisite requirements; in this iteration, students analyzed archival telescope data and directly contributed to the NASA-supported Exoplanet Watch project. There are many other citizen science projects that students can meaningfully contribute to with the guidance of their instructor. In addition to hands-on research, students also spent time reading and discussing academic literature on citizen science, science literacy, and the funding of science. They participated in Zoom discussions with guest speakers working at the intersection of conventional scientific research and citizen science initiatives. Finally, the course culminated with a conference-style public event where students presented posters about a Zooniverse project to which they made significant contributions. In this talk, I'll share the motivation for creating this course, its content, how it went, and how you can create a CURE at your own institution.

SUN-BA-03 (10:36 to 10:48 AM) | Contributed Talk | Introducing "Multi-Messenger Astronomy" as High-Tech Use of Our Five Senses

Presenting Author: Richard Gelderman, Western Kentucky University

The term "Multi-Messenger Astronomy" is more than just jargon terminology. Learners in introductory science courses have been told that the light from the electromagnetic spectrum spans wavelengths/frequencies/energies that their eyes cannot observe, but that can be otherwise detected. Recently, detection of celestial objects has extended to neutrinos and gravitational waves. The first step to share these discoveries in an introductory classroom might be to explain that as technology allows us to extend our sense of SIGHT to other wavelengths of electromagnetic light, detection of gravitational waves is a high tech extension of our sense of HEARING and detection of neutrinos is an extension of our sense of SMELL.

Session SUN-BC: Innovations in HS and Intro Labs Sunday, Jan. 7, 10 –11 a.m. Royal - 3rd Floor

Moderator: Troy Messina **Sponsor: Committee on Laboratories**

SUN-BC-01 (10:00 to 10:12 AM) | Contributed Talk | Lab Exercises with CHEAP single-photon detectors

Presenting Author: Gabriel Spalding, Illinois Wesleyan University
Additional Author | Henry P. Evans, Illinois Wesleyan University
Additional Author | Benjamin D. Heinz, Illinois Wesleyan University
Additional Author | Evan C. Hutson, Illinois Wesleyan University
Additional Author | Wanda L. Lindquist, Illinois Wesleyan University

There is broad interest in bringing more quantum physics into both high schools and undergraduate courses, and so it was serendipitous that the instructional labs community happened upon a couple of inexpensive LEDs that can function (albeit inefficiently) as single-photon detectors, at reverse bias voltages that can be achieved using three 9-volt batteries. A series of exercises are now in use at a variety of institutions, introducing students to basic test and measurement technical competencies as well as the physics of Geiger-mode detection and amplification of single quanta, and some of the basic statistics of particle counting, without the use (or risk) of more expensive components. So far, we have seen only two inexpensive models reported for instructional lab use as Geiger-mode single-quanta detectors of this sort, the AND114 R and the AND113 gallium phosphide LEDs made by Purdy Electronics Corp. Unfortunately, those LEDs, as well as other components used in many of these instructional labs, have been removed from production. Our aim is to discuss the broader set of options available for these kinds of instructional exercises, and some of the roles they can play in student development.

SUN-BC-02 (10:12 to 10:24 AM) | Contributed Talk | Measuring the Adiabatic Index of Gases Using an Ultrasonic Sensor

Presenting Author: Matthew Brynteson, University of Lynchburg

In an introductory thermodynamics course, one of the common topics introduced to students is that of the adiabatic index of a gas. Herein, we present a new apparatus capable of measuring the adiabatic index of a gas over a range of temperatures which can be implemented into an undergraduate laboratory course investigating such topics. To accomplish the desired objective, an ultrasonic sensor is used to determine the speed of sound in the gas inside a closed cell. While many previous methods use various techniques to measure the speed of sound with a similar objective, many of them require additional knowledge that many introductory students do not possess. Rather, a direct measurement of the speed of sound is far more intuitive to an introductory student, and an understanding of the experimental methodology is more readily achieved. In addition, we present the results for carbon dioxide over a temperature range which enables students to investigate the effect of molecular vibration on the adiabatic index.

SUN-BC-03 (10:24 to 10:36 AM) | Contributed Talk | The Rocks from Space Lab

Presenting Author: James Lincoln, SCAAPT.org

In this museum style lesson, students move from station to station where they get to investigate rocks found on Venus, Mars, the Moon, meteorites, and even Saturn's rings and comets. In this talk, I describe the lab and include pictures of the stations. Our standards occasionally ask us to include interdisciplinary lessons like this and - besides - all the materials are probably already in some big bin labeled "rocks" down the hall. Robotic probes have landed on our neighboring planets, but, to best understand our solar system necessitates a lesson in Geology and here it is: The Rocks from Space Lab.

SUN-BC-04 (10:36 to 10:48 AM) | Contributed Talk | An Introductory Lab Sequence with Microcontroller Apparatus

Presenting Author: Troy Messina, Berea College

We present a series of lab activities for introductory physics that use microcontrollers for constructing experimental apparatus. Each lab focuses on a particular aspect of digital data acquisition, i.e., digital I/O and analog I/O, as an introduction and then application. For the application, students design and run experiments that result in data they analyze and interpret using statistical or experimental uncertainty. The series of labs is designed to lead students through different facets of experimental design and analysis. By the end of the sequence, students are prepared to undertake projects that incorporate multiple types of digital data acquisition and choose the appropriate analysis tools to draw conclusions from experiments they create.

Session SUN-BG: Physics of Jazz–Part 2

Sunday, Jan. 7, 10 –11 a.m. Fulton - 3rd Floor

Moderator: Gordon Ramsey Sponsor: Committee on the Interests of Senior Physicists

SUN-BG-01 (10:00 to 10:12 AM) | | The Physics of Woodwinds, and a Dabble of Guitar

Presenting Author: Samuel Sampere, SYRACUSE UNIVERSITY

I love NOLA because music is everywhere! Nothing connects people like music, and it would be nice to understand a little bit about the instruments that make that music, so let's explore the similarities and difference of two very different sounding instruments that you'll hear while in NOLA – the saxophone and clarinet. Both share common fingerings to point. Why do they differ in some registers? Why do they have quite distinctive sounds? And how does flute compare? And do they relate to guitar strings, which every introductory physics course expores.

Session SUN-BD: Practical DEI for Teaching–Part 2–Discussion Session Sunday, Jan. 7, 10 –11 a.m.
Magazine - 3rd Floor Moderator: Anthony Escuadro Sponsor: Committee on Diversity in Physics

SUN-BD (10:00 to 10:48 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Beyond Single Physics Courses: Envisioning a Framework for DEI Education

Presenting Author: Kristen Burson, Grinnell College

Co-presenting Author | Janice A Hudgings, Pomona College

In this interactive roundtable discussion, we aim to engage the community of physics educators in outlining a framework for embedding equity-focussed education topics across the four year undergraduate physics curriculum. Building on the work of the Underrepresentation Curriculum, the past decade has seen an enormous growth in instructors including DEI focussed topics and lessons in individual physics classes and instructional labs. Recent special topical editions of the journal The Physics Teacher highlight these developments. How might we take this to the next level? Can we as a community envision scaffolding increasingly sophisticated discussions and skill-building about equity throughout the undergraduate curriculum, just as we progressively build lab skills or mathematical sophistication? Please join us for an interactive brainstorming session as we work together to define learning objectives and to envision a four-year undergraduate physics curriculum with a trajectory of equity-minded topics embedded throughout.

Session SUN-BE: Quantum in HS–Part 2–Interactive Session Sunday, Jan. 7, 10 –11 a.m.
Jackson - 3rd Floor Moderator: Karen Jo Matsler Sponsor: Committee on Physics in High Schools

SUN-BE -01 (10:00 to 10:48 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Integrating Engineering and Quantum

Presenting Author: Karen Matsler, UT Arlington

Quantum concepts are often challenging to incorporate into STEM lessons. Quantum for All is an NSF-funded project that is accepting the challenge by designing high school lessons based on engineering design to engage students in learning about quantum. This past summer focused on maglev and quantum levitation, Students learned about magnetic fields by designing devices that could support a mass while levitating above a track. The transition to quantum levitation was met with eagerness and awe! We will share what we did for these students, but it would also be applicable to university students.

Session SUN-BB: Teaching and Learning–What is the Core of Intro Physics Sunday, Jan. 7, 10 –11 a.m.
Camp - 3rd Floor Moderator: Beverly Trina Cannon Sponsor: Committee on Research in Physics Education

SUN-BB-01 (10:00 to 10:12 AM) | Contributed Talk | Mathematical Proficiency Enhancement for Physics Success (MaPEPS): A Study on Elevating Introductory Physics Students' Learning Experience

Presenting Author: Bilas Paul, Farmingdale State College

Additional Author | Ganga P Sharma, Fairmont State University

"Mathematical Proficiency Enhancement for Physics Success" (MaPEPS) aims to enhance the learning experience of introductory physics students by investigating the relationship between their mathematical competence and academic performance. Recognizing the prevalent issue of insufficient mathematical skill and its detrimental impact on physics problem-solving abilities, MaPEPS proposes a novel approach. The study implements concept tests as a timely intervention during the initial stages of the semester, evaluating students' foundational mathematical knowledge, a prerequisite for success in physics courses. Through early administration of concept tests, the study promptly identifies students facing challenges with fundamental mathematical concepts crucial for their success in physics. MaPEPS provides tailored support and additional resources to empower these students, fostering the development of their mathematical skills. This proactive intervention strategy bridges the gap between insufficient mathematical proficiency and excellence in physics education, significantly improving overall learning outcomes and academic achievements for introductory physics students. (The study is currently ongoing in two different US institutions, and preliminary data will be presented during the AAPT winter meeting.)

SUN-BB-02 (10:12 to 10:24 AM) | Contributed Talk | Investigating "Math" and "Physics" Conceptions in a Calculus-based Intro-Physics Classroom

Presenting Author: Idris Malik, North Dakota State University

Additional Author | Warren M Christensen, North Dakota State University

Prior Physics Education Research (PER) literature has explored student conceptions of "Math" and "Physics" in courses and disciplines, as well as the conceptions of disciplinary experts. We seek to explore how students and instructors think about what "Math" is and what "Physics" is, and how those ideas come together when talking about and doing math/physics tasks in a Calculus-based Introductory course. Electronic Field notes and recordings of audio and video using an OWL video were captured in each class period throughout the semester. Field notes documented instances where students and the instructor mentioned disciplines in general and the use of each discipline in the context of this course or other courses. Field notes also document any emergent features of student-student and student-instructor discourse and actions. Preliminary analysis of field notes and recordings reveals novel distinctions between students and the instructor regarding math and physics conceptions and work procedures.

SUN-BB-03 (10:24 to 10:48 AM) | Contributed Talk | Iconic Problems in the Physics Core

Presenting Author: Juan Burciaga, Colorado College

The "physics core" is a frequently cited though rarely defined curricular framework of the physics major. But often discussion of a physics core falls back on established courses. Iconic problems has proven to be a useful paradigm to analyze the introductory physics curriculum. Iconic problems share many of the characteristics of threshold concepts (transformative, integrative, bounded, …) but are identified by introducing problems early in the curriculum and revisiting these problems again and again, each time approaching a given problem in greater depth and complexity. The talk presents an analysis of a representative physics major in terms of the iconic problem paradigm. The analysis is one step in thinking of the physics major separate from the structure of established courses.

Session SUN-BF: Topical Discussion: Let's Talk Assessment and Grading **Sunday, Jan. 7, 10 –11 a.m.**
Canal Moderator: Debbie Andres Sponsor: Committee on Physics in High Schools

This session follows an "unconference" model around the topic of assessment and grading practices in physics. This model is an opportunity for participants to talk about topics relevant to them. It also provides a high level of flexibility in discussion topics: giving practitioners an opportunity to connect and share ideas. Participants are more than welcome to bring their own materials to share or get feedback on. When participants arrive at the session, the moderator will guide the group in deciding on table topics. After these are set, participants will rotate between topics at least two times. Movement between table topics will be fluid and anyone is welcome to join this session at any time throughout the 2 hours.

2024 Oersted Medal Winner is Laura H. Greene

Physics Education Beyond the Classroom

My path into physics and beyond has been far from traditional as have been the many ways I have tried to educate my students. I have advised over 200 undergraduates and visitors to my laboratories during my career, and over the years I have tried to recruit, whenever possible, people from diverse and non-traditional backgrounds. Furthermore, I have given about as many workshops and presentations, frequently in developing countries, and these have helped to empower women and minorities and have increased their scientific sophistication. This has not been simple philanthropy: My approach also reaches talented and determined aspiring scientists who traditionally would have been ignored. Education construed broadly increases the diversity needed to address this century's global challenges. I will give examples of how diversity has furthered scientific discovery and relate some of my journey in physics, then to science diplomacy towards human rights, and now science policy.

Greene is the Chief Scientist at the National High Magnetic Field Laboratory and the Marie Krafft Professor of Physics at Florida State University. She was previously the Swanlund and the Center for Advanced Study Professor of Physics at the University of Illinois at Urbana-Champaign. Her undergraduate studies were at The Ohio State University, and after receiving her PhD at Cornell University, she was a post doc at Bell Labs then a member of staff at Bellcore.

AAPT PHYSICS EDUCATION®

Laura H. Greene

11:30 AM to 12:30 PM
St. James - 3rd Floor

Session SUN-CA: 21st Century Physics and Astronomy in the Classroom–Part 2 Sunday, Jan. 7, 2–3 p.m.

Commerce - 3rd Floor Moderator: James Rantschler Sponsor: Committee on Contemporary Physics

SUN-CA-01 (2:00 to 2:12 PM) | Contributed Talk | AAPT as Part of the NASA Heliphysics Education Activation Team

Presenting Author: Ramon Lopez, Dept. of Physics, Univ. of TX at Arlington

Additional Author | Rebbeca Vieyra, Vieyra Software

The NASA Heliophysics Education Activation Team (HEAT) is a grant-funded project headquartered at Goddard Space Flight Center in Greenbelt MD. The focus of this project is Heliophysics education and outreach. AAPT has been a partner in this project since its inception, developing instructional resources and providing professional development for secondary and post-secondary physics and space science education, and some research into the use of space science in the classroom. In this presentation, I will descibe what the AAPT contribution to NASA HEAT has been and I will provide information about how AAPT members can take advantage of the resources that we have developed, as well as NASA HEAT resources in general.

This work is supported by NASA grant 80NSSC21K1560.

SUN-CA-02 (2:12 to 2:24 PM | Contributed Talk | Bringing Emerging Technologies in Photonics into Introductory Physics

Presenting Author: Douglas Petkie, Worcester Polytechnic Institute

Manufacturing USA was created in 2014 to accelerate the development of new advanced manufacturing technologies in the United States. To date, seventeen institutions have been created that focus on such technologies as integrated photonics circuits to flexible hybrid electrons. Each Institute in the network has ongoing workforce development initiatives that span from attracting and training STEM talent for the future, retaining and upskilling the current workforce, and creating outreach activities that promote engagement. The AIM Photonics Institute focuses on developing fundamental photonic integrated circuits (PICs) that can be manufactured to replace, complement, or expand traditional microelectronics capabilities. Curriculum modules can be built around PICs and incorporated into classes that meet the course's learning outcomes while promoting awareness of exciting technologies. Several examples will be presented and can be incorporated into the introductory physics curriculum. https://www.aimphotonics.com/

SUN-CA-03 (2:24 to 2:36 PM) | Contributed Talk | Using Quantum in General Education

Presenting Author: Jared Stenson, Rice University

Although quantum mechanics is a notoriously mysterious and technical subject, three things seem true: 1) familiarity with it is an increasingly valuable part of being an "educated" person, 2) it elicits wonder and engagement from a wide swath of people, and 3) its prominent features can be understood—or at least appreciated—by these groups. In this talk, I will discuss the creation of a class called "The Foundations of Quantum Mechanics for Regular People" that addresses these three truths. In it, students become familiar with the nature and history of science, the experiments that characterize quantum behavior, the formal aspects of the theory, and the interpretive debates and applications that follow. Efforts to move this class into the general education space as a Freshman writing course will also be discussed. Spoiler alert: students end up being able to talk intelligently about quantum and like the experience!

SUN-CA-03 (2:36 to 3:00 PM) | | High Energy Physics Experiments in the Classroom

Presenting Author: Mark Adams, Fermilab

QuarkNet provides detectors to high schools so they can pursue their own research using high energy cosmic rays. Web-based software enables students to analyze their own data as well as others' existing data. I will describe several experiments ranging from simple measurements for the class (measuring the speed of muons) to sophisticated multi-year, multi-school projects that can lead to conference presentations (searching for the shadow of the moon in cosmic rays).

Session SUN-CB: AI in Physics Education– Part 1 Sunday, Jan. 7, 2–3 p.m.

Camp - 3rd Floor Moderator: Duncan Carlsmith Sponsor: Committee on Educational Technologies

SUN-CB-01 (2:00 to 2:12 PM) | Contributed Talk | ChatGPT Joins the Physics Study Session

Presenting Author: Gerard Blanchard, Southeastern Louisiana University

I lead bi-weekly study sessions for physics majors that I call "Random Questions from Tipler". In these sessions, I use a random number generator to select a random chapter and a random end-of-chapter question from "Physics for Scientists and Engineers" by Tipler and Mosca as an exercise for the students and as the topic of an impromptu lecture. In Fall 2023, we also fed the questions into ChatGPT, both as a prompt for the students' thinking and to critique ChatGPT's solution once we have solved the question ourselves. I will present our assessment of ChatGPT's performance over the course of the semester.

SUN-CB-02 (2:12 to 2:24 PM) | Contributed Talk | Using AI in an Introductory Calculus Based Physics Course

Presenting Author: Kathy Shan, University of Toledo

I will report on the use of Chat GPT in an honors section of a calculus based introductory physics 2 course. Students used Chat GPT to help them to learn problem solving and also to write a short report on an application of the physics content of the course to technology that interests them. In

both cases, students were required to find and correct errors in the work generated by AI and report on those errors, while finding sources to back up their corrections.

SUN-CB-03 (2:24 to 2:36 PM) | Contributed Talk | Preparing to Use Spaced Repetition in A Fully Online Modern Physics Course

Presenting Author: Clifton Noel, Department of Physics, The University of Texas at Arlington

Additional Author | Atharva Dange, Department of Physics, The University of Texas at Arlington

Additional Author | Scott Yarbrough, Department of Physics, The University of Texas at Arlington

Additional Author | Ramon Lopez, Department of Physics, The University of Texas at Arlington

Spaced repetition is a method of providing students with material at intervals determined by an algorithm to counteract the exponential decay of memory, and to solidify student knowledge on a topic. This method has been used in medical education, and we are adapting this approach within a partially flipped fully-online Modern Physics course. In this presentation, we will discuss our preparations to use spaced repetition in the Spring of 2024, and then to evaluate the methodology and algorithm for adaptation to a fully asynchronous version of the course in the Fall of 2024. The database of questions for the implementation of spaced repetition will be generated using AI as described in a companion presentation.

SUN-CB-04 (2:36 to 2:48 PM) | Contributed Talk | Using AI to Generate Homework and Practice Questions in a Fully Online Modern Physics Course

Presenting Author: Atharva Dange, Dept. of Physics, The University of Texas at Arlington

Additional Author | Clifton W Noel, Dept. of Physics, The University of Texas at Arlington

Additional Author | Scott Yarbrough, Dept. of Physics, The University of Texas at Arlington

Additional Author | Ramon Lopez, Dept. of Physics, The University of Texas at Arlington

The adoption of online education, particularly in upper division physics courses like Modern Physics, necessitates effective homework question preparation. In addition, we are planning to incorporate spaced repetition in the Modern Physics course as described in a companion presentation. We are investigating the use of Generative AI to streamline the process of creating an appropriate database of questions and tasks. The first step in this process is to create a course map with detailed learning objectives that could be used as prompts for the Generative AI. In this presentation we will present a status report of work to date on this project and provide examples of questions created by Generative AI.

SUN-CB-05 (2:48 to 3:00 PM) | Contributed Talk | Revolutionizing Tutoring: Hamline University's AI-Enhanced STEM-Start Program for High Schoolers

Presenting Author: JERRY ARTZ, Hamline University

Additional Author | John Alchemy, Rate-Fast Corporation

Additional Author | Bruce Bolon, Hamline University

Hamline University's STEM-Start Program is one in which college students from Hamline mentor and tutor high school students in order to boost the high school students' confidence in science and help them develop effective study habits. The program utilizes AI-generated customized problem sets for the high school students to work through under the guidance of the college mentors. AI tailors problem sets to individual student needs, while mentors inspire and motivate. This integrated approach equips students for success in college-level science courses, fostering future contributions to the scientific community. See: https://hamlinestemstart.com

Session SUN-CG: Integrating Lecture and Lab–Part 1–Interactive Session Sunday, Jan. 7, 2–3 p.m.

Fulton - 3rd Floor Moderator: Makeda Butler Sponsor: Committee on Laboratories

UN-CG-01 (2:00 to 2:24 PM | Interactive (e.g. panel, round table discussion, hands-on activity) | Physics on the Cheap

Presenting Author: Jon Anderson, University of Minnesota-Twin Cities

This session will focus on making and using equipment for teaching physics. Some of the equipment can be used for physics demonstrations, some can be used for physics labs, and some can be used for both. The cost of the equipment varies from a few cents to a few dollars per item and the materials are easily attained at stores such as Target and Home Depot. Participants in this session will make some equipment to take with them, see some pieces of equipment demonstrated, and see video of other pieces of equipment. It is geared for physics and physical science teachers of grades 9-12.

Session SUN-CC: Lab Activities and Learning Goals–Advanced Labs Sunday, Jan. 7, 2–3 p.m.

Royal - 3rd Floor Moderator: Vittal Harith Sponsor: Committee on Laboratories

SUN-CC-01 (2:00 to 2:12 PM) | Contributed Talk | Introducing Optical Properties of Liquid Crystals and Polarization in Undergraduate Optics Course

Presenting Author: Shantanu Chakraborty, Valdosta State University

In this presentation, we present a simple technique to investigate the temperature-dependent effect on the threshold voltage of liquid crystal. Liquid

crystals are orientationally ordered fluids, their response to weak external fields, which makes the liquid crystal displays possible. They possess small amount of orientational order as they undergo liquid-like diffusion. By using some common laboratory items, we can measure Freedericksz's threshold voltage (Vth) for a commonly used nematic liquid crystals 4-Cyano-4'-pentylbiphenyl known as 5CB. Students can be introduced to the concept of birefringence of liquid crystals and learn how to control the director axis of them by applying weak electric field to the thin cells containing 5CB crystals. Later, they investigate the thermally induced nematic to isotropic (N–I) phase transition of the 5CB crystals, which takes place within a temperature range between 36 °C and 37 °C and is fully reversible. Finally, by fitting their data of threshold voltage and transmitted ratio at different temperatures to a simple temperature-dependent birefringence theory of liquid crystal, they can calculate the order parameter.

SUN-CC-02 (2:12 to 2:24 PM) | Contributed Talk | Role of Advanced Laboratory in a Research University's Undergraduate Physics Curriculum

Presenting Author: Sean Robinson, MIT

I will discuss how the learning goals of an advanced laboratory physics course can be designed to align with both the overall learning goals of an undergraduate physics major and with the role that research universities play in society.

Session SUN-CF: PTRA and Perimeter Present: Evidence for Climate Change Sunday, Jan. 7, 2–3 p.m.

Canal Moderator: Karen Jo Matsler Sponsor: Committee on Physics in High Schools

Interactive Session: *This session will actively engage participants in multiple lessons including what does heat do, understanding the Keeling Curve (rise in CO_2), and changes in sea level. Participants will collect data and discuss how these activities can be appropriately embedded into a classroom environment.*

Session SUN-CD: The Use of Critical Race Theory in Physics Education Research–Part 1 Sunday, Jan. 7, 2–3 p.m.

Magazine - 3rd Floor Moderator: Clausell Mathis Sponsor: Committee on Diversity in Physics

SUN-CD-01 (2:00 to 2:24 PM) | | CRT in PER: From the States to the World, Shifting Conversations Around Race

Presenting Author: Katemari Rosa, Federal University of Bahia, Brazil

From its genesis in the Legal Studies, the spread in education and other fields, to affecting Physics Education Research, Critical Race Theory has been in the spotlight in the last few years. In the United States, CRT has encountered resistance and has been under attack, from conservative scholars and politicians. A misinformation campaign regarding CRT affected several school districts, leading to a ban of CRT studies. This presentation focuses on how CRT has been affecting PER in the United States and abroad, showcasing how researchers have employed CRT and how this movement is helping to shift the conversation within the field of physics education.

SUN-CD-02 (2:24 to 2:48 PM) | | Critical Race Theory Perspective of Physics

Presenting Author: Miguel Rodriguez, California State University Dominguez Hills

Racism continues to be ordinary in the US, including in academia. In physics, it is well known that the majority of domestic physics graduates continue to be predominantly white men, despite decades of effort to bring in more people of color to physics. This raises many questions as to why that is and what we can do to better diversify the field going forward. To address this, critical theories should be used to examine these racial gaps, to understand how history has led us up to this point and what can be done to increase diversity. Critical Race Theory (CRT) serves as an effective theoretical framework to study the dynamics between race, racism and power. CRT has its roots come from legal studies in the late 80s and has since branched out due to many disciplines including sociology and education. This presentation will involve introducing CRT, discussing key events of race & physics, and then examine the physics field through a CRT lens. While there are large racial gaps in physics, there is a lot of progress in reducing those gaps and improving the experiences of students of color in physics overall.

Session SUN-CE: Strategies to Support K-12 Physics Learning Sunday, Jan. 7, 2–3 p.m.

Jackson - 3rd Floor Moderator: Marla Glover Sponsor: Committee on Physics in High Schools

SUN-CE-01 (2:00 to 2:12 PM) | Contributed Talk | Across the Physics-Verse: Creating Physics Comic Books for K-12 and Intro College Students

Presenting Author: Roger Freedman, University of California, Santa Barbara

Co-presenting Author | Juan Manuel Ramírez de Arellano, Tecnológico de Monterrey, Campus Ciudad de México

As described in our presentation at the 2023 Summer Meeting, we are creating a series of comic book stories to help high school and introductory college students with solving specific types of physics problems. (RAF is a textbook author and one of the original group that helped start the San Diego Comic-Con in the 1970s; JMRdeA is both a professional cartoonist and a physicist.) In this presentation we'll review the motivation behind this approach and describe the two stories presently available in both English and Spanish: one on friction forces, and one on the right-hand rule for magnetic forces. We'll also describe the responses from students and present a third, conceptual comic book story about the origin of the lift force on airplanes. Finally, we'll introduce another bilingual physics comic book project, "Science with Cuco and Pepo" (in collaboration with S. E. Tellez Flores), aimed at middle school students.

SUN-CE-02 (2:12 to 2:24 PM) | Contributed Talk | "Building Thinking Classrooms" in Physics

Presenting Author: Marianna Ruggerio, Auburn High School

During the 2022-23 school year a group of physics educators began adopting ideas from Peter Liljidahl's book "Building Thinking Classrooms in Mathematics." Conversations on Twitter turned into a nation-wide book study of physics educators. This talk will describe how Liljidahl's methods were adopted in a physics context for both AP and on-track students, including vertical whiteboarding, consolidation and making notes.

SUN-CE-03 (2:24 to 2:36 PM) | Contributed Talk | Modeling the Shape of Earth's Orbit

Presenting Author: Bryn Bishop, Art of Problem Solving

At the Art of Problem Solving, our mission is to train the great problem solvers of the next generation, and to do this, we've been building our suite of science courses. In this talk, I'll share an activity designed for a third grade science class that is useful for curious people of all ages. We had students build a classroom sized model of Earth's distance from the Sun to discover the shape of Earth's orbit, then built in more activities and models for students to make sense of evidence leading to understanding the reason for seasons. I will also share our insights on running this activity for three third grade classrooms and some surprising insights on running the activity with STEM educators.

SUN-CE-04 (2:36 to 2:48 PM) | Contributed Talk | Climate Science Lessons for Students in Grades 6-13

Presenting Author: Frank Lock, Climate Reality Project

This presentation introduces information about climate science that can be used by educators who work with science students in grades six through 13. The presentation approaches climate science through thermodynamics, specifically, the second law of thermodynamics. Students are introduced to the concept of entropy and that concept is related to producing energy for human use. Resources will be introduced as well as actions that can be taken to increase the awareness of the challenges we face from the climate emergency. It is very important to make our students aware of how the changes in climate we face will affect them.

SUN-CE-05 (2:48 to 3:00 PM) | Contributed Talk | Simple Kinesthetic Demonstrations in Astronomy Teaching

Presenting Author: Kenneth Brandt, Public Schools of Robeson County Planetarium/USC Beaufort

Come and learn some simple kinesthetic demonstrations and activities you can do with your students. These require few if any ancillary materials.

Session SUN-DB: AI in Physics Education—Part 2 Sunday, Jan. 7, 3–4 p.m.

Camp - 3rd Floor Moderator: Duncan Carlsmith Sponsor: Committee on Educational Technologies

SUN-DB-01 (3:00 to 3:12 PM) | Contributed Talk | Using AI to Promote Depth in Student-Student Physics Discussions

Presenting Author: Christopher Moore, University of Nebraska Omaha

The depth and accuracy of student discussions can vary significantly. This typically necessitates trained facilitators ensuring that discussions remain relevant, accurate, and at a depth that drives learning, which presents logistical challenges for large-enrollment physics courses. These challenges are magnified in asynchronous online courses, where just-in-time interventions are difficult to implement. We will present our preliminary work developing a framework and prototype for a ChatGPT-driven tool that parses student discussions in online course management systems, uses semantic analysis to determine accuracy and levels of discussion, and produces a real-time map of the social network. The tool will align the content of students' discussion-board posts with Bloom's Taxonomy in real-time and make just-in-time suggestions with question stems to promote greater depth of discussion. Instructors will also be able to visualize the course social network through Social Networking Analysis with visualizations showing depth of discussions and student positioning.

SUN-DB-02 (3:12 to 3:24 PM) | Contributed Talk | Exploration of AI and internet resources for student understanding of 2D and 3D Navier-Stokes equations, and applications to meteorology and other areas of physics

Presenting Author: Michael George, San Diego City College

The Navier-Stokes equations are central equations for mass and momentum conservation, locally, in fluid physics, and have generated much research over the past 200 years due to interest in connecting this local to global behavior of fluids, and applications in aerodynamics, meteorology, geophysics and other important areas of physics, engineering and mathematics (including a Millenium Problem prize for investigating the 3D Navier Stokes equation.) The goal of our session will be to see how generative AI and freely accessible internet resources can help students can an understanding of this vast interdisciplinary area of physics, and the potential for undergraduate research progress driven by such resources. Can generative AI level the playing field here for innovative and insightful work of high school or four year college students of math, engineering and science? We plan to put this into perspective and explore this idea, including discussing basics of Navier-Stokes equations in context of Stokes' theorem from calculus, the "solution" by Ladyzhenskaya of the 2D Navier-Stokes equations from 1958 [1], a perspective within the context of topological physics beyond "smoothness" considerations, and also weather prediction and understanding of turbulence.

[1] Ladyzhenskaya, O.A., 2003. Sixth problem of the millennium: Navier-Stokes equations, existence and smoothness. Russian Mathematical Surveys, 58(2), p.251.

SUN-DB-03 (3:24 to 3:36 PM) | Contributed Talk | Using AI in a University Physics Course

Presenting Author: Alexander Kusenko, UCLA

My colleagues and I use AI powered hints and AI generated practice problems in Physics classes at UCLA. I will review this innovative pracice, the lessons learned, and the steps we take to make the best use of AI for all students, especially, for underrepresented minorities.

SUN-DB-04 (3:36 to 3:48 PM) | Contributed Talk) | Could AI Radically Change Physics Education

Presenting Author: Ali Tuna, Freelance

AlphaGo beat the best Go player in the world while humans were thinking Go was a game machines could not mess with. AlphaFold analyzed and mapped out the structures of proteins better, faster, and more accurately than human beings could for decades. Google's DeepMind found ways to reduce the amount of energy used in its data centers by 40% after some of the best engineers reduced it significantly. Could AI be used to help us devise new methods in Physics teaching the way it started developing proof for Kazhdan-Lusztig polynomials or the way it brought a new perspective to knot theory? By using AI, can we find unconventional ways to solve multi-step Physics problems using shorter and clearer ways that are prone to fewer errors? Can humanity maybe come up with new interpretations of fundamental Physical laws the way Einstein did with gravity? These are the questions I will try to start a discussion on by using the literature authored by some of the brightest researchers of AI.

Session SUN-DG: Authentic Research Across the Spectrum

Sunday, Jan. 7, 3–4 p.m.
Fulton - 3rd Floor Moderator: Darsa Donelan Sponsor: Committee on Space Science and Astronomy

SUN-DG-01 (3:00 to 3:24 PM) | | Unlocking the Cosmos with Radio JOVE: Bridging the Gap for Tomorrow's Astronomers

Presenting Author: Samantha Blair, Dalton State College

Co-presenting Author | Chuck Higgins, Middle Tennessee State University

Co-presenting Author | Derek Thornton, Dalton State College

Astronomy is evolving, breaking free from the confines of expensive equipment and elusive telescope time. Radio JOVE, a NASA Partner project, empowers aspiring scientists, including high school students, to explore the cosmos through radio astronomy. Chuck Higgins, a Radio JOVE Project mentor, will guide us through this transformative journey. Radio JOVE participants construct and operate their multi-frequency radio telescopes, accessing celestial wonders like Jupiter, the Sun, and the Milky Way. Beyond observation, Radio JOVE equips participants to contribute scientific data while immersing in the universe. Samantha Blair, Associate Professor of Physics and Astronomy at Dalton State College, will share her experience integrating Radio JOVE into education, enhancing students' scientific literacy. Dr. Blair's students will join the panel to vividly recount their hands-on experiences and the excitement of conducting research under her guidance. Radio JOVE aims to expand its telescope network, demonstrating the scientific process and providing real-time data access.

Join us on this thrilling cosmic exploration. Discover how Radio JOVE ignites citizen science, nurtures science literacy, and fosters collaboration. Hear from high school teachers and students who ventured into radio astronomy, conducted research, and published findings. Learn how to introduce such projects to your classroom, unlocking the mysteries of the universe for the next generation.

Session SUN-DA: Cosmic Ray Studies in the Classroom

Sunday, Jan. 7, 3–4 p.m.
Commerce - 3rd Floor Moderator: Shane Wood Sponsor: Committee on Contemporary Physics

SUN-DA-01 (3:00 to 3:12 PM) | Contributed Talk | Use of Time to Measure Momentum/Energy of Cosmic Rays

Presenting Author: Miriam Bush, Rochelle Zell Jewish High School

Co-presenting Author | Dalya Frank, Rochelle Zell Jewish High School

Co-presenting Author | Ash Eliaser, Rochelle Zell Jewish High School

Co-presenting Author | Dory Marshall, Ida Crown Jewish Academy

Additional Author | Nathan A. Unterman, New Trier High School

Additional Author | Allen Sears, Ida Crown Jewish Academy

During the total eclipse of 2017, students reported that the anticipated cosmic ray shadow was not in line with the moon (and sun)1. It was suggested that the lunar shadow may be elsewhere in the sky. An experiment was designed to look for the cosmic ray lunar shadow to the west and east of the Moon to account for effects from the Earth's magnetic field. Low energy primary cosmic rays would be bent more than those of higher energy. This allowed the experiment to use time ahead of lunar meridian passage to measure a range of cosmic ray energies—a novel approach. The design of such an experiment will be discussed.

(1) Dallal, Tamar A., et al.; Solar Eclipse and Cosmic Ray Flux, The Physics Teacher, volume 60, pp 100-104. February 2022

SUN-DA-02 (3:12 to 3:24 PM) | Contributed Talk | The Cosmic Watch in the Classroom

Presenting Author: Kenneth Cecire, University of Notre Dame

Co-presenting Author | Daniel Kallenberg, John Adams High School

The Cosmic Watch is a small, inexpensive cosmic ray detector developed by Spencer Axani of the Massachusetts Institute of Technology. Plans and resources are available to the public for anyone to build and use one. The U.S. QuarkNet program has built 48 of these detectors, which have been used and tested by QuarkNet members in a variety of scenarios. Other groups, notably the TanQ project of Accel Kitchen in Japan, have made their own efforts to use the Cosmic Watch with students. We will discuss what QuarkNet learned about the Cosmic Watch and then discuss how it may be used in physics education.

SUN-DA-03 (3:24 to 3:36 PM) | Contributed Talk | Cosmic Ray Experiments Using Local Sites and Resources

Presenting Author: Kenneth Boldt, La Cueva High School, Albuquerque, NM

Co-presenting Author | Nathan Unterman, Del Norte High School, Albuquerque, NM

With modest investments in equipment, students may conduct cosmic ray experiments employing local topologies such as tall buildings, trams, mountains, and similar. This report centers on a trip up and down Sandia Mountain in Albuquerque, NM, experiment design, necessary arrangements, execution, and results.
Nathan Unterman will present if the other authors do not get funding to attend. All email should be directed to him.

SUN-DA-04 (3:36 to 4:00 PM) | Contributed Talk | Finding the Moon's Cosmic Ray Shadow Signal

Presenting Author: Garrett Chong, New Trier High School

Co-presenting Author | Aitak Mosen Harzandi, New Trier High School

Co-presenting Author | Benjamin Baronofsky, Ida Crown Jewish Academy

Co-presenting Author | Jedidiah Marcus, Ida Crown Jewish Academy

Additional Author | Nathan A Unterman, New Trier High School

Additional Author | Allen Sears, Ida Crown Jewish Academy

Using four stacked muon detectors oriented at different elevation angles to the sky across the Chicagoland area, a collaboration of high school students measured the baseline cosmic ray signal as a function of the moon's position. Our results are consistent with the background data, and showed no definitive lunar shadow signal. Measurements with improved angular resolution are required to reduce the background of cosmic rays not blocked by the Moon. The collaboration's goal is to have a conclusive picture of the baseline cosmic rays in preparation for the solar eclipse of April 8, 2024.

Session SUN-DE: Innovations in K-12 Teacher Professional Learning

Sunday, Jan. 7, 3–4 p.m.
Jackson - 3rd Floor Moderator: Kathleen Falconer Sponsor: Committee on Teacher Preparation

SUN-DE-01 (3:00 to 3:12 PM) | Contributed Talk | A New PD Model

Presenting Author: Karen Matsler, UT Arlington

Co-presenting Author | Ramon Lopez, UT Arlington

The logical venue for exposure to quantum might be a high school physics course, or even a physical science. Professional development (PD) for educators typically includes 1-2 weeks of intensive instruction, usually in the summer. Teachers are then expected to remember what they learned and implement it several months after the PD. The model is based on prior research indicating that an educator needs a minimum of 80 hours of PD to become comfortable enough to implement the new instruction in their classroom. However, little research has been done as to how much they actually implement. For the past three years, we have been engaged in a project funded by the NSF to build mechanisms (materials and PD strategies) for educating a quantum-ready workforce. Our PD model is based on pedagogical techniques used in classrooms, specifically the components of learn then practice in order to avoid cognitive overload. Instruction is more effective when the learners (teachers or students) are given opportunities to actively engage in the learning process through interaction/collaboration with peers, exploring challenges, and practicing what they have learned.

SUN-DE-02 (3:12 to 3:24 PM) | Contributed Talk | Teaching Physics Concepts and Science Methods with Children's Literature Non-Trade Book

Presenting Author: Philomena Agu, pagu@houstonisd.org

Elementary teachers in Texas are required to teach reading every day but not science. Integrating science content with reading allows teachers to teach science more often to their students. The themes, images, and stories in the children's literature non-trade books can be decoded to reveal some specific physics contents and sciences in general. The books contain stories that can excite and engage K-12 students and hook them into learning and wanting to study science. This session shares how "The Boy Who Harnessed the Wind", The Very Hungary Caterpillar, Pheasant King Fisher, etc., are used to teach physics contents and how literature non-trade books are generally used to teach science methods courses.

SUN-DE-03 (3:24 to 3:36 PM) | Contributed Talk (12 Minutes) | Effective Strategies for K-12 Nuclear Science Education

Presenting Author: Uchenna Ezibe, American Nuclear Society

K-12 nuclear science education plays an important role in providing students with fundamental academic enrichment. However, many educators struggle to teach nuclear science effectively or incorporate hands-on activites that can help solidify nuclear science concepts. This proposed session will explore what high-quality nuclear science education looks like in grades K-12, providing educators with strategies they can immediately incorporate into their classroom.

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Session SUN-DF: Iron Chef Challenge: Mardi Gras Style Sunday, Jan. 7, 3–4 p.m.

Canal Moderator: Nina Morley Daye Sponsor: Committee on Physics in Pre-High School Education

Are you ready for a challenge? Come and use the provided materials from daily life to create something that can be used to teach others about physics. This challenge can be done individually or as a small group. Sneak preview: one of the provided items will be Mardi Gras beads, come celebrate with us!

This session is a modification of the Make, Do, Play and Learn sessions sponsored by the pre-high school and high school committees. The moderator and organizers of the session will provide Mardi Gras beads, cups, straws, string, tape, balloons, balls and a variety of other items for people to use. Each individual or group will be given twenty minute or so to create something to be used to teach a physics concept. Then the participants will share their creation and explain how to use it with other participants. There is a video of the things done at the SM 23 in Sacramento.

Session SUN-DC: Lab Activities and Learning Goals–Intro Labs Sunday, Jan. 7, 3–4 p.m.

Royal - 3rd Floor Moderator: Jon Anderson Sponsor: Committee on Laboratories

SUN-DC-01 (3:00 to 3:12 PM) | Contributed Talk | Self Efficacy in a First-Semester Introductory Physics Laboratory Course

Presenting Author: Jennifer Delgado, University of Kansas

Additional Author | Chris Fischer, University of Kansas

Additional Author | Sarah Rush, University of Kansas

Additional Author | Jessy Changstrom, University of Kansas

As a domain-based belief, it is important to understand student self-efficacy in different educational contexts. We present results from a physics self-efficacy survey modified to gauge student self-efficacy in introductory labs from over 200 students in a first semester, calculus-based laboratory course. We further explore what may affect student experimental physics self-efficacy through the use of post lab surveys to explore changes in their self-efficacy due to student working roles within the lab group and expressed student sentiment of their lab experience.

SUN-DC-02 (3:12 to 3:24 PM) | Contributed Talk | Transforming Undergraduate Physics Labs – A TA Centered Approach

Presenting Author: Anya Guy, Washington State University

Additional Author | Heidi Schlunt, Washington State University

Additional Author | Emily Frank, Washington State University

In this talk we will share our experiences at Washington State University (WSU) in transforming the algebra-based physics labs to better support students in developing scientific experimentation skills, collaboration skills, and communication skills. Successive past incremental efforts at WSU in transforming our lab curriculum to align with the AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum failed to take hold and often resulted in a "de-transformation" by the graduate student TA lab instructors. Our most recent effort has proven to be more successful and "sticky," which we attribute to several specific factors that fall into two categories: 1) A wholistic structural transformation of an entire semester of lab curriculum and 2) TA leadership, with faculty guidance and mentorship, through the entire process from design, piloting, full-scale implementation, and assessment.

SUN-DC-03 (3:24 to 3:36 PM) | Contributed Talk | Computational Labs in Introductory Physics

Presenting Author: Andy Gavrin, IUPUI

Additional Author | Gautam Vemuri, IUPUI

At IUPUI (soon to become IUI) we have developed several computational labs that we use in both our calculus-based and algebra-based introductory physics sequences. These labs support our efforts to incorporate computation in all our courses, as well as efforts to reform our labs to stress experimental and communication skills, and to increase student agency. In these labs, students use Excel™ to do basic visualization of functions, compute trajectories in free fall and with air resistance, to model RLC circuits and to explore the potential field of a dipole. The labs include scaffolding to help students get started with computation, and promote students' learning of several key computational skills, including testing their code, using numerical integration and differentiation, and exploring the physics of the system once the simulation has been tested and verified.

Session SUN-DD: The Use of Critical Race Theory in Physics Education Research–Part 2

Sunday, Jan. 7, 3–4 p.m.
Magazine - 3rd Floor Moderator: Clausell Mathis Sponsor: Committee on Diversity in Physics

SUN-DD-01 (3:00 to 3:24 PM) | | Exposing and Challenging "Grit" in Physics Education: Dis/abling white Logics that Structure Emotion and Affect

Presenting Author: Veronica Velez, Western Washington University
Additional Author | Amy Robertson, Seattle Pacific University
Additional Author | Tali Hairston, Equitable Development LLC
Additional Author | Tra Huynh, Western Washington University

In STEM education, grit is increasingly the focus of research, with scholars seeking to develop and test interventions that would enhance persistence in fields with high attrition. In this presentation, we share analysis of interviews with twelve white physics faculty to show how physics culture has taken up the narrative that grit is key to success in the discipline. Using habitus (Bourdieu, 1977), we argue that grit is part-and-parcel of "white physics habitus," acting to reproduce systems of dominance through the internalization of a set of structures, symbols, and worldviews that produce embodied, affective responses, drawing dominant actors toward particular embodiments of hard work and away from others. Guided by Critical Race Theory (CRT), we identified (1) ways in which physics faculty used mainstream physics epistemologies (what it means to know in physics), ontologies (what physics is thought to be), and axiologies (what is valued within the discipline) to justify grit as commonsense, and (2) a limited set of discipline-specific practices that serve as evidence of grittiness in physics. We end by joining with existing calls to trouble grit, building from the work of STEM Scholars of Color who have called attention to the suffering that is endemic to notions of schooling and school science.

SUN-DD-02 (3:24 to 3:36 PM) | Contributed Talk) | Using Discourse About Sexism to Evade Discussion of Racism

Presenting Author: Tra Huynh, Western Washington University
Additional Author | Amy D Robertson, Seatle Pacific University
Additional Author | Tali Hairston, Equitable Development LLC
Additional Author | Verónica Vélez, Western Washington University

In our interviews with white male physicists about the underrepresentation of women, transgender and non-binary folks, and People of Color in physics, we found that although our interviewees often spoke freely about sexist environments and barriers faced by women in physics, they tended to evade racism as a salient phenomenon in physics. Examples include when interviewees brought up the representation of women in their department when asked about the (under)representation of People of Color, and when they were willing to discuss sexism as a barrier mitigating women's participation in the field, but evade or reject racism and white supremacy as a salient mediating force in physics or at their institutions. In this talk, I (first author) draw on my own experiences as an Asian immigrant woman to argue that this discursive move weaponizes discourses of diversity against both women and People of Color, in the way that the Model Minority Myth has weaponized discourses of diversity against Asian(American)s and other People of Color.

SUN-DD-03 (3:24 to 3:36 PM) | Contributed Talk | Spatial Dimensions of Physics Teaching and Learning Impacting Minoritized Students

Presenting Author: W. Hairston, Equitable Development LLC
Additional Author | Amy D. Robertson, Seattle Pacific University
Additional Author | Verónica N. Vélez, Western Washington University

This presentation seeks to illustrate the spatial dimensions of physics teaching and learning for minoritized students when the underlying structure of the physics learning environment is identified as assimilative. Based on our analysis of video from university physics classrooms, we argue that physics instruction produces an assimilative spatiality. This relationality seeks to enculturate minoritized students into a univocal physics learning environment. Even when instructors utilize inclusive pedagogical practices, the practices tend to assimilate students into a physics learning environment. We suggest that assimilative spatiality works to diminish the laudable goals of greater diversity in physics.

Poster Session 2

Sunday, Jan. 7, 4–5 p.m.
St. Charles - 3rd Floor Moderator: TBA Sponsor: AAPT

Astro Posters II

SUN-POSA-202 | Poster Presentation Traditional | Double-Star Astrometry with Small Telescopes

Presenting Author: Rose Paddock, Gustavus Adolphus College
Co-presenting Author | Darsa Donelan, Gustavus Adolphus College

As part of an independent study focused on the fascinating world of astrophysics, we unraveled the mysteries of the cosmos through the lens of double-star astrometry. Using small telescopes, we explored the celestial realm to gain profound insights into the evolution and behavior of binary star systems. Our mission encompassed a comprehensive understanding of astrophysical concepts, honing observational techniques, and master-

ing the intricacies of the Gustavus Adolphus Olin Observatory operations. This study represented the culmination of rigorous coursework, hands-on research experiences, and a profound passion for the cosmos. We invite you to explore the universe's hidden wonders with us at the American Association of Physics Teachers Winter Meeting, where we will share our journey and the secrets we uncovered about binary stars.

SUN-POSA-206 | Poster Presentation Traditional | Astronomy Data, Image Analysis, and Research Using NASA's UoL Web-based JS9 Software Tools

Presenting Author: Donna Young, NASA UoL STEM Program

Additional Author | Pamela J. Perry, Lewiston H.S.

Additional Author | Terry Matilsky, Rutgers Univ.

How can we provide an authentic research experience to students who want to find out what science is REALLY about? We couple JS9, a fun to use, web-based image display environment, with archival satellite data to allow students to perform astronomical analysis remotely using their browser. Energy spectra, light curves, periodic phenomena, and much more can be explored, using data from thousands of deep sky objects, spanning the gamut of observed energies, from infra-red emission to gamma rays. Since this system is platform independent, it is especially useful in the classroom, as well as in distance learning environments. Classroom ready activities and js9 user guides are available. Students explore false color images, the chemistry and physics of supernova, and merging galaxies and more and develop their own research projects.

DEI Posters II

SUN-POSC-602 | Poster Presentation Traditional | Introducing AAPT/PERTG's Working Group on Conference Accessibility (WGCA)

Presenting Author: Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education

Co-presenting Author | Liam McDermott, Rutgers University

Additional Author | Daryl McPadden, Michigan State University

Additional Author | Erin Scanlon, University of Connecticut

Additional Author | Constance Doty, University of Central Florida

Additional Author | Stephanie Williams, University of Maryland

As we near the 25th anniversary of the Americans with Disabilities Act (ADA), more individuals with disabilities have been able to access education and employment. However, disabled individuals still experience great difficulties in terms of accessibility at professional research conferences, which are necessary for establishing their standing within a field. To combat this issue, AAPT and PERTG have created the Working Group for Conference Accessibility (WGCA), a vital addition to its conference planning process. As members of the WGCA, our mission is to ensure that all participants, regardless of physical abilities, sensory profiles, or diverse needs, can fully engage in the conference experience. In this poster, we present an overview of our objectives, strategies, and the services we offer to enhance accessibility for all attendees. We invite questions and comments from our disabled peers and our allies to help us stay committed to creating a more accessible and equitable future.

SUN-POSC-604 | Poster Roundtable | Increasing Program Retention and Recruitment through Engagement of First-year STEM Students

Presenting Author: Matthew Fleenor, Univ. of Mary Washington

Additional Author | Rama Balasubramanian, Chance to Change Lives (CCL, US)

A one-hour, first-year seminar is suggested as a means of retaining undergraduate physics majors in AIP's EP3 Guide. Such a seminar (first-year colloquium, FYC) was implemented at a small, four-year institution in the US with both retention and recruitment benefits. Specifically, over an eight-year period where this FYC was implemented, the physics program more than doubled in number of majors and graduates. Moreover, the number of women in the program increased by 200% over the same period. The inclusive design of this FYC model confirms EP3's suggestions while also facilitating efficacy in other programmatic innovations. This FYC model also offers an anecdotal example of women leading men students into a greater sense of non-hostile, cohort-building, indicated by the overall programmatic growth.

SUN-POSC-606 | Poster Presentation Traditional | Building Girls' Confidence in the Physics Classroom

Presenting Author: Leslie Chamberlain, The Harpeth Hall School

Co-presenting Author | Hannah Bond, The Harpeth Hall School

Additional Author | Elsa Davids, The Harpeth Hall School

Despite increasing participation of women in many STEM fields, girls continue to face barriers in developing confidence and self-efficacy in physics classrooms. We have implemented targeted interventions at an all-girls secondary school (grades 5-12) to change the culture in the classroom around fear of failure and perfectionism - two inhibitors to girl's confidence – by providing multiple modalities for revising work and engaging in iterative problem-solving. Specific techniques include language that normalizes confusion and failure, implementing project-based units with critique periods, strategies around test revisions, and scaffolding complex problem-solving to value productive struggle. We share practical strategies and outcomes from our school-based efforts to improve girls' confidence in learning physics by encouraging resilience through iterative work in the physics classroom.

SUN-POSC-608 | Poster Presentation Traditional | Grading for Equity in AP Physics – Sucesses and Challenges

Presenting Author: Raquel Von Handorf

As students and teachers recover from the COVID pandemic, there is a clear need to continue re-examining our educational norms including access to challenging coursework, grades, the role of homework, and the use of technology for practice and assessment. This poster describes both

successes and challenges encountered when adapting the grading philosophy and assessment practices described in Joe Feldman's book, Grading for Equity, to an AP Physics C course. Past and current AP exam data, student work, and feedback from last year's students suggest that updated grading practices, including a "no points for homework" policy and a system for revision and retakes, provided more accurate formative assessment, better measurement of mastery, and increased student engagement and achievement. In this presentation, the author, a 20-year science teacher, will share the process of implementing Grading for Equity in a high-school physics classroom, and the way these changes helped her 12th AP Physics C class accomplish a post-pandemic "comeback."

Intro & Beyond Posters II

SUN-POSB-404 | Poster Presentation Traditional | Demystifying Separation of Variables

Presenting Author: Douglas Kurtze, Saint Joseph's University

A physics student's first encounter with the method of separation of variables for solving linear partial differential equations can be particularly mystifying, if the starting assumption – that the solution can be written as a product of functions, each of which depends on only one of the independent variables – is put forward without motivation or justification. We propose to avoid this difficulty by first introducing the students to the idea of expanding a function as a linear combination of basis functions, something which they will need to learn at some point in their undergraduate career anyway. Applying this idea to a partial differential equation immediately shows that any function can be written as a linear combination of functions in product form. Substituting that form into the equation quickly leads to a natural way of choosing the underlying set of basis functions, one which decouples the equations and so makes the subsequent calculations as simple as possible. To wrap up, the conventional method can then be presented as a short-cut way of implementing this more general approach.

SUN-POSB-406 | Poster Presentation Traditional | Using Research in Physics to Increase Freshmen Retention Rates

Presenting Author: Dereth Drake-Scheuermann, Valdosta State University

Many university physics programs struggle with increasing or retaining freshmen students. At Valdosta State University, historically the retention rate in physics has been very low, ~33%. In Fall 2017, our department started examining ways to increase our retention rate by using freshmen research opportunities. That year, two freshmen female students were invited to participate in research. Both of these students were retained to their sophomore year. With the limited success that year, in Fall 2018 we invited 7 of the 15 incoming freshmen to participate. The students participated in five projects throughout the year in astrophysics and plasma physics. All seven students were retained to their sophomore year. This presentation will describe the program in more detail, as well as the graduation rates for those students in the two cohorts. A discussion on how the program is being implemented post-COVID-19 will also be presented.

SUN-POSB-408 | Poster Presentation Traditional | A Practical Approach for Advanced Experimental Physics

Presenting Author: Michael Fortner, Beloit College

An advanced experimental physics class is common is most undergraduate curricula. It is usually taken by juniors or seniors and sometimes fill the role of a capstone course. The traditional course uses a number of experiments to explore advanced techniques, and the goal is typically a a paper in a form suitable for publication in a peer-reviewed journal. Rather than use the course as a vehicle to prepare students for academia, Last spring I taught a version designed to prepare students for using their physics training in a corporate lab setting. Students had to research a historically important experiment and develop a manual and working procedure. We even had open house and quality control exercises. The poster will outline the way the semester was used to model a process more like the world most of the students will face after graduation.

SUN-POSB-412 | Poster Presentation Traditional | Tutorials with Python simulations: an opportunity for conveying physics concepts with computational exercises

Presenting Author: Taejoon Kouh, Kookmin University

Additional Author | Minjoon Kouh

While introducing complex concepts in physics, we often rely on analogies, visual aids, and mathematical derivations. However, sometimes they may not provide enough intuition or generality. For instance, how can we convince our students or ourselves that the gas particles in a box always end up with a universal (i.e., Boltzmann) distribution regardless of their countless possible initial configurations? With the addition of computational pedagogy that complements traditional approaches, we can simulate a physical process of random energy exchanges among the gas particles and observe the simulated time-evolution of energy distribution, which settles into an exponential curve, as predicted by rigorous mathematical analysis. We will share a few such examples of Python simulations from statistical mechanics [1] and electrodynamics [2], which can enhance students' learning experiences in upper-level physics courses.

SUN-POSB-414 | Poster Presentation Traditional | Comsol Multiphysics model development for Materials Science Curriculum

Presenting Author: Christopher Barbieri, Ramapo College of NJ

Additional Author | Dr. Daniela Buna, Ramapo College of NJ

The goal of this work is to develop Comsol Multiphysics models for simple physical systems that include Heat transfer to be introduced as part of a Materials Science 300 level course/laboratory. The goals of the work are:

1. Develop materials science Comsol Multiphysics software models that match the Materials science class curriculum
2. Investigate useful materials constants that are not fully entered in the Comsol materials database (such as specific ranges of Temperature, emissivity as a function of wavelength, etc) , and enter their physical properties as they relate to Heat transfer and thermal properties of materials
3. Develop databases or analytic functions for the properties above and enter them in Comsol.

Comsol Multiphysics is a very useful tool for simulating physics systems and their interactions. Using the proper physical constants for the specifics of each project is critical to obtaining good data.

K-12 Posters

UN-POSF-304 | Poster Presentation Traditional | Educator Observations of Physics Concepts Applied to NGSS Earth and Space Science Discipline Activities

Presenting Author: Ilana Vertullo, Bridgewater State University

Co-presenting Author | Roger Hart, Community College of Rhode Island

Many concepts within introductory physics courses can be implemented in other science disciplines to better establish student perceptions of the interdisciplinary nature of science. Here we examine the major connections between introductory physics concepts within the Earth and Space Sciences. Specifically, we connected traditional topics within introductory physics, such as gravity, heat, vibration, electricity, magnetism, and radioactivity to the five Earth and Space Science standard topics in high school science course through data-driven (e.g., NASA data) guided-inquiry laboratory activities. These include the NGSS: Space Systems, History of Earth, Earth's Systems, Weather and Climate, and Human Sustainability. The activities aim to increase meaningful experiences for students enrolled in high school science classes. These activities were framed to improve the perception of the nature of science, activate affective factors such as describing increased confidence due to positive experience in the science laboratory, and improved content learning. We contextualize these observations to active learning strategies and the scientific practices of NGSS, highlighting both the (1) planning and carrying out investigations and (2) analyzing and interpreting data practices.

SUN-POSF-306 | Poster Presentation Traditional | Hands-On Activities to Model Exponential Functions: Application of Exponential Growth and Decay

Presenting Author: Maajida Murdock, Morgan State University, Randallstown High School, (BCPS)

High school students in a math class engaged in hands-on activities grounded in real-world applications. Through inquiry, students modeled the occurrence of physical phenomena (exponential growth and exponential decay). With guided questions, students used mathematical modeling skills to contextualize the exponential function by the pattern from their data. They used technology to manipulate their data, to determine a best-fit equation, and to calculate the percent error when comparing their experimental data to the theoretical data. This activity serves as a bridge between mathematics and physics concepts.

SUN-POSF-308 | Poster Presentation Traditional | Using Gelatin to Measure the Mass Attenuation Coefficient of Water

Presenting Author: Ignacio Birriel, Morehead State University

Additional Author | Casey Hovis, Morehead State University

In introductory nuclear physics lab, students usually investigate the attenuation of radiation via the absorption of gamma rays using lead, aluminum or plastic. To make this lab accessible to high school students, we propose the uses of gelatin, a solid phase of water. We exposed the gel to gamma rays, ranging from 0.09 MeV to 1.33 MeV from common radioactive sources commercially available for physics teaching labs. For this experiment we used Cadmium-109, Cesium-137, Cobalt-57 and Cobalt-60 and calculate the mass attenuation coefficients. We discuss our data collection method using a ST-360 Radiation Counter with a GM-35 probe and compare our calculated coefficient values with values of water from the National Institute of Standards and Technology database.

SUN-POSF-310 | Poster Presentation Traditional | N Implementation of The Investigative Science Learning (ISLE) Approach for Strengthening Ap Physics 1 Teaching

Presenting Author: Naren Krishna Jegan, Mission San Jose High School

Additional Author | Dorota Sawicka, Mission San Jose High School

The Investigative Science Learning Approach (ISLE), developed by Professor Eugenia Etkina and her team in the College Physics: Explore and Apply textbook, encourages students to use empirical experiences through observations, the development of hypotheses, and the defense of claims using scientific reasoning to strengthen their understanding of physics concepts. At Mission San Jose High School, we have adopted the ISLE approach in the AP Physics 1 curriculum by:
(1) initiating peer interactions where teams of students can lead the class in explaining how to tackle specific problems, labs, or concepts by thinking like a physicist;
(2) encouraging students to use real-time observations to describe and scientifically explain phenomena; and
(3) establishing and connecting takeaways extrapolated from lab activities to develop a firmer understanding of previous experiences and established concepts.
In this poster, we apply the principles of the ISLE approach to implementing specific practices into the AP Physics 1 curriculum. We would like to highlight topics and terminology in the AP Physics 1 curriculum that differ from the terms used in ISLE to allow students to minimize confusion in the definition of certain terminology and understanding of concepts.

SUN-POSF-312 | Poster Presentation Traditional | Kitchen Table Astronauts

Presenting Author: Jennifer Pearce, Department of Physics, Roger Williams University

Additional Author | Rachel Rodrigues, Dept. of Biology, Marine Biology, and Environmental Science; Roger WIlliams University

Additional Author | Sarah Skinner, Dept. of Education, Roger Williams University

This project involves developing digital science lessons for hands-on experiments that showcase a wide range of applications for the physical sciences, from the science of the kitchen to the science of space. We will do this by designing activities that use food to demonstrate different

principles from chemistry and physics aligned with the Next Generation Science Standards (NGSS) for middle school. The activities will also include information on how these principles are important in NASA's explorations of space. We have produced videos demonstrating the activity and giving background information about the science involved. Teacher feedback on the activity and potential for student learning will inform improvements in the next iteration of the curriculum.

Labs/Apparatus Posters II

SUN-POSD-500 | Poster Presentation Traditional | DIY Bat Detector with Gamificaton Elements

Presenting Author: Lutz Kasper, University of Education Schwaebisch Gmuend (Germany)

Additional Author | Ann-Katrin Krebs, Leuphana University Lueneburg (Germany)

Additional Author | Hannes Nepper, University of Education Schwaebisch Gmuend (Germany)

Additional Author | Jochen Pfeifer, University of Education Schwaebisch Gmuend (Germany)

Bats use ultrasonic sounds for orientation and hunting. Their frequencies are outside the human hearing range. However, theese sounds can be made audible with detectors and digital transducers. For a first practical and interdisciplinary science approach in schools, commercial detectors with digital data acquisition are useful (e.g. Echo Meter Touch 2 plug-in module for smartphones). With the connected app, they can display spectrograms. A stored database compares the sounds and indicates the most likely bat species.in real time. For a low-cost alternative and additioonal motivation via gamification elements, we have developed a DIY kit that can be manufactured with modern maker tools. In addition to the acoustic conversion of ultrasound into audible sound, the prototype also contains visually and haptically perceptible signals and resembles a game pad in function and form. The poster presents the physical and technical aspects of this detector.

SUN-POSD-502 | Poster Presentation Traditional | 3D Printing for Three-Dimensional Science

Presenting Author: Karre Nevarez, Mountain Ridge Junior High

Additional Author | Adam Bennion, Brigham Young University

The technology of 3D printing can be a powerful educational tool that enhances STEM education by connecting engineering, technology, and applications of science concepts. It can also foster a very hands-on encounter. When students experience physics and engineering together in the classroom, they are more likely to internalize the science and engineering practices. It makes it real to them. Our research has shown that pre-service teachers are more likely to incorporate tools like 3D printing when they have experience before becoming a teacher. Along with some of our research, two levels of possible usage for teachers will be presented including a 5E lesson, inspired by the Maker Movement, that integrates the use of a 3D printer, physics, and engineering to help students engage in a more realistic engineering experience.

SUN-POSD-504 | Poster Presentation Traditional | Developing an Online College Physics Laboratory Class

Presenting Author: Brent McDaniel, Kennesaw State University

An introductory college physics course is developed from all new material. Laboratory exercises include a mixture of simulation and hands-on exercises. Hands-on exercises use household and easily obtainable materials and do not require significant student expenditure. Simulations use PhET and other browser-based tools to explore a wide-variety of topics. Measurement theory and error propagation is incorporated in multiple exercises using hands-on and simulation data. The use of Excel for data analysis is covered in a separate exercise and employed throughout the course. Student opinion on success of labs, ease of use, time commitment, and clarity is shown as well as assessment data on module and course learning objectives.

SUN-POSD-506 | Poster Presentation Traditional | Cosmic Ray Muon Detection in a Simple Hand-Held Device

Presenting Author: Aaron Pilarcik, Massachusetts Institute of Technology

Co-presenting Author | Sean P Robinson, Massachusetts Institute of Technology

A simple yet in-depth experiment to measure cosmic ray muons with an inexpensive, hand-held device, the Cosmic Watch. Primary cosmic rays, often streaming thousands of light-years across the galaxy, create an airshower upon hitting Earth's atmosphere, which can now be measured in the lab and classroom with a simple handheld detector. In this poster presentation, we demonstrate the diverse capabilities of this amazing device for an incredible array of experiments.

SUN-POSD-510 | Poster Presentation Traditional | Teaching Particle Identification Using Jupyter Notebooks

Presenting Author: Richard Dube, University of Connecticut

Additional Author | Diego diego.valente@uconn.edu Valente, University of Connecticut

As high-school and undergraduate students become increasingly involved in physics research, there is higher demand for entry-level materials that teach the fundamentals of advanced fields of research. In particular, there have been many efforts to make particle physics more accessible with resources like Particle Physics Playground. However, these resources focus on the second stage of the data analysis process (reconstruction), and provide pre-processed data to analyze. In contrast, publicly available data is unprocessed, meaning these resources provide an incomplete picture of particle physics research. This project provides python-based activities to teach students about the first stage of particle physics data analysis, called particle identification, which will provide students with the knowledge and skills necessary to perform complete analysis of experimental data and allow them to engage with particle physics far earlier than previous students. This poster will describe the motivation of the project, capabilities of the notebooks, and next steps.

SUN-POSD-512 | Poster Presentation Traditional | An Optics Laboratory at Home During the Pandemic

Presenting Author: Adam Green, University of St. Thomas

Additional Author | Lexi C Serreyn, Medtronic

During the COVID-19 pandemic, we developed optics kits for undergraduate students to use at home during weekly 3.5-hour Zoom sessions. Labs were simpler than the ones they would have otherwise performed on campus, but the quality of the equipment was still reasonably high. Each of the twelve students in the Fall of 2020 borrowed a $4,000 kit that supported experiments involving imaging, image processing, spectroscopy, polarized light, interference, diffraction, and holography. Lab reports, surveys, and interviews indicated that students learned the material well and had a positive experience. Students also expressed appreciation for being trusted with expensive, fragile equipment at home; and they returned all of it in excellent condition.

SUN-POSD-514 | Poster Presentation Traditional | A Simple Coincidence Measurement of Annhilation Photons Using a Low Cost Gamma Detection System

Presenting Author: Daniel Marble, Tarleton State University

Co-presenting Author | Christopher B Marble, Tarleton State University

Co-presenting Author | Kassie S Marble, Texas A&M University

The measurement of the angular distribution of the annihilation photons from an electron-positron event using traditional coincidence techniques is a common education activity in undergraduate nuclear labs. These labs traditionally have used specialized nuclear instrumentation modules and are more time consuming to set up and perform. This can pose a difficulty for smaller undergraduate institutions and high schools with limited funds as well as for student groups less experienced in electronics. We have used a cross patch cable to connect the amplifier signal from two low cost NaI Detector systems to the two speaker channels in a computer's audio card to perform coincidence measurements of the angular distribution of the coincidence photons from an exempt Na22 source. By adjusting various lab parameters, we have designed a lab that is easy to setup, provides excellent results, and costs under $2600 and for under $25 (cost of patch cord) if the institution already has the two low cost NaI detector systems to perform other lab actvities. Furthermore, the software control of the computer's audio card enables students to configure the system to either coincidence or anticoincidence modes quickly offering other lab possibilities.

SUN-POSD-516 | Poster Presentation Traditional | Using Wireless Carts with Built-in Sensors to Generate Graphs that Integrate Lab and Lecture Discussions

Presenting Author: Scott Reed, Niles North High School

This year I have added a lab to each unit of my AP Physics C course that incorporates the use of wireless carts with built-in sensors. My students have access to the iOLab Wireless Lab System and the Pasco Smart Cart. For each of these sensor-cart labs, students are challenged to generate a graph that represents the concept(s) of the lab activities. Students annotate these graphs with key locations and moments. The graphs are shared among the class and are used during discussion of lab results. These graphs have led to rich discourse about the graph shapes and patterns and the reason why they are shaped that way. The poster highlights the most compelling of the student-generated graphs and the laboratory activities used to generate them. Winter meeting participants will have access to the complete set of resources and labs used to generate these graphs via QR code links.

SUN-POSD-518 | Poster Presentation Traditional | How to Build Anything: Equipping Your Physics Shop

Presenting Author: Sean Lally, Jemicy School

You might be surprised (and perhaps a little dismayed) to learn how few of your students have built things with their own hands, or have even used basic tools. Science teachers (particularly we physics folks) have a unique opportunity, regardless of budget and background, to help students learn to work with their hands. I will use this poster to describe several methods by which the teacher can assemble a toolbox, a workspace, or even a small shop. A portion of the poster will suggest projects for you and your students to start building.

SUN-POSD-520 | Poster Presentation Traditional | Design Audio Demonstrations for Teaching Acoustics to Students from Diverse Backgrounds

Presenting Author: Peter Xinya Zhang, Columbia College Chicago

Teaching acoustics to students from diverse backgrounds has always been a challenge. At Columbia College Chicago, Department of Audio Arts and Acoustics, students come from both science and art backgrounds. The acoustics courses not only cover the fundamental concepts and calculations in physics but also have to let the students understand the impact of various physical parameters on sound and hearing. Through specially designed audio demonstrations, python programs for interactive listening experiments, and computer-supported calculation practices, the students associate the physical quantities with the subjective quantities in hearing. They get immediate feedback on the sound effects of various parameters, which also serves as a training process. This kind of practical knowledge is important for students' future careers. During the pandemic when remote learning was necessary, the interactive demonstrations that students were able to do individually on their own laptops led to positive learning outcomes.

Physics Education Research (PER) Posters II

SUN-POSE-702 | Poster Presentation Traditional | Conceptions of STEM Integration in Physics Education Research

Presenting Author: Spencer Perry, Indiana University Bloomington

Co-presenting Author | Esther K Namaluka, Indiana University Bloomington

Since the advent of the 2012 Framework for K-12 Science Educatoin, physics teachers have been under increasing pressure to teach in ways that integrate Science, Technology, Engineering, and Mathematics (STEM). However, there is little agreement on what it means to "integrate" STEM ideas or how integration should be acheived. This poster will report on our effort to examine several hundred research articles that conceptualize STEM integration in both physics educaton research (PER) and in the broader domains of STEM education research. We use a computational approach that includes collocation analysis and text network mapping as well as thematic analysis to identify and describe trends in how physics education researchers conceptualize STEM integration.

SUN-POSE-704 | Poster Presentation Traditional | Preliminary Results Fluids Conceptual Evaluation (FCE) Pilot Test

Presenting Author: Rebecca Lindell, American Association of Physics Teachers andTiliadal STEM Education: Solutions for Higher Education

Additional Author | Liam Mcdermott, Rutgers University

Additional Author | Mary Urquhart, University of Texas Dallas

Additional Author | Dedra Demaree, AAPT and Blue Ridge School

Additional Author | Kory Watson, American Association of Physics Teachers

The FCE, a research-based conceptual learning assessment (RB-CLA), evaluates post-secondary life science majors' understanding of fluids in their introductory physics course utilizing a two-tier multiple-choice instrument comprised of a conceptual item (Tier I) and an item assessing test takers reasoning behind their choice (Tier II). Currently, the FCE has 67 Tier I items. In Fall 2023, we initiated the pilot test of the FCE to assess the suitability of its Tier I conceptual items and participants' reasoning. Data from this pilot test will inform the development of approximately 30 final two-tier FCE items. Using Qualtrics, the pilot test participants each completed 14 randomly selected current FCE items online within a 30-minute timeframe. This process will be repeated for up to 250 responses per item." This poster shows the evolution of the original 67 FCE Tier I items evolution to two-tier multiple-choice items.

SUN-POSE-706 | Poster Presentation Traditional | Developing and Application of Physics Identity Survey Tool for Preservice Teachers

Presenting Author: Junhee Kim, Daegu University

Additional Author | Sungmin Im, Daegu University

This study aims to develop a Physics Identity survey tool for pre-service teachers and apply it to analyze their Physics Identity. To this end, tools and frameworks suggested in previous studies were critically reviewed. The developed tool was applied to pre-service physics teachers through the survey. From the collected data, the distribution of Physics Identity according to gender, grade, and GPA of preservice teachers was analyzed. From the results, the implications of the distribution of the Physics Identity of preservice physics teachers in physics teacher education were discussed.

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SUN-POSE-708 | Poster Presentation Traditional | The Conceptual Framework Model for Knowledge Integration and Deep Learning in Physics

Presenting Author: Lan Yang, The Ohio State University

Co-presenting Author | Lei Bao, The Ohio State University

Deep understanding of core scientific ideas and cross-cutting concepts in STEM disciplines has become the focus of current science education standard. However, ample research has demonstrated that traditional instruction often falls short of helping students develop deep understanding in physics learning. To support the assessment and instruction that promote knowledge integration and deep learning, a new Conceptual Framework model has been developed, which represents students' knowledge structures with a focus on the core idea(s) and sub-dimensions of a given concept. A Conceptual Framework is content specific model that maps the knowledge structures of novices and experts and helps identifying missing connections between conceptual core ideas and other elements within the knowledge structure. Assessments based on the Conceptual Framework model make emphasis on determining what connections exist in student knowledge structures, while instruction based on Conceptual Framework targets which material to emphasize for developing expert-like connections within the students' knowledge structures. This talk will introduce the Conceptual Framework model and review the recent studies that have shown promising outcomes from applying this model. Examples of instructional and assessment approaches using the Conceptual Framework model will also be discussed.

SUN-POSE-710 | Poster Presentation Traditional | "Math" and "Physics" Conceptions Present in a Calculus-based Intro-Physics Classroom

Presenting Author: Idris Malik, North Dakota State University

Additional Author | Warren M Christensen, North Dakota State University

Prior Physics Education Research (PER) literature has explored student conceptions of "Math" and "Physics" in courses and disciplines, as well

as the conceptions of disciplinary experts. We seek to explore how students and instructors think about what "Math" is and what "Physics" is, and how those ideas come together when talking about and doing math/physics tasks in a Calculus-based Introductory course. Electronic Field notes and recordings of audio and video using an OWL video were captured in each class period throughout the semester. Field notes documented instances where students and the instructor mentioned disciplines in general and the use of each discipline in the context of this course or other courses. Field notes also document any emergent features of student-student and student-instructor discourse and actions. We present examples of novel distinctions between students and the instructor regarding math and physics conceptions and work procedures from our preliminary analysis.

SUN-POSE-712 | Poster Presentation Traditional | Supporting ELL High School Students with Modeling Physics Curriculum in Introductory Courses

Presenting Author: Brittany Johnson, John Brown University

The Modeling Physics curriculum has been found to best support English Language Learners (ELL) in high school introductory physics courses. Not only by implementing paradigm labs to introduce key concepts, but by utilizing these experiences to provide a common background of knowledge of the content for all students in the course. By providing a common background that all students can reference in their discussion of key ideas, students are able to develop a scientific vocabulary that is based on concrete laboratory experiences, observations, and analyses. Pre- and post-test scores using the Force Concept Inventory were collected over a two-year period at a high school in Northwest Arkansas with 52% Hispanic student population and compared to scores collected at New York City College (Steinburg, Donnelly 2002), which showed comparable growth as part of the ESOL Academy at John Brown University. In addition to utilizing the Modeling Physics curriculum, additional scaffolds including sentence-stems and discussion prompts may encourage ELL students' success and inclusion in introductory physics courses that may prepare them for STEM careers.

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SUN-POSE-714 | Poster Presentation Traditional | Students' Self-Assessment in an "Ungraded" Introductory Physics Course

Presenting Author: Miguel Vasquez-Vega, Tufts University

Additional Author | Hugh R Gallagher, Tufts University

We present an approach to teaching introductory physics to predominantly first-year engineering students at Tufts University adopting an "ungrading" methodology. We refrained from assigning traditional scores to assessments. Instead, students engaged in self-assessment based on individual learning goals established at the course's outset, focusing on preparation, participation, collaboration, and understanding. The class was divided into two sections under the facilitation of two different instructors. Assessments included weekly physics homework, multiple choice question tests we called Solo Check-ins, and open-ended physics problems to be approached in what we called Collaborative Assessments, all devoid of numerical scoring. We provided feedback and shared written solutions. Midway, students self-assessed their solutions and participated in anonymous peer reviews. In the end, students submitted a self-assessment essay with a recommended grade. Our study explores the impact of ungraded modalities on student learning, emphasizing their evolving approach to assessment, reasoning, and ability to deal with confusion and uncertainty. Insights gained shed light on the effectiveness of this unconventional teaching method in fostering a deeper understanding of physics and self-directed learning.

SUN-POSE-716 | Contributed Talk | Circuit-Algorithm-Math-Physics (CAMP): A novel integrated model to assess the educational goals of Associate of Science Degree program in Quantum Literacy

Presenting Author: ANIL PYAKURYAL, University of District of Columbia-Community College

"Circuit-Algorithm-Math-Physics (CAMP): A novel integrated model to assess the educational goals of Associate of Science Degree program in Quantum Literacy" University of District of Columbia (UDC) and its satellite college, an HBCU institution is slated to begin Associate of Science Degree in Quantum Literacy, an unique program designed to promote elementary education in Quantum Information Science and Technology for the first time in the nation. Primary objective of the program is to support University's critical mission on work-force development by preparing skillful technician in Quantum Technology as a trailblazer to overcome the anticipated crisis in the field in this decade ahead. We have primarily designed the course curricula for the program, and its appropriate assessment models using CAMP based assignments. Currently we are in a phase of collecting feedbacks from the physics and other science educators, institutions as well as industrialist and business entrepreneurs to improve the quality of program and its prospects. Therefore we would like to give a presentation highlighting our program and its applications to the community.

Plenary Speaker K. Renee Horton

K. Renee Horton is a native of Baton Rouge, Louisiana, and a lifelong lover of science and NASA. A graduate of Louisiana State University with a B.S. in Electrical Engineering with a minor in Math in 2002 and a Ph.D. in Material Science with a concentration in Physics, becoming the first African American to graduate from the University of Alabama in 2011 in this area.

K. Renee Horton currently serves as the Electrified Powertrain Flight Demonstrator Project (EPFD) Airworthiness Deputy at NASA's Michoud Assembly Facility in New Orleans. She worked for NASA, first as a student from 2009 to 2011, and then started her career as a mechanical test engineer in 2012.

K. Renee Horton

Homer L. Dodge Citation for Distinguished Service to AAPT and Barbara Wolff-Reichert Travel Award and Fellows

Sunday 5:30 –6:30 p.m.

St. James – 3rd Floor

Recipients of the 2024 Dodge Citation for Distinguished Service to AAPT:

Jennifer Blue, Miami University, Oxford, OH
Juan Burciaga, The Colorado College, Colorado Springs, CO
Anthony (Tony) Mwene Musumba, Riverside City College, Riverside California
Tatiana Erukhimova, Texas A&M University, College Station, TX

Recipients of the 2024 Barbara Wolff-Reichert Travel Grant:

Mike Florek, Glenvar High School, Salem, VA
Saara Naudts, Peel District School Board in Ontario, Canada

MON-EC-01 (9:00 to 9:12 AM) | Contributed Talk | Should We Trade Off Higher-level Mathematics for Abstract on to Improve Student Understanding of Quantum Mechanics?

Presenting Author: James Freericks, Georgetown University

Undergraduate quantum mechanics teaches via a wavefunction approach with a concrete representtion in postion space. This leads to a differential equation perspective for teaching the material. However, we know that abstract representation-independent approaches often work better with students, as seen, for example, when we compare the series solution of the harmonic oscillator to the abstract operator method. While students overwhelmingly prefer the operator method, which approach actually leads to a beter understanding? We have been teaching a class focused on an operator-first viewpoint, which we like to call "operator mechanics." It teaches quantum mechanics in a representation-independent fashion and allows for most of the math to be algebraic, rather than based on differential equations. I illustrate how this works with the pardigmatic case of the harmonic oscillator wavefunctions. I will also summarize the experiences we have had with this approach and describe what resources are available for others interested in trying the approach in their classroom. Together, we can help modernize quantum instruction and advance the second quantum revolution.

MON-EC-02 (9:12 to 9:24 AM) | Contributed Talk | Making Physics Beyond Spherical Cows Accessible With Jupyter Notebooks

Presenting Author: Jeffrey Hyde, Swarthmore College

When introducing a difficult new physics concept, we often ask students to apply it in simplified situations as they gain experience. Dealing with the full complexity of an interesting application may not even be possible with a pen-and-paper approach. While computational problems can help achieve this, limited computational experience of students is a significant barrier. In this presentation I will describe how I've used Jupyter notebooks to help bridge this gap in courses where students have a wide range of computational experience. I will give examples from courses I taught at three different institutions, where students either modeled a phenomenon they encountered in person, or worked with data from a relevant experiment. I will focus on how these notebooks and related tools were set up to reduce (but not eliminate) the difficulty for those with little to no prior coding experience.

MON-EC-03 (9:24 to 9:36 AM) | Contributed Talk | Machine Learning Based Study of Mirages

Presenting Author: Anna Horváth, Wigner Research Centre for Physics
Additional Author | Gergely Gábor Barnaföldi
Additional Author | Balázs Bámer

A mirage or fata morgana is typically an upside-down "mirror" image of a scenery in deserts, over sun-heated roads, or above bodies of water. When the temperature gradient of air is large, as can happen near a surface, it results in a large gradient of the density and the refractive index as a function of height. Mirages appear when light travels through a medium with a gradient in its refractive index and therefore gets bent towards the higher values, generating reflected images. A computer program that simulates mirages above water using the method of ray tracing has been developed and used to generate data for training a deep neural network in order to predict temperature differences from photographs. Testing the model in real-life scenarios at Lake Balaton, Hungary is also provided.

MON-EC-04 (9:36 to 9:48 AM) | Contributed Talk | An Interesting Way to Reinvent a Wheel: Fourier Transform

Presenting Author: Lishang Rao, future Start & Candle Light

While studying the numerical solution of general polynomial equations. I surprisingly found such a connection between the Fourier Transform and periodic sequence, does it have other applications?

Session MON-EE: Bringing Science Out of the Classroom–Part 1

Monday, Jan. 8, 9–10 a.m.

Jackson - 3rd Floor Moderator: Nina Morley Daye Sponsor: AAPT

MON-EE-01 (9:00 to 9:24 AM) | | Out of the Classroom: STEM and World War II

Presenting Author: LaToya Williams, The National World War II Museum

So much of the events of WWII and innovations that came after were impossible without STEM. We will share how we work with students from elementary to high school to learn about the wide world of STEM in WWII outside of the classroom through field trip visits to the Museum, summer camp and more. Additionally, we will share how we bring STEM in WWII to classrooms through our curriculum and teacher professional development opportunities.

MON-EE-02 (9:24 to 9:36 AM) | Contributed Talk | Physics and Resilience: Helping Communities and Physics Students Gain a Sense of Efficacy with Real-World Challenges

Presenting Author: Randall Tagg, University of Colorado Denver

News reports continually describe disasters like hurricanes, floods, wildfires, and earthquakes as well as ongoing challenges like climate change, housing, equitable access to food, pandemics, crime, and economic instability. The host city for the AAPT winter 2024 conference, New Orleans, is a prime example for the need to create both technical and social structures to further mitigate the impact of hurricanes and floods. Physics students hearing dire news reports may anxiously wonder "What can I do?" A student organization Physics Student Innovators (*and Alumni), or PSI*, has been set up to organize physics student / community partnerships to develop effective technologies to improve resilience to contemporary challenges. A current CU Denver project aims to use physics to improve local food production. Another project focuses on modeling and mitigation of urban heat islands. The wider goal is to scale projects like this to students and communities nationwide in the spirit of the workshop "Physics for Humans" run at the last three Physcon meetings.

MON-EE-03 (9:36 to 9:48 AM) | Contributed Talk | Meeting Learners Where They Are – Physics and Astronomy Engagement in a Rural Setting

Presenting Author: Matthew Cass, Southwestern Community College

Going beyond the classroom is a fantastic way to promote science learning within your community and a great way to interact with students: present, past, and future. It is especially important if you are trying to reach learners in a rural region to meet them where they are. In this talk, I will share my experiences with community engagement and place-based education activities. From art fairs to breweries and airports to civic clubs, I will share ways to take learning beyond the classroom by utilizing the resources in your region as well as salient science events. In addition to success stories, I will also share challenges and obstacles in organizing and putting on such events, along with strategies to overcome them. I have nearly a decade of experience with community engagement as part of my work with NASA Science's Science Activation group. I have successfully organized and led a number of diverse events ranging from solar eclipse totality events with audiences numbering in the hundreds to smaller, more personal events such as science story-time for youth at the local library.

Session MON-EF: Hands-On Ears-On Sound Activities from the Exploratorium

Monday, Jan. 8, 9–10 a.m.

Canal Moderator: Bree Barnett Dreyfuss Sponsor: Committee on Physics in High Schools

Join us for a series of hands-on activities where we'll help professors, teachers, and students to develop mental models of how instruments generate sound, from the macroscopic effects of sound like pitch and volume to microscopic processes of the motion of air, wood, and metal. Using sequences of activities, teachers and professors will be able to determine the best ways to help their students figure out how musical instruments create pleasing sound.

This interactive session will be run by Zeke Kossover and Desire Whitemore of the Exploratorium's Teacher Institute.

Session MON-EG: Highlights from the AAPT Journals: TPT and AJP–Part 1

Monday, Jan. 8, 9–10 a.m.

Fulton - 3rd Floor Moderator: Beth Parks Sponsor: Committee on Professional Concerns

MON-EG-01 (9:00 to 9:24 AM) | | Intuition and Reasoning: What We Can Learn from Cognitive Psychology

Presenting Author: Mila Kryjevskaia, NDSU

Additional Author | Brianna Santangelo, California State University

Most science instructors will probably agree that one major goal of our instruction is cultivating the ability to use formal knowledge to construct logically sound arguments. When students struggle to build such arguments, it can be easy to assume that they either do not possess the necessary content knowledge or their reasoning skills are weak. While these interpretations may be productive, dual-process theories of reasoning from cognitive psychology suggest that intuition is also a critical aspect of cognition. In fact, intuition is often powerful enough to significantly enhance or hinder explicit reasoning (even by those who hold correct formal knowledge). Indeed, many scientists and expert teachers believe that their intuition makes thinking and problem-solving more productive and enjoyable. However, this may not be the case for our students who are just starting their journey toward developing their expertise. In this talk, I will discuss how insights from cognitive psychology can help science instructors

gain a deeper understanding of the roles of intuition and formal knowledge in reasoning. I will describe common reasoning pathways suggested by the dual-process theories of reasoning and discuss reasoning hazards present along the way. I will highlight promising instructional approaches to help students navigate the reasoning hazards more successfully.

This material is based on work supported by the National Sci- ence Foundation under the grant nos. DUE-1821390, DUE- 1821123, DUE-1821400, DUE-1821511, DUE-1821561, and FAR-0035257.

MON-EG-02 (9:24 to 9:48 AM) | | An Energy Unit Fueled by Climate Change

Presenting Author: Elissa Levy

Additional Author | Abigail Daane, South Seattle College

Additional Author | Leslie Chamberlain, The Harpeth Hall School

How can students analyze and model climate change within the parameters of a typical physics curriculum? In this presentation, authors of a recent TPT article share their approach: to use the traditional energy unit as a launching point for students to study how our society's energy use warms our planet. In these lessons, students connect the physics canon (energy forms) with a climate-focused sociopolitical energy topic (energy resources). Students model the flow of energy through a geopolitical region to connect conservation of energy to macroscopic, human-driven processes. Students also engage with a seeming contradiction: energy is conserved by universal law, but it's up to us to conserve energy in society. The authors of this paper will share their lessons, adaptations, and resources, which have been used in various high school and college settings across the US.

Session MON-EA: Infusing Computation into Astronomy and Space Science- Part 1

Monday, Jan. 8, 9–10 a.m.

Commerce - 3rd Floor Moderator: Tracy Hodge Sponsor: Committee on Space Science and Astronomy

MON-EA-01 (9:00 to 9:24 AM) | | Trying Machine Learning in Introductory Astronomy

Presenting Author: Donald Smith, Guilford College

Machine learning models are surrounding us more and more every day, and much of their function is invisible to the users. It is imperative that modern students are given a chance to understand the underlying principles behind these tools. Incorporating machine learning activities into Introductory Astronomy courses poses challenges, though, from math phobia on the side of the students to the danger of ML concepts taking up too much real estate at the expese of Astronomy topics. I have tried implementing a machine learning assignment as a lab activity in an introductory course on Galaxies and Cosmology. Students spend one class session working through a set of activities to explore the properties of neural networks and machine learning models. A second lab builds on an earlier lab on Galaxy classification by giving them the opportunity to train a model to classify galaxies, and then test it by seeing if it could achieve better accuracy than the students. I will demonstrate these tools and discuss the strengths and weaknesses of my assignment.

MON-EA-02 (9:24 to 9:48 AM) | | ESCIP: A Collaboration for Developing and Sharing Educational Jupyter Notebooks

Presenting Author: Britt Lundgren, University of North Carolina Asheville

Additional Author | Chris Richardson, Elon University

Additional Author | Ryan Trainor, Franklin and Marshall College

As the data-intensive field of astronomy moves toward the petabyte regime, students will increasingly require a foundation in computational methods in order to engage in authentic and impactful research. In response, a growing number of astronomy faculty are incorporating Jupyter Notebooks into their coursework and research onboarding practices. However, a common platform and community for sharing notebooks and best practices remain to be developed and supported. Enhancing Science Courses by Integrating Python (ESCIP) is a new, faculty-led collaboration dedicated to creating and distributing Jupyter Notebooks for chemistry, physics and astronomy undergraduates. With funding from the Research Corporation for Science Advancement, ESCIP aims to build a freely accessible repository of well-tested Jupyter Notebooks for educators and students. ESCIP also supports faculty networks to facilitate the sharing of instructional modules through virtual and in-person workshops. This talk will introduce the ESCIP project and solicit participation and contributions from the physics and astronomy community.

Session MON-ED: PER: Addressing Norms and Marginalization

Monday, Jan. 8, 9–10 a.m.

Magazine - 3rd Floor Moderator: Jonathan Perry Sponsor: Committee on Research in Physics Education

MON-ED-01 (9:00 to 9:12 AM) | Contributed Talk | Who Constructs Knowledge and Who Defines Norms? Physics Implications of Neuroqueer Literacies

Presenting Author: Liam McDermott, Rutgers University

As more neuroqueer, the intersection of neurodiversity and queer, students enter higher education, especially in STEM fields, it is imperative that we, as physics educators, commit to effectively educating these students who have historically been pushed out of pursuing their studies due to differences in learning. Part of this commitment lies in interrogating traditional education practices, and questioning how we define who is scientifically litereate and who is not. Combining Walker's Neuroqueerness with reading-specific literacy, Kleekamp and Smilges assert the need for a redefining of literacy towards "Neuroqueer Literacy." We here discuss Kleekamp's and Smilges's works, and build on them for a physics class-

room context. We discuss how traditional physics education practices serve to marginalize neuroqueer students, and call for a subversion of norms to create a more inclusive classroom. We finish this talk with a reimagining of the physics classroom and curriculum to engage with students developing a Neuroqueer Physics Literacy.

MON-ED-02 (9:12 to 9:24 AM) | Contributed Talk | Merging Attributes and Results in Education and Careers (MARIE-C)

Presenting Author: Gabrielle Dawson, Miami University

Additional Author | Jennifer Blue, Miami University

Historically, physics has exhibited a "leaky pipeline" effect in which minority students drop out due to lack of support, resources, and negative social environmental factors. MARIE-C (Merging All-Girls Results in Education and Careers) is a project that surveyed 102 non-male Miami University STEM students, broadly defined, to better understand the motivations behind their choice to pursue a STEM major or career. Our survey focused on secondary school factors such as demographics, geography, socialization, socioeconomics, diversity, religion, and single-sex versus coeducational qualities of their student bodies. We found that higher socioeconomic status, social encouragement, and positive peer influence were major indicators of non-male individuals pursuing STEM outcomes. The identification of these factors enables us to tailor experiences for individuals within this "critical period" (the year preceding a student entering their first year of college) to effectively influence their interest and pursuance of STEM outcomes.

MON-ED-03 (9:24 to 9:36 PM) | Contributed Talk | Limitations of Traditional Demographic Data and Categories in PER: Some Questions and Considerations

Presenting Author: Sarah Stella

Amy D. Robertson

W. Tali Hairston

Verónica N. Vélez

Trà Huynh

Lauren C. Bauman

In physics education research (PER), demographic analysis often relies solely on traditional quantitative data and categories to evaluate questions of equity vis a vis race, gender, and all other identity dimensions. Relying solely on these categories and data fails to seriously consider critiques such as non-standardized and non-enforced methods of data collection, inconsistency in reporting categories, incapacity to capture the nuances of student experience, infrequent reporting on limitations of individual data sets, and even access to these enrollment/faculty demographic data. Quantitative research rooted in Critical Race Theory (CRT) argues that these limitations – and, more broadly, failure to consider critical perspectives on data – contribute to the reproduction of whiteness. This presentation advocates for the consideration of critical theory and methods in the use of quantitative data, and for the supplementation of quantitative data with qualitative data that lends insight into the experiences of research participants. Such efforts have the potential to transform how we use and interpret data toward more liberatory ends.

This work is supported in part by NSF Grant No. 2201929 and 2201930

Session MON-EB: Viral Physics with YouTube, Blogs and Other Media

Monday, Jan. 8, 9–10 a.m.

Camp - 3rd Floor Moderator: Aaron Titus Sponsor: Committee on Educational Technologies

MON-EB-01 (9:00 to 9:24 AM) | | All Things Physics: A Repository of Video Explorations

Presenting Author: David Jackson, Dickinson College

How does one go about creating a physics YouTube channel that will actually be useful to students and faculty? Is it as simple as videotaping a lecture or an interesting experiment, or is it necessary to incorporate elaborate video-editing techniques and fancy graphics? Should the videos be short, or are longer format videos just as impactful? And how does one create a sustainable workflow so that the channel continues to grow and doesn't simply wither away once the novelty wears off? In this talk I will discuss my attempt to create a repository of video explorations that are compelling enough to attract both students and faculty and keep them coming back for more. Although still a work in progress, I'll share some of the important lessons I've learned so far, including the good, the bad, and the ugly.

MON-EB-02 (9:24 to 9:48 AM) | | Physics Engagement: Exploring the Best of WIRED and YouTube

Presenting Author: Rhett Allain, Southeastern Louisiana University

Online physics content is a dynamic and ever-evolving resource for students and educators alike. With over a decade of experience creating physics content for WIRED.com and YouTube. In this talk, I will share my personal favorites from both platforms and provide insights into the creation of online physics content. In particular, I will look at which topics are the most valuable and which ones have the highest engagement.

Session MON-FE: Bringing Science Out of the Classroom–Part 2 Monday, Jan. 8, 10–11 a.m.

Jackson - 3rd Floor Moderator: Nina Morley Daye Sponsor: Committee on Physics in Pre-High School Education

MON-FE-01 (10:00 to 10:24 AM) | | Physics Outreach via a Mobile Makerspace

Presenting Author: Anne Cox, Eckerd College

The aim of our Mobile Makerspace is to bring hands-on building activities into the community and to teach a bit of physics along the way. Come to this talk to learn about and try out some of our activities. For middle-grade students our activities focus on circuits: soldering workshops and the use of a laser-cutter for participant-designed artwork integrated into a glowing LED project. For elementary-grade students our activities focus on optics: building kaleidoscopes and making solargraph pinhole cameras (particularly appropriate in advance of the upcoming eclipse). We will also discuss the design and building of the Mobile Makerspace and how it connects to our outreach through middle school summer science camps.

Funding provided by Duke Energy Foundation.

MON-FE-02 (10:24 to 10:48 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | So You Have a MakerSpace, Now What?

Presenting Author: Mari Oates, Fermilab

Join us as we discuss the developement, planning, and implementation of MakerSpace in an organization. Mari has working in MakerSpaces including This sessions will include topics like guiding documents, program developement, and marketing and reqruitment. Participants are encouraged to bring their questions and experinces to contribute to the conversation.

Session MON-FG: Highlights from the AAPT Journals: TPT and AJP–Part 2 Monday, Jan. 8, 10–11 a.m.

Fulton - 3rd Floor Moderator: Beth Parks Sponsor: Committee on Professional Concerns

MON-FG-01 (10:00 to10:24 AM) | | Scattering of Identical Particles by a One-Dimensional Delta Function Barrier Potential: The Role of Statistics

Presenting Author: Paul Berman, University of Michigan

Additional Author | Alberto G Rojo, Oakland University

Calculating the reflection and transmission coefficients of a one-dimensional Dirac delta function barrier is a standard problem in elementary quantum mechanics. When a wave packet is incident on the barrier, these coefficients determine how much of the packet is reflected and how much is transmitted. The question arises as to what will happen if two particles are incident on the barrier, one from each direction. Interestingly, the result depends critically on whether the particles (1) are distinguishable, (2) obey Fermi-Dirac statistics, or (3) obey Bose-Einstein statistics. It will be shown that the results can differ dramatically for the three cases. As such, this scattering problem represents an effective means for introducing advanced undergraduate students to the importance of the role of statistics (that is, whether the particles are distinguishable or obey Fermi-Dirac or Bose-Einstein statistics) in an elementary scattering process.

MON-FG-02 (10:24 to 10:48 AM) | | The Discovery of a Supermassive Black Hole at The Center of The Milky Way Galaxy

Presenting Author: Bryanne McDonough, Boston University

Additional Author | Paul Withers, Boston University

In this talk, we will use concepts accessible to upper division physics majors to explain the discovery of a supermassive black hole at the center of the Milky Way galaxy, which was recognized by the award of the 2020 Nobel Prize in Physics. We will demonstrate how, given the sizes and decadal-scale periods of stellar orbits in the galactic center, Newton's version of Kepler's third law can be used to determine the mass and maximum radius of the concentration of mass at the galactic center. We show how to rule out various possible physical interpretations consistent with this mass and maximum radius to demonstrate that a supermassive black hole is the only possible explanation for the observed orbits of stars close to the galactic center.

Session MON-FA: Infusing Computation into Astronomy and Space Science–Part 2 Monday, Jan. 8, 10–11 a.m.

Commerce - 3rd Floor Moderator: Tracy Hodge Sponsor: Committee on Space Science and Astronomy

MON-FA-01 (10:00 to 10:24 AM) | | Computational Astronomy: A Universe of Calculations

Presenting Author: Martha Garlick, South Dakota School of Mines and Technology

For the last 7 years, we have offered Computational Astronomy workshops for high and middle school math and science teachers. The aim has been to give them computational and mathematical tools to apply to astronomy and space exploration topics in their classrooms. Some activities during the workshop have been using variable stars and supermnovae to determine intergalactic distances, determing Jupiter's mass using Kepler's third law, calculating how to get the Space X Crew Dragon to the International Space Station, and measuring the speed of light in your backyard. We introduce the teachers to math modeling and dimensional analysis techniques and demonstrate the use of Excel and DEMOS for calculations and for building a street map of the solar system.

MON-FA-02 (10:24 to 10:36 AM) | Contributed Talk | Computational Lab in Sophomore Astrophysics

Presenting Author: David Klassen, Rowan University

For several years now I have been incorporating computational work into my sophomore/junior Math Methods for Physics class; this past year when I took over Introductory Astrophysics, I knew I wanted to start adding computation there as well. All the students have had a one-year intro physics sequence and a semester of calculus so I felt confidnet we could have some fun. One of the tasks I have an intro level Solar System class do is geometrically construct the orbit of Mercury using a list of greatest elongations by date. To mirror this, I had the Astrophysics students computationally construct the orbit of any planet in our solar system, of their choice, given only the perihelion distance and speed of the planet. In this talk I will discuss the methods we used, some of the pitfalls we ran into, and show some of the student results.

MON-FA-03 (10:36 to 10:48 AM) | Contributed Talk | Techniques for Simulation of Charged Particles in Gravitational and Electromagnetic Fields

Presenting Author: Martin Melhus, Widener University

Additional Author | William F McConville, Widener University

Additional Author | Bennett J Richman, Northrop Grumman

We present recent developments in the simulation of the motion of charged particles in electromagnetic and gravitational fields. Employing a combination of explicit and implicit methods produces a simulation algorithm that is second order accurate and exact energy conserving, making it suitable for long time duration simulations. We demonstrate a method to solve the implicit equations of motion explicitly, increasing the speed of execution of the simulation. This modern approach makes the material accessible to undergraduate students and talented high school students; this presentation is intended to help an instructor present the material to that audience. These techniques can be used to simulate astrophysical phenomena such as solar wind interactions with the Earth's magnetosphere, the Van Allen radiation belts, and the effects of the Earth's magnetic field on the orbits of charged bodies, as well as the more general problem of motion of charged particles in a magnetic dipole field.\

Session MON-FC: Panel: How Do We Choose to Represent Something as a Scalar, Vector or Quaternion?

Monday, Jan. 8, 10–11 a.m. Royal - 3rd Floor Moderator: Toby Dittrich Sponsor: Committee on History & Philosophy of Physics

Historically, in introductory physics, angular displacement has been treated as a scalar quantity and quaternions have been used, more recently, in advanced applications. Only once in an engineering text 1 in 1905 has a vector definition of angular displacement been presented. This Topical Discussion (involving the audience) is designed to explore the questions arising from the current use of the scalar definition of angular displacement. Typical questions are: 1) How can the time derivative of a scalar quantity be a vector? 2) Does the apparent difference in the appearance of a rotating object (typically a textbook) when rotated in two angular displacements in different successive orders truly mean that finite angular displacements are not commutative? 3) If infinitesimal angular displacements are commutative, how can finite angular displacements not be commutative? and 4) Would there be any negative consequences to physics pedagogy or teachings if the vector definition of angular displacement were adopted for general use in introductory and advanced rotational theory? Discussion of these questions should lead to a very interesting session, so please attend and plan to contribute in a brief and succent way so as to make for efficient use of time.

Panelists include: Wolfgang Bauer, Joe Heafner and Toby Dittrich

Session MON-FD: PER: Beyond Intro

Monday, Jan. 8, 10–11 a.m.

Magazine - 3rd Floor Moderator: Mamadou Bailo Barry Sponsor: Committee on Research in Physics Education

MON-FD-01 (10:00 to 10:12 AM | Contributed Talk | Student Performance in Modern Physics in An Active, Partially-Flipped Classroom: Comparing Online Vs. In-Person Outcomes

Presenting Author: Scott Yarbrough, University of Texas at Arlington

Additional Author | Ramon Lopez, University of Texas at Arlington

The effectiveness of the flipped classroom and hybrid-flipped (partially flipped, partially lecture-based) method of instruction has been extensively studied for high school and introductory undergraduate physics courses, and it has been shown to increase student understanding and performance. However, few studies have been done for upper-level undergraduate courses, and even fewer have been done for virtual courses. In Spring 2021 and Fall 2023, a fully virtual, hybrid-flipped Modern Physics course was taught, primarily to a class of primarily juniors and seniors, with some sophomores. All were STEM majors. The same course, with a similar enrolment and demographic of students, was taught in Spring 2022 and Spring 2023. However, in these classes, the synchronous problem-solving session was conducted in-person. We investigate the differences in student performance in the two versions of the course by comparing homework and exam grades.

MON-FD-02 (10:12 to 10:24 AM) | Contributed Talk | Students' Ideas Around Quantum Measurement in the Context of Interaction-free Experiments

Presenting Author: Leanne Doughty, Georgetown University

Additional Author | Cecilia Ochoa, Georgetown University

Additional Author | Justyna Zwolak, National Institute of Science Standards and Technology

Additional Author | James Freericks, Georgetown University

Our research analyzes the effectiveness of two massive open online courses (MOOCs) offered by Georgetown University via edX, Quantum Mechanics (QM) and Quantum Mechanics for Everyone (QME). The QM course was designed for undergraduate physics majors and teaches quan-

tum mechanics using operators in a representation-independent formalism. QME was created for those without a physics background and focuses primarily on conceptual understanding. Here, we focus on student responses to open-ended questions within both courses that target students' understanding of "quantum seeing in the dark" (interaction-free measurements) in the context of the Stern-Gerlach experiment and Mach Zehnder Interferometer. We present our preliminary findings around students' conceptions of how atoms interact with the analyzers as well as the reasoning strategies students employ as they develop a model of quantum measurement.

Session MON-FB: Using Video Analysis in Intro Labs

Monday, Jan. 8, 10–11 a.m.
Camp - 3rd Floor Moderator: George Trammell Sponsor: Committee on Apparatus

MON-FB-01 (10:00 to 10:12 AM) | Contributed Talk | Video Analysis of 2D Human Motion

Presenting Author: Nancy Beverly, Mercy University

In our introductory Physics for Life Sciences courses, students track the approximate center of mass of their own bodies moving in 2D. Because human motion is rarely constant velocity or constant acceleration, the data is not readily amenable to the typical introductory kinematic equations. As an alternative, students learn to recognize and identify the sequence of simple segments that make up each motion. (e.g. where does the person's acceleration in each dimension change direction or become zero). The synchronized video helps students visually identify the "oomph" (maximum acceleration) moments of interest. Students can take a screenshot of those moments and use the data to draw corresponding force diagrams and estimate forces. They can also use the data in an energy perspective, such as estimating power and caloric expenditure.

MON-FB-02 (10:12 to 10:24 AM) | Contributed Talk | A Simple Experimental Procedure to Determine the Gravitational Acceleration and the Coefficient of Kinetic Friction

Presenting Author: Andreas Johansson, University of Gothenburg

Additional Author | Sebastian Kilde Löfgren, University of Gothenburg

Classical methods to study kinetic friction are by sliding objects at a constant velocity on a horizontal or inclined plane measuring the pulling force or the inclination angle. These methods require previous knowledge of the value of the gravitational acceleration. The presentation will introduce a laboratory experiment to be used by students at the high school level for simultaneous measurements of gravitational acceleration and the kinetic friction coefficient via video analysis of accelerated and decelerated motion. The simple experiment can be useful for learning aspects of kinetic friction that fall outside of classical models taught in high school and, it can be used to problematize these models in real-world situations.

Session MON-FF: Women+ and Gender Minorities in Physics: A Roundtable Discussion

Monday, Jan. 8, 10–11 a.m.
Canal Moderator: Jolene Johnson Sponsor: Committee on Women in Physics

Come to this roundtable discussion about women+ and gender minorities in the field of physics. This will be a "safe space" for women+ and gender minorities to come together to discuss their lived experiences, barriers they have encountered and how they have persevered. We hope that this chance to speak with others especially helpful for those that may be the only woman+ or gender minority in their departments, programs or labs.

Katherine (Katie) Mack Recognized as 2024 Recipient of the Richtmyer Memorial Lecture Award

Dark Matter: The Cosmic Mystery at the Heart of Particle Physics

Dark matter is one of the most mysterious and essential components of the Universe. It enabled the formation of our own Galaxy and everything we see in the night sky, and yet, it appears to be completely invisible. I'll talk about how astronomy told us dark matter exists, how particle physics might answer the question of its true nature, and why discovering it might reshape our picture of the fundamental physics of the cosmos.

Katherine (Katie) Mack is a theoretical astrophysicist who studies a range of questions in cosmology, the study of the universe from beginning to end. She currently holds the position of the Hawking Chair in Cosmology and Science Communication at the Perimeter Institute. Throughout her career, she has placed an emphasis on sharing science with the broader public. A scientist whose research relies on public funding, she considers it part of her job to share her knowledge and expertise with people outside the world of science and academia. As part of her role, she frequently takes part in outreach activities (public lectures, school visits, mentoring events, videos, podcasts, etc) and makes herself available for interviews.

Katie Mack

11:30 a.m. - 12:30 p.m.
St. James

Sea Change Award Presented (11:20–11:30 a.m.)

Smith College Physics Department has earned a Bronze Award from the Physics and Astronomy SEA Change Committee (P/A SEA Change) for their work to create a more inclusive and diverse physics department. This marks not only the first P/A SEA Change award, but also the first disciplinary award in SEA Change.

Session MON-GB: Effective Practices in Educational Technology–Part 1

Monday, Jan. 8, 2–3 p.m.

Camp - 3rd Floor Moderator: Bilas Paul Sponsor: Committee on Educational Technologies

MON-GB-01 (2:00 to 2:12 PM) | Contributed Talk | OpenSpace: An Open-Source Tool for Astrophysical Visualization

Presenting Author: Robert Steiner, American Museum of Natural History

OpenSpace is open-source interactive data visualization software designed to visualize the entire known universe – across human, planetary, stellar and galactic scales. OpenSpace supports interactive presentation of dynamic data from observations and simulations and can power planetarium domes as well as desktop computers. With modest preparation, educators can, for example, fly from Earth to the International Space Station, explore the moons of Saturn, land on Mars and explore galactic superclusters as well as the Cosmic Microwave Background. The presentation will include a project overview as well as discussion of opportunities for teachers and students to use the software. Some of the power of OpenSpace to explore the Solar System, the Milky Way Galaxy and beyond will be demonstrated.

MON-GB-02 (2:12 to 2:24 PM) | Contributed Talk | Formative Assessment With Microsoft OneNote Class Notebook

Presenting Author: Sean Wu

In most physics courses, exams provide cumulative assessments several times per semester. Often, time and class size prohibit the use of formative assessments outside of online homework, and providing personalized feedback is all but impossible. Microsoft OneNote Class Notebook, a part of any institution's Microsoft license, enables instructors to create classwork that can be evaluated daily. When an instructor creates an assignment, it is synced to each students' personal notebook. Students can then use their choice of a tablet or pen and paper to work on assignments within OneNote. As students solve problems, they are automatically synced back to the instructor. Instructors can then quickly flip through students' work and write comments. This talk will demonstrate OneNote Class Notebook, illustrate how student work improves over the course of a semester, and show how to integrate OneNote into your classroom.

MON-GB-03 (2:24 to 2:36 PM) | Contributed Talk | Integrating PBL-based Multimedia Courses into a Pre-service Physics Teacher Education Program

Presenting Author: Kathleen Falconer, Universität zu Köln Institut für Physikdidaktik

Additional Author | Stefan Hoffmann, Universität zu Köln Institut für Physikdidaktik

At the University of Cologne in the pre-service Physics teacher education (Bachelors and Masters programs), there are media practicum courses which include both a seminar and practical experience. The Media Practicum (MP) is a practical course with experiences in the use, creation and implementation of media and technology for instructional purposes in the science and physics classrooms. The MP course has two hours of contact time a week for a fifteen week semester (13 to 14 weeks with breaks). Usually there are about two or three hours of homework assigned a week leaving a substantial amount of work time for the final project. The course was designed to integrate Pedagogical Content Knowledge (PCK), media, technology and physics content into a course to enable the students to actively participate in the creation of media and the use of media and technology in an appropriate manner. The goals for the MP course are as follows: computational thinking and problem-solving skills, creative teaching and learning, self-expression and collaboration, equity and inclusion within the classroom and using technology and media in the classroom. We will discuss the scope and sequence of the courses as well as the Project Based Learning (PBL) within individual classes and the entire course.

MON-GB-04 (2:36 to 2:48 PM) | Contributed Talk | Enhancing Student Participation and Real-time Assessment with the Chat Tool

Presenting Author: Lanre Obadina, Rhodes College

When I had to teach my summer introductory physics course remotely (and synchronously) due to the pandemic, the biggest barrier I faced was how I would implement student participation. For two summers, my attempts to incorporate online teaching tools such as "break-out rooms", polling, mute/unmute buttons to aid student participation were unsatisfactory - students simply did not want to share their thoughts/solutions on camera and managing break-out rooms took too much time. As a last resort, I decided to use the chat tool and was surprised by its results. In this talk, I will discuss how the chat tool has helped to overcome some barriers in classroom participation, and more importantly, how it serves as a tool for real-time assessment of my students' understanding during lectures.

Session MON-GC: Improving Teaching with Lecture Demonstrations–Part 1

Monday, Jan. 8, 2–3 p.m.

Royal - 3rd Floor Moderator: Dale Stille Sponsor: Committee on Apparatus

MON-GC-01 (2:00 to 2:24 PM) | | 30+ Years of Thriving High School Physics Teacher Interactions – How Do We Do it?

Presenting Author: Samuel Sampere, SYRACUSE UNIVERSITY

The physics department at Syracuse University has been hosting 3 to 6 Saturday morning workshops per academic year for regional physics teachers for more than 30 years! These were started by my (quite important!) early career mentors, John Fitzgibbons and Joe Drenchko, collaboratively with the physics department, and organized by now emeritus professor Allen Miller, who continues leading this effort. During this talk, I will discuss my role in these workshops and the amazing value the teachers find as a result of their time with us. You will learn how these started, but more importantly, how and why they are still vibrant 30 today.

MON-GC-02 (2:24 to 2:48 PM) | Contributed Talk Funicli, Funicula – An Improbable Funicular-

Presenting Author: Constantin Rasinariu, Loyola University Chicago

In a previous paper[1] we introduced a novel, two-mass system that slides up while its center of mass moves down. A corollary of that paper is that an ideal pendulum whose point of suspension is moving freely and without friction on an inclined plane, a sort of a funicular, will move such that the string is always perpendicular on the incline. This counterintuitive motion makes for a good class demo for introductory physics students. Here we report on such a demo.

[1] C. Rasinariu and A. Gangopadhyaya, "The motion of two identical masses connected by an ideal string symmetrically placed over a corner," Am. J. Phys., Vol. 84, No. 11, Nov. 2016

MON-GC-03 (2:48 to 3:00 PM) | Contributed Talk | Introductory Mechanics as a "Research" Program

Presenting Author: Douglas Kurtze, Saint Joseph's University

I present an approach to teaching introductory mechanics driven by taking data on dynamics-cart collisions. First, a sequence of increasingly complicated collisions leads the students to formulate the principle of momentum conservation in greater and greater generality. As a side issue, they also note that for magnet-to-magnet collisions the relative velocity of the carts reverses during the collision; we save this observation for future investigation. Later we revisit these collisions to investigate whether total momentum remains constant throughout the collision or changes, returning to its original value as the collision finishes. The former is the case; this leads to Newton's laws, with "force" defined as "that which changes an object's momentum". Later still, for magnet-to-magnet collisions we show that mathematically combining momentum conservation with reversal of relative velocity leads to conservation of kinetic energy. We then find that during these collisions, total kinetic energy decreases and then increases again to its original value. Plotting kinetic energy vs. separation then reveals that at a given separation, the kinetic energy deficit is the same when the carts are approaching and when they are moving apart. This motivates the idea of potential energy.

Session MON-GG: Innovations in Teaching Astronomy

Monday, Jan. 8, 2–3 p.m.
Fulton - 3rd Floor **Moderator: Dan Burns** **Sponsor: Committee on Space Science and Astronomy**

MON-GG-01 (2:00 to 2:24 PM) | | Calculations of Seasonal Properties: Daylight Hours and Observed Solar Path

Presenting Author: Margaret Greenwood, Retired physics professor

The calculations use a model in which the spherical Earth revolves in a circle around the Sun. A parallel beam of sunlight illuminates one hemisphere of the Earth with the other, in darkness. The circular boundary between these light and dark regions is called the Light-Dark-Circle (LDC), which changes daily. We shall see how to find the two locations on the chosen latitude circle, where the latitude circle and the LDC intersect, yielding sunrise and sunset. The fraction of the latitude circle immersed in sunlight (between sunrise and sunset) multiplied by 24 hours yields the hours of daylight. We are familiar with the path of the Sun in the sky between sunrise, noon, and sunset. For a given date, the direction of the sunlight striking the Earth is assumed to be unchanged during one day, but changes each day. However, due to the Earth's rotation, the observer sees the direction of the sunlight continually changing. How these effects are included in calculations for December 21, March 21, and June 21 will be described.

MON-GG-02 (2:24 to 2:48 PM) | | Introducing Mobile Phone Astrometry

Presenting Author: Duncan Carlsmith, University of Wisconsin-Madison, Dept. of Physics

While eye-opening mobile phone star-gazing apps like Luminos and Redshift Sky can help you identify celestial bodies that you might see from your backyard, the real discovery is in understanding how such apps work and what your own mobile phone camera can actually capture. I introduce MATLAB Live Scripts that empower students to identify thousands of stars now observable within a single mobile phone image and to explore star catalog data programmatically. With their own phone and laptop, students can start a deep dive into astrometry and astronomy, and possibly participate in variable star research

Session MON-GD: PER: Impact of Varying Pedagogy

Monday, Jan. 8, 2–3 p.m.
Magazine - 3rd Floor **Moderator: Baaz Pathan** **Sponsor: Committee on Research in Physics Education**

MON-GD-01 (2:00 to 2:12 PM) | Contributed Talk | First Year of Teaching Mechanics and Calculus-I Together within the NSF S-STEM Project

Presenting Author: Andrei Blinkouski, Penn State Abington

Additional Author | John Majewicz, Penn State Abington

Additional Author | Samir Ouzomgi, Penn State Abington

In this presentation, we will share our experience of the first year of teaching the integrated course in PHYS211 (General Physics: Mechanics) and MATH140 (Calculus with Analytic Geometry I) within the NSF S-STEM Project "Integrating the Teaching of Mathematics, Physics and Engineering Courses to Improve Retention of Engineering Students at Penn State Abington". The rationale behind the integrated curriculum, as well as pedagogical challenges of this course will be discussed.

MON-GD-02 (2:12 to 2:24 PM) | Contributed Talk | Seminars to Incorporate Non-technical Skills into the Physics Curriculum at Marquette University

Presenting Author: Karen Andeen, Marquette University

As physics educators, one of our main goals is to ensure that our students become successful physicists in a variety of career paths. However, becoming a successful physicist requires many skills that are often not explicitly taught in the physics classroom, including working together in teams to develop new ideas, gathering and presenting information to a variety of audiences, and being strong and inclusive allies for colleagues from all backgrounds. The Joint Task Force on Undergraduate Physics Programs suggests in their Phys-21 report that these skills be more explicitly addressed within the physics curriculum to better prepare our physics graduates. At Marquette University in Milwaukee, WI, we have recently revised our physics curriculum. Using the suggestions made in the JTUPP-Phys-21 report, we designed six new 1-credit seminar courses, taught one per semester over three years, which focus on explicitly teaching these non-technical skills that our physics graduates need to succeed. The first cycle of the seminar series was completed this year. This presentation will cover our local educational landscape at Marquette, the learning goals of our physics curriculum, how those goals are addressed through the each of the six new seminars, and our initial evaluation of success.

MON-GD-03 (2:24 to 2:36 PM) | Contributed Talk | Normalized Gains Comparing Interactive Lecture Tutorial to Small Classroom Settings

Presenting Author: Charlotte Zimmerman, University of Washington

Additional Author | Peter S. Shaffer, University of Washington

Additional Author | Paula Heron, University of Washington

The University of Washington has been developing tutorials to be used in small classroom sections over the course of many years. However, many universities find it challenging to create small classroom sections, due to high enrollments and/or a lack of resources available to them. At the University of Washington, we face such challenges in the algebra-based introductory sequence. Therefore, we are in the process of developing tutorials designed for an interactive, lecture-style classroom. These tutorials have been implemented in the introductory, algebra-based physics courses at the University of Washington for the last several years. In this presentation, we will describe recent research into student gains in the lecture-style tutorials compared to the small section format. This work is supported by the National Science Foundation, under grant No. DUE-1821032.

MON-GD-04 (2:36 to 2:48 PM) | Contributed Talk | Group Work in the Physics Courses to Enhance Students Learning Outcomes

Presenting Author: Ganga Sharma, Fairmont State University

Additional Author | Bilas Paul, Farmingdale State College, Farmingdale, NY

This talk aims to present our findings about effectiveness of groupwork in introductory physics courses. Group work plays a pivotol role, serving as a dynamic platform for fostering collaboarative learning and enhancing students comprehension of fundamental scintific concepts. Students are expossed to diverse prspectives and methologies through group discussions, problem-solving sessions and colaborative projects. Our finding shows that students are benefited from diverse prospectives and methodlogies related to multiple angles of complex physical phenomena through group work. Group work not only encourages active engangement, but also enables students to clarify doubts, share insights, and collectively tackle challenges that might otherwise seems dounting. This collaborative environment not only nurtures critical thinking and communication skills but also reflects the real-world nature of scientific research, where collaboration and interdisciplinary approaches are crucial. By working together, students can consolidate their understanding of abstract theories into practical applications,leading to a deeper grasp of physics and laying a solid foundation for their academic journey.

This study is being carried out in two different US institutions named Fairmont State University and Farmingdale State College.

MON-GD-05 (2:48 to 3:00 PM) | Contributed Talk | Integrating the Teaching of Mathematics, Physics and Engineering Courses at Penn State, Abington

Presenting Author: Michael Kagan, Penn State Abington

Additional Author | Burcu Ozden, Penn State Abington

Additional Author | Andrei Blinkouski, Penn State Abington

Additional Author | Matthew Fury, Penn State Abington

Additional Author | Samir Ouzomgi, Penn State Abington

Additional Author | John Majewicz, Penn State Abington

Even though calculus is a prerequisite for physics at the majority of US undergraduate institutions, many students do not seem to retain the necessary math skills, which undermines their success in physics. Interestingly, we have recently started hearing complaints from engineering majors about having to take math courses prescribed by engineering curricula. This may appear ludicrous to the engineering and math faculty but is reasonably understandable because students are generally taught math as an abstract science and do not necessarily see how it would help them in their future careers as engineers. As a possible solution to the problem, Penn State Abington embarked on creating Integrated Curriculum starting with two pairs of courses: Calculus I + Physics I (Mechanics) and Physics 2 (E&M) + Electrical Engineering (Circuits and Devices). In this talk, we provide a general overview of this project including motivation and challenges of the integrated curricula. Two follow-up talks will elaborate on the methodology and students' feedback in each of the two integrated courses. This study is funded by an S-STEM NSF award.

Session MON-GF: Recent Development in Two-Year College Programs

Monday, Jan. 8, 2–3 p.m.
Canal **Moderator: Amit Chowdhury** **Sponsor: Committee on Physics in Two-Year Colleges**

MON-GF-01 (2:00 to 2:12 PM) | Contributed Talk | One Year Report on The Organization for Physics at Two-Year Colleges (OPTYCs)

Presenting Author: Kris Lui, AAPT-OPTYCs

Additional Author | Sherry Savrda, AAPT-OPTYCs

Additional Author | Dwain Desbien, Estrella Mountain Community College

Additional Author | Robert Hilborn, AAPT

OPTYCs, The Organization for Physics at Two-Year Colleges, is an NSF-funded initiative to create and sustain a national community to support physics and astronomy instructors at the introductory college level. We began July 2022, and in the following year, have offered over 40 different events, including professional development workshops, increased physics education research interest and participation, and supported new TYC faculty. In this talk, we present evaluation data from our first year and outline plans for the future. OPTYCs is supported by NSF-DUE-2212807.

MON-GF-02 (2:12 to 2:24 PM) | Contributed Talk | Creating a Physical Science Course Focused on Sustainability

Presenting Author: Sherry Savrda, Seminole State College of Florida

Driven by trends to include sustainability topics in science courses, and to serve the technical certificate in sustainability of an engineering technology program, a physical science course focused on sustainability topics was developed. One of the main goals of the course was that it would also meet the requirements of the physical science elective for general education students and would be open to students from any major. In this talk, the development of the course and some of the challenges met in its design and implementation will be presented.

MON-GF-03 (2:24 to 2:36 PM) | Interactive (e.g. panel, round table discussion, hands-on activity) | TYC Tandem Meetings: Feedback and Planning Future Events

Presenting Author: Paul Heafner, Independent Scholar

Co-presenting Author | Tom O'Kuma, Lee College

Co-presenting Author | Kristine P.H. Lui, AAPT

The recent TYC Tandem Meeting at the Summer 2023 AAPT meeting in Sacramento, sponsored by OPTYCs, the Organization for Physics in Two-Year Colleges (https://optycs.aapt.org), was a success according to feedback from participants. Those of us who plan tandem meetings need to ensure we are meeting the needs of TYC physics community. In this session, we will ask colleagues for input on what topical content include in the next tandem meeting, tentatively scheduled for 2025, and for input on aspects of planning where there may be room for improvement. OPTYCs is supported by NSF-DUE-2212807.

Session MON-GF: Teaching the IPLS

Monday, Jan. 8, 2–3 p.m.
Jackson - 3rd Floor **Moderator: Juan Burciaga** **Sponsor: Committee on on Physics in Undergraduate Education**

MON-GF-01 (2:00 to 2:24 PM) | | Medical Physics: Intersecting Physics and Life Sciences

Presenting Author: Kip Matthews, Louisiana State University and A&M College, Baton Rouge

Medical physics as a discipline exists as the intersection of physics with the life sciences. By the nature of this field, medical physicists must be conversant with biology, chemistry, medicine, and computer science, integrating their physics expertise with these topics. Medical physicists assist radiologists, radiation oncologists, and allied health professionals to diagnose and treat disease by contributing their physics knowledge, especially about radiation. Medical physicists conduct research and development of new diagnostic imaging and radiation therapy systems, provide quality assurance of these systems in the clinical environment, and contribute to education and training of physicians, technologists and therapists, and medical physics graduate students. This talk will describe medical physics and its subspecialties, including the role of medical physicists in clinical and academic settings. The typical education path for medical physicists will be described. Finally, the talk will highlight ways to introduce medical physics at the undergraduate level and to involve undergraduates in medical physics research, as a means to get students interested to pursue medical physics or related careers in radiological medicine.

MON-GF-02 (2:24 to 2:48 PM) | | The Process of Creating an IPLS Course Sequence / Designing an RE Tutorial

Presenting Author: Brandon Lunk, Texas State University

Prior to 2020, Texas State University ran a traditional, 2-semester General-Level Introductory physics sequence. As is typical of many large institutions, the student population who went through these courses included biological and professional pre-healthcare majors as well as non-life sciene majors including construction management and sound recording design. Starting in 2021, we split this sequence into two: an IPLS sequence and a traditional sequence. In this talk, I will discuss the process that we went through in creating this new sequence---including navigating institutional logistics and deciding on content and pedagogy for the IPLS sequence----as an example for other institutions who might want to make a similar transition. If time permits, I will also discuss some original content my undergrade student and I designed for the course: a tutorial worksheet on Reynolds Number.

Session MON-GA: The Global Origins of Newton's Laws

Monday, Jan. 8, 2–3 p.m.
Commerce - 3rd Floor **Moderator: Elissa Levy** **Sponsor: Committee on History & Philosophy of Physics**

MON-GA-01 (3:00 to 3:12 PM) | Contributed Talk | Galileo's Contribution to Newton's Laws

Presenting Author: Asim Gangopadhyaya, Loyola University Chicago

We explore Galileo's discoveries prior to Newton's three laws of motion

MON-GA-02 (3:12 to 3:24 PM) | Contributed Talk | The Significance of Newton's Work in Alchemy

Presenting Author: James Simmons, Shawnee State University

The "5 Cs" of historical research, five principles that guide a historian's work, are change, causality, context, complexity, and contingency. These ideas can lead us to a better understanding of the role that alchemy played in Newton's natural philosophy. Some historians argue that alchemy was an essential, not marginal, element of his thinking and that it was a factor in the development of the ideas presented in the Principia.

MON-GA-03 (3:24 to 3:36 PM) | Contributed Talk | Revisit the Newton's Laws, the inertial mass, and attractive mass.

Presenting Author: Lishang Rao, Future Start Learning Technology

Almost everything has an inertial mass as described in Newton's Second Law, F=ma. When I was a physics student, I wondered why everything has a mass and how to calculate it using fundamental numbers. However, Newton did tell us the origin of such inertial mass. In the previous meetings, I talked about the E&M theory to define and calculate such inertial mass as mentioned in Newton's second law; I also talked about the E&M theory to demonstrate two neutral objects attract each other due to the field fluctuation in the background where the two objects coexist, which is possibly the source of universal gravitation. In this AAPT winter meeting, I would like to have a review of the models to develop these theories. Since Quantum Mechanics and Relativity Theory give up using the force concept explicitly, these models, other models, and classical physics, in general, could be very interesting approaches to studying inertial mass, attractive mass, spin, and more.

MON-GA-04 (3:36 to 3:48 PM) | Contributed Talk | Keplerian Kinesthetics

Presenting Author: Jack Waddell, ASMSA

Kepler's laws of planetary motion present an excellent opportunity to engage students in multiple modes of reasoning. Some students will find the geometric and mathematical formulations easy to grasp, but others will benefit from intuition-building activities. In this kinesthetic activity, students collaborate to develop a large-scale elliptical orbit partitioned into intervals of equal area. The perimeter is then marked corresponding to these intervals. Volunteers will serve as the gravitating body and the planetary body. The orbiter will match their pace on the marked perimeter to the rhythm that observers provide. This activity can be expanded by creating another orbit with a different eccentricity and major axis, which is pre-calculated to correspond to an orbital period that is a simple ratio of the first orbit. A pair of volunteers can then run the orbits simultaneously, demonstrating Kepler's three laws simultaneously. A final computation can determine the "mass" of the gravitating body.

Session MON-HA-01: Astronomy Education Research

Monday, Jan. 8, 3–4 p.m.
Commerce - 3rd Floor **Moderator: Shannon Willoughby** **Sponsor: Committee on Space Science and Astronomy**

MON-HA-01 (3:00 to 3:12 PM) | Contributed Talk | A Review of Astronomy Education Research: 20 Years Later

Presenting Author: Janelle Bailey, Temple University

Additional Author | Molly N. Simon, Arizona State University

In 2003, Bailey and Slater1 published a review of astronomy education research to survey the field, identify areas of robust coverage, and uncover gaps in the research to help guide future researchers. We now have taken on an update to consider how the field has grown since that publication. After initially considering more than 400 works (primarily peer-reviewed publications, with some conference proceedings and dissertations), we narrowed our focus to include research conducted in tertiary (undergraduate and graduate) education settings. We have identified 10 broad categories of publications, including both a continuation of several categories identified in the original study, such as student understanding and efficacy of instructional strategies, and new groupings, such as course-based research experiences and online education, that demonstrate the evolution of astronomy education research. A future review will consider research conducted with K-12 students and teachers.

1 Bailey, J. M., & Slater, T. F. (2003). A review of astronomy education research. Astronomy Education Review, 2(2), 20–45. https://doi.org/10.3847/AER2003015

MON-HA-02 (3:12 to 3:24 PM) | Contributed Talk | Inquiry Style Planetarium Activities

Presenting Author: Emma Rasmussen, Brigham Young University

Additional Author | M Jeannette Lawler, Brigham Young University

Additional Author | Adam Bennion, Brigham Young University

Inquiry learning is difficult to implement in introductory astronomy classrooms for a number of logistic reasons. The night sky is only observable

at inconvenient times and sophisticated instruments that cannot be easily used by novices are needed for many direct measurements. A planetarium provides a means to remove many of these barriers, allowing for inquiry style activities even in introductory classes. In astronomy courses, planetariums are commonly used as a supplementary tool to demonstrate astronomical occurrences. We will discuss preliminary results measuring the impact of five different interactive planetarium activities designed to allow students to investigate their own knowledge. Preliminary results of our initial trials will be presented.

MON-HA-03 (3:24 to 3:36 PM) | Contributed Talk | Learning Hubble-Lemaître's Law Using SDSS Data and Computational Thinking

Presenting Author: James Newland, Bellaire High Schoo/University of Houston

Modern astronomical science is increasingly driven by data science and computational thinking. It is possible to have astronomy students construct astronomy knowledge while employing computational thinking and data science pedagogies by using partially-reduced datasets like those from the Sloan Digital Sky Survey (SDSS) in conjunction with Python and Google Colab notebooks. Here, we explore a highly scaffolded activity for students to build a Hubble-Lemaître diagram using data from the Baryon Oscillation Spectroscopic Survey (BOSS) from SDSS. Educators with access to plates from the BOSS mission can tie the activity directly to data associated with the plate. Students access the data directly from the database and use Python and Google Colab notebooks to reduce, visualize, and interpret data in a highly scaffolded format. Students are asked to interpret plots and place data in an astrophysical context. This activity is part of ongoing research into the impacts of using computational thinking pedagogies with physics and astronomy students. This activity has been used in a high school astronomy course. The activity and all associated programming code are freely available as Creative Commons content.

MON-HA-04 (3:36 to 3:48 PM) | Contributed Talk | ASTRO ACCEL: Advancing Research-informed Programming and Practices

Presenting Author: Tiffany Stone Wolbrecht

Learn more about the innovative ASTRO ACCEL initiative, a global effort to propel research and research-to-practice in the realms of astronomy education, engagement, culture, and communication. With over 28 networks spanning across 6 continents, ASTRO ACCEL is set to catalyze collaborative research in these vital fields. By bringing together both researchers and practioners, ASTRO ACCEL aims to foster a community where ideas are exchanged, priorities are collaboratively set, and meaningful progress is made towards advancing astronomy education and communication. As both practitioners and researchers, educators have a critical role in shaping the future of astronomy education and outreach worldwide. Join us as we discuss this exciting new initiative and how you might get involved.

Session MON-HB: Effective Practices in Educational Technology–Part 2

Monday, Jan. 8, 3–4 p.m.
Camp - 3rd Floor **Moderator: Karen Camarda** **Sponsor: Committee on Educational Technologies**

MON-HB-01 (3:00 to 3:12 PM) | Contributed Talk | MATLAB Live Scripts to Explore the Damped Shaken String

Presenting Author: Duncan Carlsmith, University of Wisconsin-Madison, Dept. of Physics

A common 1st-year physics demonstration delves into the resonant patterns of a taut string shaken at one end, highlighting "nodes" and "anti-nodes." Yet, in practice, nodes don't truly exist. This presentation unveils the reasons behind this phenomenon using three MATLAB interactive Live Scripts, suitable for enriching a standing waves lab experience. "Shaken String Explorer" offers insights into the exact analytic solution for a damped shaken string's motion in the linear approximation. "Taut String with Realistic Drag" provides a numerical calculation of the movement of the shaken string including nonlinear drag models. "Nonlinearly-damped Oscillator Simulation" delves into a driven simple harmonic oscillator with nonlinear damping, shedding light on the genuine resonance shape of a damped driven string.

MON-HB-02 (3:12 to 3:24 PM) | Contributed Talk | Teaching Computational Modeling in 9th-grade Physics with an Easy-to-use, Purpose-built Environment

Presenting Author: John Burk, Pivot Interactives

Co-presenting Author | Steve Temple, San Rafael High School

Co-presenting Author | Sabrina Paiz, San Rafael High School

Incorporating computational modeling into introductory high school physics courses can often be challenging for teachers and students, as it is often difficult for learners to see where the physics is inside the code they are writing. Many platforms require students to write a significant amount of code, often introducing incomprehensible syntax errors given through delayed feedback when trying to run a program. We will share a novel approach to computational modeling in high school physics classes using Tychos, a platform designed for introductory physics that emphasizes the physics in computational modeling. By integrating Tychos and Pivot Interactives, students get real-time feedback as they are building their simulations, and then customized questions that test their understanding of the model. Overall, this presents a new model for teaching computational modeling in introductory physics that lowers the demands on teachers and students while providing opportunities for students to deepen and demonstrate their understanding.

MON-HB-03 (3:24 to 3:36 PM) | Contributed Talk | Emphasizing Conceptual Understanding Using Maple: A Paradigm-Shift in Teaching Physics

Presenting Author: Scot Gould, Claremont McKenna, Pitzer, Scripps

Our department uses computer algebra systems (CAS), usually Maple, in the undergraduate introductory upper-division physics courses. Teaching with Maple has many desired qualities.
* The interpretative programming environment provides immediate feedback to the student.

* Compared to Python or MATLAB, Maple has a lower learning barrier because: - much of Maple's "coding" is via clickable icons, - Maple's input and output are readable to the non-user.
* Maple derives symbolical results, which are more instructional than a numerical calculation.
* Maple performs the mathematical busy work of both derivations and calculations, allowing the student to think more about physics.
* Maple allows for a top-down problem-solving approach, i.e., the problem-solving process of physicists.
* Maple can solve real-world problems, well beyond traditional spherical cow problems.
* The Maple approach is transferable to other quantitative disciplines.

For the courses, students learn the skillsets of Maple using a collection of ten-minute videos. Each skillset is introduced when needed for solving the type of mathematical problem. All presentations and homework submissions are in the form of a Maple document. Using anonymous surveys, nearly all students say Maple increases their interest in physics. Students feel they concentrate more on understanding physics principles, producing a more inclusive learning environment and a more prosperous learning outcome.

Session MON-HC: Improving Teaching with Lecture Demonstrations–Part 2

Monday, Jan. 8, 3–4 p.m.

Royal - 3rd Floor **Moderator: F. Fatima** **Sponsor: Committee on Apparatus**

MON-HC-01 (3:00 to 3:12 PM) | Contributed Talk | Growing Student Abilities in Physics and Beyond through a Project-based course creating demonstration

Presenting Author: Aida Torabi, University of Texas at Austin

Additional Author | John T Markert, University of Texas at Austin

Additional Author | Greg O Sitz, University of Texas at Austin

Additional Author | Jonathan D Perry, University of Texas at Austin

Demonstrations provide visually engaging ways for students to see physics concepts they are learning in a real world setting. But using demonstrations to enhance lectures is not the only way they can be employed to benefit students. Here, we present the design, goals, and implementation of a course which allows advanced undergraduate physics majors to take the lead on projects in developing, visualizing, and building new physics demonstrations. Within this course students take on tasks different from a typical lecture course, learning and applying skills in project management, teamwork, creation, and time management as they tackle expected and unexpected tasks in taking projects from concept to reality in the span of a single, long semester. We will discuss the pedagogical structure of the course which emphasizes the role of student agency and decisions in their projects, while the instructor acts as mentor, guide, and occasional just-in-time lecturer. As a capstone to their projects, student create materials to communicate about their demonstrations and the underlying physics with both technical and general audiences. They also have the opportunity to build something that will be used for years to come in courses both introductory and advanced which will benefit both education and outreach.

MON-HC-02 (3:12 to 3:24 PM) | Contributed Talk | Demonstration of Sound Waves Using Drones and Students: Connecting Individual Experiences to Large-scale Observations

Presenting Author: Sebastian Kilde Löfgren, Department of Physics, University of Gothenburg

Sound is a phenomenon central to everyday life and is present in many stages within the physics classroom. However, the wavelike nature of sound is not trivial for students as it has a deep connection to mathematical formulation. It is common to use experiments or demonstrations to build intuition for physics concepts and highlight central aspects. A demonstration consisting of three experiments has been developed and tested during a science festival to highlight the propagation of sound waves, the speed of sound, and interference. By having students react to the sound produced by speakers and filming the students from above using a drone, it is possible to connect the experience of what happens inside the experiments with the view of an external observer. Insights and learnings from testing the demonstration will be shared and reflected upon in relation to previous research.

MON-HC-03 (3:24 to 3:36 PM) | Contributed Talk | The Physics Laboratory Center (PLC): Inspiring Learning and Outreach through Interactive Demonstrations

Presenting Author: Allison McGraw, Texas A&M University

The Physics Laboratory Center (PLC) at the Texas A&M University's Physics & Astronomy Department has been involved in creating, designing, building, delivering, and maintaining nearly 300 physics demonstrations for over 40 years. The main themes covered by these demonstrations include Mechanics, Electricity & Magnetism, Thermodynamics, Optics & Waves, Astronomy, and Modern Physics. The PLC thrives with an undergraduate workforce that assists in constructing these demos. Lecturers can utilize the various demos when teaching physics to thousands of undergraduates each semester. These demonstrations also play a crucial role in large outreach events, extending their impact beyond the classroom to a broader community. The PLC demonstrations are featured in events such as First Fridays in the Bryan/College Station area and International Observe the Moon Night. Additionally, the department maintains an educational channel on YouTube, where some of these demos are showcased to an audience of millions, encompassing people of all ages from the public all around Earth.

MON-HD-01 (3:00 to 3:12 PM) | Contributed Talk | Development of a High School Quantum Information Science and Technology Concept Inventory

Presenting Author: Angela Kelly, Stony Brook University
Additional Author | Dominik Schneble, Stony Brook University
Additional Author | Tzu-Chieh Wei, Stony Brook University

The Quantum Education for Students and Teachers (QuEST) project develops high school students' quantum science content knowledge and quantum computing practices that promote critical thinking, reasoning, and communication skills. Students (N=46) attended a week-long summer camp that focused on quantum information science and technology (QIST) principles, including wave-particle duality, superposition, entanglement, unitary evolution, and measurement. A QIST conceptual progression was developed based upon physical science concepts typically taught in high school coursework, along with advanced quantum ideas and applied skills. To measure student learning, a 19-item QIST concept inventory was designed by quantum physics experts with high school teachers providing additional content validity. Items addressed quantum principles as well as quantum computing applications such as quantum key distribution, quantum circuits, and probability distributions. The concept inventory was piloted and demonstrated adequate internal consistency. This instrument shows promise in measuring knowledge and skills in a relatively new and rapidly growing discipline.

MON-HD-02 (3:12 to 3:24 PM) | Contributed Talk | Multiple Predictors of Performance in Introductory General Physics Courses

Presenting Author: David Meltzer, Arizona State University
Additional Author | Dakota H. King, University of Arizona College of Veterinary Medicine

We have examined the relationship between various pre-instruction assessment measures and final course grades for students enrolled in introductory general physics courses at five campuses of four universities; the total sample size was over 1000. The three assessments were the Force Concept Inventory, the Lawson Test of Scientific Reasoning, and a mathematics diagnostic test that we have developed and tested over the past seven years. We find, with greater than 95 percent consistency, that top-quartile scorers on the pre-instruction assessments have double or greater probability of receiving high (top quartile) course grades, and half or less probability of receiving low (bottom quartile) course grades, compared to students who scored in the bottom quartile on the assessments. We estimate the relative strength of the various predictors using multiple linear regression, and comment on the course-to-course variations observed both in relative strength of, and degree of intercorrelation among the assessment measures.

Supported in part by NSF DUE #1504986 and #1914712

MON-HD-03 (3:24 to 3:36 PM) | Contributed Talk | Developing a Survey to Measure Academic Burnout in Physics Students

Presenting Author: Harshini Sunil, Miami University
Additional Author | Jennifer Blue, Miami University

Physics students experience stressors from their responsibilities including coursework, research, jobs, etc. that can contribute to feelings of academic burnout. Burnout is mental or physical exhaustion caused by excessive or prolonged stress. Increases in academic burnout present concerns about increased dropout rates, lower student performance and decreasing mental and physical health. The purpose of this research is to develop a questionnaire, in combination with the Burnout Assessment Tool (BAT), to identify the extent academic burnout presents in undergraduate students. Student's burnout levels are determined using the BAT and self-identified ranking of burnout. Students are asked how their academic and personal responsibilities contribute to their burnout. By classifying what aspects of an undergraduate student's life contribute to burnout, we can better understand how to prevent and limit burnout.

MON-HD-04 (3:36 to 3:48 PM) | Contributed Talk | The iSTAR Framework for Modeling and Assessing Scientific Reasoning

Presenting Author: Lei Bao, The Ohio State University
Additional Author | Lan Yang, South China Normal University
Additional Author | Kathleen Koenig, University of Cincinnati

Scientific reasoning has been emphasized as a core ability of 21st century education. For decades the only assessment instrument available for large-scale application was Lawson's Classroom Test of Scientific Reasoning, but the instrument has demonstrated validity weaknesses and ceiling limitations. As a result, there is urgent need for the development of a valid and updated scientific reasoning assessment instrument that is based on a coherent model and targets the wide-ranging skills required for 21st century learners. This talk reports on the development of a modeling framework of scientific reasoning along with a new assessment instrument, referred to as Inquiry for Scientific Thinking, Analytics, and Reasoning (iSTART). The modeling framework integrates research in scientific and causal reasoning and operationally defines the skills and subskills that underlie the reasoning for knowledge development through scientific inquiry. Subsequently, this framework is used to guide the development of an assessment instrument on scientific reasoning. The validity and reliability of the instrument, which have been established based on large-scale testing, will also be discussed.

Lei Bao, Kathleen Koenig, Yang Xiao, Joseph Fritchman, Shaona Zhou, Cheng Chen, (2022) Theoretical model and quantitative assessment of scientific thinking and reasoning, Physical Review Physics Education Research, 18 (1), DOI:https://doi.org/10.1103/PhysRevPhysEducRes.18.010115.

Session MON-HF: Rethinking the Undergraduate Physics Curriculum

Monday, Jan. 8, 3–4 p.m.
Canal **Moderator: Ernest Behringer** **Sponsor: Committee on Physics in Undergraduate Education**

The AAPT has convened a working group to engage the physics community in a discussion regarding the status of the undergraduate physics curriculum in the U.S. and to explore possible changes to the curriculum. The working group deployed a survey and will report on the results as well as solicit input on curricular issues.

Session MON-HG: Some Interesting Bauder Fund Projects

Monday, Jan. 8, 3–4 p.m.
Fulton - 3rd Floor **Moderator: Tom O'Kuma** **Sponsor: Committee on Teacher Preparation**

MON-HG-01 (3:00 to 3:24 PM) | | Eastern Kentucky Light at Night Education Project

Presenting Author: Kevin Adkins, Morehead State University

Additional Author | Jennifer J. Birriel, Morehead State University

Light pollution, or the artificial brightening of the night sky, is a global issue affecting entire ecosystems. The human impact of living in heavily light polluted areas includes a higher risk of certain types of cancer and sleep disorders. Educating school students and the public is a logical first step towards ultimately reducing light pollution. We developed a one-week, project-based curriculum suitable for middle and high school classrooms in Eastern Kentucky. Each exploration focuses on the physics of light pollution and solutions for minimizing unwanted light at night. Participating students took a diagnostic survey before and after completing the curriculum. We will present an overview of the curriculum and the results from the diagnostic surveys. We conclude with a discussion of lessons learned during the pilot study and how they influenced revisions for an updated curriculum.

MON-HG-02 (3:24 to 3:48 PM) | | Physics of Flying Unmanned Aircrafts

Presenting Author: Eldred Bagley

The sponsor is AAPT Bauder Fund and SkyLark Motion Inc., non- profit drone training organizations that provide a path to FAA Part 107 UAS (Unmanned Aircraft Systems) Pilot Certification by employing result driven methods to foster skill and attitude acquisition and to help developing pilots understanding of the demands both now and into the future for a drone business or employee. Their aim is to prepare pilots (teachers) from under-served communities to meet the growing demand for a job market that is predicted to increase exponentially in the coming years. As a strategic Organization Skylark Motion Inc., AAPT Bauder Fund and the Philadelphia Board of Education aligns diversified work ethics, life skills, career and personal development training with curated related technical instruction administered through these key partnerships and mastery of FAA content to ensure 70% or better retention and certification rates. Skylark Motion Inc. and AAPT will help nurture economic development within underserved communities by leveraging innovation, business and community relationships. Their effort to help develop a trained skilled workforce and create living wage jobs while both strengthening local businesses and creating new enterprises within these communities and will lend itself to the whole person while supporting ecosystem (whole community) development.

MON-HE-01 | Poster Presentation Traditional | Mass Attenuation Coefficients of Humimic Gels: A Medical Physics Project

Presenting Author: Ignacio Birriel, Morehead State University
Additional Author | Tara Johnson, Morehead State University
Additional Author | Katie Stumbo, Morehead State University
Additional Author | Casey Hovis, Morehead State University

Humimic Medical offers six different grades of medical gel. The density of the gels ranges from 834.3 kg/m3 to 981.6 kg/m3 and are commonly used to simulate a wide range of human tissues. In this study we exposed five of the medical gels to gamma rays using common radioactive sources found in physics labs and calculated their mass attenuation coefficients. Sources used for this experiment were Cesium-137 and Cobalt-60. We will discuss our data collection method using a ST-360 Radiation Counter with a GM-35 probe and compare our calculated coefficient values with respect to density.

MON-HE-02 | Poster Presentation Traditional | Student Engagement Activities in Introductory Physics for Pre-health

Presenting Author: Jency Sundararajan, University of Virginia

Adopting diverse student-centered activities to facilitate in-depth learning via active participation supports student engagement and promotes a positive, passionate classroom environment. Creating a safe space for the students to share knowledge in a democratic setting where each student senses the responsibility to contribute to learning is crucial in providing a dynamic and entertaining learning experience. A model of the activities implemented in teaching physics for pre-health will be displayed in detail. Positive outcomes of the adopted techniques in terms of student involvement, enhanced learning experience will be presented and suggested changes for improvement will be discussed.

MON-HE-03 | Poster Presentation Traditional | IPLS Student Difficulties with Algebraic Ratios

Presenting Author: Nancy Beverly, Mercy University

For IPLS students, we try to create quantitative problems using real-life data in which the result of a calculation has meaningful life inference. Since life phenomena are complex, it is often helpful to include ratios to reduce the data needed or to simplify complexity. Many students, however, struggle with algebraic ratios, especially if the expressions in the numerator and denominator are themselves fractional. We do not want the mathematics to overshadow the physics. What is really appropriate for an IPLS class?

Sanlyn Buxner

Plenary Speaker Sanlyn Buxner

Tuesday, Jan. 9, 9–9:50 a.m. **St. James – 3rd Floor**

Sanlyn Buxner is a Senior Research Scientist and Senior Education and Communication Specialist at the Planetary Science Institute in Tucson, Arizona. She is also an Associate Research Professor in the Department of Teaching, Learning, and Sociocultural Studies at the University of Arizona where she serves as a director of graduate studies. She serves as the Public Engagement Lead for the SSERVI TREX node and the Director of Broader Impact for the NASA SHIELD DRIVE Science Center. She is an active science education researcher, her research areas include: investigating the impact of research experiences on K-12 teachers and students and undergraduate students; understanding and improving of undergraduate experiences and outcomes in general education and major-level STEM courses; supporting and diversifying graduate students in STEM; supporting K-12 students and teachers in out of school informal education spaces; and understanding the role of supporting community science on empowering communities. She is the co-chair of the AAS Education Committee, recent past Education Officer of the Division for Planetary Sciences, and serves on the Education Executive Committee of the American Geophysical Union. She has co-authored over 40 peer-reviewed journal publications as well as numerous conference papers and presentations, book chapters, and co-authored and edited several books in astronomy education.

Presidential Transfer **(9:50–10 a.m.)**

Duane Merrell (2023) **Kelli Warble (2024)**

Session K-12 Resource: Using Authentic Data to Explore the Expansion of the Universe

Tuesday, Jan. 9, 10 a.m.–12 p.m. Newberry - 3rd Floor Moderator: K-12 Sponsor: AAPT

"Expanding Universe" is one of six free, classroom-ready online investigations developed by Vera C. Rubin Observatory. Each investigation includes a phenomenon, teacher guide, presentation slides, videos, and a variety of three-dimensional formative and summative assessments complemented by scoring guides. The investigation introduces the use of galaxy redshifts and supernova distances to construct Hubble plots that reveal the expansion and acceleration of spacetime, hinting at the role of dark energy in cosmological models.

Session TUE-IB: Adding New Features to an Old Favorite in Lab

Tuesday, Jan. 9, 10–11 a.m.

Camp - 3rd Floor Moderator: Virginia Card Sponsor: Committee on Laboratories

TUE-IB-01 (10:00 to 10:12 AM) | Contributed Talk | Adding A Sous Vide Cooker to The Introductory Physics Laboratory Arsenal

Presenting Author: Tony Mendez, Campbell University

Additional Author | Jason Ezell, Campbell University

Additional Author | Scott Fedorchak, Campbell University

Many experiments in chemistry and physics require the use of a temperature-controlled water bath. A favorite experiment in our introductory university physics course, in which the students measure the temperature dependence of resistivity for a coil of copper wire using a Wheatstone Bridge circuit, is one such experiment. The rise in popularity of sous vide-style cooking has brought inexpensive immersion heater/circulators to the consumer market. These sous vide cookers can maintain a water bath to within +/- 0.1 degree C from just above room temperature to near boiling. Previously, our students used hot plates and glass thermometers to set and control the temperatures for this experiment. We show how replacing the old setup with a sous vide cooker water bath yields consistently better results in student labs, which now reflect the precision of the Wheatstone Bridge measurement.

TUS-IB-02 (10:12 to 10:24 PM) | Contributed Talk | The Egg Drop Project for All Eggs Teaches Students to Think About the Implications of Engineering Design Decisions That Affect Large Groups of People

Presenting Author: Charles Sabatier, Oxford High School

The Egg Drop project for ALL Eggs is a new twist on a classic HS Physics project. The typical project involves students building a container that holds an egg and protects it from a fall of a known height. Often there are constraints that encourage students to apply their understanding of the impulse momentum theorem. This new twist requires students to design a container that can protect eggs of different sizes. Students learn about the history of gender bias in crash test studies, and recognize social implications of engineering design decisions. Students extend their learning by designing vehicle safety features that protect all people, large and small, male and female. This session will support teachers to learn how to use the engineering design process to explore social justice issues, and to promote equitable practices and culturally relevant teaching in your classroom. This project has been supported by the Knowles Teacher Initiative as part of the Engineering for Student and Community Empowerment project. The Knowles Teacher Initiative is a nonprofit organization that supports a national network of mathematics and science teachers who are collaborative, innovative leaders improving education for all students in the United States.

TUE-IB-03 (10:24 to 10:36 AM) | Contributed Talk | Updating Galileo's Ramps with 3-D Prints and Ternary Energy Diagrams

Presenting Author: Bob Brazzle, Jefferson College

In my introductory University Physics course, we begin our rotational unit with a missing-energy mystery. Students roll three different shapes (Pasco's Rotational Inertia set) down a track and use Excel to create ternary energy diagrams. These show that the energy is "lost" (transformed) continuously, at a constant fraction that differs for each shape; students are challenged to develop a hypothesis to explain these differences. This contrasts an earlier example of energy dissipation in dropping coffee filters. I then deepen the mystery with a demo: I designed and 3-D printed a smooth curve that joins two sloped Pasco aluminum tracks (bottom side up) in a shallow "V". A 3-D printer filament spool beautifully rolls up and down these tracks repeatedly, thus showing that not all the "missing" energy is dissipated. I resolve the mystery the following day in lecture, when I introduce rotational kinetic energy and moments of inertia.

TUE-IB-04 (10:36 to 10:48 AM) | Contributed Talk | New Options for the Old Wilberforce Pendulum

Presenting Author: Lutz Kasper, University of Education Schwaebisch Gmuend (Germany)

Coupled pendulums sometimes show fascinating phenomena that can amaze laypersons and experts alike. Examples of such pendulums have often been presented. Experimental investigations of mechanical oscillations using smartphone apps have also often been described. Here, I describe an extension of the experimental possibilities that can be realized by an external sensor box ("satellite box") in connection with the app Phyphox. A suitable application of this satellite box is the direct and simulta- neous recording of angular velocity and vertical acceleration in the Wilberforce pendulum. In this respect, the new experimental idea can be a great stimulus for physics courses at highschool school or even college level.

TUE-IB-05 (10:48 to 11:00 AM) | Contributed Talk | An Easy-to-Build Armillary Sphere for Introductory Astronomy

Presenting Author: Jeffrey Regester, High Point University

Three-dimensional thinking is one of the most difficult skills Introductory Astronomy students struggle with. For instance, how one's latitude on Earth and the declination of the Sun affect the path of the Sun over the course of a day. Typically, we use diagrams, animations and a lot of hand gestures to try to convey these concepts. Here I present a simple 3D model of the celestial sphere that can used in conjunction with 2D representations. This is not a new invention – the traditional name for it is "armillary sphere" – but this version is easy to build, easy to use, large enough to gather a class around, and inexpensive.

Session TUE-IA: History of the Eddington Experiment–Part 1 Tuesday, Jan. 9, 10–11 a.m.

Commerce - 3rd Floor Moderator: Chuck Winrich Sponsor: Committee on History & Philosophy of Physics

TUE-IA-01 (10:00 to 10:24 AM) | | Eclipse, Eddington and Einstein: The Triumph and Decline of General Relativity

Presenting Author: Clifford Will, University of Florida

Einstein completed his monumental theory of General Relativity in 1915, and four years later became an international science superstar when Eddington announced that the Sun's gravity bent light rays in agreement with his theory. Yet within a decade, interest and research in the theory began to decline, and by the late 1950s, people did not consider general relativity to be a suitable topic for a serious scientist to pursue. I will describe the historical context that led to the British eclipse expedition, the skepticism and backlash that ensued, and other factors that led to the decline. The renaissance for general relativity would begin in the 1960s, fueled in part by astronomical discoveries.

TUE-IA-02 (10:24 to 10:48 AM) | | The Eclipse of 1919 and the Meaning of Replication in Science

Presenting Author: Daniel Kennefick, University of Arkansas

The 1919 Eclipse expeditions to test Einstein's light bending prediction were amongst the most important scientific experiments of the 20th century. In recent decades a counter-narrative has arisen which calls into question the reliability of the original science, as well as the motives of the expedition leaders, especially Arthur Stanley Eddington. In fact recent studies firmly demonstrate that their conclusions were justified. In any scientific experiment of such importance, subsequent replication is of great importance. The peculiar difficulties of eclipse expeditions, with no opportunity to repeat a given experiment, hampered subsequent expeditions. This meant that in half a century of replicationsm from 1919 to 1973, experimental precision never substantially improved, but subsequent results did confirm thos of earlier expeditions.

Session TUE-ID: Inclusive Actions for Physics Clasrooms of All Levels Tuesday, Jan. 9, 10–11 a.m.

Magazine - 3rd Floor Moderator: Jolene Johnson Sponsor: Committee on Diversity in Physics

TUE-ID-01 (10:00 to 10:24 AM) | | Everyday Actions in the High School Classroom

Presenting Author: Bree Barnett Dreyfuss, STEP UP and Amador Valley High School

Reflecting on current practices in the physics classrooms is a helpful first step to creating a more inclusive space for all students to learn and enjoy physics. The next step of how to make that space more welcoming to all can be more elusive. I will share the STEP UP programs' Everyday Actions Guide and related resources with tips and strategies to be used in all classrooms, focusing on high school classrooms. Small, incremental changes to your everyday interactions with students, their guardians and other school staff can help change who does physics at your school. Many have reported increased enrollment in their physics classes of all levels as well as a shift in the demographics of their class to better match the background of the students in the school as a whole.

TUE-ID-02 (10:24 to 10:48 AM) | | Using the Everyday Actions Guide at the Postsecondary Level

Presenting Author: Jolene Johnson, University of Wisconsin River Falls

Post secondary physics classrooms are often perceived as unwelcoming to a variety of students including women and minorities. I will discuss how the strategies in the Everyday Actions Guide can be applied to a variety of postsecondary physics classrooms including community colleges, online courses, non major and major classes. Additionally I will discuss how we have applied these strategies to improve our interactions with prospective students, admissions and other counselors, and high school staff. As we make these changes we are starting to see preliminary results of a small shift in student attitudes towards physics and student retention.

TUE-ID-03 (10:48 to 11:00 AM) | | Guided Discussion Inclusive Everyday Actions

Presenting Author: Jolene Johnson, University of Wisconsin River Falls

Co-presenting Author | Bree Barnett Dreyfuss, Amador Valley High School

We will facilitate a discussion of attendees focused on how each of us can apply these inclusive everday actions effectively at our own institutions.

Session TUE-IC: Integrating Lab and Lecture–Part 2 Tuesday, Jan. 9, 10–11 a.m.

Royal - 3rd Floor Moderator: Robert Hobbs Sponsor: Committee on Apparatus

TUE-IC-01 (10:00 to 10:12 AM) | Contributed Talk | Integrating Experiential Learning into an Optics Lecture Course via Simulation Led Optical Design Assessments

Presenting Author: Vincent Rossi, Utah Valley University

Simulation Led Optical Design Assessments (SLODA) are a means of integrating practical, application-based skills in computation and optical design principles into a lecture-based Optics course. In order to introduce students to these practical, application based skills, the SLODA curriculum integrates a computational approach to the presentation of theoretical optics. Computational skills and considerations are scaffolded within the course curriculum. After establishing basic foundations in both computation and theoretical optics, the SLODA curriculum then shifts towards larger, application-based student assessments. These Simulation Led Optical Design Assessments integrate the design of optical systems with computational modeling of those systems and the underlying optical phenomena by which they operate. Curriculum details, along with those of its implementation will be covered in the presentation. Online resources will be shared for faculty interested in adopting the SLODA curriculum.
This presentation will cover the curriculum which I have published in the *American Journal of Physics* and the Partnership for Integration of Computation into Undergraduate Physics.
Vincent M. Rossi; Simulation led optical design assessments: Emphasizing practical and computational considerations in an upper division physics lecture course. Am. J. Phys. 1 April 2022; 90 (4): 279–285. https://doi.org/10.1119/5.0064138
Simulation Led Optical Design Assessments, Partnership for Integration of Computation into Undergraduate Physics, Faculty Commons material developed by Vince Rossi - Published September 15, 2021. https://www.compadre.org/PICUP/exercises/exercise.cfm?A=SLODA

TUE-IC-02 (10:12 to 10:24 AM) | Contributed Talk | Workshop Physics: Teaching Physics Without Lectures

Presenting Author: David Jackson, Dickinson College

Co-presenting Author | Priscilla W Laws, Dickinson College

Co-presenting Author | Brett J Pearson, Dickinson College

Workshop Physics is the brainchild of Priscilla Laws and was developed at Dickinson College beginning in the mid 1980s. At the time, this curriculum represented a radical departure from the traditional format of three 50-minute lectures and one three-hour lab session each week. Instead, students attend three two-hour session each week and are immersed in an activity-based environment in which they perform experiments, graph and analyze data, work through theoretical derivations, and carry out mathematical modeling exercises. In addition to being a more active and enjoyable environment, students taking workshop physics perform much better on diagnostic exams, such as the FCI or the FMCE. In this talk I will discuss the latest edition of the Workshop Physics Activity Guide, highlighting the most significant revisions that have been made.

TUE-IC-03 (10:24 to 10:36 AM) | Contributed Talk | Learn by Doing in an IPLS Course

Presenting Author: Nancy Beverly, Mercy University

Mercy University has small classes with lab activities integrated with lectures and other class activities. Every physics concept has class activities in which students engage with that concept, in a learn-by-doing approach. The activities, taking varying lengths of time, can include hands-on explorations, data acquisition and analysis, and digital worksheets. The lab activities either involve the students' own bodies or relate directly to life phenomena, making them relevant and hopefully memorable.

SUN-CC-02 (10:37 to 11 AM) | Contributed Talk | Optical Fourier Transforms & Phase

Presenting Author: Sean Bentley, Adelphi University

Fourier transforms are of great importance in many areas of physical science and engineering. When students are learning about Fourier transforms, they can often seem abstract and purely mathematical. It is important to show the students that Fourier transforms are physical and occur simply in many experimental situations, from electricity to quantum mechanics and much in between. To add to the difficulty, the importance of phase in a Fourier tranform can be elusive to students. Optics goes further by introducing two-dimensional transforms. The lab I will describe is designed to give the students an intuitive, visual, hands-on, and even fun introduction to Fourier transforms, particularly two-dimensional, while also exploring phase information within the transform. The lab is centered on taking direct optical Fourier transforms of images (printed on transparency sheets...old tech for a new generation) with simple lens configurations. The optical experiments are done following a 1-D electronics intro using function generators and oscilloscopes. The students also use Matlab to take the transforms of the images for comparison. By "transforming a transform," as well as transforming an image (magnitude but no phase) of a transform, they explore the critical importance of phase.

Session TUE-IE: PER: Teaching Strategies and Motivation Tuesday, Jan. 9, 10–11 a.m.

Jackson - 3rd Floor Moderator: Itumeleng Phage Sponsor: Committee on Research in Physics Education

UE-IE-01 (10:00 to 10:12 AM) | Contributed Talk | Investigating the Intersection between Tutorials in Introductory Physics and Mathematical Reasoning

Presenting Author: Al Snow, University of Washington, Seattle

Additional Author | Charlotte Zimmerman, University of Washington, Seattle

Additional Author | Paula Heron, University of Washington, Seattle

The Tutorials in Introductory Physics have been used successfully for many years in calculus-based introductory courses. We are in the process of adapting these materials to a large-lecture style format for algebra-based courses. The tutorials mainly focus on conceptual development, but we are also interested in how mathematical reasoning develops alongside as a result of instruction. We use a reasoning inventory called the Generalized Equation-based Reasoning inventory for Quantity and Negativity (GERQN) to measure student reasoning about fundamental algebraic ideas. In this presentation, we will characterize student groups by their normalized gain on the GERQN, and examine how these groups may be experiencing the tutorial materials differently. Implications for future research and instruction will be discussed.

TUE-IE-02 (10:12 to 10:24 AM)) | Contributed Talk | Motivations from Higher Education for Teaching Science

Presenting Author: Iliana De La Cruz, Texas A&M University

I investigated the purposes that education faculty hold for teaching science by interviewing twelve science education professors who serve as instructors to science content and instructional methods courses in preservice teacher preparation programs. I sought out to investigate why teacher educators started their science instructional careers. I conducted a study using qualitative methods with an emergent research design in which I iteratively coded interview data. Three major ideas resulted across six focused codes for teaching science from education faculty: 1) they prefer science content over and above other subject areas; 2) they wish to promote student growth and development from learning science; and 3) they foster large-scale progress for humanity, technology, and science because people learn science, therefore they must teach it. Purposes specific to an individual student persisted throughout the faculty member's career and as such offers us the purposes necessary to succeed teaching science that will persist throughout careers. Peoples' intrinsic motivations to become teachers matter for their perseverance throughout their career and their hopefulness for teaching. Members of AAPT will gain findings from science education research about the significance in our motivations to continue teaching science.

TUE-IE-03 (10:24 to 10:36 AM) | Contributed Talk | Positive CLASS Gain in a Labor-based Introductory Physics Course Case Study

Presenting Author: Richard Pearson, Embry-Riddle Aeronautical University

Labor-based grading systems are not (yet) generally found in introductory physics classrooms. Indeed, their start came in rhetoric and composition courses to help account for highly variant baselines of student's skills. However, it is very apparent that introductory physics students also arrive with a potpourri of preparedness, problem-solving skills, and perceptions. One of the most significant ways to build up a skill is to learn in a mistake-friendly environment. Labor-based grading, along with a closely related structure called "specifications grading", allows for such mistakes to be built into the course structure. By using these foundational principles, a labor-based system was implemented for a small, introductory physics course (with an N = 12). CLASS pre-post data showed a positive gain in overall favorability: the first time it happened in the author's introductory physics teaching experience. This presentation will discuss the application of labor-based grading to physics courses, its impact in student participation, its effect on student learning perceptions, and proposed ways to expand its capacity.

TUE-IE-04 (10:36 to 10:48 AM) | Contributed Talk | The SPS Internship: Opening Career Pathways

Presenting Author: Mikayla Cleaver, Society of Physics Students, American Institute of Physics

Ask most students, "What can someone do with a physics degree?" Most answers will be some form of research. The SPS Internship program helps to open students' eyes to different career opportunities to them after they graduate with a physics degree. From positions in outreach, science writing, history, policy, and more, interns live and work with each other in Washington, DC, applying their skills in ways they have not before. Walk through the different programs SPS offers and meet a couple of the SPS Interns who have moved onto successful careers that use physics in some not-so-obvious ways.

TUE-IE-04 (10:48 to 11:00 AM) | Contributed Talk | Career Readiness for Physics Students (and Faculty): A Présumé Program

Presenting Author: Charlotte Bimson, Case Western Reserve University

Additional Author | Robert W Brown, Case Western Reserve University

We present the results of a campaign to improve physics undergraduate and graduate career awareness and development. Students are unaware of possible nonacademic career paths—specifically in industry—and have limited knowledge of populating a strong, job-focused resume. To tackle this issue, we created a seminar course where a series of industrial physics talked about their career path. It is important to emphasize that the class did not dissuade students from academia but created opportunities to prepare for all career paths. The proposal is made based on the results of the course. We suggest that student advisors take a more vital role in preparing physics students for various careers: being aware of the career probabilities for a physics bachelor, encouraging electives and internships outside of physics to build a diverse background, and continuously building the students' resume and cover letters. The focus is on the latter. We suggest that all physics students, as they progress academically, should create practice resumes: a pre-résumé or a présumé for short (with accent marks for pronunciation). We propose a program presuming early students should have a présumé: The physics présumé program.

Session TUE-IF: PIRA Session: The Positive Outcomes of Doing Outreach Tuesday, Jan. 9, 10–11 a.m.

Canal Moderator: Dale Stille Sponsor: Committee on Apparatus

TUE-IF-01(10:00 to 10:24 AM) | | Impacts of Facilitating Informal Physics Programs Measured through a National Sample

Presenting Author: Jonathan Perry, University of Texas at Austin

Additional Author | Tatiana L Erukhimova, Texas A&M University

Additional Author | Toni Sauncy, Texas Lutheran University

Additional Author | Susan White, American Institute of Physics

Additional Author | Rachel Ivie, American Institute of Physics

Additional Author | John Tyler, American Institute of Physics

Research into informal physics outreach programs has shown that students who help to run these programs tend to experience improved physics identity and develop career skills important vital for the 21st century. This work, however, has been limited to a small number of institutions with modest numbers of facilitators in their studies. Building on these intriguing results, we developed a survey and distributed it through the national network of Society of Physics Student chapters. The goal of this survey was to measure students' perceptions of their physics identity, sense of belonging, mindset, and related constructs, as well as collect information about how often they helped to run informal physics outreach programs. Here, we describe the construction, validation, and distribution of the survey as well as the analysis methods, and codebook developed to interpret written responses. Preliminary results will be shared from both closed and open ended responses to the survey. We will focus on similarities and differences between students who did, and did not, facilitate informal physics outreach programs.

TUE-IF-02 (10:24 to 10:48 AM) | | Let Your Students Teach Through Physics Outreach

Presenting Author: Tatiana Erukhimova, Texas A&M University

Additional Author | Jonathan Perry, University of Texas at Austin

Additional Author | Jonan Donaldson, Texas A&M University

Can physics outreach become not only a service provided by an academic department to the public but also a unique learning opportunity for students? We built a diverse set of informal physics programs which not only attract the public of all ages and backgrounds but also provide a unique growth environment to hundreds of student volunteers who facilitate these programs. I will discuss how participation in informal physics programs helps our students build their physics identity and boost their development through a less structured, but critically important, learning environment. I will present findings from our mixed methods study on the impact of five informal physics programs on undergraduate and graduate students at Texas A&M University.

Session TUE-JB: Adding New Features to an Old Favorite –Part 2

Tuesday, Jan. 9, 11 a.m.–12 p.m.

Camp - 3rd Floor Moderator: Robert Hobbs Sponsor: AAPT

TUE-JB-01 (11:00 to 11:12 AM) | Contributed Talk | Creative Student Engagement: Facilitating Student Ownership in Coursework & Peer Assessment

Presenting Author: Paul Campbell, University of Dundee

For the past decade, the senior Electromagnetism class at Dundee has developed YouTube videos (in teams of 5 or 6 students) over the course of the semester. The exercise is worth 10% of the overall mark and the objective is to generate a 4 to 5-minute video on one of the Maxwell Equations that is both entertaining and educational. Many graduating students have highlighted this exercise as a high point in their undergraduate experience, in terms of their enjoyment and esprit de corps developed during the exercise. Whilst the students retain complete control over the scientific and artistic interpretation of their project, also self-assessing their respective performances, the exercise also affords faculty the opportunity to assess the strengths and weaknesses of teams and their respective members and to provide constructive and strategic feedback in real-time. The result has been that this form of assessment allows students to take ownership of the project and their role in it; to telegraph this success to employers downstream by the inclusion of the URL on their CV. Overall module scores have also improved significantly (6%) since the introduction of the exercise.

TUE-JB-02 (11:12 to 11:24 AM) | Contributed Talk | Light Reflection and Refraction. An Approach with Inhomogeneous Waves and Without Complex Angles

Presenting Author: Salvador Bosch

Additional Author | Josep Ferre-Borrull

Additional Author | Adolfo Canillas

Additional Author | Oriol Arteaga

In textbooks, for obtaining the Fresnel formulas the continuity of the tangential components of the fields at the interface is invoked. This considers the coexistence of three homogeneous electromagnetic transverse waves: the incident, the reflected and the transmitted one. However, there are practical situations where the transmitted wave is not a homogeneous wave and, thus, the theoretical basis of the proof fails. A complete theoretical method for solving the electromagnetic problem at an interface between isotropic materials has been recently presented [1] but important details on how to apply the formulas are not given there. In the present work we explain how our recent results [1] facilitate the computation of the reflected and transmitted waves at the interface between a transparent and an absorbing material.

TUE-JB-03 (11:24 to 11:36 AM) | Contributed Talk (12 Minutes) | A New Representation for Motion

Presenting Author: Thomas Foster, SIUE Physics

The value of representations has been made abundantly clear in physics problem-solving. However, there is no quick and descriptive representation for problem solving for kinematics. What we have is either overkill, such as the kinematic graphs, or vague, like motion diagrams. I hope you disagree with these assertions enough to visit my presentation and defend your point of view as you listen to mine. This new representation has further use whenever kinematic variables arrive with other physics concepts. This presentation will demonstrate the new representation in kinematics, projectile motion, forces, and momentum. Are you here at AAPT to learn new ideas? Then this presentation will be for you.

Session TUE-JA: History of the Eddington Experiment–Part 2

Tuesday, Jan. 9, 11 a.m.–12 p.m.

Commerce - 3rd Floor Moderator: Chuck Winrich Sponsor: Committee on History & Philosophy of Physics

TUE-JA-01 (11:00 to 11:24 AM) | | Modern Eddington Experiment: Resurrection of the Optical

Presenting Author: William Dittrich, Portland Community College

Since Eddington's 1919 successful experiment utilizing 14 stellar images, many other attempts (discussed above) have been made until the 1970's. These measurements of the Einstein Coefficient (EC) came from a total number of 100-200 stellar images, none closer to the limb than radius R=2. Then for forty years no experiments were attempted. In 2017 the Modern Eddington Experiment (MEE) was born because of the use of modern CCD cameras. These fast and sensitive cameras allowed one camera to collect 500-800 images in 2.5 minutes. From the 2017 data sets, two parties were successful: Don Bruns (San Diego,CA) performed the most accurate optical measurement of the EC in history, which was exactly equal to the theoretical value (1.752") with a 3% error; and the Berry/Dittrich result from Oregon at 1.68". MEE2024 experiment is planned to use CMOS cameras on 10 stations to collect two million images (100 stars on 2000 plates) on April 8,2024. Stacking short 0.1 s exposures, simulations show that 20 stars could be imaged in the region R=1-2 where images have never before been collected. From this MEE2024 can then perform the best curve fit of the hyperbolic Einstein Deflection Law in history. The Modern Eddington Experiment, and MEE2024, has resurrected optical experiments.

Session TUE-JG: Hybrid Physics Instruction–Part 2

Tuesday, Jan. 9, 11 a.m.–12 p.m.

Fulton - 3rd Floor Moderator: Joseph Ganem Sponsor: Committee on Physics in Undergraduate Education

TUE-JG-01 (11:00 to 11:24 AM) | | Teachers' Retention of Physics Content Within a ybrid Professional Development Program

Presenting Author: Renee Clary, Mississippi State University

Teacher Academy in the Natural Sciences (TANS) provided middle level teachers (N= 81) with professional development (PD) in physics, chemistry, or geosciences over its 3-year program. TANS included an intensive 10-day summer institute and three academic PD days. Online modules, administered by a professional science organization, extended discipline content beyond the institute. We assessed online and instructional content before (Pre-) and after the summer institute (Post1). We assessed online content after module completion and instructional content at the PD year's end (Post2). Some teachers were retained and rotated into different disciplines; we investigated content retention 1-2 years beyond instruction (Post3). One online module resulted in significant gains after completion; physics modules' gains occurred at the summer institute's end, before module assignment. There was no association between module access times and content gains. With instructional content, all discipline participants exhibited significant gains at the summer institute's conclusion, though physics participants experienced significant loss at the PD year's end. Physics participants also exhibited no significant differences between incoming knowledge and content retention 1-2 years post instruction. Our research indicates that science content support is needed after PD programs end, support varies by discipline, and online content should parallel and extend instruction.

TUE-JG-02 (11:24 to 11:36 AM) | Contributed Talk | 3 Years of Hybrid Physics at a TYC: Lessons Learned

Presenting Author: Thomas Herring, Western Nevada College

Experiences and observations from an instructor who has been teaching calculus based physics in a hybrid in-person/online mode at a small TYC since fall 2020. This presentation discuss successes and failures in terms of technology, classroom management, student outcomes, enrollment stability, and instructor effort. In addition some thoughts on why to continue with this mode or not will be presented.

Session TUE-JE: Innovations in the Intro Classroom

Tuesday, Jan. 9, 11 a.m.–12 p.m.

Jackson - 3rd Floor Moderator: Basilio José Augusto José Sponsor: AAPT

TUE-JE-01 (11:00 to 11:12 AM) | Contributed Talk | Case Study Bringing Real-Life Scenario into Introductory Physics Curriculum

Presenting Author: Tetyana Antimirova, Toronto Metropolitan University

Many examples in the introductory physics courses present ideal scenarios where important physical features of the system are often deliberately neglected. Resistive forces are often disregarded despite being virtually always present. In general, the topic of air resistance is often omitted from the introductory curriculum, although this topic provides an excellent opportunity to talk about real-life scenarios. This talk presents a case study exploring air resistance. The case study is based on a real-life event: a record-setting 2011 fall of the Austrian skydiver Felix Baumgartner from the Stratosphere. The video of the fall and the data are publicly available. During his fall from an altitude of 39,045 meters he broke the world records for the highest "freefall" and the highest manned balloon flight, and he also became the first person to break the sound barrier during his fall. The examples of student activities based on this scenario will be discussed.

TUE-IE-02 (11:12 to 11:24 AM) | Contributed Talk | A Class Without Email

Presenting Author: Kristine Callan, Colorado School of Mines

Do you ever wonder if you spend more time and energy responding to student emails than teaching or preparing to teach? That is how I felt after the start of the pandemic. Since then, I've been crafting policies and procedures for medium-entrollent (50-75 student) and large-enrollment (>600 student) courses that aim to minimize the need for asynchronous back-and-forth communication between all parties (students, TAs, and faculty), so we can maximize the value we can bring to students as physics teachers. In this talk I will share the strategies I've found most effective in moving away from an inbox-driven course, toward one that I believe provides better and more sustainable support for students.

TUE-IE-03 (11:24 to 11:36 AM) | Contributed Talk | Combining Engineering and Physics with PBL

Presenting Author: Carlos Mayoral, St Charles Parish Public Schools Satellite Center

The St Charles Parish Schools Satellite Center teaches engineering as the application of physics to real-world problems using a Project Based Learning approach. This year-long course follows the typical freshman college physics curriculum while adding corresponding concepts of engineering. Major topics are taught as units involving lectures, problem solving, hands-on demonstrations, labs, and ending with a project. The concepts and skills needed to accomplish the projects are introduced by the teacher. But the projects are done by the students, organized into project teams, applying what they've learned. The projects are more than a great learning tool. They're a great source of motivation and satisfaction as the projects are organized as design competitions that are publicly demonstrated to faculty, classmates, local industry representatives, and parents.

TUE-IE-04 (11:36 to 11:48 AM) | Contributed Talk | Splitting the Classroom: Increasing Active Engagement and Student Understanding

Presenting Author: D. Blane Baker, William Jewell College

Several years ago--in an effort to gauge and increase students' understanding--we began requiring students to complete a daily problem or question before leaving class. To apply this method, we have implemented a "splitting the classroom" approach in which instructors provide a lecture

with embedded problems and questions, along with lecture demonstrations for the first 45 minutes of class. During the final 10-15 minutes we assign a daily problem or question that is due at the end of the class period. After beginning this approach, students asked many more questions during the in-class problem period and generally engaged more fully in the rest of class. We believe this method is effective, because students are motivated to "learn as they go." A full description of how we manange these classes is discussed.

Session TUE-JC: Integrating Lab and Lecture–Part 3–Interactive Session

Tuesday, Jan. 9, 11 a.m.–12 p.m.
Royal - 3rd Floor **Moderator: Melissa Vigil** **Sponsor: Committee on Laboratories**

TUE-JC-03 (11:00 to 11:24 AM) | Interactive (e.g. panel, round table discussion, hands-on activity) | Bringing Physics to Life

Presenting Author: Patti Ego, St. John's School Houston
Co-presenting Author | Anna Faulk, St. John's School Houston

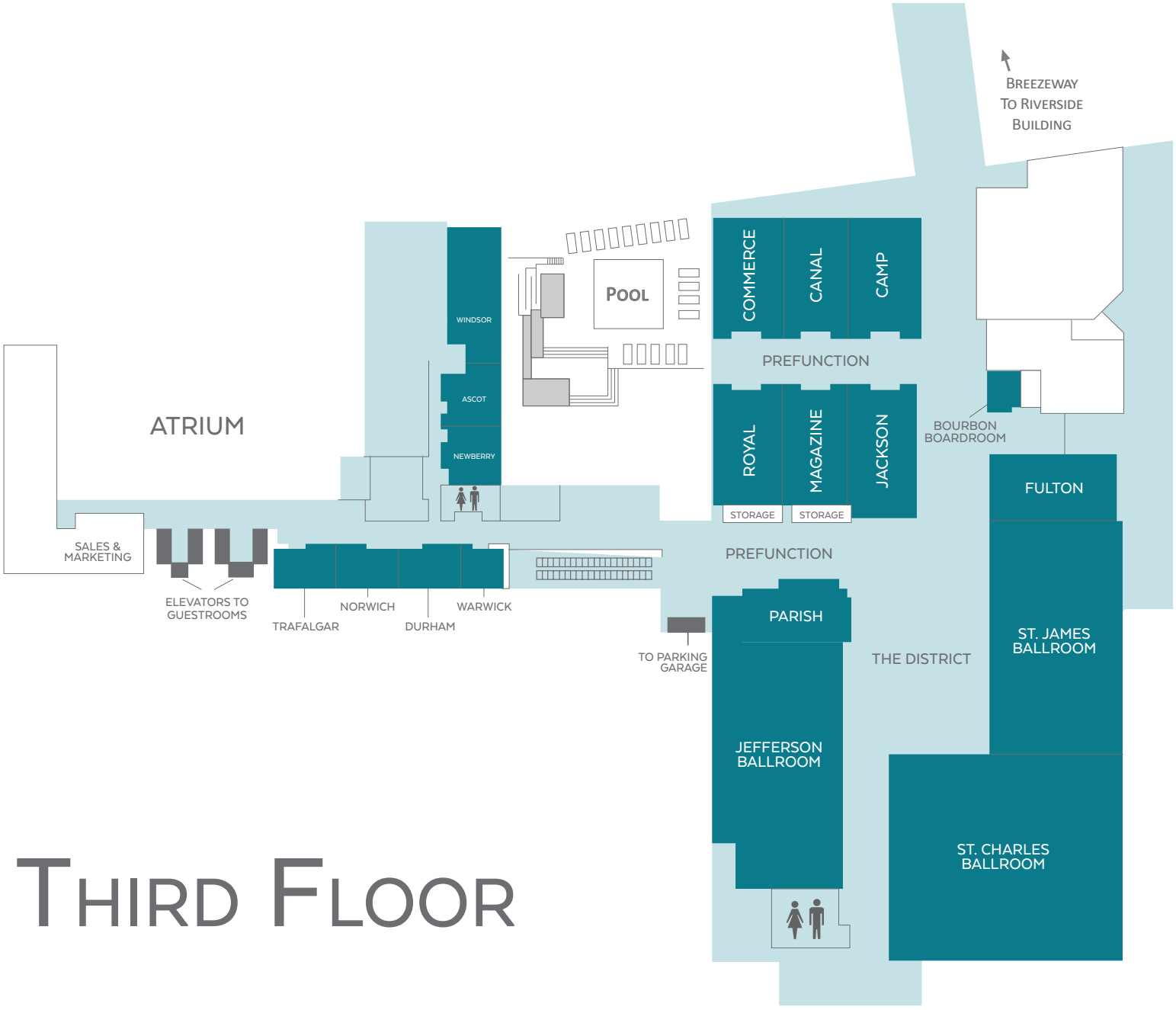
Students learn physics by doing physics, not listening to someone talk about it or watching someone else solve physics problems. We need to tranform our traditional teaching methods - aka lectures and follow up labs - to student explorations and collaborations. In this session, you will learn how to transform traditional lectures and follow up lab activities into more meaningful, hands on activities where students learn physics by doing physics. Introducing topics using lab activities that teachers are already using takes only minor adjustments - no reason to reinvent the wheel. Teachers will leave this session with lesson plans for activities to use with their students to bring physics to life. Topics that will be discussed Kinematics, Forces and Newton's Laws, and Energy and Momentum.
The activities that will be discussed are using constant velocity and constant acceleration labs to introduce a topic rather than being follow up labs. The participants will get to participate in balanced and unbalanced forces lab stations activities that bring traditional practice problems to life allowing students to gain a deeper understanding of types of forces and force interactions. Several activity ideas to introduce energy and momentum will also be discussed and teachers will leave with lesson notes and outlines for at least one activity per topic.

Session TUE-JF: Let's talk about how COMMUNITIES can work for you Topical Discussion

Tuesday, Jan. 9, 11 a.m.–12 p.m. **Canal** **Moderator: Sam Sampere** **Sponsor: AAPT**

Come join us for the good, not bad and NOT ugly discussion about how the AAPT COMMUNITIES communication platform can be used to keep you in the know about opportunities for you and your students, and how to share cool things you are up to, learn what your colleagues are doing, and more. All questions and concerns are welcome, as AAPT works to make sure that COMMUNITIES is widely adopted by AAPT members as a tool to make your job and life easier.

Hilton Riverside New Orleans maps



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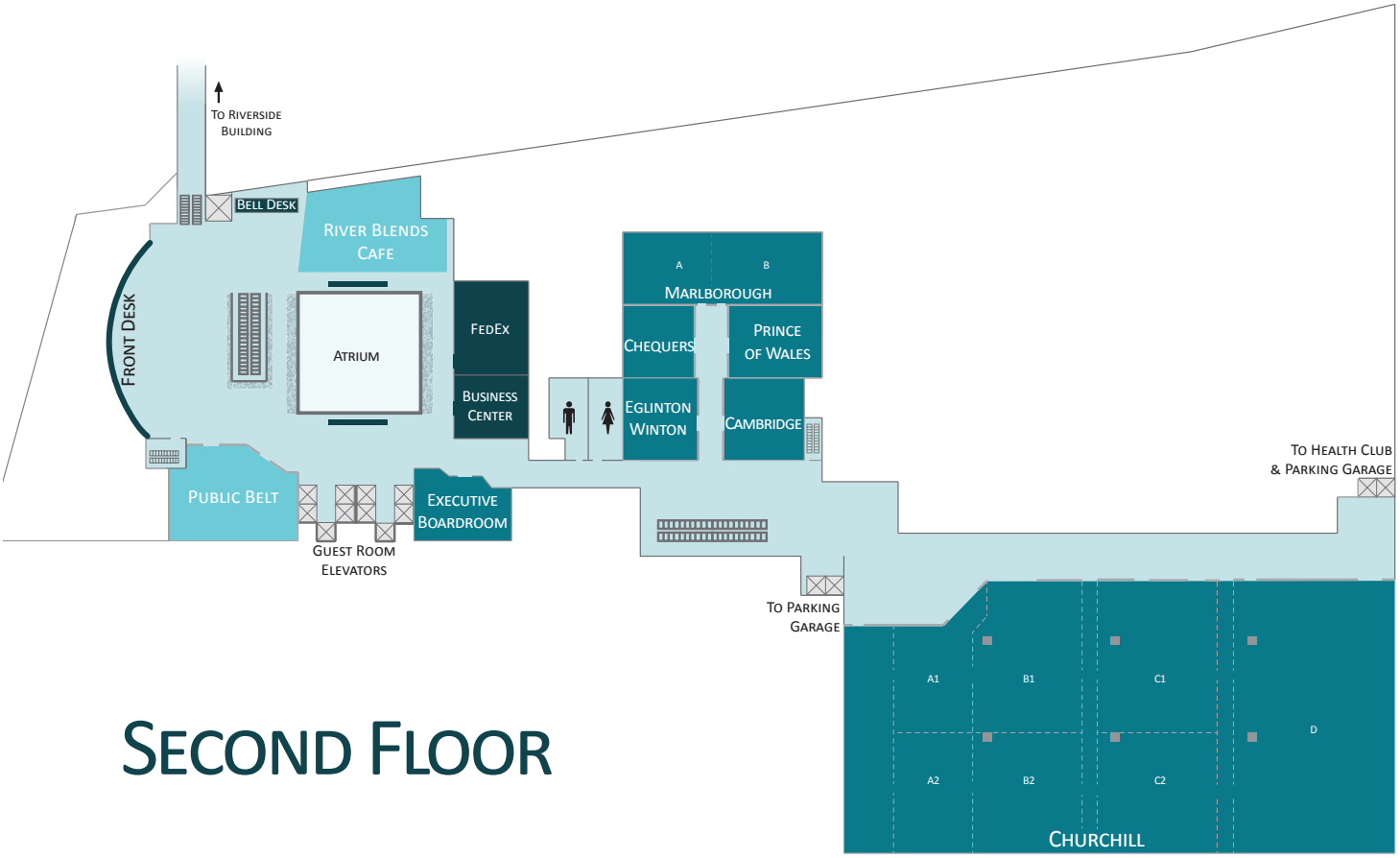

Second Floor