2019 AAPT Winter Meeting

AAPT
PHYSICS EDUCATION

National Society of Hispanic Physicists

Practice

Graphing the Work-Energy Theorem

Exam

HOMEWORK

STUDY

Prep for Quiz on C.O.E

Feedback

Math Review: The Dot Product

Conservation Worked Example

EXPERT

Physics Video Series

Equipping instructors with physics educational resources beyond online homework.

Lunch & Learn Workshop

Sunday, January 13th

11:30 am - 12:30 pm

Plaza Ballroom I

Discussion

Work & Non-Conservative Forces Derived

Work Done by Varying Force

Group Work

Work, Potential, & Equilibrium Example

Introduction to C.O.E

LECTURE

Booth 203

2019 AAPT Winter Meeting

Houston, Texas
January 12–15, 2019

American Association of Physics Teachers

One Physics Ellipse
College Park, MD 2040
www.aapt.org
301-209-3311

Thank You to AAPT's Sustaining Members

The American Association of Physics Teachers is extremely grateful to the following companies who have generously supported AAPT over the years:

American Institute of Physics

Arbor Scientific

Expert TA

Johns Hopkins University Center for Talented Youth

Klinger Educational Product Corporation

Knowles Teacher Initiative

Liquid Instruments

Morgan and Claypool Publishers

OpenStax College

PASCO Scientific

Perimeter Institute for Theoretical Physics

Physics2000.Com

PlaneWave Instruments, Inc

Spectrum Techniques LLC

Vernier Software

Special Thanks

AAPT wishes to thank the following persons for their dedication and selfless contributions to the Winter Meeting:

Rebecca Forrest and **Donna Stokes** from the University of Houston for helping to organize the workshops.

Paper sorters:

Trina Cannon
Andy Gavrin
Sarah Formica
Debbie French
Karen Gipson
Tommi Holsenbeck
Daniel Jackson
Eric Kuo
Gen Long
Kenn Lonnquist
Marie Lopez del Puerto
Dan MacIsaac
Steve Maier
Adriana Predoi-Cross
Brian Pyper
Charlene Rydgren
Jeff Saul
Daniel Thompson

AAPT Board of Directors

Gordon P. Ramsey, President
Loyola University–Chicago
Chicago, IL

Mel Sabella, President Elect
Chicago State University
Chicago, IL

Chandralekha Singh, Vice President
University of Pittsburgh
Pittsburgh, PA

Wolfgang Christian, Secretary
Davidson College
Davidson, NC

Thomas L. Okuma, Treasurer
Bay College
Baytown, TX

George A. Amann, Past President
60 Schoolhouse Rd..
Staatsburg, NY

Dyan Jones, Chair of Section Representatives
Mercyhurst University
Erie, PA

David E. Sturm, Vice Chair of Section Representatives
University of Maine
Orono, ME

David M. Crowe, at large (High School Representative)
Loudon Academy of Science
Sterling, VA

Karen Jo Matsler, at large (4-Year College Representative)
University of Texas – Arlington
Arlington, TX

Arlissa Richardson, at large (2-Year College Representative)
Chandler-Gilbert Community College
Chandler, AZ

Richard H. Price (ex officio)
Editor, *Amer. Journal of Physics*

Gary D. White (ex officio)
Editor, *The Physics Teacher*

Beth A. Cunningham (ex officio)
AAPT Executive Officer

Robert C. Hilborn (guest)
AAPT Associate Executive Officer

Wireless for Westin Galleria and Westin Oaks:

Network: *WestinMeetingRooms*
Password: *aapt2019*

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 **#aaptwm19**. 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 Cincinnati area. We look forward to connecting with you!

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

Download Your Mobile App Now!

Download Steps:

To Download the App

- Go to your Apple "App Store" or Android "Play Store" and download the "CrowdCompass AttendeeHub" app
- Under "Search for Event" type in "AAPT" and click on the "2019 AAPT Winter Meeting" The event password is **"aapt2019"**

Gay Stewart

"A spectacular Opportunity for the Physics Community to Broaden its Community of Learners"

Tuesday, January 15
11:30 a.m.–12:30 p.m.
Galleria Ballroom I

2019 Oersted Medal Awarded to Gay Stewart

Gay Stewart received her PhD in physics from University of Illinois, Urbana-Champaign and accepted a faculty position at the University of Arkansas (UA) in 1994. At UA, she focused on three interrelated issues: improving the introductory sequence to better prepare students to succeed in STEM, improving the preparation of physics majors for the variety of career options open to physicists, and the preparation of future faculty, both high school and professoriate. The undergraduate program saw dramatic improvement—a tenfold increase in graduates. One of six initial institutions in the Physics Teacher Education Coalition, UA is a proud member of the 5+ Club. Gay first received NSF support for course reform in 1995. As a teaching assistant mentor, she developed what grew into one of four sites for the NSF/AAPT "Shaping the Preparation of Future Science Faculty." She was co-PI of an NSF GK-12 project that placed fellows in middle school mathematics and science classrooms. The results were so favorable that helping math and science teachers work together was integral to the $7.3M NSF-MSP *College Ready in Math and Physics.*

She received $1,050,000 NSF Noyce support for students and master physics teachers. She chaired the College Board's Science Academic Advisory Committee, co-chaired the Advanced Placement Physics Redesign commission, and the AP Physics 2 Development Committee. In 2014, Gay transitioned to West Virginia University, where she is Eberly Professor of STEM Education and founding director of the Center for Excellence in STEM Education. The transdisciplinary center works with faculty across STEM and related disciplines at WVU, partner programs, and the WVU Department of Education to enhance STEM education and STEM education opportunities, grades K-20. The center also houses the high school STEM teacher program and supports WVU's PhysTEC implementation. Gay has served in leadership positions in AAPT and APS, and is a fellow of both.

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.

Jack Hehn

"May the Work I Have Done Speak for Me"

Tuesday, January 15
10:30–11:30 a.m.
Galleria Ballroom I

2019 Melba Newell Phillips Medal Awarded to Jack G. Hehn

Jack Hehn has a wide range of experience in physics and science education having taught and worked with students in elementary school through graduate school. He was reared and educated in Texas completing a Bachelor of Science in Physics at the University of Texas in Austin (1971), a Master of Science Degree at Texas A & M University (1976), and the Ph.D. (1990) from the University of North Texas.

He has served in administrative staff and instructional roles within physics departments for 19 years and has spent much time developing and teaching the freshman physical science course for pre-service teachers, developing mentoring and training programs for teaching assistants, and developing instructional laboratory programs using multimedia and interactive computer technologies.

In 1992, Hehn joined the American Association of Physics Teachers (AAPT) as the Associate Executive Officer. Two of the efforts he helped to direct included a high school textbook, *Active Physics*, and a college physical science course for pre-service teachers, "Powerful Ideas in Physical Science." He was also active in the effort to create national science standards and in the development of a large-scale networking project for two-year colleges, TYC21.

Hehn served three years (1996-1999) as a program director with the Division of Undergraduate Education (DUE) in the National Science Foundation (NSF). In August of 1999, Hehn joined the American Institute of Physics (AIP) as the Director of Education. He was a Co-Principal Investigator on the Physics Teachers Education Coalition (PhysTEC) a partnership of the American Physical Society (APS), AAPT, and AIP. He worked in support of earth systems education efforts; and encouraged and supported the development of a physics digital library for educational resources, ComPADRE. He also served on the National Task Force on Undergraduate Physics and has been involved with the Physics New Faculty Workshop.

Retired from AIP, Hehn is now volunteering in the AAPT office as the AAPT Senior Fellow, providing consulting services in learned society organization and administration, and working with physics departments in efforts to improve instruction. He has been and continues to be active in proposing and directing large-scale educational programs including science policy review and commentary, curriculum development, and technology and multi-media program development. Hehn has served as a reviewer, advisor, and consultant to many physics departments and large-scale projects, and he has developed and implemented leadership workshops for faculty and principal investigators in education and research projects. Hehn is recognized as a national advocate for science, science policy, and science education.

He is a fellow of the American Association for the Advancement of Science (AAAS), the American Physical Society (APS), the American Association of Physics Teachers (AAPT), and The Texas Society of Natural Philosophy.

The Melba Newell Phillips Medal is presented to AAPT leaders who, like Melba Newell Phillips after whom the medal is named, have provided creative leadership and dedicated service that resulted in exceptional contributions to AAPT. The recipient, who must be an AAPT member, delivers an address at the AAPT Meeting at which the medal is presented and receives a monetary award, the Melba Newell Phillips Medal, an Award Certificate, and travel expenses to the meeting.The medal is presented only occasionally. Self-nomination is not appropriate for this award.

Growing Up Feynman

Michelle Feynman

"Growing Up Feynman"

Monday, January 14
9:30–10:30 a.m.
Galleria Ballroom I

Book Signing, 10:30-11:30 a.m., AAPT Booth

In 1977, when she was only nine years old, Michelle's adventurous parents, Richard and Gweneth Feynman, decided they had to visit Tannu Tuva, a mountainous country nestled between the Soviet Union and Mongolia, almost on a whim. Their motivation was fueled, oddly, by Richard's childhood curiosity over the culture's exotic stamps and the quizzical spelling of the forgotten nation's capital city. But Richard didn't want special treatment. He wanted to get there on a more basic level. That famously quirky stubbornness of Richard Feynman meant he would wait eleven years before being granted a travel visa to Tuva. To explain and elaborate on her father's quirky perspective and personality, Michelle presents an unprecedented, intimate look at what it was like to grow up as a Feynman, complete with vivid personal stories and vibrant photographs. Richard loved public games, catching people off guard, and challenging Michelle's math teachers, much to her embarrassment. It wasn't until she was much older that Michelle learned that her father was even considered a genius. Her experience was with that of a loving, clumsy, forgetful, but hard-working teacher that never took himself too seriously. In 1988, Richard finally received permission from Moscow to travel to Tuva, but it was too late. Richard had passed the day before. Twenty-one years later Michelle was given the opportunity to visit Tuva in her father's place. She will close by sharing this deeply personal and emotional experience.

Nobel Laureate Kip Thorne, Nobel Prize 2017, LIGO and Gravitational Waves

Kip Thorne

"My 60 Year Romance with the Warped Side of the Universe"

Monday, January 14
5:30–6:30 p.m.
Galleria Ballroom I

Kip Thorne was born in 1940 in Logan, Utah, and is currently the Feynman Professor of Theoretical Physics, Emeritus at the California Institute of Technology (Caltech). From 1967 to 2009, he led a Caltech research group working in relativistic astrophysics and gravitational physics, with emphasis on relativistic stars, black holes, and especially gravitational waves. Fifty three students received their PhD's under his mentorship, and he mentored roughly sixty postdoctoral students. He co-authored the textbooks Gravitation (1973, with Charles Misner and John Archibald Wheeler) and Modern Classical Physics (2017, with Roger Blandford), and was sole author of Black Holes and Time Warps: Einstein's Outrageous Legacy.

Thorne was cofounder (with Rainer Weiss and Ronald Drever) of the LIGO (Laser Interferometer Gravitational Wave Observatory) Project. LIGO - largely in the hands of a younger generation of physicists - made the breakthrough discovery of gravitational waves arriving at Earth from the distant universe on September 14, 2015. For his contributions to LIGO and to gravitational wave research, Thorne has shared the 2017 Nobel Prize in Physics, and other major awards.

In 2009 Thorne stepped down from his Caltech professorship to ramp up a new career at the interface between art and science, including the movie Interstellar (which sprang from a Treatment he co-authored, and for which he was Executive Producer and Science Advisor).

2018 Andrew Gemant Award

David Kaplan

"Particle Fever: A Temporary Bout of Insanity"

Sunday, January 13
12:30–1:30 p.m.

and

"Dark Matter: The Next Frontier"

Sunday, January 13
4–5:30 p.m.

David E. Kaplan received his PhD from the University of Washington in 1999. He had postdocs at the University of Chicago/Argonne National Lab and SLAC and joined the faculty at Johns Hopkins in 2002. Kaplan discovers possible theoretical extensions to the standard model of particle physics and cosmology, and then novel ways to discover those and other models. Kaplan is a Fellow of the APS, and has been named an Outstanding Junior Investigator by the DOE, a Kavli Frontiers Fellow of the NAS and an Alfred P. Sloan Fellow. He has also created and produced the documentary film, "Particle Fever," for which he has won a DuPont Journalism Award, and other accolades.

Homer L. Dodge Citations for Distinguished Service to AAPT

Tuesday, January 15 • 10:30–11:30 a.m. • Location: Galleria Ballroom I

Janelle M. Bailey

Janelle M. Bailey

Janelle Bailey earned her BA in Astrophysics at Agnes Scott College, MEd in Science Education at the University of Georgia, and PhD in Teaching & Teacher Education (Astronomy Education) at the University of Arizona.Her long history of dedicated service to the organization began many years prior to entering the four-year AAPT Presidential Chain in 2014 and included: Co-Founder, President, and Section Representative, Southern Nevada Section; Editorial Board Member and occasional reviewer, *The Physics Teacher*; reviewer, *American Journal of Physics*; Chair and Committee member, Committee on Space Science and Astronomy; Organizer/presider of multiple sessions and workshops; and Paper Sorter for WM07 (Joint Meeting with the American Astronomical Society) and WM12. In 2014 she was elected to serve as Vice President on the AAPT Executive Board and continued serving as President-Elect in 2015, President in 2016, and Past President in 2017.

Heather Lewandowski

Heather Lewandowski

Heather Lewandowski is an Associate Professor, Associate Chair and Director of the Engineering Physics Program, at the Physics Department at the University of Colorado at Boulder, and a Fellow at JILA. In 2007, She received an Air Force Office of Scientific Research Young Investigator Award, was named an Alfred P. Sloan Research Fellow, won an NSF Career Award, and received a University of Colorado Junior Faculty Development Award. She was awarded the Chancellor's Award for Excellence in STEM Education in 2010 at the University of Colorado. Her dual research areas are in fundamental experimental molecular physics as well as Physics Education Reserach. The Lewandowski Group studies collisions and reactions of simple cold molecules and ions. Lewandowski has been an active member of AAPT since 2007 and has also been an active member of ALPhA, serving on their board since 2011.

Sherry Savrda

Sherry Savrda

Sherry Savrda earned her BS and MS in Physics at the University of Central Florida (UCF). Her Ed.D. in Curriculum and Instruction is also from UCF. She has been Professor of Physics at Seminole College since 1993. An active member of AAPT since 1993, Savrda has served on the AAPT Nominating Committee, and the Committee on Physics in Two-Year Colleges, twice as chair, prior to her election to the Board of Directors as the At Large Representative for Two-Year-Colleges where she served from 2015-2018. As a member of the Board she served on the Lotze Scholarship, Awards, and Audit Committees. She has presented workshops, given talks both contributed and invited, and presented posters at national AAPT meetings. She has worked tirelessly in promoting physics and physics teaching locally in Florida and nationally through her efforts in TYC21, ICP21 grant project.

Robert Teese

Robert Teese

Robert Teese is a pioneer in the use of video analysis. He initiated and directs the LivePhoto Physics project, which published a book of video-analysis activities for introductory physics courses and is currently developing Interactive Video Vignettes for physics and biology courses. This project has held frequent workshops for university and high-school teachers at AAPT meetings, including multi-day workshops. A professor in the Department of Physics at the Rochester Institute of Technology, Teese got his BS in physics at North Carolina State University in Raleigh. His M.A in Experimental Physics and his PhD in Theoretical Physics were both earned at the University of Texas. He has been an AAPT member since 1987, serving on the Committee on Educational Technologies, presenting at AAPT Summer and Winter Meetings, and supporting several AAPT education funds. Additionally, he served as Treasurer of the Southern Ohio Section of AAPT.

Aaron Titus

Aaron Titus

Aaron Titus is Professor and Chair of the Department of Physics at High Point University, High Point, North Carolina. He has been an active member of AAPT for 20 years and, besides the committees required as part of his Board of Directors role, he has served on the Lotze Scholarship, Physics in Undergraduate Education, and Graduate Education in Physics committees. He was elected and served as the Four-Year College Representative for AAPT from 2013-2016. In addition, he has been active in the North Carolina Section, presenting talks (several receiving awards) and workshops as well as hosting several Section Meetings. When he arrived at High Point University, there was no physics department and no physics major. Aaron was instrumental in creating a physics major as part of the Department of Chemistry. He was equally instrumental in the creation of a separate Department of Physics and he has served as its first and only Chair.

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 11

Finance Committee	4–5 p.m.	Monarch Room
New Board of Directors Orientation	5–6 p.m.	Monarch Room
Board of Directors I	6:30–9:30 p.m.	Monarch Room

Saturday, January 12

Meetings Committee	8–9:30 a.m.	West Alabama
Publications Committee	8–9:30 a.m.	Chevy Chase Room
Board of Directors II	10:15 a.m.–4:45 p.m.	Monarch Room
Resource Letters Committee	11:30 a.m.–2:30 p.m.	West Alabama
Nominating Committee I	2:30–4:30 p.m.	Chevy Chase Room
New Chairs Orientation	5:30–6:30 p.m.	San Felipe Room
Section Representatives and Officers	5:30–6:30 p.m.	Tanglewood
ALPhA Open Meeting *	5:30–7 p.m.	Westchester Room
Programs and Planning I	6:30–8 p.m.	San Felipe Room

Sunday, January 13

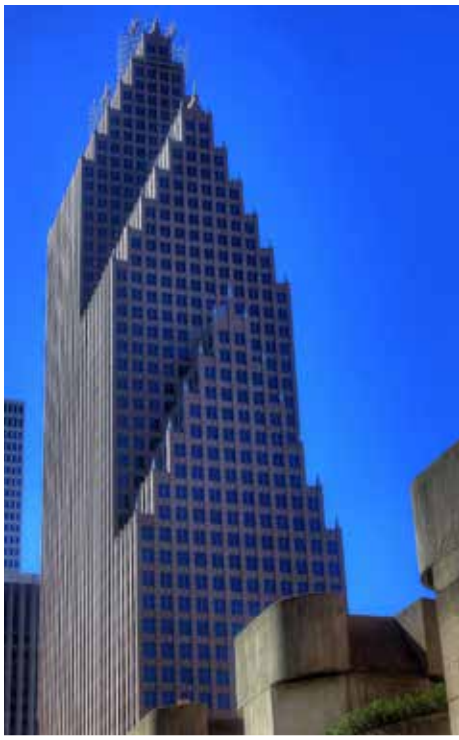
Review Board	7:30–9 a.m.	Chevy Chase Room
Physics Bowl Advisory Committee	7:30–9 a.m.	Bellaire
Venture/Bauder Fund Review Committees	9–10 a.m.	Grand Ballroom III
Governance Structure Committee	9–10 a.m.	Chevy Chase Room
Executive Programs Committee	9–10 a.m.	Post Oak
Diversity in Physics Committee *	4–5:30 p.m.	Westin Oaks – Consulate Room
Apparatus Committee *	4–5:30 p.m.	Monarch Room
International Physics Education Committee *	4–5:30 p.m.	Westin Oaks – Continental Room
Professional Concerns Committee *	4–5:30 p.m.	Westin Oaks – Embassy Room
Pre-High School Education Committee *	4–5:30 p.m.	Chevy Chase Room
Interests of Senior Physicists Committee *	4–5:30 p.m.	West Alabama Room
Physics in Undergraduate Education *	4–5:30 p.m.	Galleria Ballroom II
Laboratories Committee *	7–8:30 p.m.	West Alabama Room
History & Philosophy of Physics Committee *	7–8:30 p.m.	Monarch Room
Physics in High Schools Committee *	7–8:30 p.m.	Sage Room
Research in Physics Education *	7–8:30 p.m.	Tanglewood
Graduate Education in Physics *	7–8:30 p.m.	Plaza Ballroom I
Science Education for the Public *	7–8:30 p.m.	Chevy Chase Room
Physics in Two-Year Colleges *	7–8:30 p.m.	Post Oak
Meeting of the Members *	8:30–10 p.m.	Galleria Ballroom I

Monday, January 14

Investment Advisory Committee	7:30–9 a.m.	TBD
Membership and Benefits Committee	7:30–9 a.m.	Chevy Chase Room
PTRA Advisory Committee	7:30–9 a.m.	Bellaire
Educational Technologies Committee *	12:30–2 p.m.	West Alabama
Contemporary Physics Committee *	12:30–2 p.m.	Tanglewood
Space Science and Astronomy Committee *	12:30–2 p.m.	Plaza Ballroom I
Women in Physics Committee *	12:30–2 p.m.	San Felipe Room
Teacher Preparation Committee *	12:30–2 p.m.	Sage Room
PIRA Committee *	12:30–2 p.m.	Post Oak
PERLOC *	7–8:30 p.m.	West Alabama
Awards Committee	7–8:30 p.m.	Chevy Chase Room

Tuesday, January 15

Programs and Planning II	7–8:30 a.m.	Chevy Chase Room
PERTG Town Hall *	7:30–8:30 a.m.	Galleria Ballroom I
Nominating Committee II	2:30–3 p.m.	West Alabama Room
Paper Sort Provo Meeting	2:30–3 p.m.	Chevy Chase Room
Board of Directors III	3–5 p.m.	Monarch Room



CW01 Expert TA: Learning Resources beyond Online Homework

• Location: Plaza Ballroom I • Time: 11:30 a.m.-12:30 p.m. • Date: Sunday, January 13 • Sponsor: Expert TA

Leader: Jeremy Morton

There is a broad range of learning resources available now, but because these are spread out across many different platforms, utilizing them can be difficult for instructors and can make the total cost of materials excessive for students. Expert TA continues to enhance our online homework system, but we have also developed additional educational tools to provide these from one centralized location at a low cost to students. Now instructors can assign Pre-Class videos for both Algebra and Calculus-based sequences, use Clicker-Style questions, utilize an advanced Academic Integrity tool suite that effectively keeps students off answer-sharing websites, and more. In addition, building off the success of our automatically graded Free Body Diagrams released in fall 2017, we have developed "Engineering Style" Extended Free Body Diagrams. During the workshop, we will offer a preview of these resources. We will also discuss the differentiating features of Expert TA's online homework system. Our textbook independent library helps to reinforce the problem-solving process with an abundance of multi-step questions. The majority of these problems involve symbolic answers, and based on a six-year data-mining initiative students receive specific and meaningful feedback for incorrect answers. Please join us for lunch if you are interested in learning more.

CW02 Perimeter Institute: Evidence for Climate Change

• Location: Chevy Chase Room • Time: 11:30 a.m.-12:30 p.m. • Date: Sunday, January 13 • Sponsor: Perimeter Institute

Leaders: Damian Pope, Laura Pankratz

Anthropogenic climate change is one of the most important issues facing our students. Join us as we explore the basic science behind climate change and introduce a new classroom resource that will help your students build a better understanding of this important topic. The Evidence for Climate Change resource is the product of collaboration between classroom teachers, Perimeter Institute researchers, and climate scientists.

CW03 What's New from PASCO Scientific?

• Location: Woodway Hall III • Time: 11:30 a.m.-12:30 p.m. Date: Sunday, January 13 • Sponsor: PASCO

Leader: Brett Sackett

For 55 years, PASCO scientific has brought innovation to the physics classroom with apparatus, sensors, datalogging software, and now even our own curriculum! From Newton's Laws to Ampere's Law, PASCO has your physics lab covered! See the latest to come out of the PASCO factory enabling better ways of teaching physics.

CW04 Perimeter Institute: Wave Model Applications

• Location: Chevy Chase Room • Time: 1:30-2:30 p.m. • Date: Sunday, January 13 • Sponsor: Perimeter Institute

Leaders: Damian Pope, Laura Pankratz

Waves are a very powerful way to model many natural phenomena such as hearing, earthquakes, and gravitational waves. They also form the basis for several important technologies such as SONAR and ultrasound imaging. Join us as we explore some of the applications of waves using hands-on activities. The Wave Model Applications resource is the product of collaboration between classroom teachers and Perimeter Institute researchers.

CW05 The PASCO Wireless Smart Cart – Game Changer for the Physics Lab

• Location: Woodway Hall III • Time: 1:30-2:30 p.m. • Date: Sunday, January 13 • Sponsor: PASCO

Leaders: Fran Poodry, David Vernier, John Gastineau

Pivot Interactives is a customizable online-video environment that is a superb complement to hands-on experiments with Vernier sensors. Students are quickly engaged by these high-production-quality videos of hard-to-implement phenomena, which are a powerful supplement to hands-on experimentation. Explore the possibilities with us!

CW06 PASCO: Untangling Basic Circuits

• Location: WoodwayHall III • Time: 3-4 p.m. • Date: Sunday, January 13 • Sponsor: PASCO

Leader: Brett Sackett

Chances are, your students have had difficulty learning basic circuits. PASCO's Modular Circuits provides a better way to teach circuits in a way that helps your students break through conceptual barriers and not get confused with tangled wires. Focus more time teaching circuit theory than troubleshooting spaghetti. Get hands on with new technology to discover a better way to teach circuits!.

CW07 Introducing Pivot Interactives from Vernier

• Location: Woodway Hall III • Time: 11 a.m.–12 p.m. • Date: Monday, January 14 • Sponsor: Vernier Software & Technology

Leaders: Fran Poodry, David Vernier, John Gastineau

Pivot Interactives is a customizable online-video environment that is a superb complement to hands-on experiments with Vernier sensors. Students are quickly engaged by these high-production-quality videos of hard-to-implement phenomena, which are a powerful supplement to hands-on experimentation. Explore the possibilities with us!

CW08 Perimeter Institute: What's New in Physics?

• Location: Chevy Chase Room • Time: 11 a.m.-12 p.m. • Date: Monday, January 14 • Sponsor: Perimeter Institute

Leaders: Damian Pope, Laura Pankratz

Are you looking for ways to connect your students with current physics research? Join us as we describe some of the recent developments and explore hands-on activities that bring the latest science into your classroom. This year we will look at exoplanets, black holes, gravitational waves, neutrinos, and more.

CW09 Vernier: Solutions for Physics and Chromebooks

• Location: Woodway Hall III • Time: 12-1 p.m. • Date: Monday, January 14 • Sponsor: Vernier Software & Technology

Leaders: Fran Poodry David Vernier, John Gastineau

Bring your Chromebook (or use one of ours) and learn how easy it is to connect sensors and collect and analyze data. Test drive the Go Direct Sensor Cart! Explore the free and improved Graphical Analysis 4 app for data collection and analysis.

CW10 Perimeter Institute: Visualizing Energy

• Location: Chevy Chase Room • Time: 12-1 p.m. • Date: Monday, January 14 • Sponsor: Perimeter Institute

Leaders: Damian Pope, Laura Pankratz

Understanding energy is crucial to success in physics but many students struggle with it. Join us as we explore how using energy representations allow our students to deal with concepts like nuclear binding energy, radioactive decay, and the formation of elements. A Deeper Understanding of Energy is the product of collaboration between classroom teachers and Perimeter Institute researchers.

Welcome to new members and thank you to members rotating off area committees!

AAPT PHYSICS EDUCATION

Members rotating off area committees following this meeting:

Abigail Daane
Ben Jenkins (Chair)
Bob Weber
Bradley Gearhart (Chair)
Bruce Mason
Carolina Alvarado (Chair)
Cassandra Paul
Charlene Rydgren (Chair)
Charlie Holbrow (Chair)
Chris Ritacco
Christine Callan Christopher
Christopher Porter (Chair)
Craig Wiegert
Cyrill Slezak
Debbie Andres
Ed Hasenohr
Eldred "Jay" Bagley
Erin Sutherland
Frank Lock
Gabe Spalding (Chair)
Genrikh Golin (Chair)
Ian Bearden
Jackie Chini (Chair)
James T. Laverty (Chair)
Jasjit Mangat
Jim Mallmann
Joel Klammer
Jon Anderson
Josh Samani
Katie Ansell
Katie Page
Kristine Callan
M. Nakamura (Chair)
Mamadou Keita
Martin Shaffer
Michael Thoennessen
Michelle Milne
Negussie Tirfessa
Reid Mumford (Chair)
Richard Hechter
Rob Salgado
Scott Bonham
Scott Dudley
Shahida Dar (Chair)
Shane Wood
Shannon Willoughby
Sissi Li (Chair)
Steve Henning
Tara Peppard (Chair)
Toby Dittrich
Tom Carter
Tommi Holsenbeck (Chair)
Trina Cannon
Will Sams
William Dittrich

K12 PHYSICS TEACHERS LOUNGE

New digital resources from comPADRE

Topical discussions

Interactive labs & lesson plans

Sunday, January 13

9:00 - 10:30 Digi Kit Exploration

Explore innovative lessons supported with high quality digital resources.

10:00 - 10:30 PTRA Info Session

Come to learn more about the Physics Teacher Resource Agents (PTRA). Hear from members as they share their passions and experiences in this group.

10:30 - 11:30 Digi Kit: Analog to Digital

Come to see this activity in action with materials and an expert on the activity.

11:30 - 12:30 Digi Kit: Photoelectric Effect

2:30 - 3:30 STEP UP 4 Women

Join a fact exploration and discussion on the NSF grant STEP UP for Women aiming to drastically increase the number of women in undergraduate physics through interventions in the high school classroom

5:00 - 6:00 Open Lounge

Pick up resources for your classroom, or use the space for a gathering. The lounge is open for your use at this time.

Monday, January 14

8:00 - 9:00 Open Lounge

Pick up resources for your classroom, or use the space for a gathering. The lounge is open for your use at this time.

11:00 - 12:00 Get the Facts Out

Join an exploration of unexpected trends in the data on educators in the United States while discussing perceptions of STEM teaching in society.

1:00 - 2:00 Digi Kit: Terminal Velocity

Come to see this activity in action with materials and an expert on the activity.

2:00 - 3:00 Digi Kit: Nerve Science

3:00 - 4:00 Digi Kit: DNA and Geo-electric Fields

4:00 - 5:00 Open Lounge

Pick up resources for your classroom, or use the space for a gathering. The lounge is open for your use at this time.

For more information: Tweet @AAPTHQ #AAPTWM18

AAPT PHYSICS EDUCATION

Bus schedule for workshops

Saturday, January 12

Buses departing the Westin Galleria to head for University of Houston

- 7:15 a.m.
- 7:25 a.m.
- 12:20 pm.

Buses departing the Univ. of Houston to head for Westin Galleria

- 12:15 p.m.
- 1:00 p.m.
- 5:15 p.m.
- 5:30 p.m.

The Workshop buses will pick-up at:
Westin Galleria Hotel, West Alabama Street (outside the main entrance across from the valet)

Sunday, January 13

Buses departing the Westin Galleria to head for University of Houston

- 7:15 a.m.
- 7:25 a.m.

Buses departing the Univ. of Houston to head for Westin Galleria

- 12:15 p.m.
- 12:40 p.m.

Bus for Sunday Gemant Award at Univ. of Houston

Bus will be departing the Westin Galleria for the University of Houston

- 3:15 p.m.

Return to Hotel:

- 5:30 p.m.

Sunday • 10:15 a.m. Echo Spot

Sunday • 3:40 p.m. Celestron PowerSeeker Telescope

Exhibit Hall Raffles

Sunday and Monday

Echo Spot

Celestron PowerSeeker 7QEQ Telescope

4K Ultra HD Sports Action Camera

Holy Stone HS110D FPV RC Drone with 720P HD Camera

(Must be present to win)

Woodway Hall I & II

Purchase tickets at Registration desk!

Monday • 10:45 a.m. 4K Ultra HD Sports Action Camera

Monday • 3:15 p.m. Holy Stone RC Drone w/ camera

AAPT Exhibitors

Woodway Hall I & II: ***Saturday, 8-10 p.m., Sunday, 10 a.m.–5 p.m., Monday, 10 a.m.–4 p.m.***

American Association of Physics Teachers

Booths #402, 301
One Physics Ellipse
College Park, MD 20740
301-209-3300, www.aapt.org, ksheridan@aapt.org
Welcome to Houston! Join us at the AAPT booth to enter the Great Book Giveaway free raffle and spin our prize wheel for your chance to win some free prizes. This year try out our interactive demos based on lesson plans created from *The Physics Teacher*! We will also have a large wide-variety selection of educational resources available including resources to support teaching including our popular Physics in 21st Century Science Standards: The Role of Physics in the NGSS booklet.

AAPT – Local SPS Chapter

Booth #503
One Physics Ellipse
College Park, MD 20740
301-209-3300; www.aip.org, bconrad@aip.org
Come interact with the local chapters of the Society of Physics Students! Undergraduate physics and astronomy students of regional SPS chapter will be available to show off their activities, outreach, demos, and chapters. Stop by to learn or just connect.

AAPT – Publications

Booth #303
One Physics Ellipse
College Park, MD 20740, www.aapt.org, mgross@aip.org
Drop by for information on how you can become part of the AAPT Publications program. Learn why you should submit articles for publication, consider becoming a reviewer, and make sure your physics department subscribes to *American Journal of Physics* and *The Physics Teacher*. It is rumored that it may be possible to catch up with journal editors and other members of the Publications Committee during your visit. If you are an online only member, you'll get a chance to see the print copies and reconsider your choice. If you aren't yet an AAPT member we will do our best to help you decide which option is best for you.

AAPT – Texas Section

Booth #200
One Physics Ellipse
College Park, MD 20740
301-209-3300; http://www.texasaapt.com/about-tsaapt
cbahrim@lamar.edu
Texas Section of the American Association of Physics Teachers (TSAAPT) is an organization dedicated to physics teaching at all levels. The organization holds two meetings each year which include presentations on research into the many aspects of physics instruction. Presentations include both invited speakers who are recognized nationally as leaders in physics education research and contributed papers by any teacher who has something interesting to report.

American Institute of Physics

Booth #500
One Physics Ellipse
College Park, MD 20740
301-209-3100, www.aip.org, lcaron@aip.org
AAPT is a Member Society of the American Institute of Physics (AIP), a federation representing 123,000 scientists, educators, and students. In addition to *Physics Today,* AIP offers many resources you can tap into in the areas of careers and education, science policy, fellowships, history, and media—even group insurance. Stop by the AIP booth to learn more.

American Physical Society

Booth #504
One Physics Ellipse
College Park, MD 20740
301-209-3206, www.aps.org, thompson@aps.org
The American Physical Society's Public Engagement Department aims to bring the excitement of physics to all. Stop by to grab our new coloring book for adults and some colored pencils, your copy of Spectra's Energetic Escape, to learn about our PhysicsQuest program or hear more about www.physicscentral.com.

Arbor Scientific

Booth #302
PO Box 2750
Ann Arbor, MI 48106
800-367-6695, www.arborsci.com, Sebastian@arborsci.com
For 30 years, Arbor Scientific has worked with physics and physical science teachers to develop educational science supplies, science instruments, and physics lab equipment that make learning fun, engaging and relevant for students and teachers alike.

Council on Undergraduate Research Physics and Astronomy Division (CURPA)

Booth #501
734 15th Street NW Suite 850
Washington, DC 20005
tsaucy@tlu.edu
https://www.cur.org/who/governance/divisions/physastron/
The Council on Undergraduate Research (CUR), founded in 1978, is an organization of over 13,000 members from over 750 institutions around the world. CUR members share a focus on providing high-quality and collaborative undergraduate research, scholarly, and creative activity opportunities for faculty and students. The Physics and Astronomy division (CURPA) was formed in 1985, with physicists from predominantly undergraduate institutions (PUIs). The division has since expanded to include representatives from being part of CURPA! community colleges through large research institutions. CURPA is very active in supporting research with undergraduates by gathering and sharing information about undergraduate research funding, gathering and sharing information about curricular opportunities, and identifying and delivering support services to departments and faculty. CURPA offers a wide variety of programs and services to our members as part of a CUR-wide effort to promote research with undergraduates. Stop by and see how you can benefit from being part of CURPA!

Dipont Education

Booth #300
PO Box 424
Croton Falls, NY 10519
www.dipont-edu.org, stephen.woolbert@dipont-edu.com
Who We Are: Dipont operates international education centers within existing Chinese high schools. These programs function as schools within schools. We deliver international curricula to Chinese students: Advanced Placement (AP), A-level (British curriculum) and International Baccalaureate (IB). We currently manage 26 international programs in many of the best high schools in China serving approximately 7,000 students. All of our students will attend university abroad. Dipont opened its first two, independent K-12 schools in Wuxi and Hangzhou. Many more Dipont schools will follow. See the linked videos on our Youtube page. Dipont Education Management Linkedin: https://www.linkedin.com/company/dipont-education/ Youtube: https://www.youtube.com/channel/UCytmH4-liuJMB9PYPy4hj_A Website: http://www.dipont.com/en

Expert TA

Booth #203
624 South Boston Avenue, Suite 220
Tulsa, OK 74119
877-572-0734, www.theexpertta.com, main@theexpertta.com
There is a broad range of learning resources available now, but because these are spread out across many different platforms utilizing them can be difficult for instructors and can make the total cost of materials excessive for students. Expert TA continues to enhance our online homework system, but we have also developed additional educational tools to provide these from one centralized location at a low cost to students. Now

instructors can assign Instructional videos for both Algebra and Calculus-based sequences, utilize an advanced Academic Integrity tool suite that effectively keeps students off answer-sharing websites, and more. In addition, building off the success of our automatically graded Free Body Diagrams released in Fall 2017, we have developed "Engineering Style" Extended Free Body Diagrams. During the workshop, we will offer a preview of these resources. We will also discuss the differentiating features of Expert TA's online homework system. Our textbook independent library helps to reinforce the problem-solving process with an abundance of multi-step questions. The majority of these problems involve symbolic answers, and based on a six-year data-mining initiative students receive specific and meaningful feedback for incorrect answers. Please join us for lunch if you are interested in learning more.

Houston Space Center

Booth #201
1601 NASA Parkway
Houston, TX 77058
https://spacecenter.org/
Phyllis Friello (pfriello@spacecenter.org)

Morgan and Claypool Publishers

Booth #305
1210 5th Ave. Suite 250
San Rafael, CA 94901
908-630-7188
www.morganclaypool.com, filler@morganclaypool.com

IOP Concise Physics (by Morgan & Claypool) publishes short books in over 30 distinct areas of physics. These books provide researchers, teachers, and students with an introduction to key principles in multiple areas, a look back at historical events and people, and also delve into issues surrounding effective teaching methods.

OpenStax

Booth #204
6100 Main Street MS-375
Houston, TX 77005
713-348-3674, www.openstaxcollege.org, jva1@rice.edu

OpenStax is a nonprofit based at Rice University, and our mission is to improve access to education. Our free, peer-reviewed college textbooks have been used by nearly 700,000 students, and we're piloting adaptive, personalized learning technology that improves student learning. Through philanthropic partnerships, OpenStax is empowering students and instructors to succeed.

Otto Trading Inc.

Booth #306
1921 Carnegoe Avenue Suite C
Santa Ana, CA 95747
www.unimedmassager.com, ottotradeinc@gmail.com

Otto aims to manufacture and distribute product and services in order to make people's lives easier and more comfortable.

PASCO scientific

Booth #103
10101 Foothills Blvd.
Roseville, CA 95747
800-772-8700, www.pasco.com, dferrari@pasco.com

PASCO designs and manufactures a wide range of Physics apparatus including the revolutionary Smart Cart (the Physics Lab on Wheels). We have a broad range of products to meet your needs. Drop by our booth or attend one of our workshops to see what is new for 2019 and learn how the Smart Cart and Modular Circuits can make your classes easier to teach.

Perimeter Institute for Theoretical Physics

Booth #614
31 Caroline Street N.
Waterloo, ONT
N2I 2Y5 Canada
519-569-7600, www.perimeterinstitute.ca, twilliams@perimeterinstitute.ca

Science is a powerful way of investigating mysteries of our universe and the process of building ever-changing models to describe our world. Perimeter is passionate about supporting science teachers so that, together, we can raise scientific literacy. PI outreach develops classroom modules; offers PD opportunities; online multimedia resources; and contests.

Quantum Experience Ltd.

Booth #101
Moskovich 13/34
Rehovot, Israel 7617413
972-773-179301
www.quantumlevitation.com, boazal@quantumlevitation.com

Quantum Levitation is the world leader in the research & development of superconductivity and modern physics experiment and demonstration kits. Our products are used by more than 600 prominent K-12 schools, U.S. government agencies, and colleges and universities, including Harvard, MIT, Stanford, CalTech, Yale, Princeton, Oberlin, Ithaca, NASA and the U.S. Army.

Qubitekk, Inc.

Booth #206
1216 Liberty Way
Vista, CA 92081
858-750-9353, www.qubitekk.com, srosenthal@qubitekk.com

Qubitekk's Quantum Mechanics Lab Kit provides the tools to explore and more deeply understand quantum physics. Suitable for both classroom instruction and R&D, this kit includes all of the equipment and instructions needed to perform six fundamental experiments in Quantum Physics.

Society of Physics Students

Booth #502
One Physics Ellipse
College Park, MD 20740
301-209-3008, www.spsnational.org, lquijada@aip.org

The Society of Physics Students (SPS), along with Sigma Pi Sigma, the national physics honor society, are chapter-based organizations housed within the American Institute of Physics. SPS strives to serve all undergraduate physics students and their mentors with a chapter in nearly every physics program in the country and several international chapters. Sigma Pi Sigma, with over 95,000 historical members, recognizes high achievement among outstanding students and physics professionals. SPS and Sigma Pi Sigma programs demonstrate a long-term commitment to service both within the physics community and throughout society as a whole through outreach and public engagement. Partnerships with AIP member societies introduce SPS student members to the professional culture of physics and convey the importance of participation in a professional society. SPS and Sigma Pi Sigma support scholarships, internships, research awards, physics project awards, outreach/service awards, and a job site for summer and permanent bachelor's level physics opportunities (jobs.spsnational.org).

University of Houston

Booth #309
Houston, TX77204
http://www.uh.edu/

Meet representatives from the University of Houston, Department of Physics!

Varafy Corporation

Booth #307
10359 104 Street Suite 202
Edmonton, Alberta Canada T5J 1B9
www.varafy.com, wbiegler@varafy.com
Varafy is an affordable, innovative online STEM homework and assessment platform incorporating advanced technologies which support student success in learning Physics. As an OpenStax Partner, Varafy supports OpenStax Science and Math textbooks including College Physics, University Physics and College Physics for AP. Varafy's algorithmic platform ensures instructors have access to unique practice, homework and assessments problems— for online or print use. All STEM illustrations authored in Varafy are dynamically rendered to scale to provide rich content. Instructors can easily create their own homework or assessment problems in Varafy. Varafy's AI driven Free-Body Diagram Assessor—provides hints to students—was recognized by the Association of Test Publishers as a top 5 innovative assessment product for 2018. Varafy integrates with your LMS.

Vernier Software and Technology

Booth #205
13979 SW Millikan Way
Beaverton, OR 97005
888-837-6437, www.vernier.com, aharr@vernier.com
Vernier Software & Technology is the leading worldwide innovator of real-time data-collection, graphing, and analysis tools for science education. Visit our booth to see our Go Direct Force and Acceleration and Go Direct 3-Axis Magnetic Field sensors, as well as our new Graphical Analysis 4 software.

Wiley

Booth #207
111 River St.
Hoboken, NJ 07030
201-748-6518
www.wiley.com, asmelando@wiley.com
Wiley is a global leader of knowledge and knowledge-enabled services in research, professional practice and education. Continuously developing digital education, learning, assessment and certification resources to help ensure student success, and communicate the research discoveries of the future.

Support Physics Education through AAPT.

Your gift enables AAPT programs to reach the physics teachers of today and tomorrow.

Help Today:

Travel and Dependent Care Grants: Support someone's attendance at an annual meeting by contributing toward their travel and dependent care costs. This is an effective way to increase the representation of traditionally underrepresented groups at AAPT meetings.

Invest in Tomorrow:

Early Career Engagement Award: This new award will recognize Early Career Educators who demonstrate promise as future leaders of AAPT. Help us reach our $25,000 goal to fund this prize!

For more information, please visit aapt.org/donations

SPS Undergraduate Research and Outreach Poster Session

Time: 8–10 p.m. **Date: Saturday, Jan. 12** **Location: Woodway Hall**

SPS01: 8-10 p.m. A Low-Cost Leaning-Ladder Experiment

Poster – Adrian M. Palmer, Southwest Baptist University, Bolivar, MO

Joshua A. Yount, Perry A. Tompkins, Southwest Baptist University

This presentation demonstrates an experiment of the classic static equilibrium problem of a ladder leaning against a wall. This experiment was completed in a low-budget laboratory setting, using the principles of static equilibrium. Since static friction is very difficult to measure, we removed friction as much as possible from this experiment using inexpensive skateboards. This allowed us to focus on measurable forces in the solution and the experiment.

SPS02: 8-10 p.m. An Acoustic Analogy to Defects in Quantum Band Formation

Poster – Raphael P. Francisco, Berry College, Mount Berry, GA

Todd K. Timberlake, Shawn A. Hilbert, Berry College

The electrons in a solid are restricted to specific energy levels which are grouped together into bands. Between these bands are forbidden ranges of energy, or band gaps. Impurities can be introduced into a pure solid, creating defects which allow new energy levels to exist within these gaps; this process, known as doping, is used to create semiconductors. We have constructed an acoustic analogy to defects in a solid. Our apparatus involves multiple PVC pipe sections coupled together, each acting as an atom. Each section is separated by a holed disk. A function generator sweeps a range of frequencies, which are played through a speaker inside the pipe apparatus. A microphone records the resulting amplitudes of each frequency, and the resonance frequencies form into bands. Varying the sizes of the holes in the disks causes resonant frequencies to appear between the bands, effectively representing band defects.

SPS03: 8-10 p.m. An Overview of Hand Held Sun Photometer Measurements of Atmospheric Aerosols in New Orleans: A Case Study of the Xavier University Study Site

Poster – Morewell Gasseller, Xavier University of Louisiana, Metairie, LA

Maryssa Bradley, Xavier University of Louisiana

Aerosol optical depth (AOT) was measured at Xavier University of Louisiana (XULA, 29.96? N, 90.11° W and 3m above sea level) using a GLOBE hand-held sun photometer. The measurements were done at two different wavelengths, 505nm and 625nm. The measured values were used to extrapolate the AOT values for wavelengths 667nm, 551nm, 532nm and 490nm at the XULA site. The measured and calculated AOT values were then compared with values from the nearest AERONET station at Wave CIS Site 6 in the Gulf of Mexico (AERONET, 28.87? N, 90.48° W and 33m above sea level). In this study we tracked the annual and daily variations of AOT for a 12-month period from September 2017 to August 2018.

SPS04: 8-10 p.m. Applying Various Curves for Sheer to Percolation Model of Galaxy Formation

Poster – Jared M. Mooney, Berry College, Mount Berry, GA

Truong Le, Berry College

This project strives to expand on Percolation and Galaxies (eg. L. S. Schulman & P. E. Seiden), by recreating the model they presented, and by expanding upon their model to account for curves for sheer. A modernization of the original coding will be the first part of the process, allowing for the expansion of the fixed velocity model to be easily adapted to a model that then account for sheer curves. After the model has been complied and modernized, various galactic sheer curves can initialized with the base parameters of the galaxy, and from this, we can compare the model to observed galaxies, and test for the validity of the model.
Dr. Truong Le

SPS05: 8-10 p.m. Breaking Barriers through Untold Stories

Poster – Stephanie Marie, American Institute of Physics, Silver Spring, MD

To increase diversity in science is a monumental task requiring many perspectives on the challenge. One way the American Institute of Physics is contributing to increased diversity in physics is through the resources at the Center for History of Physics and Niels Bohr Library & Archives. Working with Greg Good, I spent summer 2018 learning the untold stories of people from underrepresented groups in physics, and wove their lives and work into lesson plans which high school teachers can implement. Focusing on the Latinx, Native American, and LGBT+ communities, I developed six unique lesson plans dedicated to elevating the stories of these communities. They are accessible online at history.aip.org/teaching-guides. This poster provides an overview of the 56 total lesson plans with a closer look at my contributions. A greater diversity of young people can now find a likeness of themselves among accomplished scientists and engineers.

SPS06: 8-10 p.m. Developing Student Notebook Practices in the Introductory Lab

Poster - Michael T. Zwartz, Lewis University, Tinley Park, IL

Joseph Kozminski, Lewis University

Though keeping a good laboratory notebook is a critical skill in graduate school and industry, studies have shown that undergraduate physics students often do not receive adequate training in this skill. According to the AAPT Recommendations on the Undergraduate Physics Laboratory Curriculum Laboratory, keeping a laboratory notebook is an efficient means of documenting and communicating one's work in the lab, and this skill should be developed starting at the introductory level. Using pre- and post-laboratory surveys, this study examines how students use lab notebooks, how they learned notebook practices, and how their attitudes toward keeping a notebook change throughout the three semester introductory calculus-based physics sequence. A preliminary analysis of what methods of training are most beneficial in developing students' notebook practices and their attitudes about keeping a laboratory notebook will be presented.

SPS07: 8-10 p.m. Martial Arts: Force and Impulse

Poster – Audrey Burch, Berry College, Mount Berry, GA

Charles Lane, Berry College

In this experiment, we analyze force and impulse related to punches to evaluate three separate components that make up a punch. We broke down the punch to arm extension, torso rotation, and forward step. Around 30 young adult subjects punched a shoulder level force plate mounted to a punching bag structure. The tests evaluate to what extent force and impulse hold consistent between the added components and full out punch.

SPS08: 8-10 p.m. Mechanics Activities with a Local Positioning System

Poster – Cora Siebert, Portland State University, Portland, OR

Paul DeStefano, Zachary Dale, Eduardo Martins, Ralf Widenhorn, Portland State University

Using a local positioning system in conjunction with commonly used lab apparatuses can present both teachers and students with the opportunity to evolve their current

introductory mechanics exercises. With the ability to collect both one- and two-dimensional position, acceleration, and rotation data, we present several activities that focus on physics fundamentals taught in introductory physics at the college and high school level. In one activity, students are presented with various motion graphs and challenged to act them out, while in another, students release objects from rest and use experimental data to compare free fall and drag models. Also shown is a brief exploration of two-dimensional collisions using "hover" disks, in which students can investigate the behavior of colliding objects.

SPS09: 8-10 p.m. Who Can Change Physics Education?

Poster – Krystina H Williamson, Barnard College, Hayward, CA

Teachers and students can feel powerless when it comes to their capability to change physics education. However, through my internship at AAPT, I've witnessed teachers and students changing physics education in their classrooms, through local policy and through research. I experienced, cultivated and participated in education policy, (through the AAPT/AIP Master Teacher Policy Fellows), education technology (through the Computational Modeling Workshop in Physics First), and education research (through Step Up 4 Women). During this internship, I not only learned how to become a strong teacher, but also how to better advocate for myself, my students, and my physics community. I look forward to applying the skills and knowledge I have gained through this internship towards future grant projects, future outreach programs and workshops, and future initiatives at my college to support physics students and physics faculty.

SPS10: 8-10 p.m. Resolving the Problem of Excess GRB's at Low Redshift

Poster – Cecilia Ratke, Berry College, NW Mount Berry, GA

Gamma-ray bursts (GRBs) are extremely energetic bursts that last from milliseconds to hours. They are divided into two categories based on duration: short and long GRBs. Long GRBs generally result from the death of massive stars, implying that GRB activity should have a correlation with star formation rate. Le & Mehta (2017) show that such a relationship is possible, and their analysis also indicates that an excess of LGRBs exist below a redshift of 2. Current observations using two different methods have indicated a tension between the value of the Hubble constant H0. Our model of GRB redshift distribution relies on the distribution of GRB formation rate at different redshifts, the shape of the power-law spectrum, the gamma-ray energy release, and the Hubble constant. In this research, we seek to explain the excess of LGRB by exploring some of the above constraints and will present our findings at this meeting.

Lactation Room

(Focus Room)

Hours:

Friday, 8 a.m.–11 p.m.
Saturday – 6 a.m. to 11 p.m.
Sunday – 6 a.m. to 11 p.m.
Monday – 6 a.m. to 11 p.m.
Tuesday – 6 a.m. to 11 p.m.

W01: Learn to Create Interactive Physics Simulations for Phones, Tablets, and Computers in Just 4 Hours

Sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $70 **Non-Member Price: $95**
Location: Fleming 231

Andrew Duffy, Department of Physics, Boston, MA

Wolfgang Bauer

You will learn how to author you own interactive physics simulations from scratch in HTML5, which is replacing Java and Flash as the dominant programming language of the web. In step-by-step exercises on your laptop computer you will experiment with how to draw and paint on the screen, how to use buttons, input fields, and sliders to allow the users to control your simulation parameters, how to work with images, and how to process mouse, touch, and keyboard inputs. Working step-by-step through instructive examples will allow you to create your own complete interactive simulations, which help your students gain physics insight.

W02: STEP UP 4 Women

Sponsor: Committee on Women in Physics
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: Farish 213

Robynne Lock, Assistant Professor, Department of Physics & Astronomy Texas A&M University - Commerce Commerce, TX

Blake Head

Support gender equity in physics education through active strategies and discussions. Come to this workshop to learn how to be a part of a national campaign for high school physics teachers and their students, STEP UP for Women (Supporting Teachers to Encourage Pursuit of Undergraduate Physics for Women). During this workshop, learn about gender representation in physics in the U.S. and around the world, and engage in active strategies and two specific lessons that are demonstrated to enhance the physics identity of young women. If only one-third of high school physics teachers was able to recruit an interested young woman to a physics undergraduate program, gender imbalance upon enrollment would be offset. Undergraduate faculty have a special role to welcome and retain these young women. Whoever you might be, be a part of the change! (This workshop is fully funded by NSF #1720869. Participants who complete the workshop may seek full reimbursement of their workshop registration fee.)

W03: Introduction to LaTeX for Teachers and Students

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Graduate Education in Physics
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 235

Joe Heafner, Conover, NC

LaTeX is the de facto standard for publication quality document preparation in mathematics and science, yet few students ever learn to use it because of its steep learning curve. In this workshop, I will introduce LaTeX within the context of physics for instructors and students at all levels, including the introductory level, but without the steep learning curve. Participants will construct both simple and more complex documents using Overleaf, an online LaTeX editing portal for which accounts are free. I will also describe how to install LaTeX locally. Participants are asked to have previously created a free Overleaf account at Overleaf.com and to bring a laptop or tablet.

W04: PTRA: Quantum Cryptography: An Applied Way to Teach the Basics of Quantum Mechanics

Sponsor: Committee on Physics in Pre-High School Education
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $90 **Non-Member Price: $115**
Location: Farish 215

Tommi Holsenbeck, Hardaway, Al 36039

Karen Jo Matsler, Jan Mader

Quantum mechanics is not only very different than classical physics, it also allows us perform tasks are impossible with today's technology. This hands-on workshop is about the physics behind quantum cryptography – a mature technology allowing for unbreakable information security. Using affordable light polarizers, we will investigate two of the most fundamental quantum phenomena, namely the principles of quantum superposition and quantum measurement. We'll then demonstrate how these quantum effects are leveraged to share a secret key between two parties in such a way that any attempt at eavesdropping will be detected.

W05: The Colliding Neutron Stars GW170817: A Nuclear Astrophysics Case study for the Classroom

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Modern Physics
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Farish 217

Peggy Norris, Sanford Underground Research Facility, Lead, SD

In October 2017, the LIGO and VIRGO collaborations announced the discovery of GW170817 - the first direct observation of two colliding neutron stars. The collision was observed with gravitational waves followed by observations across the full range of the electromagnetic spectra. Observations over the following months provided evidence for the formation of r-process elements. The story of this discovery, and the physics concepts underlying it, is accessible to students and makes an excellent case study that incorporates Next Generation Science Standards in both physical science and earth/space science. Interspersing hands-on activities with video clips of scientists discussing their results can bring a sense of discovery into the classroom that students cannot get from textbooks.

W06: Computational Modeling Using Glowscript in Introductory Physics

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: Farish 218

Dwain Desbien, Avondale, AZ

Tom O'kuma, Nathan Quarderer

Over the last few years, there has been a push to integrate computational modeling earlier in the physics curriculum. Participants will work activities used in a typical two-semester introductory physics course ranging from conceptual level to calculus-based level. We have been using Glowscript (http://www.glowscript.org), and this is the computational modeling tool we will be using in this workshop. Participants will learn some basic glowscript coding so that they can code some of activities used by the leaders in their classes. Several activities have been developed in conjunction with a series of workshops done as part of the ATE Physics Workshop Project and these will be shared with the participants. Additionally, we will discuss implementing computational modeling into your introductory physics classes. Participants are asked to bring their own laptops and have created an account on glowscript before arrival.

W07: Intro to Modeling Instruction, a Research-Based Curriculum

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $72 Non-Member Price: $97
Location: Farish 219

Jeff Saul, Albuquerque, NM 87111

Jeff Hengesbach, Kathleen Harper

Instruction is an active-learning teaching method and a curriculum for physics, physics first (middle school or high school), chemistry, and biology that has been twice recognized by the US Dept. of Education as an exemplary curriculum. The Modeling Instruction project is a national program that has trained thousands of middle school, high school, and undergraduate science teachers in activity-based learning using guided-inquiry and problem-based learning techniques. Most teachers report that their students achieve statistically significant learning gains in annual progress and increased physics enrollment within 2-3 years of implementing Modeling Instruction in their classrooms. Both beginning and veteran physics teachers who would like to try a more activity-based approach will benefit from this workshop, which introduces the Modeling Instruction approach. The materials can be used to replace or supplement direct instruction. This workshop offers an overview and introduces the key points of Modeling Instruction to help faculty decide if one of the full workshops (1-3 weeks long) offered during the summer is worth their time and effort. For more information on Modeling Instruction including summer workshops, go the American Modeling Teachers Association Website at https://modelinginstruction.org.

W08: Promoting STEM Engagement by Creating Pop-Culture Projects

Sponsor: Committee on Science Education for the Public
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $85 Non-Member Price: $110
Location: Fleming 233

Jeremy Benson, Northern Illinois University

Finding ways to make projects relevant to our students' interests, while also highlighting the material being presented, all while making sure everyone has fun at the same time can be a real challenge. In this hands-on session we'll look at some of the projects that NIU STEM Outreach has used in their camps to capture students' imaginations, while allowing them to demonstrate the skills and concepts being presented. But we won't just talk about the projects, attendees will actually get to create their own working* light sabers as we learn basic electronics and soldering. (*Light sabers may not actually cut through blast doors.)

W09: Fun and Engaging Labs

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Teacher Preparation
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: Fleming 239

Wendy Adams, 1500 Illinois St., Golden, CO 80401

Duane Merrell

In this workshop we will share many labs that are suitable for both high school and introductory college physics. The labs are challenging but not too difficult and, leave plenty of room for creativity! We have found success by limiting the goals for the labs to: 1. Fun and engaging, 2. Built in student choice, 3. Related to this week's material. The labs are effective at engaging the students in problem solving and conceptual understanding. Merrell used this type of lab as a high school teacher and physics quickly became one of the most popular classes in the school. Adams, inspired by Merrell, has found that her college students no longer rush to leave, and in some cases stay to see how other groups do even after they've turned in their lab write up for the day! This workshop will allow you to try out these labs for yourself.

W10: LIGO & Interferometers

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $100 Non-Member Price: $125
Location: Fleming 232

Dan Beeker, Physics Department, Indiana University, Bloomington, IN

Ken Cecire, Amber Strunk

Learn about how the LIGO experiment uses interferometry to detect gravitational waves and study the result. We will put together an interferometer (you get to take home) and do other hands-on activities with LIGO physics. Bring your laptop to work with LIGO data. Bring a web cam if you would like to analyze diffraction data using video.

W14: PICUP: Integrating Computation into Introductory Physics

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Physics in Undergraduate Education
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Farish 213

Marie Lopez del Puerto, University of St. Thomas, St. Paul, MN

Larry Engelhardt, Kelly Roos, Marcos D. Caballero, Robert Hilborn

In this workshop we will discuss the importance of integrating computation into the physics curriculum and will guide participants in discussing and planning how they would integrate computation into their courses. The PICUP partnership has developed materials for a variety of physics courses in a variety of platforms including Python/VPython, C/C++, Fortran, MATLAB/Octave, Java, and Mathematica. Participants will receive information on the computational materials that have been developed, will discuss ways to tailor the materials to their own classes, and will learn about opportunities that are available to receive additional support through the PICUP partnership. PLEASE BRING A LAPTOP COMPUTER WITH THE PLATFORM OF YOUR CHOICE INSTALLED. This workshop is funded by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525. This workshop is funded by an NSF grant. The participant will pay up front for the workshop during registration and receive a refund after the workshop is completed in the amount of $60. Each participant will be refunded $40.The total cost of the workshop to each participant is $20 for AAPT members and $45 for non-members of AAPT.

W15: Building the Living Physics Portal Community

Sponsor: Committee on Physics in Undergraduate Education
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 235

Chandra Turpen, University of Maryland

Sam McKagan

The Living Physics Portal an AAPT online project hosted on ComPADRE, is a dynamic community collection of instructional materials for teaching physics for the life sciences, with community input and support, serving a wide spectrum of users and developers of curricular materials and pedagogies. It is now ready to accept contributions for inclusion in three different levels with distinct submission criteria regarding the extent of preparation needed to make the materials useable for others, and type of review. There is a basic "sandbox" level that is appropriate for materials or ideas in development. There is another level that houses more finished materials, which have undergone a basic editorial review. A third level is for well-tested, mature materials that have been through a peer-review process, equivalent to a journal peer-review. Come with materials, drafts, or ideas and receive guidance as you go through the submission process at the appropriate level. Learn how easy it is to share ideas and materials and get community input. You will also have the chance to be a beta test user to see how materials can be accessed for you to use or modify for your own classes, and seek community support.Laptop required.

W18: Teaching Systems and Energy in Algebra-Based Physics

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in High Schools
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Farish 215

Gay Stewart, West Virginia University, Department of Physics, Morgantown, WV

Deep conceptual understanding of work and energy builds upon defining systems. While we know what we mean when we say "potential energy of a ball," our students hear what we say; when to use work due to gravity or potential energy becomes a guessing game instead of being determined by what is in the system. That energy is always conserved, so constant in closed, isolated systems is another area where small inaccuracies in language can cause our students to misunderstand and misapply conservation laws. Work, defined as the transfer of energy to a system by a mechanical process, requires work be done by a force exerted by something external to the system. By carefully defining systems and categorizing work, potential and internal energy, we can provide our students with a logical framework that does not require memorization of special cases (or guessing). In this workshop we share materials supporting this approach to teaching about energy and work and discuss how a few changes in discourse can significantly improve students' understanding of these important concepts, while preparing them to do better in future study. This approach aligns with the NSF-sponsored best practices study that informed the AP physics redesign.

W19: Neutrino Masterclass

Sponsor: Committee on Modern Physics
Co-sponsor: Committee on Physics in High Schools
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $62 **Non-Member Price: $87**
Location: Fleming 231

Kenneth Cecire, Department of Physics 225 Nieuwland Science Hall

Marla Glover, Shane Wood

Experience the discovery of neutrino physics by exploring data from Fermilab neutrino experiments. Learn about wrap around activities that you can use in the Middle/High School to get students exploring real data and how these activities fulfill NGSS requirements.

W20: Deep Learning with Python

Sponsor: Committee on Educational Technologies
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $65 **Non-Member Price: $90**
Location: Fleming 232

Jeff Groff, Shepherd University, Shepherdstown, WV

Deep learning is a specialized area of machine learning that is having myriad impacts on our lives. It is the technology on which advances in areas like self-driving vehicles, speech recognition, and computer vision are based. This workshop will be a project-based primer on deep learning using Python with Jupyter Notebook, Keras, and TensorFlow. The aim is to provide physics instructors with the skills and experience they need to introduce their students to deep learning. Topics covered will include the basics of supervised learning, artificial neural networks, convolutional neural networks, and recurrent neural networks. Participants will explore artificial intelligence applications such as the automated classification of images and the generation of human-readable text.

W21: Teaching Introductory Physics in an Earth & Space Science Context -- Resources for Hands-on & Minds-on Activities

Sponsor: AAPT
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 233

Ramon Lopez, Brad Ambrose, and Shannon Willoughby

Join this fully reimbursible workshop to engage in integrated activities appropriate for high school and introductory college physics and astronomy teachers who want to teach with integration and authentic NASA data. Attendees will use resources developed and tested by physics education researchers through the NASA Space Science Education Consortium, including labs, lecture tutorials, clicker questions, and diagnostic assessments. These materials address topics that integrate Physics, Earth Science, and Space Science, including (1) coronal mass ejection videos to understand both simple mechanics as well as accelerations of relativistic particles, (2) sunspot data to understand period and frequency, (3) eclipses to understand geometric optics, and (4) auroral currents to understand electromagnetism. (This workshop is fully funded by a NASA Grant/Cooperative Agreement Number NNX16AR36A awarded to Temple University and the AAPT. Participants who complete the workshop may seek full reimbursement of their workshop registration fee.)

W23: PICUP: Integrating Computation into Upper-Level Physics

Sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 231

Larry Engelhardt, Francis Marion University, Florence, SC

Walter Freeman, Marie Lopez del Puerto, Kelly Roos, Danny Caballero, Norman Chonacky

Abstract: In this workshop we will demonstrate several examples of how computation can be integrated into upper-level physics courses in ways that will add value to the existing curriculum. The PICUP partnership has developed materials for a variety of physics courses in a variety of platforms including Python/VPython, C/C++, Fortran, MATLAB/Octave, Java, and Mathematica. Participants will receive information on the computational materials that have been developed, will discuss ways to tailor the materials to their own classes, and will learn about opportunities that are available to receive additional support through the PICUP partnership. PLEASE BRING A LAPTOP COMPUTER WITH THE PLATFORM OF YOUR CHOICE INSTALLED. This workshop is funded by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525. The participant will pay up front for the workshop during registration and receive a refund after the workshop is completed in the amount of $60. The total cost of the workshop to each participant is $20 for AAPT members and $45 for non-members of AAPT.

W26: Improving Pedagogical Content Knowledge of Teaching Assistants and Instructors

Sponsor: Committee on Graduate Education in Physics
Co-sponsor: Committee on International Physics Education
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 233

Alexandru Maries, Cincinnati OH

Being aware of common student alternate conceptions in physics is beneficial when designing instruction to help students develop a coherent knowledge structure. It is thus not surprising that knowledge of common student difficulties is one aspect of what Sulman coined "pedagogical content knowledge", or in other words, knowledge about how to teach a subject that is different from the content knowledge itself. This workshop will first explore the literature on the extent to which TAs (undergraduate and graduate students teaching labs and recitations) and instructors are aware of various introductory student alternate conceptions. Participants will identify common alternate conceptions of students in certain question and discuss potential uses in a professional development class. In addition, participants will discuss productive approaches to help both TAs and instructors learn about these alternate conceptions and integrate this knowledge into their pedagogical design.

W27: Are You Testing What You Think You Are Testing? An Introduction to Factor Analysis

Sponsor: Committee on Space Science and Astronomy
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Farish 213

Shannon Willoughby, Montana State University Department of Physics Bozeman, MT

Philip Eaton

Typically, when an instructor creates assessments their goal is to probe specific concepts, and the questions they design would likely be deemed by other experts to probe those concepts. However, after an assessment is given, the instructor may find that students responded in unexpected ways. Factor analysis enables instructors to determine if the intended concepts were answered consistently by students or not. Using a statistical process, factor analysis attempts to identify the number of independent concepts on a given assessment. In this workshop, the basic underpinnings of exploratory factor analysis (EFA) will be discussed. Then, attendees will use supplied data and the statistical computing language R to extract the number of concepts on a given assessment. By combining expert analysis of the questions and the EFA results, attendees will then build factor models for the assessment. These models will be verified through confirmatory factor analysis (CFA) with another data set to verify whether their EFA driven model is a product unique to the sample data or can be generalized to larger populations.

W28: Intro to Using Robotic Telescopes in Student Research

Sponsor: Committee on Space Science and Astronomy
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Farish 215

Rachel Freed

Paul Hardersen

In this half-day workshop, attendees will learn how to use available remotely- and robotically- controlled telescopes that are set up for students to access in learning how to conduct fundamental research in astronomy. Designed for the relative novice in professional-grade astronomy research, this first-steps workshop will demonstrate how educators can help students conduct authentic research by studying binary star astrometry, exo-planet photometry, asteroid astrometry and photometry, and solar astronomy. The end goal of these research projects is for students and their mentoring teachers to formally publish the results of their work.

W29: A Suite of Research-Based Labs for E&M

Sponsor: Committee on Laboratories
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Fleming 239

Andrew Boudreaux , Department of Physics Western Washington University, Bellingham, WA

Over the past several decades, many physics curricula have been developed on the basis of physics education research. Some have been stand-alone (e.g., Physics and Everyday Thinking), while others are more supplemental (e.g., Tutorials in Introductory Physics). Relatively few have targeted the lab component of an otherwise traditional course. Recently, labs for mechanics and E&M have been developed and classroom tested at Western Washington University and Whatcom Community College. These labs, which draw on PET, TiIP, and the Minnesota Context Rich Problems for inspiration, use a three-part structure: guided experiments to promote conceptual understanding, a structured reflection, and an open-ended, quantitative challenge task. The labs focus on sense making rather than verification. They are scaffolded, and thus constitute an incremental step from traditional pedagogy. The labs can be used in conjunction with either a traditional or a "reformed" lecture, and can be taught by undergraduate or graduate TAs. The labs may be valuable for those considering implementation of student-centered instruction in just a single course component, especially perhaps in a course that does not have a recitation. In this workshop, participants will work through selected activities from the E&M labs and discuss implementation.

W30: Making Good Physics Videos

Sponsor: Committee on Apparatus
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: Fine Arts Building 314

James Lincoln, Newport Beach, CA

Flipping the Classroom and the emergence of free online video hosting has led many of us to be asked to make videos of our lessons and demos. In this workshop, you will learn the five methods of video engagement, fast and effective video writing techniques, and beginner/intermediate editing skill competency that will improve your video quality and help get your message across more effectively. Your instructor is master physics teacher and filmmaker James Lincoln who has made over 100 science videos. Tips and ideas for effective and engaging physics demos are also included.

W31: Space Center Field Trip

Sponsor: Committee on History and Philosophy in Physics
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $95 **Non-Member Price: $120**
Location: offsite

Ekaterina Michonova, Due West, SC

Toby Dittrich

This one day field trip to the Space Center Houston will take participants to unique historical locations and expose them to the history of space exploration, including the history of the USA space program. The Space Center offers over 400 things to see and do, including a tram tour.

W32: Integrating NGSS Practices with the Physics Through Evidence—Empowerment Through Reasoning Suite

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $75 **Non-Member Price: $100**
Location: Farish 217

Valerie Otero, UCB Boulder, CO

Shelly Belleau

This workshop introduces high school physics teachers and teacher educators to curricular resources for implementing NGSS practices in the physics classroom. In addition to understanding physics, scientific practices, and students, teachers of NGSS must also recognize their roles as curating transformative educational experiences among students. As students make claims from evidence and establish principles from consensus (often for the first time), they undergo a kind of transformation in their understanding of the role of science education in their lives. In this workshop, teachers learn to manage the multiple demands of supporting students through this transformation while providing meaningful laboratory experiences and consensus building opportunities. By analyzing video and interview transcripts, participants will discuss their roles as teachers in helping students integrate physics content and scientific practices as they develop models, explanations, and principles that explain the physical world.

W33: Fun, Engaging, Effective, Research-Validated Lab Activities and Demos for Introductory University, College and High School Physics

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $75 **Non-Member Price: $100**
Location: Fleming 236

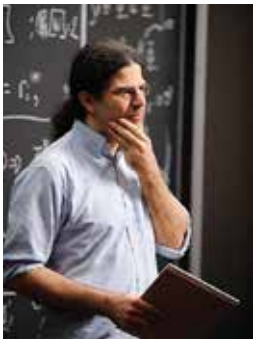
David Sokoloff , Dept. of Physics 1274 University of Oregon Eugene, OR

Priscilla Laws, Ronald Thornton

Participants in this workshop will have hands-on experience with research-validated active learning activities for the introductory laboratory—including RealTime Physics (RTP) labs using computer-based tools and video analysis—that have been used effectively in university, college and high school physics courses. We will also experience Interactive Lecture Demonstrations (ILDs)—a strategy for making lectures more active learning environments. These active learning approaches are fun, engaging and validated by physics education research (PER). Research results demonstrating the effectiveness of RTP and ILDs will be presented. Emphasis will be on activities in electricity and magnetism and optics. The following will be distributed: Modules from the Third Edition of RTP, and the ILD book.

Awards: 2018 Andrew Gemant Award to David Kaplan

Location: Galleria Ballroom I **Time:** 12:30–1:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Michael Moloney



David Kaplan

2018 Andrew Gemant Award – Particle Fever: A Temporary Bout of Insanity

David E. Kaplan received his PhD from the University of Washington in 1999. He had postdocs at the University of Chicago/Argonne National Lab and SLAC and joined the faculty at Johns Hopkins in 2002. Kaplan discovers possible theoretical extensions to the standard model of particle physics and cosmology, and then novel ways to discover those and other models. Kaplan is a Fellow of the APS, and has been named an Outstanding Junior Investigator by the DOE, a Kavli Frontiers Fellow of the NAS and an Alfred P. Sloan Fellow. He has also created and produced the documentary film, "Particle Fever," for which he has won a DuPont Journalism Award, and other accolades.

Come and Listen to NASA Astronaut Don Pettit!

Donald Pettit, NASA Astronaut
Lyndon B. Johnson Space Center Houston

Session FG: Space Science in Introductory Courses

Location: Bellaire
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, January 14
Time: 6:30–8 p.m.

FG04: 8–8:30 p.m. Techno-Stories from Space

Invited – Donald Pettit, Lyndon B. Johnson Space Center, Houston, TX

Frontiers are interesting places; they offer the possibility to make observations outside our normal range of experience; the International Space Station is such a frontier. A smattering of my observations will be presented in story form. There will be many questions and few answers, which of course is a characteristic of being in a frontier and why we venture there.

Session BA: Approaches to Recruiting Women in Physics

Location: Plaza Ballroom I **Sponsor:** Committee on Women in Physics **Co-Sponsor:** Committee on International Physics Education
Time: 1:30–3:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Beth Cunningham

BA01: 1:30-2 p.m. How to Strengthen Physics by Making it Inclusive

Invited – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA

Despite some efforts to encourage women to pursue a career in physics, the percentage of women majoring in physics remains low. There are several frameworks that focus on the dearth of women in physics, which take into account motivational characteristics, e.g., interest in physics, self-efficacy, mindset about intelligence, sense of belonging, and identity as a physicist. We performed a longitudinal analysis of these motivational characteristics of female and male college students in large physics courses along with their performance in those courses. Among other findings, our data suggest that female students had lower physics self-efficacy than male students, even when controlling for performance. Moreover, this self-efficacy gap continued to grow throughout the college introductory physics course sequence. Based upon these findings, we implemented short in-class activities that were designed to improve the inclusivity in the physics courses and address issues related to students' sense of belonging, self-efficacy and intelligence mindset. We found that female students in physics classes who participated in these activities performed significantly better than those who did not, and they were also less likely to withdraw from the courses. We thank the National Science Foundation for support.

BA02: 2-2:30 p.m. The Art of Scientific Outreach

Invited – Shohini Ghose Wilfrid, Laurier University, W Waterloo, ON N2L 3C5 Canada

Eden Hennessey Wilfrid, Laurier University

Research has shown that the low representation of women in science and engineering has a negative impact on scientific innovation and the economy. However, much like the debate around climate change, despite the overwhelming evidence showing the challenges and biases that hinder women's full participation in science, there is still no strong widespread push for structural and cultural change. We describe some initiatives that combine art, science and research to change the conversation and build awareness that can lead to a more inclusive science community.

BA03: 2:30-3 p.m. On the Road to Equality: UK Efforts for Women in Physics

Invited – Jessica Wade, Imperial College London, Greater London SW7 2BW United Kingdom

The aim of this paper is to demonstrate the increasing engagement of the UK physics community with recruitment, progression, and retention of women at all stages of their involvement with physics. Recognizing the under-representation of certain groups, the programs look to identify barriers to participation and to use evidence-based research to create models of good practice that break down these barriers and encourage and engage diverse groups. The flagship activity is Project Juno, but other initiatives look to support all scientists in their careers; including people from the LGBTQ+ community and those with disabilities. For more than 25 years there has been little change in the proportion of girls studying physics post-16. Only around a fifth of final year high school students are girls, despite similar success between the genders in previous physics qualifications. We will discuss the extensive research and evidence-based resources and action developed by the Institute of Physics.

Session BB: Frontiers Session: Living and Working in the Space Beyond Earth

Location: Plaza Ballroom II **Sponsor:** Committee on Space Science and Astronomy **Time:** 1:30–3:20 p.m. **Date:** Sunday, Jan. 13
Presider: Timothy Slater

BB01: 1:30-2 p.m. Countermeasures: Defending the Human Body Against the Hazards of Spaceflight

Invited – Andrea Hanson, NASA Johnson Space Center, Houston, TX

Dr. Hanson will discuss how living and working in the extreme environment of microgravity aboard the International Space Station (ISS) challenges the human body in extraordinary ways, and the great measures NASA astronauts must take to protect their physiology to complete physically demanding tasks in space and return safely back to Earth. Results from recent research focused on increased effectiveness and efficiency to optimize exercise countermeasures to will be shared. She will discuss lessons learned from the use of wearable technologies, virtual reality, and robots to help keep astronauts fit while working in space. Dr. Hanson will also provide an overview of the challenges associated with maintaining exercise systems in the smaller space vehicles NASA will use to travel to the moon and Mars.

BB02: 2-2:30 p.m. What do Physics Teachers and Astronauts Have in Common?

Invited – Dorit B Donoviel, Translational Research Institute for Space Health, TMCx Houston, TX

Though the vast unknown of outer space consists of all the characteristics of fantasy, many similarities exist between life on earth and life in space. As humans, we still need to eat, sleep, and exercise in space much the same way we do on earth to maintain physical and mental health. The challenge of living and working in space is two-fold because we don't know what we don't know. And what we do know – the instruments, medicines, and tools that have been proven to maintain human health on earth, we must adapt for use in space. Based at Baylor College of Medicine and partnered with NASA, the Translational Research Institute for Space Health funds groundbreaking research from all over the country. With the help of our consortium partners, the California Institute of Technology, and the Massachusetts Institute of Technology, we are transforming health for humans on and off the planet.

BB03: 2:30-3 p.m. How Will the Spaceflight Environment Affect Physiology of Space Explorers?

Invited – Virginia Wotring, Center for Space Medicine, Baylor College of Medicine, Houston, TX

Even after >50 years, we are still learning how the spaceflight environment affects physiology. In the 1970s it became apparent that bones demineralized and muscles atrophied, presumably due to reduction of gravity-associated skeletal loading. Since then, many other physiological systems have been studied on missions, and in virtually every case, in-flight changes were measured. However, it's not clear if reduced gravity is the cause – the spaceflight environment also includes space radiation, elevated stress, and a closed environment. Research now attempts to determine if spaceflight-associated physiological changes might be problematic and require countermeasures to maintain crew health. As mission durations increase, we've also begun study the adaptation of physiology over time in the spaceflight environment. Some physiological changes (altered vision) were identified only after missions reached >4 months. Of current interest are needs for human exploration of deep space, so crewmembers remain healthy and productive in spaceflight for 3 years.

BB04: 3-3:10 p.m. From Classrooms to Capsules: Physics for the Final Frontier

Contributed – Geoffrey M. Steeves, University of Victoria, Dept. Physics and Astronomy, Victoria, BC V8P5C2 Canada

Space explorers require a solid foundation in physics to survive and thrive in the challenging physical environment beyond Earth. Not every astronaut is a physicist, so it is crucial to create curriculum to engage students from a myriad of backgrounds. Drawing on my experiences working with astronauts, teaching in the cross-disciplinary environment of the International Space University and working as a flight instructor, I will discuss what an 'Essential Physics for Astronauts' course will look like. For students of this course, a knowledge of physics alone is not sufficient. Astronauts must also be able to apply what they've learned in a time-critical, resource limited environment, therefore I will also discuss how a course like this should be taught and evaluated, to best prepare future space explorers for success.

BB05: 3:10-3:20 p.m. An Out-of-This-World Approach to Centripetal Acceleration

Contributed – Grant D. Thompson, Wingate University, Wingate, NC 28174

The merry-go-round is often the go-to example of centripetal acceleration in many physics classrooms. However, in an increasingly technological world, this classic amusement ride is becoming less familiar with students. We have recently moved to introducing this concept using a new example – that of 'artificial gravity.' Not only is this example exciting to students, but it also brings with it connections to current research problems and interdisciplinary interests. In this talk, I will present how the results of an experiment to determine the effect of simulated gravitational fields on plant growth have been used to teach students the concept of centripetal acceleration in the physics classroom.

Session BC: Introducing Computation into Introductory Physics Classes

Location: Bellaire **Sponsor:** Committee on Physics in Two-Year Colleges **Time:** 1:30–2:50 p.m. **Date:** Sunday, Jan. 13 **Presider:** Michael Butros

BC01: 1:30-2 p.m. Using LaTeX in Introductory Calculus-based Physics

Invited – Paul Heafner, Catawba Valley Community College, Hickory, NC 20602

In this talk, I will describe how I introduced LaTeX, a de facto standard typesetting system for mathematical and technical documents, into an introductory calculus-based physics course at a community college. I will include brief demonstrations of all the technology described in the talk, and I will show examples of students work. My thesis is that perhaps LaTeX might be used as an alternative way to introduce computation into introductory courses.

BC02: 2-2:30 p.m. Introducing Computation: Getting Started with Help from PICUP*

Invited – Marie Lopez del Puerto, University of St. Thomas, Saint Paul, MN 55105

How do you get started? By learning about what others have done, and then tailoring the approach to fit your preferred mode of instruction, course, institution, etc. The Partnership for Integrating Computation into Undergraduate Physics (PICUP) runs workshops, hosts an online collection of curricular materials, and supports a growing community of interested faculty - all with the main goal of making it easier for faculty to integrate computation into their courses. In this talk, I will discuss different approaches that are used by faculty who integrate computation into introductory physics courses and I will highlight materials in the PICUP collection that are relevant to faculty teaching this type of courses.

*The PICUP project is is funded in part by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

BC03: 2:30-2:40 p.m. Expanding Introductory Mechanics with Mathematica(R) Software

Contributed – Mark A. Cunningham, Katy, TX

The study of introductory mechanics is greatly restricted by students' mathematical abilities. Discussion of the flight of balls, for example, always excludes wind resistance, except in the single case of a vertically falling object where the solution in one dimension can be obtained analytically. The Mathematica (R) function NDSolve permits the numerical solution of systems of differential equations which can include other aerodynamic terms that do not give rise to closed-form solutions. Introduction of any computer software brings an assortment of additional hurdles but also provides the means for discussion of more realistic problems. I will demonstrate examples of an object subject to velocity-dependent and spin-dependent forces.

BC04: 2:40-2:50 p.m. Radioactive Dice: A User's Manual

Contributed – David M. DeMuth, Valley City State University, Valley City, ND 58072

Peggy Norris, Sanford Underground Research Facility

Shane Wood, QuarkNet

Timothy R. Young, University of North Dakota

Utilizing rolled dice to simulate probability of decay of radioactive elements is a well-known hands-on activity, often coins or M&M's replacing the dice. In a recent educator workshops we guided teachers through the practice using six-sided dice. Moreover 12-sided dice representing daughter emissions were integrated for a more accurate depiction of radioactivity. In recognizing the limitation of using fewer faced dice, we extended the activity with a Google Sheet based Javascript simulation for 20-sided dice with improved results and interpretation via histograms and scatter plots. In this presentation the authors will share a radioactivity user's manual for teachers.

Reference: https://goo.gl/HMCMEP

Session BD: K-12 Ideas from PTRA, PIRA, AIPHA

Location: Galleria Ballroom III **Sponsor:** Committee on Physics in Pre-High School Education **Time:** 1:30–3:30 p.m. **Date:** Sunday, Jan. 13
Presider: Tommi Holsenbeck

During the summer of 2018, PTRA, PIRA, and ALPhA worked to join forces and meld the strengths of the three programs with benefits for all. This session will share with teachers 1) demonstrations tools and techniques from PIRA, 2) ALPhA's support of advanced experimental physics education, and 3) PTRA's high quality of professional development for high school physics and physical science teachers across the U.S.

Session BE: PER in Latin America and at Hispanic-Serving Institutions in the U.S.

Location: San Felipe Room **Sponsor:** AAPT/PER **Time:** 1:30–3:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Ramon E. Lopez

This session will feature invited speakers from Latin America and Hispanic-Serving Institutions (HSIs) in the U.S. who are engaged in Physics Education Research at their institutions. The speakers will give an overview of the kind of work being conducted at their institutions as well as their perspectives on PER issues of particular interest to their respective communities. The aim of the session is to provide the broader PER community some insight into work being conducted in Latin America and at HSIs in the U.S., as well as to generate ideas for research, collaboration, and enhanced "Broader Impacts" sections in proposals submitted to the NSF.

BE01: 1:30-2 p.m. Research in Conceptual Understanding: The Case of Latin America

Invited – Genaro Zavala, Tecnologico de Monterrey Garza Sada, NLE 64849 Mexico

Physics Education Research (PER) began in the late 1970s with an emphasis on research on conceptual understanding. Even though other lines of research have contributed to the consolidation of PER, studies on conceptual understanding remain valid and essential. In this talk, I will present the basics of this line of research, the methods that are used and how Latin American groups have contributed.

BE02: 2-2:30 p.m. Physics Education Research in Brazil

Invited – Katemari Rosa, Federal University of Bahia, Rua Barao de Loreto, Salvador, Bahia 40150-270 Brasil

Brazil is the largest country in Latin America, with over 200,000,000 people. With national standards, and facing a curriculum reform, Brazil has the largest federal sponsored textbook distribution in the world and physics is a mandatory discipline in middle and high school all over the country. It is in this scenario that a large Physics Education Research community has been established in the past decades. With over 350 PER groups around the country, specialized journals, and international collaborations, Brazil has been developing quality and diverse PER, in spite of adversities. This talk will present a panorama of PER in Brazil and points of possible connections with research made in the States and worldwide.

BE03: 2:30-3 p.m. Physics Education Research: Optimizing, Leveraging and Enabling Change at FIU

Invited – Laird Kramer, Florida International University, STEM Transformation Institute, Miami, FL

Physics education research at Florida International University (FIU) began in 2003. Early efforts established Modeling Instruction, transformed labs and launched an undergraduate Learning Assistant (LA) program. The initial efforts showed improved learning, attitudes about physics, and student success, and, in concert with other reforms, led to a dramatic increase in the number of physics majors at FIU. The early work was used to create momentum to continue and expand educational change on campus, leading to an institution-wide STEM education transformation movement that engages students, faculty and administrators. Key elements facilitating these efforts include research, collaborations and integrating culturally relevant instructional approaches into the reforms. FIU is a public research university in Miami serving over 57,000 students, the majority of whom come from historically underrepresented groups. The talk will focus on the mechanisms, strategies, and partnerships that enabled PER to thrive at FIU.

BE04: 3-3:30 p.m. PER at UT Arlington

Invited – Ramon Lopez, Dept. of Physics, UT Arlington, Arlington, TX 7

In this panel discussion I will outline the kind of work in Physics Education Research (PER) that we have done at UT Arlington, a Hispanic Serving Institution. Many of the challenges facing UT Arlington are common to other urban, comprehensive universities. I will make the case that understanding how best to serve students in physics courses at such institutions is an important avenue of investigation for PER.

Session BF: Physics Outreach for Underserved Populations

Location: Westchester Room **Sponsor:** Committee on Science Education for the Public **Co-Sponsor:** Committee on Diversity in Physics
Time: 1:30–3:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Jacquelyn Chini

BF01: 1:30-2 p.m. How to Speak to People Your Own Age

Invited – Thomas B. Greenslade, Jr., Kenyon College, Department of Physics, Gambier, OH

In the popular usage, education seems to be for young adults. In most situations AAPT members teach students in the 14 to 22 age range. But there is an opportunity to speak to those who are more mature – who are our own ages. Historical societies, genealogical societies, alumni groups and library lecture series are all venues where we can talk about science to those with considerable life experience. I will talk about my own experiences with these groups of people, and, in doing so, will speak with people who are almost my age.

BF02: 2-2:30 p.m. Including Students with Physical Disabilities into Physics Programs

Invited – Steven Sahyun, University of Wisconsin - Whitewater, 800 W Main St., Whitewater, WI

Providing instruction to students with physical challenges can seem like a burdensome task. However, by planning course material with universal design principles in mind, and by taking advantage of available resources, it is often possible to provide fairly simple modifications to existing physics course material to create classroom or laboratory environments that, regardless of disability provides enhanced learning for all students. This talk will focus on the need for accommodation practices in the physics classroom and laboratory, several types of instructional challenges related to students with disabilities, finding resources to help make courses universally accessible and provide some examples for accommodating student learning needs. Specific examples will include student inclusion in research and field trip experiences, methods for providing material such as large print, tactile displays, electronic formats that are useful for text to speech and multimodal (tactile, auditory and visual) presentation methods.

BF03: 2:30-2:40 p.m. Experiences with the New York School for the Deaf

Contributed – Drake E. Brewster, United States Military Academy, Bartlett Hall, Science Center, West Point, NY*

STEM outreach programs often overlook special needs schools and programs during planning efforts. During the summer of 2018, STEM outreach program for the Department of Physics and Nuclear Engineering invited the New York School for the Deaf to our facility for an interactive STEM demonstration. Despite a learning curve for our presenters, the event was a success and led to several important discoveries in our after action report. We will share these findings during our presentation.

*Sponsored by LTC Corey Gerving, PhD

BF04: 2:40-2:50 p.m. Physics Outreach to Spanish Town and Linstead in Jamaica

Contributed – Michael J. Ponnambalam, Holy Cross College, Vadakkankulam Tamil Nadu, India

Physics Outreach was started by this author in Jamaica in 2006 at the University of the West Indies, catering to students at all levels and to the general public. It has been extremely successful, and has played a key role in increasing the number of students doing introductory physics. Some of us visited a few elementary schools for this outreach, while some came to the university on a Science Field Trip, arranged by us. Due to various reasons, the elementary school students in Spanish Town and Linstead have missed both of these since 2006. To make up for this, in April 2018, the author conducted the Interactive Show on 'Science Is Fun' to around 800 students in Spanish Town and Linstead. The results, as seen from their feedback, will be presented in this talk.

BF05: 2:50-3 p.m. Synergies Among Broader Impact, Service Learning and Outreach

Contributed – David Sederberg, Purdue University, West Lafayette, IN

We describe the inspiration, unique approach, and rationale behind three successful Physics and Astronomy Outreach programs at Purdue University. Sidewalk Science, engages parents, grandparents and high school students, in interactive exhibits for elementary grades in a traveling format. Physics Inside Out, a five-day summer camp, opens the doors for middle school students to current research topics and fundamental concepts of physics and astronomy, and engages faculty with rewarding opportunities for broader impact. Saturday Morning Astrophysics, a monthly on-campus workshop, engages grade 7-12 students in timely topics, such as dark matter, gravitational waves, and exoplanets, as well as concepts related to posing and answering questions pondered throughout millennia of human curiosity. We will describe the role of faculty engagement and undergraduate service learning that forms the framework and contributes to the success of these outreach programs, and the challenges of recruiting underserved communities.

BF06: 3-3:10 p.m. University Physics Service Learning in an Alternative Learning Classroom

Contributed – Shannon R. Clardy, Henderson State University, Arkadelphia, AR

While the pedagogy of service learning is not widely employed in physics, service learning in an alternative classroom environment is seen even less frequently. Alternative classroom environments (ACEs) serve students who do not perform well in a traditional classroom setting, often with a disproportionate number of minority students. ACE are an important form of intervention used to encourage academic, social, and emotional success for K-12 students. There are a number of challenges to creating service learning courses that address this population; however, the benefits are immense. With both challenges and benefits considered, an implementation of service learning pedagogy in calculus-based physics was developed at Henderson State University, with student knowledge gains compared to University Physics without the service learning element.

BF07: 3:10-3:20 p.m. Preliminary Analysis of Informal Quantum Science Education in Underserved Communities

Contributed – Quinn Manning, Project QUERB, Palo Alto, CA

Jeremy Manning, Project QUERB

Recent work demonstrates certain challenges that arise when engaging high school students in underserved communities with laboratory work and related project-based pedagogy. We suggest that a new approach to the traditional physics curriculum be undertaken by targeting those areas of physics which naturally appeal to and inspire students. Given the extensive literature written on the importance of, and demand for, a Quantum Information Science (QIS) workforce in the United States, it is proposed that the QIS field itself could provide these more appealing and inspiring learning experiences to students. We offer preliminary data on the design of an informal quantum science education platform called Project QUERB, which enables students to remotely conduct experiments through an online interface, and on the use and benefits of the platform, including functionality to evaluate the pedagogical efficacy of different epistemological approaches to QIS.

BF08: 3:20-3:30 p.m. Physics Classes as Corporate Training

Contributed – Anya Rasmussen, Pullman, WA

Schweitzer Engineering Laboratories (SEL), an international employee-owned company headquartered in Pullman, WA, designs and manufactures digital devices used to monitor and protect the power system. SEL recently initiated a STEM education program geared towards manufacturing employees. This unique program aims to enrich and develop employee-owners through STEM education. Employees are invited to step away from their normal roles and participate in a weeklong, workshop-style science, engineering, or mathematics class. Currently, employees elect to take an introductory physics or introductory statistics class. We have plans to expand the curriculum to 15 courses over the next two years. In this presentation, we describe the physics course design, discuss the challenges and advantages of teaching and learning physics in this unusual setting, and report student learning gains on the Force Concept Inventory.

Session BG: Recruiting Physics Teachers: Research and Best Practices

Location: Sage Room **Sponsor:** Committee on Teacher Preparation **Co-Sponsor:** Committee on Research in Physics Education
Time: 1:30–3:20 p.m. **Date:** Sunday, Jan. 13 **Presider:** Monica Plisch

BG01: 1:30-2 p.m. Best Practices at Texas State University Physics Department*

Invited – Hunter G. Close, Texas State University, San Marcos, TX

Eleanor W. Close, Texas State University

Teaching is a complex profession that involves the synthesis of many diverse skills and components of knowledge, some practical and some intellectual. Perhaps more fundamental than these objects of knowing is that "teacher" is a way of being a person, with distinctive approaches to other people and their developing knowledge and skills, and also similarly to one's self. At Texas State University, the physics teacher preparation program and its supporting Learning Assistant program emphasize the formation of fundamental attitudes toward the teaching enterprise—attitudes of humility, curiosity, wonder, exploration, friendship, and mutual support. Texas State currently hosts the RADIANS Noyce Teacher Scholarship Program and is a former funded PhysTEC site. We describe the spirit of the program and how this shapes its practical design, and we illustrate the outcomes in attitudes of the program's teacher candidates and graduates.

*Supported by NSF grants DUE-1557405 and PHY-0808790

BG02: 2-2:30 p.m. Effectiveness of a Physics By Inquiry Course in a STEM Teacher Preparation Program

Invited – Donna Stokes, University of Houston, Houston, TX

This presentation highlights the outcomes of the development and implementation of a Physics By Inquiry course in the teachHouston STEM teacher preparation program at the University of Houston. Preparing and retaining qualified physics teachers is important since in major urban centers, 50–70% of beginning teachers leave the field within the first 4–6 years and 28.7% high school science teachers are teaching out of field. The Physics By Inquiry course engages pre-service high school STEM

teachers in interactive, inquiry-based teaching pedagogies for physics. The course focuses on increasing the knowledge base for teaching physics through best practices in inquiry instruction through formal and informal experiences, and outcomes indicate positive impact on pre-service teachers' self-efficacy in content knowledge, student engagement and use of inquiry style teaching in the classroom. In addition, the course has led to an increase in physics teacher production through the teachHouston program.

BG03: 2:30-2:40 p.m. Recruiting Physics Teachers Who Succeed in the Classroom

Contributed – Jill A. Marshall, University of Texas, Austin, TX

Pamela Romero, Michael Marder, University of Texas

Graduates of Texas UTeach secondary STEM teacher certification programs have been shown to go into teaching in larger numbers, stay in the classroom longer, and succeed with students from all demographics. Part of this success has come from recruiting broadly and removing barriers to entry in the admission process. I will describe the rubrics and metrics we use for admission into UTEach Austin and how these metrics, for example GPA, correspond to success in the classroom.

BG04: 2:40-2:50 p.m. How Can AAPT Members Support 'Get the Facts Out'

Contributed – Marla Jane Glover, Purdue University, Lafayette, IN

Physics teachers have always been in high demand. With the decrease in enrollment in education departments across the nation, the number of prospective physics teachers have also dropped. "Get the Facts Out" is an initiative that is looking at how to change the conversations about the teaching profession. This talk will share how AAPT with other STEM associations are combining to change the conversation. The goal is to inform the members of AAPT the efforts of our association and how members can support the initiative.

BG05: 2:50-3 p.m. Get the Facts Out: Understanding the Impact on Diverse Populations*

Contributed – Wendy K. Adams, Colorado School of Mines, Golden, CO

Richard Pearson, Savannah Logan, Colorado School of Mines

Recent research in STEM teacher preparation has identified strongly held beliefs about the teaching profession, many of which are misperceptions. These misperceptions discourage STEM undergraduates from exploring teaching as a viable career option. The Get the Facts Out campaign toolkit is designed to support faculty efforts to change the conversation about STEM teaching careers in their departments. The toolkit, based on pilot interventions that show positive results in shifting perceptions among students and faculty, and which have been shown to outperform traditional recruitment efforts, is designed to be customizable and adaptable to the local situation. Here we will share the research studies that have been designed to understand the response to these strategies with different populations of students.

* This project is supported by NSF DUE-1821710.

BG06: 3-3:10 p.m. Getting the Facts Out About the High School Teaching Career*

Contributed – Hsiapo Kuo, Colorado School of Mines, Golden, CO

Gay B. Stewart, West Virginia University

Misperceptions about high school teaching discourage STEM undergraduates from exploring teaching as a viable career option. The Get the Facts Out campaign toolkit is designed to support faculty efforts to change the conversation about STEM teaching careers in their departments. Funded by NSF grants 1821710 and 1821462, this project involves professional societies in physics, mathematics and chemistry. In each field "Change Agents" have been chosen to help get the facts out. The authors are two of those change agents and will share information about their roles and plans.*This work is supported in part by grants from the National Science Foundation.

*This work is supported in part by grants from the National Science Foundation.

Session BH: The New Advanced Laboratory

Location: Tanglewood **Sponsor:** Committee on Laboratories **Co-Sponsor:** Committee on Apparatus
Time: 1:30–3:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Randy Peterson

BH01: 1:30-2 p.m. Experiment-based Resources for Teaching Optics & Photonics, Applied Laser Physics & Imaging Science

Invited – Gabriel C. Spalding, Illinois Wesleyan University, Bloomington, IL

This talk aims to share resources for use in your own teaching. I teach labs starting with qualitative observation of aberrations, using hand-held lenses, then "walking a laser" through "cloned apertures" on an optical breadboard, and "optical cloaking" as a means of teaching ABCD matrices. Students disassemble "broken" classroom projectors. They use diffraction to find the "filling fraction" of their Spatial Light Modulators (SLMs), and compare those to educational SLMs and low-cost Digital Micromirror Devices (DMDs), which are used for teaching Fourier Optics, computer-generated Holograms, Aberration Correction, Laser Modes, encoding information, linear momentum, spin angular momentum, and orbital angular momentum of light beams. This complements an introduction to single-photon quantum mechanics, including "Ghost Imaging," where the photons incident upon the detecting camera have never interacted with the object imaged (by exploiting correlations that are required by simple principles: conservation of energy and conservation of momentum.)

BH02: 2-2:30 p.m. Updating the Advanced Lab – What Do Faculty Choose to Change?

Invited – Lowell McCann, Univ. of Wisconsin - River Falls, River Falls, WI

The Advanced Laboratory Physics Association's (ALPhA's) Laboratory Immersion program exists to help faculty and staff improve their knowledge about experiments that have been developed for undergraduate courses beyond the introductory year. The choices participants in these programs make can tell us about how these labs are (or aren't) changing in the country and what may be influencing those changes. In this talk, I will look at the experiments participants chose and their implementation rates to investigate those changes.

BH03: 2:30-3 p.m. Takeaways from BFY3: Integrating Experiment, Theory, and Computation

Invited – Joseph Kozminski, Lewis University, Department of Physics, Romeoville, IL

Building on the themes of the previous Conferences on Laboratory Instruction Beyond the First Year (BFY), BFY III highlighted creating engaging laboratory experiences that integrate experiment, theory, and computation. The conference provided hands-on workshops, plenary talks, breakout sessions, and poster sessions aimed at developing laboratory experiences that help students develop good laboratory practices and a range of transferrable skills while enriching their understanding of physics and interdisciplinary applications of physics. Formal and informal networking allowed for dialog and community building so that discussions from BFY III would continue beyond the conference. This talk will provide takeaways from the conference, an overview of the post-conference survey results, and opportunities and challenges for the advanced lab community moving forward.

BH04: 3-3:30 p.m. Simple and Inexpensive Lensfree Holographic Microscopy

Invited – Euan McLeod, University of Arizona, College of Optical Sciences, UA, Tucson, AZ

In the last two decades, there has been an explosion in the capability of portable consumer computing and imaging technologies, such as smartphones and their integrated camera modules. This surge in technology can be harnessed to develop high-performance, high throughput, inexpensive, and field-portable microscopic imaging

platforms to be used as diagnostic tools in point-of-care and resource-limited settings. This presentation will show how to use these sensors in lens-free holographic imaging where an in-line hologram is captured on an image sensor and computational techniques are used to reconstruct an image of the sample from its hologram. Lens-free holographic microscopy platforms are well-suited for undergraduate laboratory courses and research. A range of devices where undergraduates have played a major role in their design, fabrication, testing, and analysis will be presented. In many cases, the image quality obtained using these devices rivals the image quality of much larger and more expensive laboratory-based equipment.

Session BI: Physics Majors: High School to Doctorate

Location: Post Oak **Sponsor:** AAPT **Time:** 1:30–3:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Brad Ambrose

BI01: 1:30-1:40 p.m. Beyond the FCI – Assessing Conceptual Learning of Physics Majors

Contributed – Ian Bearden, Niels Bohr Institute, Blegdamsvej 17 Copenhagen, Denmark

Inkeri Kontro, University of Helsinki

The Force Concept Inventory (FCI) is one of the most widely used assessments for quantifying the conceptual learning of students of introductory physics. However, it contains many problematic items, including questions with very low or high difficulty, high false positive rates, or large gender differences. In addition, students who have studied physics more extensively at the secondary level tend to saturate the assessment already when entering the university. For example, the average pre-test score of physics students from the University of Helsinki, Finland, were 22.9 (76.4%), with 27% of students achieving >90% (N = 195). For Niels Bohr Institutet in Denmark, the corresponding numbers are 19.7 (65.7%) and 15% (N = 779). In its current form, the FCI is not a good instrument for assessing the conceptual learning for these students. In this talk, we discuss FCI results from NBI and UH and the ways the FCI might be extended to make it usable in high-achieving physics populations.

BI02: 1:40-1:50 p.m. Incorporating a Physics Engagement Assignment into First-Year Physics

Contributed – Kristen M. Burson, Hamilton College, Clinton, NY

Physics students enter college with different levels of understanding about the availability and importance of out-of-class learning opportunities and academic support resources. In order to incentivize participation in out-of-class activities that help students thrive in their study of physics, a 'physics engagement' assignment was introduced to the first-semester introductory physics course at Hamilton College. The assignment includes mentoring, connecting with the physics department, and utilizing academic support resources. In this talk, I will discuss the implementation and outcomes of this assignment from two-years of implementation based on student submitted responses and personal observations. Since implementation, there has been a significant increase in the use of drop-in tutoring at the quantitative and symbolic reasoning center. We have also seen increased attendance among first-year students at the physics colloquia series (sustained in subsequent semesters). Lessons learned from the pilot year of the assignment will be discussed.

BI03: 1:50-2 p.m. Integration of AP and Dual Enrollment Courses Plus Project Based Learning*

Contributed – Fatih Gozuacik, Harmony Science Academy - Houston, Missouri City, TX

Small campuses always aim to increase AP and dual credit course offerings. However, due to the student count, mostly advanced courses face closures. In that case, school ends up losing the high achievers. Therefore, we were in need of finding a way to keep our AP programs alive. As a solution, presenter, who have been teaching AP Physics course and college counselor of the campus, started offering integrated AP and dual courses. A great success was harvested! College credit earning rate increased by 400%. Year by year data tables and graphs will be projected to distinguish the effectiveness of the plan. Students who are willing to register to take the AP exam, do so; whereas local students prefer just receiving their college credit through dual physics course. Such plan is applicable for most of the AP and matching dual credit courses. Project Based Learning (PBL) in AP classes for enhancing the class and well designed STEMSOS PBL program will be introduced.

*A unique system where AP and dual credit courses are combined with the implementation of Project Based Learning and 21st century skills.

BI04: 2-2:10 p.m. Project BoxSand: What Are My Students Doing When I'm Not Looking?

Contributed – Kenneth C. Walsh, Oregon State University, 301 Weniger Hall Corvallis, OR Ever wondered what your students are studying outside of class and if it correlates to better learning outcomes? Project BoxSand started with the simple question, "Will my students prepare for a flipped class by watching pre-lecture videos?" The project has since expanded into providing a completely re-envisioned digital replacement for the textbook, packed with all the best open resources from around the web and built in-house, including text, videos, simulations, and more. Students' engagement with resources is tracked on a click-by-click basis on the boxsand.org site, providing big data for learning analytics research. I'll present initial findings on nearly 4 million student clicks on resources and homework collected over the past 2 years. I'll discuss what online study habits correlate with performance in the class. For example, are there good and bad cramming behaviors? Come learn about our educational data mining study.

BI05: 2:10-2:20 p.m. Development of Teaching Learning Materials Using Excel: About Absolute Age of Rock

Contributed – Minkyoung Kim, Korea National University of Education, Gangnae-myeon, Chungcheongbuk-do, Korea Chungju-si, Korea 29173 Korea

Soomeen Wee, Korea National University of Education

In this study, the purpose is to develop teaching materials that can cultivate computing thinking skills in relation to the absolute age section of rock at the high school earth science level. Software education for human resource development necessary for future intelligence information society is emphasized, and in 2015 revised curriculum in Korea, functions related to mathematical thought and computer use have been added to the content system of science subjects. Therefore, in this study, we are presenting teaching learning materials to implement the half-life of radioactive isotope on clock and graph using an Excel program. By doing this, we will learn the half-life of radioactive isotope and the concept of age measurement of rock, and expect the effect that we can improve computing thinking power.

BI06: 2:20-2:30 p.m. Could Less be More in the Introductory Kinematics Lab?

Contributed – Roland C. Woodward, University of Wisconsin-Oshkosh, Fond Du Lac, WI

For years, I have used a popular commercial computer interface in my mechanics labs, which reports all major kinematic quantities automatically. After follow-up questions indicated that my students did not understand the relationships among displacement, velocity, acceleration, and time--not to mention how they were actually being measured or computed--I developed a minimalist interface that reports the times (and only the times) at which, e.g., a photogate beam is interrupted. I felt that requiring the students to figure out for themselves how to determine displacement etc. would enhance student learning. The interface itself has been described in previous talks [1]; in this talk, I present preliminary results from a systematic comparison of the effect on student learning of this minimalist approach, compared to the conventional method and equipment, for one classic mechanics lab.

[1] http://tinyurl.com/LabSplits

BI07: 2:30-2:40 p.m. Unstructured Play – What Happens When You Do Nothing At All

Contributed – Carolyn Martsberger, Wofford College,Physics Department, Spartanburg, SC

Mackay Salley Wofford College

Wofford College has a unique January, or "Interim," where students only take one class. Students can take courses in a wide range of offerings such as the Art and Sci-

ence of Craft Brewing, Welding, 3-D printing, or Breakdancing, or they can design their own interim. As a result, students take ownership of their education, get a large chunk of unscheduled time, and get to investigate what they would do if they could do anything. Often Interim allows students to try new things that they might not yet know interests them. The results of Interim can be astounding for some students. As one students puts it, Interim is "one of the most terrifying and rewarding things she has conquered in her time at Wofford." This talk will share how allowing students to step out of the traditional classroom and "play" can be a fruitful academic exercise.

BI08: 2:40-2:50 p.m. Science 100: Using Energy, Expose the Students to Biology, Chemistry, Earth and Space, Physics*

Contributed – Donald G. Franklin, Hampton, GA

Many students attend schools that do not have physics, or they do not take physics for fear it will lower their GPA. Science 100 allows the school to expose the students to all the major sciences and show how they are interrelated. Using Energy as the major theme, any Science teacher can teach the class, some may need a workshop to prepare.

*Using Openstax, the class does not require that 4 textbooks be used. There is no cost of using multiple text for a class.

BI09: 2:50-3 p.m. How Did We Integrate Engineering Tools and Projects into Physics Curriculum?

Contributed – Levent Sakar, Harmony Public Schools, Houston, TX

It has been seven years that we are assigning year-long projects to the students in physics classes. The students started with simple project ideas and later on, they came with more advanced projects like; 1- 3D Prosthetics Hand/Finger 2- Solar Tech & Research projects (Solar Cars) 3- Rocketry Projects 4- Remotely Operated Vehicles (ROV); drones and underwater robotics 5- Near the Space Projects (Weather Balloon) 6- Eco Car Design 7- Aquaponics 8- Variety of RasperryPi and Arduino projects I would like to present where the teachers can follow up on students' work and mention the "share and shine" approach to promote these projects to create a STEM-focused school culture.

BI10: 3-3:10 p.m. Problem-Solving Competitions and the U.S. Physics Team

Contributed – Mark Eichenlaub, Art of Problem Solving, San Diego, CA

The U.S. Physics team provides opportunities for students who want to explore physics problem-solving and teachers looking for extra-curricular physics opportunities. Each year, the U.S. Physics team runs the F=ma exam, then the U.S. Physics Olympiad exam. Approximately 20 students from across the country qualify to join the U.S. Physics team for a 10-day training camp involving extensive theoretical and experimental problem-solving, guest lectures and lab tours from physicists, and the opportunity to participate in public outreach. Five students continue to the International Physics Olympiad and participate in a week-long program including theory and experiment exams, touring local destinations, and meeting talented young students from around the world. This talk will share the goals and methods of the U.S. Physics team program, give example problems, and show how high school teachers and students can begin participating.

BI11: 3:10-3:20 p.m. Formula Recollection Made Simple with Acronyms

Contributed – Shannon A. Schunicht, mnemonicwriting.com, Orlando, FL

Physic's formula recollection is overwhelming to students without such aspirations. Simple acronyms, like FOIL (First, Outside, Inside, & Last) for quadratic equations, and My Dear Aunt Sally [Multiply, Divide, Addition, then Subtraction], are always remembered from grade school. Difficult formulas apparent in college PHY 201 & 202 courses usually thwart further pursuit thereof. This was particularly apparent when taking PHY 201 & 202 following a severe head injury (19 days unconsciousness) => without a Short term memory! For this reason, a mnemonic technique [Vowels: Mathematical Operations] was devised, and recognized by Marquis' WORLD Who's Who Lifetime achievement amongst significant others. Examples include an acronym; exCePT i buiLD rabbiTS 4 caTS oN 2 HaTS, for The Quadratic Equation. Everyone remembers Dr. Seuss (Theodor Seuss Geisel). **Note how ADDITIONAL CONSONANTS insertion enhance intelligibility. This mnemonic technique's Western languages application is unfounded, whereas its Eastern Character's application has yet to be explored? Regardless, its possibilities remain limitless as ?X => 0

Find some quiet space during the meeting!

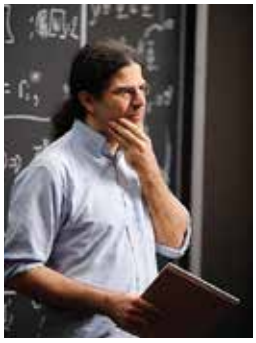
Quiet Room
(River Oaks)

Hours:

Friday – 8 a.m. to 11 p.m.
Saturday – 6 a.m. to 11 p.m.
Sunday – 6 a.m. to 11 p.m.
Monday – 6 a.m. to 11 p.m.
Tuesday – 6 a.m. to 11 p.m.

Awards: 2018 Andrew Gemant Award to David Kaplan

Location: offsite at University of Houston **Time:** 4–5:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Brad Conrad



David Kaplan

2018 Andrew Gemant Award – Dark Matter: The Next Frontier

David E. Kaplan received his PhD from the University of Washington in 1999. He had postdocs at the University of Chicago/Argonne National Lab and SLAC and joined the faculty at Johns Hopkins in 2002. Kaplan discovers possible theoretical extensions to the standard model of particle physics and cosmology, and then novel ways to discover those and other models. Kaplan is a Fellow of the APS, and has been named an Outstanding Junior Investigator by the DOE, a Kavli Frontiers Fellow of the NAS and an Alfred P. Sloan Fellow. He has also created and produced the documentary film, "Particle Fever," for which he has won a DuPont Journalism Award, and other accolades.

Session CA: Innovations in Teaching Analytical Mechanics

Location: Plaza Ballroom I **Sponsor:** Committee on Physics in Undergraduate Education **Time:** 5:30–6:30 p.m. **Date:** Sunday, Jan. 13
Presider: Andy Gavrin

CA01: 5:30-6 p.m. Classical Mechanics with Lab Projects

Invited – Anne J. Cox, Eckerd College, St. Petersburg, FL

Junior level Classical Mechanics is traditionally taught as a theory course with the occasional sprinkling of computational exercises. However, the material lends itself to low-cost experiments that students can implement relatively easily. Unfortunately, many Classical Mechanics courses do not have an associated lab, so students miss out on the satisfying connection between theory, computation and experiment. We have found that students will elect to complete laboratory projects for the class given the appropriate incentive. We will discuss the incentives used, the associated assignments, the faculty-side logistics, as well as a sampling of the types of projects students have completed and what it has added to the course as a whole.

CA02: 6-6:30 p.m. Using EJS to Add Computational Modeling to a Junior-Level Mechanics Course

Invited – Mario Belloni, Davidson College, Department of Physics, Davidson, NC

Anthony Kuchera, Davidson College

At Davidson College, physics majors take a one-semester mechanics course typically as juniors. This course covers the typical topics of Newtonian and Lagrangian mechanics, non-linear dynamics, followed by assorted topics of the instructor's choosing. To address the amount of topics that result in solutions that are not analytically solvable, we have added low-level computation into the course via Easy Java Simulations, EJS. EJS is a Java application that creates Java and JavaScript simulations of physical phenomena. We have used EJS to create Java programs in the past but this fall transitioned to having students create JavaScript simulations. Our goal in having students create these simulations is to help students understand the physics, not necessarily to become proficient in JavaScript. In this talk, we will outline the specifics of our course, demonstrate EJS, and show several examples of how we get students to better understand the underlying physics through low-level computational modeling.

Session CB: Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers and Video Analysis

Location: Plaza Ballroom II **Sponsor:** Committee on Research in Physics Education **Co-Sponsor:** Committee on Educational Technologies
Time: 5:30–6:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** David Sokoloff

CB01: 5:30-6 p.m. Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers and Video Analysis

Invited – David R. Sokoloff, Dept. of Physics, University of Oregon, Eugene, OR

Ronald K. Thornton, Depts. Of Physics and Education, Tufts University

The results of physics education research and the availability of computer-based tools have led to the development of the active learning materials for the introductory physics course. Some of these materials are designed for hands-on learning in the lab, for example the student-centered laboratory curriculum, RealTime Physics (1),(2). One reason for the success of these materials is that they encourage students to take an active part in their learning. This interactive session will demonstrate through active audience participation materials designed to implement active learning in lecture, Interactive Lecture Demonstrations (ILDs) (3) including those using clickers and video analysis.

1. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, "RealTime Physics: Active Learning Labs Transforming the Introductory Laboratory," Eur. J. of Phys., 28 (2007), S83-S94., 2. David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, RealTime Physics: Active Learning Laboratories, 3rd Edition (Hoboken, NJ, John Wiley and Sons, 2011). 3. David R. Sokoloff and Ronald K. Thornton, Interactive Lecture Demonstrations (Wiley, Hoboken, NJ, 2004).

CB02: 6-6:30 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Tufts University, Medford, MA

David Sokoloff, University of Oregon

The effectiveness of Interactive Lecture Demonstrations (ILDs) in teaching physics concepts has been studied using physics education research based, multiple-choice conceptual evaluations. Results of such studies will be presented, including studies with clicker ILDs. These results should be encouraging to those who wish to improve conceptual learning in their introductory physics course.

1. David R. Sokoloff and Ronald K. Thornton, "Using Interactive Lecture Demonstrations to Create an Active Learning Environment," Phys. Teach. 35, 340 (1997).

Session CC: Physics at Hispanic Serving Institutions (HSIs): Challenges and Opportunities

Location: Bellaire **Sponsor:** Committee on Diversity in Physics **Co-Sponsor:** Committee on Physics in Undergraduate Education
Time: 5:30–6:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Tom O'Kuma

CC01: 5:30-6 p.m. Physics Programs at HSIs: A Report to the Community

Invited – Juan Burciaga, Colorado College, Colorado Springs, CO

AAPT and NSHP hosted a Conference on Enhancing Undergraduate Physics Programs at Hispanic Serving Institutions (EUPP-HSIs) at the Winter 2018 meeting in San Diego. The conference was used as a way to bring together physics faculty from representative HSIs to discuss the challenges and opportunities of physics education at HSIs, to explore what resources exist to enhance physics programming at HSIs, what resources and programs need to be developed, and the role of professional societies in faculty development at HSIs. Indeed, the principle value of the conference may well have been the opportunity for physics faculty from diverse HSIs to come together to discuss their experiences and needs. The talk will focus on the conference design, summaries of discussions from the conference that articulated key criteria of both curricular and extra-curricular physics programs, and the suggested practices that can enhance the impact of these programs.

CC02: 6-6:30 p.m. Physics at the University of the Incarnate Word (UIW)

Invited – Rosa E. Cardenas, The University of the Incarnate Word, San Antonio, TX

The University of the Incarnate Word (UIW) is a Hispanic Serving institution (HSI) in San Antonio, TX, with 4300 undergraduates -- 51% are Latino or Hispanic, 59% are female, and 40% are first generation college students. With these demographics, a physics program at UIW could lead to a huge impact on the demographics of physics as a whole. But would a physics program at UIW attract enough students to succeed? Currently, Mechanics and Electricity and Magnetism are taught as support courses for other majors. This semester I asked my physics students if they had considered physics as a career path. They responded, "what does a physicist do? Where do they work? How much are they paid?"

Session CD: Panel – Science Cafe/Nerd Night: Scientists Engage the Public in Casual Settings

Location: San Felipe Room **Sponsor:** Committee on Science Education for the Public **Co-Sponsor:** Committee on Graduate Education in Physics
Time: 5:30–7 p.m. **Date:** Sunday, Jan. 13 **Presider:** Jackie Chini

CD01: 5:30-7 p.m. Zero-budget, Community-based Cafe Scientifique: 4 Years and Thriving

Panel – Richard Gelderman, Sky Science Festival, Bowling Green, KY

Imagine the best-ever dinner party conversation. That is what we promise with the Cafe Scientifique operating in Bowling Green, Kentucky. Started by the non-profit entity that runs our annual Science Festival, we desired a monthly event to keep our efforts in front of the population. Inaugurated in a micro-pub just opening its doors in the summer of 2015, our events grew on word of mouth, social media, and some manipulation of local TV, radio, and newspaper interviews. We don't charge and we don't pay. The speakers donate their time. The restaurant provides the space at no charge, The audience owes nothing up front, but is welcome to order a drink or something to eat while they participate in the discussions. The founder of Cafe Scientifique established a spirit of democratic conversation, and we do our best to stay true to that model. We promote topics, and don't distribute biographical sketches, titles, or affiliations with the name of the person leading the discussion. Rather than hosting a "lecture in a bar," we do not allow microphones or PowerPoints, and actively promote a free-flowing conversation between all.

CD02: 5:30-7 p.m. Drinking in the Universe: Astronomy on Tap in San Antonio, TX

Panel – Tracy M. Becker, Southwest Research Institute, San Antonio, TX

Vincent Hue, Southwest Research Institute

Emily L. Rice, CUNY College of Staten Island; American Museum of Natural History

Jeffery Silverman, Samba TV

Astronomy on Tap (AoT) is a network of public outreach events that are typically hosted at bars and are designed to be laid-back, fun, and educational events for adults. AoT was started in 2013 by Dr. Meg Schwamb and has since spread to over 50 locations across the globe. Each "satellite" location taps into its local community of scientists and educators, reminding the audience that these experts are their neighbors. Each location also adapts and grows with the desires of that audience. At AoT SATX, hosted monthly in San Antonio, TX, two experts give 15-minute talks about different astronomical topics of their choice, followed by trivia. Having a larger, unifying network greatly eases the creation of the satellite events; however, there remain challenges in advertising, selecting strong public speakers, and engaging the audience. This presentation will discuss these challenges and the many successes and benefits of these casual-style outreach events.

CD03: 5:30-7 p.m. Establishing Nerd Nite Houston: A Newcomer's Perspective

Panel – Aaron Dunn, YES Prep Public Schools – Northside Campus, Houston, TX

Nerd Nite is a national network of local organizations that host monthly talks on a variety of topics in social settings. Topics vary widely and are limited only by who is interested in speaking– from Shakespeare to astronaut bathrooms to the history of airport carpets. Nerd Nite's topic-agnostic format allows a broad audience to feel welcome. The typical format is a once-monthly evening of three presentations using PowerPoint, located at a bar and intended for a general audience. The Nerd Nite phenomenon has quickly become highly successful across America and we are currently in the process of re-establishing the Houston chapter. This presentation will discuss what we have learned so far in our effort to re-establish Nerd Nite Houston and our advice for others who might be interested in doing so.

.

Session CE: Teaching with Data: Multi-messenger Astronomy

Location: Galleria Ballroom III **Sponsor:** Committee on Modern Physics **Co-Sponsor:** Committee on Space Science and Astronomy
Time: 5:30–6:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Amber Strunk

CE01: 5:30-6 p.m. Extracting Astrophysics from Gravitational Waves: GW170817 Case Study

Invited – Amber L. Stuver, Villanova University, Villanova, PA

A new era of multi-messenger astronomy began with the coincident detection of gravitational waves by LIGO (an event labeled GW170817) and electromagnetic waves by over 70 observatories across and orbiting Earth. Part of the light observed came in the form of a short gamma-ray burst; the source of this class of GRB has been a longstanding mystery. The observation of associated gravitational waves finally proved that the merger of a neutron star binary system is a source of these bursts. This talk will focus on how information about a gravitational wave source is extracted from the recorded signal and the contributions this makes to a fuller understanding of our universe. Classroom connections with references to the GW170817 detection will be discussed.

CE02: 6-6:30 p.m. The Complementarity of Multi-wavelength and Multi-messenger Observations

Invited – Joseph D. Romano, Texas Tech University, Lubbock, TX

Just as sight and sound provide complementary information about the everyday world around us, so to do electromagnetic and gravitational-wave observations for celestial objects in the universe. In this talk, I will give examples showing the wealth of information provided by multi-wavelength observations of the electromagnetic sky, and then describe how that picture is enlarged by gravitational-wave observations. References will be made to GW170817, our first multi-messenger observation of a binary neutron star merger.

Session CF: UTeach at 20 Years

Location: Westchester Room **Sponsor:** Committee on Teacher Preparation **Co-Sponsor:** Committee on Physics in Undergraduate Education
Time: 5:30–7 p.m. **Date:** Sunday, Jan. 13 **Presider:** John Stewart

CF01: 5:30-6 p.m. Origins and Consequences of UTeach at The University of Texas at Austin

Invited – Michael Marder, The University of Texas at Austin, Austin, TX

UTeach is a STEM teacher preparation program at The University of Texas at Austin. It started in the fall of 1997, partly as a response to changes in Texas state policy a decade before. The program design was a collaboration between three groups: Master Teachers, who are award-winning former secondary STEM teachers, STEM education research faculty, and research faculty from the College of Natural Sciences. Hallmarks of the program include early and repeated field experiences, emphasis upon content knowledge, emphasis upon inquiry in general and project-based instruction in particular, and attention to constraints on university students including time and money. UTeach eventually expanded across the country, but in addition its example played a role in numerous additional educational developments at UT Austin, including growth of the physics major, and a Freshman Research Initiative. This session will describe these developments.

CF02: 6-6:30 p.m. Strengthening STEM Teacher Preparation Through a National Networked Improvement Community

Invited – Kimberly Hughes, UTeach Institute, The University of Texas at Austin, Austin, TX

20 Years. 44 Universities. 700 Faculty. 4500 Graduates. Ten years ago, UTeach expanded beyond UT Austin and the National UTeach network was born. The UTeach Institute serves as the hub of a vibrant, networked improvement community made up of 44 university-based UTeach secondary STEM teacher preparation programs all committed to developing STEM literacy for all students through innovation and excellence in university-based teacher education. We will share data on our collective impact and discuss the historical development of the UTeach network, how we collaborate to share best practices and address common challenges, and the current challenges we are tackling as a community.

CF03: 6:30-7 p.m. STEM Teacher Preparation at the University of Houston: teachHOUSTON

Invited – Paige Evans, University of Houston, Houston, TX

The University of Houston's (UH) STEM teacher preparation program, teachHOUSTON, is the first replication site of UTeach, a nationally acclaimed program. teachHOUSTON began in 2007 and is a collaboration between the College of Natural Science and Mathematics (NSM), the College of Education, and local school districts and aims to combat the shortage of qualified math and science teachers. The program provides grades 7-12 teacher certification for students obtaining an NSM degree while emphasizing early and ongoing field experiences. This session will examine replicating UTeach, the impact on STEM teacher production, and current initiatives including culturally relevant pedagogy. Additionally, the collaboration between teachHOUSTON and the physics department will be highlighted which has resulted in streamlined degree plans for physics majors and minors, physics courses for both middle school and high school preservice teachers, and grant funded internships and scholarships.

Session CG: PER: Student and Instructor Support & Professional Development, Program and Institutional

Location: Sage Room **Sponsor:** AAPT **Time:** 5:30–6:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** TBA

CG01: 5:30-5:40 p.m. Team-based Instructional Change: Examining Differences in Team Setup

Contributed – Alice R. Olmstead, Texas State University, Dept of Physics, San Marcos, TX

Diana Sachmpazidi, Andrea Beach, Charles Henderson, Western Michigan University

Instructional change efforts involving teams are becoming increasingly popular in higher education. Such teams have the potential to create higher quality outcomes and more sustained improvements than instructors working alone. But not all team-based efforts are successful, and research in this area is limited. We have interviewed 28 leaders of team-based instructional change initiatives and reviewed literature on teams in other contexts. From this, we developed an initial model that delineates important aspects of team setup, and suggests how this is ultimately linked to team outcomes. In this talk, we show our model and highlight some interesting variations in team setup, such as whether project leaders encourage administrators to directly participate on teams, recruit instructors because they teach specific courses, and create fixed boundaries for team membership. We use existing literature to hypothesize about what the underlying causes of these differences might be and consider implications for project leaders.

CG02: 5:40-5:50 p.m. Team-based Instructional Change: Participants' Perspectives

Contributed – Diana Sachmpazidi, Western Michigan University, Kalamazoo, MI

Alice Olmstead , Texas State University

Charles Henderson, Andrea Beach, Western Michigan University

Team-based instructional change efforts are becoming a widely used strategy for improving undergraduate STEM education. However, current literature on this topic is limited. Our goal is to empirically investigate how these teams are set up, work together, and generate positive outcomes. In this talk, we focus on characterizing teamwork processes and understanding the links between inputs, mediators, and outcomes. Data presented represents three different types of teams: interdisciplinary teams, teams initiated within single departments, and teams that are part of cross-campus, multi-discipline initiatives. Individual interviews with team members allow us to explore team members' perspectives on, for example, how their team processes were established, the nature of their collaboration, and how conflicts that emerged during their work were resolved. In the talk, we will connect these results to prior results based on interviews with project leaders.

CG03: 5:50-6 p.m. Epistemological Framing and Mechanistic Reasoning During Collaborative LA Preparation Sessions*

Contributed – Austin C. McCauley, Texas State University, San Marcos, TX

Shahrzad A. Hesaaraki, Jessica Conn, Eleanor W. Close, Texas State University

The physics department at Texas State University has implemented a Learning Assistant (LA) program with reform-based instructional changes in our introductory course sequences. The LA program structure at TXST is informed by the theory of communities of practice. We are interested in how participation in the program influences LAs' reasoning and comprehension of physics concepts. Russ et. al. [1] developed a framework to identify students' mechanistic reasoning, including "chaining." Scherr and Hammer created a theoretical framework to identify student behavior and epistemological framing during collaborative learning activities [2]. We utilize Scherr and Hammer's framework to identify episodes of group engagement in video recordings from weekly preparation meetings, and Russ' framework to analyze LAs' use of higher-level mechanistic reasoning during these episodes. We will describe evidence of collaborative chaining during group engagement episodes, and describe its impact both on the group and in individual students.

*Supported by NSF DUE-1557405, DUE-1431578, and PHY-0808790 [1] Russ et al., Sci. Ed., 92: 499-525, 2008. [2] Scherr & Hammer, Cognition and Instruction, 27(2): 147-174, 2009.

CG04: 6-6:10 p.m. Understanding the Benefits of the Learning Assistant Program Weekly Preparation Session

Contributed – Mel Sabella, Chicago State University, Dept. of Chemistry and Physics, Chicago, IL

Felicia Davenport, Fidel Amezcua Andrea Van Duzor, Chicago State University

The Learning Assistant (LA) Model involves undergraduate students as peer support in STEM classrooms. LAs meet weekly with the instructors, in whose classes they serve, and these weekly meetings provide multiple benefits for the students in LA supported classes, the LAs, and the instructors. Developing a better understanding of these sessions can aid LA Programs in establishing different norms and expectations in the partnerships between LAs and instructors. The Preparation Session Observation Protocol (PSOT) developed by CSU LAs can help support LAs and instructors in reflecting on their weekly interactions and can provide a guide for including more avenues of collaboration. Involvement in collaborative relationships can help LAs feel like valued members, rather than guests, in learning and teaching communities. We present versions of PSOT for researchers and practitioners and draw on the framework of "rightful presence" (Calabrese-Barton & Tan, 2017), used to understand equity-oriented teaching, as a useful lens in analyzing partnerships in the LA Model.

Barton, A. C., & Tan, E. (2017). Designing for rightful presence in STEM-rich making: Community ethnography as pedagogy. * supported by the National Science Foundation (DUE#1524829) and the Department of Education.

CG05: 6:10-6:20 p.m. Applied Physics Workshops for Teacher-Student Teams*

Contributed – Matthew P. Perkins, Coppola Purdue University, Fort Wayne, Fort Wayne, IN

Mark P. Masters, Purdue University Fort Wayne

In June 2018, our university hosted an Applied Physics Workshop for teams of high school teachers and students. Teams worked together to construct multiple apparatus and constructed lesson plans centered on integrating these into the high school curriculum. Apparatus included model demonstrations of NMR and atomic force microscopes, as well as functioning spectroscopes, interferometers, and acoustic levitators. A qualitative research study conducted by Dr. Perkins Coppola investigated the dynamic interaction of high school teachers and students within the workshop. Field notes, interviews, and pre/post testing provided rich insights into how teachers and students interacting with each other during a professional development activity might encourage integration of demonstrations into the teaching curriculum and offer insights as to how to do so.

*Funded with generous support from the William F. and Edith R. Meggers Project award of the American Institute of Physics. https://www.aip.org/aip/awards-and-prizes/meggers

CG06: 6:20-6:30 p.m. Understanding the Structures and Practices of Informal Physics Programs

Contributed – Kathleen A. Hinko, East Lansing, MI

Claudia Fracchiolla, University College Dublin

Dena Izadi, Michigan State University

Many physicists and physics graduate and undergraduate students participate in informal physics education programs that have a goal of engaging youth and public audiences. Often these informal and outreach programs are supported with financial, material, and personnel resources by physics departments, and also may be connected to other campus groups. Thus, to consider how informal physics programs should be best sustained, it is important to understand the structures and practices both within informal physics programs themselves and at the departmental and university levels. Here we report on our initial investigations of several informal physics programs of varying types using a lens of a non-profit organization framework. By using this lens to analyze in depth interviews with program facilitators, we seek to determine the practices and structures that most influence the "success" of these programs.

Session CH: Teacher Training/Enhancement

Location: Tanglewood **Sponsor:** AAPT **Time:** 5:30–6:30 p.m. **Date:** Sunday, Jan. 13 **Presider:** Dan MacIsaac

CH01: 5:30-5:40 p.m. iTEAMS: An Integrated STEM Professional Development Program for Teachers*

Contributed – Jennifer L. Docktor, University of Wisconsin - La Crosse, 2005 Cowley Hall of Science, La Crosse, WI

Gubbi Sudhakaran, Josh Hertel, University of Wisconsin - La Crosse

Jerry Redman, Winona State University

Mike LeDocq, Nicole Cooksey, Western Technical College

A Mathematics and Science Partnerships project at the University of Wisconsin – La Crosse provided professional development (PD) to local teachers in integrating Technology, Engineering, Arts, and Mathematics with Science (iTEAMS). Teachers in high-needs school districts from grades 5-12 participated in summer institutes and ongoing weekend workshops during the two years of the project. The PD was aligned with the Next Generation Science Standards and was designed to include engineering and Lego Mindstorms robotics projects. We will summarize activities and findings from the entire grant project including gains in teacher content knowledge, science teaching efficacy and beliefs, student achievement data, and other impacts of the project

*This project is supported in part by a grant from the U.S. Department of Education via the Wisconsin Department of Public Instruction (DPI). The opinions expressed are those of the authors and do not represent views of the U.S. Dept of Education or DPI.

CH02: 5:40-5:50 p.m. Progress of PSI^3

Contributed – Richard L. L. Pearson, Colorado School of Mines, Golden, CO

Wendy K. Adams, Kristine Callan, Colorado School of Mines

One aspect of our science teacher preparation program, PSI^3 (Partnerships for Science Identity: Three Populations of Active Learners), partners pairs of future secondary teacher candidates with elementary teachers and their students. This partnership is meant to develop science identities to both the elementary teachers and their students, encourage and empower elementary teachers to teach more science activities, present examples of classroom management to the teacher candidates, and to establish vertical articulation expectations with teacher candidates. Topical activity kits are developed and constructed by the candidates in conjunction with the elementary teachers, who then distribute them to the elementary classrooms. The boxed activities provide engaging science learning designed to inspire elementary teachers and their students. Summaries of these activities, initial responses, and challenges will be presented, along with future extensions of the PSI^3 program. This project is supported by 100Kin10.

CH03: 5:50-6 p.m. An Online Master's in Physics to Support In-service High School Physics Teachers

Contributed – William G. Newton, Texas A&M University-Commerce, Department of Physics and Astronomy, Commerce, TX

Robynne Lock, Bahar Modir, Texas A&M University-Commerce

I will report on the progress of a new online Master's in physics designed specifically for in-service high school physics teachers. Piloted as six face-to-face courses to an initial cohort of 7 in 2014-15, there are currently over 60 students enrolled from 16 different states and three countries. The program is intended to help physics teachers by reinforcing their content knowledge, introduce them to advanced physics topics, enhance their teaching by studying the content through the lens of physics education research, and provide access to teaching resources and a community of fellow physics teachers with whom to share ideas and support. In this talk we discuss the challenges of creating a physics Master's program to meet the needs of physics teachers and cater to a variety of backgrounds, and give an overview of the content of our classes.

CH04: 6-6:10 p.m. Improving the Pedagogical Content Knowledge of Teaching Assistants

Contributed – Alexandru Maries, University of Cincinnati, Cincinnati, OH

Being aware of common student alternate conceptions in physics is beneficial when designing instruction to help students develop a coherent knowledge structure. It is thus not surprising that knowledge of common student difficulties is one aspect of what Shulman coined "pedagogical content knowledge", or in other words, knowledge about how to teach a subject that is different from the content knowledge itself. This talk will discuss a semester-long professional development program designed to improve the pedagogical content knowledge of TAs (undergraduate and graduate students teaching recitations) as well as improve their effectiveness as educators. Finally, results from over three years of the implementation of this program will be presented.

CH05: 6:10-6:20 p.m. Enhancing Instruction and Engaging Students Through Theories of Theatrical Magic

Contributed – Philip R. La Porta, Rowan University, Allentown, PA

Educators that have attended any recent professional development workshops have certainly been urged to make sure our students are actively engaged in learning. We are constantly bombarded with information about the importance of, and learn various methods to help increase student engagement. However, the advice we receive and the methods that are taught often ignore an obvious truth: method alone is not enough to ensure students are engaged and learning. Fortunately, we can use theories found in the performance of theatrical magic as a tool for reflective practice. This talk examines five important principles in the performance of theatrical magic and how they can be used to improve our teaching methods and dramatically increase student engagement.

CH06: 6:20-6:30 p.m. 21st Century e-portfolios: Outreach, Tracking and Training with Share & Shine Model

Contributed – Fatih Gozuacik, Harmony Science Academy - Houston, Houston, TX

21st Century; everything has changed, all moved into digital portals. One great way to build up your resume, keep track of your awesome work, do school outreach, attract best students into your AP classes and principal amusement...Benefits don't fit here. I started using Google+, YouTube, and Facebook as an educational tool and it sparkled my teaching way. Parents see and get proud of their kids' work, school yells out that we are a STEM academy, teachers create their name brands... Reaching your society with such tools inspires next generations and increases STEM awareness. You can also use these interactive albums to train other teachers even in other countries! Only thing you need is an internet connection and then "share & shine." In this session you will see how to use and reroute social media, and critical points need to be careful. Best practices of a sharing & shining physics teacher…

Session CI: Pre High School

Location: Post Oak **Sponsor:** AAPT **Time:** 5:30–6:10 p.m. **Date:** Sunday, Jan. 13 **Presider:** Peggy Norris

CI01: 5:30-5:40 p.m. Finding Gifted Underachievers with Spatial Ability in Elementary Science Field

Contributed – Yeon Su Jung, Korea National University of Education Cheongju, ChungBuk 28173 South Korea*

Jung Bog, Kim Korea National University of Education

Spatial ability is an important element in the development of science and learning science. Because instructional strategies and assessment methods are based on verbal skills, gifted students with high spatial ability and low verbal ability tend to underachieve in the school. This study aims to explore the possibility to find underachieved gifted students with high spatial ability and low verbal ability. The participants are 5th grade students in elementary school. Their science academic achievement and understanding about concept of light propagation were analyzed by their spatial ability and verbal ability. This study shows the risk that nominating gifted students using science academic achievement can make the gifted student with high spatial ability and low verbal ability to underachieve. And it shows the possibility that using nonverbal test can find the student with high spatial ability and low verbal ability.

*Sponsored by Jung Bog Kim

CI02: 5:40-5:50 p.m. Where do Students Get their Ideas about What Physics Is?

Contributed – AJ Richards, The College of New Jersey, Ewing, NJ

Cynthia Reynolds, The College of New Jersey

In a previous study investigating middle- and high-school students' attitudes towards physics, we found that most students had strong feelings (often negative) about physics, yet many of them indicated that they had never formally taken any physics courses. This made us curious about how these students developed notions about what physics is and what a physicist does. Since it appears students arrive at the secondary level with these ideas already formed, we have chosen to examine 5th- and 6th-graders' attitudes about physics. In this talk, we will present preliminary findings from this research and speculate on possible explanations and implications.

CI03: 5:50-6 p.m. Bauder Fund Endowment Helps Pre-HS Teachers

Contributed – Ann M. Robinson, Dallas, GA Sharon Kirby

The Bauder Fund Endowment enabled the University of West Georgia to host a workshop to improve the teaching and learning of kinematics for teachers in grades 3-8. Six teachers attended a workshop for 10 hours of instruction. Two PTRA leaders, Ann Robinson, Sharon Kirby, and David Todd were the instructors. The project focused on operational teaching pedagogy to keep participants involved. The topic of kinematics contained content driven activities as well as engineering, literature, and technology lessons. The participants were provided with lesson plans and "make and take" materials to take back to their schools to share with their students and peers. All activities were correlated with the Georgia Science Standards.

CI04: 6-6:10 p.m. Comparison of Creativity Evaluation Among Four Groups about Science-Art Converged Products

Contributed – Arla Go, Korea National University of Education, Heungdeok-gu Cheongju-si, Korea

Jiwon Lee, Korea National University of Education

As a result of various convergence education, students' converged products are being created, but these products are rarely evaluated and the research is also insignificant. Especially, in case of converged products, which are different from general products, it is a question to evaluate by a specialist in one area in relation to the domain general viewpoint or domain specific viewpoints of creativity. Therefore, this study uses the consensual assessment technique (CAT), which is a representative method assessing the creativity of artifacts, to compare results of the creativity assessment of the four expert groups on the converged products of science and art field. The research subjects are 15 shadow arts produced by elementary school science gifted students. The participants are 5 physicists and 5 artists, 10 science teachers and 10 art teachers. In this way, we intend to obtain implications on how to evaluate the converged products.

Session TOP01: Graduate Student Topical Session

Location: Galleria II **Sponsor:** Committee on Graduate Education in Physics **Co-Sponsor:** Committee on Research in Physics Education
Time: 11 a.m.–12:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Lisa Goodhew

This session is the primary opportunity for student members of the PER community to meet and discuss common issues. While this session is aimed toward graduate students, we welcome undergraduates who are interested in studying PER or curious about life as a graduate student!

Session Poster Session 1

Location: Woodway Hall **Sponsor:** AAPT **Time:** 8–9:30 a.m.
Date: Monday, Jan. 14

Persons with odd-numbered posters will present their posters from 8 to 8:45 a.m.; those with even-numbered posters will present from 8:45 to 9:30 a.m. Posters will be available until 4 p.m.

PST1A01: 8-8:45 a.m. Kinesthetic Graphing of Position, Velocity and Acceleration

Poster – Bradley F. Gearhart, Buffalo Public Schools, Grand Island, NY

Over the past seven years, teaching physics in an urban school district to diverse high school students that typically struggle in science has driven me to explore alternative ways to construct kinematic graphs. Using physical dots and arrows to mark the position and velocity of a moving object we are able to skip quantitative data collection and construct x vs. t, v vs. t, and a vs. t graphs in the physical space of the moving object. Most notably, I have seen benefits to my ENL and Special Education students who typically struggle with multiple layers of abstraction; however, increased fluency has been seen across all student populations.

PST1A02: 8:45-9:30 a.m. Momentum First and Gauss (nearly) Last

Poster – Bruce Sherwood, University of North Texas, Argyle, TX

Ruth Chabay, University of North Texas

Aaron Titus, High Point University

Since fundamental physics principles are at the heart of what we want students to learn, our mechanics course is structured around the Momentum Principle, the Energy Principle, and the Angular Momentum Principle. Starting with momentum and 3D vectors establishes the centrality of these concepts, and is surprisingly easy for students. Emphasizing the atomic nature of matter, thermal physics is easily unified with mechanics. E&M starts with the field concept, and this concept remains central throughout the entire semester, even in the analysis of circuits. Gauss's law and Ampere's law are delayed to nearly the end of the semester, to a time when students have become very familiar with patterns of field in 3D space. Magnetic field is introduced very early in the semester, to provide students with a second example of a field, deepening their understanding of the field concept. See matterandinteractions.org.

PST1A04: 8:45-9:30 a.m. Circuit Simulations to Teach the Hodgkin-Huxley Membrane Potential Model

Poster – Mickey D. Kutzner, Department of Physics/Andrews University, Berrien Springs, MI

The understanding of cell membrane resting potentials and action potential transmission in axons can be enhanced by the construction of virtual Hodgkin-Huxley circuits. Students can use the Circuit Construction Kit PhET Interactive Simulation with appropriately scaled voltage sources and resistors to simulate various membrane potentials. Virtual batteries simulate Nernst Potentials for various ion species. Adjustable resistors represent the presence of leakage channels as well as opening and closing voltage-gated ion channels.
https://phet.colorado.edu/sims/html/circuit-construction-kit-dc-virtual-lab/latest/circuit-construction-kit-dc-virtual-lab_en.html

PST1A05: 8-8:45 a.m. Assessing Team-based Learning in General Physics

Poster – Marta L. Dark, Spelman College, Atlanta, GA*

Christopher Oakley

We present our assessment of team based learning activities in our algebra-based sequence for life and health science majors, General Physics. Students work in teams to complete three projects during each semester of the year long course. The project requires teams to research topics, present concepts to the class, and develop models and solutions for the project. After each project concludes, students evaluate the effectiveness of the team's effort in a reflection essay. We also present results of a student survey, which assesses student viewpoints on team-based learning overall. The majority of students rate the group work as helpful to developing their study skills, understanding of physics content, and ability to work in teams.
*Sponsored by Christopher Oakley

PST1A06: 8:45-9:30 a.m. Scripted Tutorials to Guide Troubleshooting Skills

Poster – Duane H. Pontius, Birmingham-Southern, Birmingham, AL

We present a series of contextually rich problems in introductory mechanics for presentation to students in a tutorial setting. Each has a scripted solution that deliberately includes common students errors. Instructors present the solution during a recitation section and carefully present the work leading to the errors, thus demonstrating good problem solving work habits. The errors are "discovered" by methods commonplace to working physicists, e.g., estimation, approximation, unit checking, and examining special cases of algebraic solutions. Students then work a similar problem, and the grading rubric explicitly requires including those same steps in their own solutions. Our goal is to illustrate the utility of these practices and to motivate our students to adopt them. Physics majors are required to use these methods in advanced classes, and each major also serves one term grading tutorial solutions from the introductory course.

Other Posters

PST1B01: 8-8:45 a.m. Measuring Sensitivity to Initial Conditions in Rigid Body Dynamics

Poster – Madeline Carter, University of St. Thomas, Houston, TX

Joseph Gutheinz, James Clarage University of St. Thomas

Our experiment concerns the mathematical and experimental observation of a sensor-enabled parallelepipedal object in free-fall to test sensitivity to initial rotation conditions. The independent variable was the axis along which the parallelepipedal object rotates, with the expectation that the intermediate or z axis (where the lengths of the object are: $x > z > y$) would produce greater sensitivity to initial conditions in accordance with the interpretation of the mathematics driving the expected motion of the object. To test the predictions of theory, an experiment was devised wherein we went to the top of our university science building and did controlled drops of a PASCO Smart Cart off of a ledge along all three axes. This allowed the cart to experience free fall, drag force, and rotation along all three axes. The data were parsed and modeled using code written in Mathematica allowing for quantitative analysis of the experimental results.

PST1B02: 8:45-9:30 a.m. 2019 AAPT-MX National Meeting

Poster – Sergio Flores, Universidad Autonoma de Juarez Batopilas, Chihuahua 31320 Mexico

Mario Ramirez, Instituto Politecnico Nacional

Maria Dolores Gonzalez, Instituto Tecnologico de Juarez

The chapter Mexico of AAPT (AAPT-MX) was born in 2008, and since has organized an annual national meeting. The first in Monterrey, later in Mexico City, Guanajuato, San Luis Potosí, Tabasco, Ensenada, Guanajuato, UNAM, Cancun, San Luis Potosí and celebrating the 10th anniversary in Monterrey in 2018. To the 2019 AAPT-MX meeting was selected Ciudad Juárez in the campus of the Universidad Autónoma de Ciudad Juarez Mexico. In this meeting we will be looking for the union of math and physics education. The meeting will be developed in December and every teacher of all educational levels in and out of Mexico are invited. The official announcement will be published in July 2019. We will be waiting all of you in Ciudad Juarez 2019 AAPT.MX meeting

PST1B03: 8-8:45 a.m. Induction Motor Demo for STEM Outreach

Poster – Daniel J. Huerta, University of Arkansas, POETS REU 2001, College Station, TX

The Center for Power Optimization of Electro Thermal Systems (POETS) aims to improve power density through interdisciplinary research involving electrical, mechanical, and materials science methods. POETS also has education goals for outreach in students to promote interest in STEM fields and careers. To help aid in outreach at the four POETS institutions, an outreach demo involving different STEM topics was decided on by POETS administration. This demo would involve an electromagnetic phenomenon, an induction motor that shows principles such as Faraday's Law and alternating current. To present this, information on how the motors worked, including mathematical equations and visual models, was collected, as well as how to best communicate science principles to a variety of audiences in different age groups. It was decided to use models, visual aids, and use Arduino on the demo to illustrate the magnetic field. This demo will be used at all POETS institutions for outreach.

PST1B04: 8:45-9:30 a.m. Record of Rheology: Documenting Past Bingham Medal Winners

Poster – Mikayla Lorraine Cleaver, American Institute of Physics and the Society of Rheology, Collegeville, PA*

The year 2029 will be the 100th Anniversary of the founding of the Society of Rheology. In preparation for the centenary, I have been compiling precise and engaging biographies of past Bingham Medal winners to be uploaded to the Society of Rheology webpage, as well as to the Physics History Network on the American Institute of Physics (AIP) website. I have also been promoting higher engagement with the members of the society through the use of social media via the Niels Bohr Library and Archives (NBLA) Facebook and Twitter. Why is it important to do this? Studying the history of science allows us to learn about the great men and women in science and their accomplishments that moved the scientific community forward. This project will help preserve the history of the Society of Rheology for future generations of members.

*Sponsors: American Institute of Physics, Society of Rheology

PST1B05: 8-8:45 a.m. Practical Method for Measuring Coefficient of Thermal Expansion Using Interferometry

Poster – Abdallah M. Kiswani, Seminole State College, Sanford, FL

Robert Bellentine, Sherry L. Savrda, Seminole State College

Latifah Maasarani, University of Central Florida

A basic student Michelson interferometer was used to measure the coefficient of expansion of a copper rod. The heating mechanism was a standard PASCO thermal expansion apparatus, adapted to heat without the use of steam. A similar experiment was previously described in The Physics Teacher1. In our version of the experiment, we adapted the procedure to use only equipment available at our state college. The success of our measurements demonstrated the feasibility of using interferometry in settings with limited equipment availability, such as state or community colleges.

1. "Using a Michelson Interferometer to Measure Coefficient of Thermal Expansion of Copper." Ryan Scholl and Bruce W. Liby, The Physics Teacher; 47, 306 (2009).

Technologies

PST1C01: 8-8:45 a.m. Deepening Physics Understanding with Types and Higher-order Functions

Poster – Scott N. Walck, Lebanon Valley College, Annville, PA

We show how a typed functional programming language can be used for a course in computational physics or to provide a computational component in introductory or upper-level physics courses. A language with types and higher-order functions (such as the functional programming language Haskell) is particularly well-suited to express the ideas of basic theoretical physics. The fundamental notions of mechanics, waves, electromagnetic theory, and quantum mechanics find commonality in the ideas of state and state update. A language with a rich set of types allows the clear specification of the state of a physical system by a type. A language with higher-order functions allows one to concisely and elegantly express ideas such as numerical integration and the Euler method. Asking students to express the ideas of theoretical physics in such a language and to solve problems using this language can deepen their insight and understanding of physics. We give examples of student assignments ranging from solving a mechanics problem to expressing the Biot-Savart law to animating the state of a qubit.

PST1C02: 8:45-9:30 a.m. Science for the Modern World

Poster – Donald G. Franklin, Hampton, GA

Using existing ebooks, build a syllabus that reflects your syllabus. Now because of having online textbooks, you can design a course and have a "text" that your students can use, with no or very little, cost. My model is designed for Pre Med students, so the course uses Nuclear Physics as the first Chapter. The ebook is available to use at Openstax.college. You can design any course syllabus without having multiple texts for your students to buy in cooperation with your IT team at your school.

Astronomy

PST1D01: 8-8:45 a.m. Archaeoastronomy at Garden Creek

Poster – Mikayla L. Absher, Appalachian State University, Boone, NC

Alice Wright, Appalachian State University

Between the 1960s and the 2010s, archaeological fieldwork at the Garden Creek site (31Hw2, 31Hw8) in Haywood County, North Carolina revealed monumental earthworks dating to the Middle Woodland period (ca. 300 BC -- AD 600). Artifacts recovered from Mound No. 2 and Enclosure No. 1 have been interpreted as evidence for ceremonial exchanges between communities in the Appalachian Summit and in the Ohio River Valley as part of the wider Hopewell Interaction Sphere. Ongoing assessment of the architecture of Enclosures No. 1 and 2 provide additional support for this interpretation. In this poster, we present evidence for possible solar and lunar alignments associated with Garden Creek's enclosures, and discuss how these alignments compare to well-known archaeoastronomical patterns observed at Scioto Hopewell sites in Ohio.

PST1D02: 8:45-9:30 a.m. Updates to the Astronomy4Kids Online Video Education Outreach Program

Poster – Richard Luther Pearson, Astronomy4Kids, Denver, CO

Recent research indicates significant benefits of early childhood introductions to language, mathematics, and general science concepts. Specifically, a child that is introduced to a concept at a young age is more prepared to receive it in its entirety later. Astronomy4Kids was created to bring science, technology, engineering, and math (STEM) concepts to the youngest learners (those under the age of eight, or those from pre-school to about second-grade). The online video series are presented in a succinct, one-on-one manner, and provide a creative learning environment for the viewers. These can be used within formal and informal education settings and hope to give young children access to an expert astronomer/scientist who can explain things simply and sincerely. We believe presenting the material in this manner will make it engaging for even the youngest scholar and available to any interested party. The videos can be freely accessed at www.astronomy4kids.net or www.youtube.com/astronomy4kids .

Physics Education Research I

PST1E01: 8-8:45 a.m. Student Attitudes Towards Rubric-Based Peer-Review of Problem Solving

Poster – Andrew D. Bartholet, University of Nebraska at Omaha, Omaha, NE

Christopher Moore, University of Nebraska at Omaha

We have investigated student attitudes towards rubric-based peer review of problem solving in the introductory physics course. Students in a first semester calculus-based introductory physics course participated in a Cooperative Group Problem Solving (CGPS) session and then completed individual context-rich problems as homework. A detailed problem-solving rubric based on research in expert-like problem solving was used as both a scaffold for the student and for assigning a grade. After submission of individual problems, students were randomly assigned three of their peer's work to assess using the rubric through an online learning management system. We have developed and implemented an affective inventory to measure student attitudes towards the peer-review process, rubric-based grading, and structured problem solving.

PST1E02: 8:45-9:30 a.m. Student Authorship Patterns in Physics and Chemistry at PUI's

Poster – Birgit Mellis, University of St. Thomas, Houston, Houston, TX

Patricia Soto, Creighton University

Chrystal D. Bruce, Graciela Lacueva, John Carroll University

Anne M. Wilson, Rasitha Jayasekare, Butler University

For undergraduate students, involvement in authentic research represents scholarship consistent with disciplinary quality standards and an integrative learning experience. The communication of the research results via presentations or publications is a measure of the level of scientific engagement. The empirical study presented here focuses on the research experiences of undergraduates at four Primarily Undergraduate Institutions (PUIs) in physics and chemistry over a time frame of 10 years. Descriptive statistics and generalized linear mixed models with hierarchical bootstrapping were used to examine how gender of research participants and discipline of study impact the means of dissemination of undergraduate research results. Our analysis indicates a small gender effect in physics, resulting in a lesser likelihood of female students to author a research outcome than male students. Gender effects on undergraduate student authorship in chemistry are not detectable.

PST1E03: 8-8:45 a.m. Team-based Instructional Change: A Model of How Teams Become Successful

Poster – Diana Sachmpazidi, Kalamazoo, MI

Alice Olmstead, Texas State University

Charles Henderson, Andrea Beach, Western Michigan University

Recently there has been a shift from only supporting instructors working individually to supporting teams in working together to improve undergraduate STEM instruction. Such efforts are promising in their potential to generate not only sustainable instructional changes, but also high-quality outcomes. However, as in any collaboration, there are risks that such teams will not be as successful as planned. Literature about teams in this context is currently very limited. In this poster, we investigate the relationships between the way teams are set up, teamwork processes, and team outcomes. We highlight important aspects of how teams work together, such as shared vision, team cohesion, interpersonal processes, social interactions, and consider how these aspects shape the team outcomes. We show how this data from team members enhances our initial model of instructional change teams, and present implications for research and practice.

PST1E04: 8:45-9:30 a.m. Development of Resources-oriented Instructional Materials for Introductory Physics

Poster – Lisa M. Goodhew, University of Washington, Seattle, WA

Amy D. Robertson, Rachel E Scherr, Seattle Pacific University

Paula R. L. Heron, University of Washington

Research-based instructional materials in physics have historically been informed by investigations of students' common misunderstandings, misconceptions, or difficulties – that is, ways in which student ideas are discontinuous with canonical understandings. In our previous work, we have identified common student resources for understanding physics – ways in which student ideas are continuous with canonical understandings. We describe the development and preliminary testing of small-scale instructional materials that elicit and build upon some of these common conceptual resources. We discuss some affordances of resources-oriented instructional materials that emerge from video analysis of preliminary use of these materials in small groups of introductory physics students.

PST1E05: 8-8:45 a.m. Updating the Inclusive Teaching Strategies Inventory for Postsecondary Physics Instructors

Poster – Jacquelyn J. Chini, University of Central Florida, Orlando, FL

The Inclusive Teaching Strategies Inventory (Lombardi, Murray and Gerdes, 2011) measures faculty attitudes and actions regarding inclusive teaching across six constructs: (a) multiple means of presentation; (b) inclusive lecture strategies; (c) accommodations; (d) campus resources; (e) inclusive assessment; and (f) accessible course materials. The survey has been used with a diverse sample of instructors from multiple disciplines, institutions, institution types, and countries. However, I used the survey with a group of physics and chemistry faculty and graduate teaching assistants who had difficulty interpreting multiple items. This poster will present potentially problematic items for this group, provide possible modifications to those items, and seek colleagues' feedback on the updated items.

PST1E06: 8:45-9:30 a.m. "Success in Physics Is Like…" – A Researcher-participant Co-analysis

Poster – Brian Zamarripa, Roman University of Central Florida, Orlando, FL

Jacquelyn J. Chini, University of Central Florida

Researchers and instructors tend to frame success in physics as academic achievements, such as degree attainment and high assessment scores; however, these views of success may not represent the views of marginalized groups in physics. To address this, we explore women's metaphors of success in physics elicited during semi-structured interviews. In addressing equity issues, we implemented co-analysis to empower participants, challenge researcher biases, and provide valid interpretations of their metaphors. We present structural metaphors that emerged from the participant responses as well as the factors they attribute their success to. In this interactive poster we involve the audience in the creation and interpretation of their own metaphors to engage them in the discussion of what is success in physics and to demonstrate some of the co-analysis methods employed in our study.

PST1E07: 8-8:45 a.m. A New Survey: Faculty Perceptions of Teaching as a Profession

Poster – Richard Luther Pearson, Colorado School of Mines, Golden, CO

Wendy K. Adams, Savannah Logan, Colorado School of Mines

Following the development of the Perceptions of Teaching as a Profession (PTaP) survey—which measures students' interest in and view of teaching as a career—we outline our development and validation efforts pertaining to a new instrument that measures university faculty's perceptions of teaching as a profession. We have conducted faculty interviews and collected survey responses from a range of institutions and STEM disciplines. Categorical data, preliminary results, and responses will be highlighted. This project is supported by NSF DUE-1821710.

PST1E08: 8:45-9:30 a.m. An Exploration into Student Conceptions in Physics through Writing Activities

Poster – Robert P. Dalka, University of Michigan, Randall Lab, Ann Arbor, MI*

Timothy McKay, University of Michigan

This study is an investigation into a series of three writing-to-learn (WTL) activities implemented throughout a full semester of an introductory physics course for engineers and scientists enrolling more than 650 students. These WTL activities involved students responding to a prompt that put them in a real world scenario with tangible questions. Each activity featured three parts; a First Draft, Peer Review, and Revised Draft. Both qualitative and quantitative analysis of the students' work will be employed to develop a richer picture of a student's evolution of understanding and possible sources of conceptual misinterpretations. Results of categorizing different modes of understanding will be presented through a topic modeling approach. The level of understanding and score students receive on these assignments will be compared to student performance in other aspects of the course.

*Sponsored by Timothy McKay

PST1E09: 8-8:45 a.m. Applying the Energy Conservation Principle: Two Contrasting Reasoning Frames

Poster – Andrew Boudreaux, Western Washington University, Bellingham, WA

Luke Westbrook, Emily Borda, Western Washington University

The conservation principle is an important component of a model for energy. We have identified two frames, or approaches, that novices and experts seem to adopt when reasoning about energy conservation. The first, referred to as "system-frame" reasoning, involves defining a system, tracking energy inputs and outputs across the system boundary, and relating those transfers to an accumulation or depletion of the energy contained within the system. This approach is familiar to physics instructors and is found in many textbooks. The second approach, "energy-frame reasoning," involves identifying some initial amount of energy and "following" that energy as it transfers and transforms in a sequence of interactions, until that energy is fully accounted for. This reasoning approach does not necessarily include a strong definition of a system. In this poster, we present examples of these reasoning approaches drawn from a set of interviews conducted with undergraduate physics majors.

PST1E10: 8:45-9:30 a.m. Collaborative Chaining: A Proposed Mechanism for Learning in Interactive Instruction*

Poster – Shahrzad A. Hesaaraki, Texas State University, Austin, TX

Austin McCauley, Jessica Conn, Eleanor W. Close, Texas State University

Many studies show that interactive instruction leads to greater student conceptual learning [e.g., Freeman et. al., 2014; Von Korff et al., 2016]. Fewer studies describe possible mechanisms for this increased learning. We propose that interactive learning environments facilitate "collaborative chaining": shared construction of chains of causal mechanistic reasoning leading to improved understanding by all members of the group. In our current study, we examine video records of Learning Assistant (LA) preparation sessions for evidence of collaborative chaining. In these preparation sessions, LAs work in small groups to complete the same instructional activities as introductory students. Though they have already successfully completed the course in which they assist, LAs often have more to learn, and they are highly motivated to develop their understanding and reasoning in order to be prepared for student questions. This setting can serve as a model of what good group work looks like in introductory courses.

*Supported by NSF DUE-1557405, DUE-1431578, and PHY-0808

PST1E11: 8-8:45 a.m. Computational Modeling in Intro Physics: Assessing Student Learning

Poster – Ruth Chabay, University of North Texas, Dept of Physics, Denton, TX

Bruce Sherwood, University of North Texas

Aaron Titus, High Point University

In order to improve our instruction in computational modeling in physics, we need to assess what students have learned and identify areas where our instruction could be improved. In a calculus-based introductory physics course that integrates computational modeling, portions of our lab practical exams at the end of both first and second semester focused on computational modeling. We discuss our goals for student learning and the tasks we used to assess them, and compare the performance of students with no previous computing experience with that of experienced computer science majors.

PST1E12: 8:45-9:30 a.m. Effect of Peer Review on Students' Problem-Solving Ability Development

Poster – Taylor Crouch, University of Nebraska-Omaha, Omaha, NE

Christopher Moore, University of Nebraska-Omaha

We are continuing to investigate the effects of peer-review on students' problem-solving ability in an introductory physics course. We compare the results of two groups' pre/post-test results where one group participates in a peer-review process. Both groups received identical instruction in lecture and Collaborative Group Problem-Solv-

ing (CGPS) sections. Then, individual students would submit problem solutions online to be evaluated through a problem-solving process rubric that was used throughout the course. The treated group would be randomly assigned three students' work to peer-review, whereas the control group would only receive instructor feedback. This experiment will compare the results from the two groups over a five-week period.

PST1E13: 8-8:45 a.m. The Chi Sci Scholars Program: Efforts to Develop Community for Incoming First Year and Transfer Students at an Urban Institution*

Poster – Gabrielle Jones Hall, Chicago State University, Department of Chemistry and Physics, Chicago, IL

Jayla McClure, Kristy Mardis, Mel S. Sabella, Chicago State University

Ensuring that all students who want to pursue degrees and careers in science can do so is an important goal of a number of equity programs in college STEM throughout the United States. The CSU Chi Sci Scholars (CSS) program brings in ideas and activities from the Berkeley Compass Program, the Access network and other programs to support students in building science identity and creating a close knit cohort of peers. The Chi Sci Scholars program builds on the resource of community to retain and grow the number of underrepresented students entering the Physical Sciences. In this poster we focus on the efforts we have put in place to develop community within our cohort of scholars, specifically focusing on our summer program and retreat as well as our new mentoring program.

* Supported by the National Science Foundation (NSF DUE # 1356523), the Department of Education, and the CSU Center for STEM Education and Research.

Plenary: Growing Up Feynman — Michelle Feynman

Location: Galleria Ballroom I **Time:** 9:30–10:30 a.m. **Date:** Monday, Jan. 14 **Presider:** Chandralekha Singh

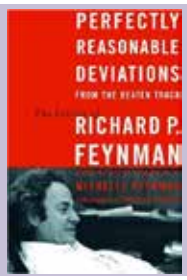
Michelle Feynman

In 1977, when she was only nine years old, Michelle's adventurous parents, Richard and Gweneth Feynman decided they had to visit Tannu Tuva, a mountainous country nestled between the Soviet Union and Mongolia, almost on a whim. Their motivation was fueled, oddly, by Richard's childhood curiosity over the culture's exotic stamps and the quizzical spelling of the forgotten nation's capital city. But Richard didn't want special treatment. He wanted to get there on a more basic level. That famously quirky stubbornness of Richard Feynman meant he would wait eleven years before being granted a travel visa to Tuva. To explain and elaborate on her father's quirky perspective and personality, Michelle presents an unprecedented, intimate look at what it was like to grow up as a Feynman, complete with vivid personal stories and vibrant photographs. Richard loved public games, catching people off guard, and challenging Michelle's math teachers, much to her embarrassment. It wasn't until she was much older that Michelle learned that her father was even considered a genius. Her experience was with that of a loving, clumsy, forgetful, but hard-working teacher that never took himself too seriously. In 1988, Richard finally received permission from Moscow to travel to Tuva, but it was too late. Richard had passed the day before. Twenty-one years later Michelle was given the opportunity to visit Tuva in her father's place. She will close by sharing this deeply personal and emotional experience.

Join us for a book signing in the Exhibit Hall!

Michelle Feynman, book signing
Monday, January 14
10:30–11:00 a.m.
Exhibit Hall - AAPT Booth

Perfectly Reasonable Deviations From The Beaten Track: The Letters Of Richard P. Feynman



Session DA: 100 Years of Experimental Relativity

Location: Plaza Ballroom I **Sponsor:** Committee on History and Philosophy in Physics **Time:** 11 a.m.–12:20 p.m. **Date:** Monday, Jan. 14
Presider: Svilen Kostov

DA01: 11-11:30 a.m. Einstein's Jury: Trial by Telescope

Invited – Jeffrey Crilinsten, The Impact Group, Toronto, ON M5T 2C7 Canada;

While Einstein's theory of relativity ultimately laid the foundation for modern studies of the universe, it took a long time to be accepted. Its acceptance was largely due to the astronomy community, which at Einstein's urging undertook precise measurements to test his astronomical predictions. This paper focuses on astronomers' attempts to measure the bending of light by the sun's gravitational field. The work started in Germany and America before Einstein had completed his general theory, which he published during the depths of the First World War. Only a handful of astronomers, including Arthur Stanley Eddington in England, could understand the theory. Most astronomers were baffled by it and focused on testing its empirical predictions. The well-known 1919 British eclipse expeditions that made Einstein famous did not convince most scientists to accept relativity. The 1920s saw numerous attempts to measure light bending, amid much controversy and international competition.

DA02: 11:30-12 p.m. Modern Eddington Experiment

Invited – Donald Bruns, Stellar Products, San Diego, CA

William A. Dittrich, Portland Community College

Svilen Kostov, Georgia SW State University

The Modern Eddington Experiment (MEE) was performed by many teams during the Great American Eclipse in August 2017. The experimental method used by the successful teams will be discussed and compared to the methods used in prior experiments. Three MEE experiments obtained positive results of varying accuracy. The accuracies ranged from similar to previous attempts (10%) to a fantastic result of less than 1% result error and 3% uncertainty error. These results will be summarized, explaining why the best MEE result is 250 times better than ever before. A "MEE Lab Manual" for future eclipse experiments in 2019 and 2024 will be outlined, with the aim to perform the MEE with many college experimental teams in the next great eclipse in 2024.

DA04: 12-12:10 p.m. Original Derivation of Einstein's $E=mc^2$

Contributed – Ajay Kumar Sharma, Fundamental Physics Society, GPO Shimla Shimla, HP

In his paper Einstein derived $\Delta L = \Delta mc^2$ (light energy –mass equation). It has not been completely studied; it is only valid under special conditions of the parameters involved e.g. number of light waves, magnitude of light energy, angles at which waves are emitted and relative velocity v. Einstein considered just two light waves of equal energy, emitted in opposite directions and the relative velocity v uniform. There are numerous possibilities for the parameters which were not considered in Einstein's derivation. $\Delta E = \Delta mc^2$ is obtained from $\Delta L = \Delta mc^2$ by simply replacing L by E (all energy) without derivation. If all values of valid parameters are taken into account then the same derivation also gives $L\ \Delta mc^2$ or $L = A\ \Delta mc^2$, where A is a coefficient of proportionality. Thus Einstein's derivation under valid parameters also predicts that energy emitted may be less than or more than $\Delta L = \Delta mc^2$

DA05: 12:10-12:20 p.m. Gamow, Hoyle, Popper and The Big Bang

Contributed – Svilen D. Kostov, Georgia Southwestern State University, Americus, GA

The birth and rise of the Big Bang model during the 40s, 50s, and its success over the Steady State model in the 60s was, in addition to high drama in the arena of fundamental science, also a milestone test case for the relatively young discipline of philosophy of science. The defining moments of this debate are examined and the role of three larger than life personalities, two in science, George Gamow and Fred Hoyle, and one in philosophy, Karl Popper, are discussed

Session DB: 30 Demos in 60 Minutes

Location: Galleria III **Sponsor:** Committee on Teacher Preparation **Co-Sponsor:** Committee on Physics in High Schools
Time: 11 a.m.–12:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Wendy Adams

Our panel of physics teachers will present at least 30 dynamic demonstrations that will engage students in the wonder of science. Presenters will share tips on the setup, materials, procedure, and underlying science concepts so the audience can integrate these demos into their own classrooms.

Session DC: Drones and VR: Examples of Emerging Educational Technologies Across the World

Location: Westchester Room **Sponsor:** Committee on Educational Technologies **Co-Sponsor:** Committee on International Physics Education
Time: 11 a.m.–12:20 p.m. **Date:** Monday, Jan. 14 **Presider:** Shahida Dar

DC01: 11-11:30 a.m. VR as a Medium for Physics Education

Invited – Daniel Wickeroth, University of Cologne, NRW 50931 Germany

With the advent of the second hype around Virtual Reality (the first having occurred in the late 90s) VR is currently again being widely discussed as a medium for education in general, and physics education specifically. This talk will illuminate the challenges and chances of using VR for this purpose by giving an overview of the technology itself and its use at the University of Cologne. Therefore, a brief introduction into VR will be given, and a carefully chosen subset of the current VR hardware will be discussed. We will show educational projects at the university of cologne with a focus on Physics in Biology and Engineering Context, including fluid dynamics simulation and customized collaboration techniques for heterogeneous hardware configurations. Finally, we will provide examples that a modern Game Engine that can be downloaded and used for free is actually a simple and very powerful way to get started in Virtual Reality.

DC02: 11:30-12 p.m. Drones Are Fascinating – And they Carry a Lot of Physics

Invited – Andre Bresges, University of Cologne, NRW 50931 Germany

Drones are literally everywhere. Once expensive toys, they rapidly became serious tools for filmmakers and hobbyists. Currently, we see them entering the mass market as a lifestyle device, supplying countless numbers of youtube channels with video footage. Their attractivity for students makes them a good tool for teachers to deliver lessons in physics. We use the Airblock Drone in introductory courses of mechanics to apply Newton's Laws to win a classroom competition, the "Drone Petanque". Students can measure the speed and mass of the airflow that is necessary to keep the drone maintaining altitude, and put it in relation to its mass. In hovercraft mode,

they can measure the trust that the fans produce directly and put it in relation to its mass and acceleration. Using Vernier Video Physics or another videography tool, students can estimate the acceleration, cruise speed, and braking distance of the drone. They combine all their knowledge when they programme a route for the drone using the SCRATCH programming language. The task is to program the drone to fly along a course using only "dead reckoning", alas flying a given direction for a given time, and land as close as possible to a target. Since no GPS and optic guidance is available, student's knowledge about speed, acceleration, and thrust manipulation is essential to win. This marks the end of a STEAM Physics course that combines physics, engineering and programming skills to win in our "Drone Petanque" Competition.

DC03: 12-12:10 p.m. 1000' Classroom: How 3D Printing and Drones Got Us There

Contributed – Derek C. Segesdy, Pomfret School, Pomfret, CT

Josh Lake, Pomfret School

Encouraging students to truly visualize the interplay of gravity and air resistance on objects in free fall can be challenging, especially if you teach at a school that doesn't allow you on the roof. Rather than bringing students to a high bridge or structure, we took to the skies by unleashing the power and control of commercially available drones. This talk will focus on the design and use of a 3D printed box and laser-cut acrylic pieces to construct a functional 'drone dropper.' Attaching the box to the base of a DJI Phantom allowed us to bring students' payloads up dozens or hundreds of meters, drop them repeatedly, and take meaningful data. Student payloads included balls of different masses, student designed parachutes, Arduino imaging equipment, and a Doppler Effect demonstration. The results are lively and exciting outdoor experiments that students enjoy and remember, contributing significantly to their learning outcomes.

DC04: 12:10-12:20 p.m. Communicating Special Relativity Through Simulation in Virtual Reality*

Contributed – Jared Phelps Canright, University of Washington, Department of Physics, Seattle, WA

Peter Shaffer, University of Washingto,n Department of Physics

The What Is Relativity project is a virtual reality (VR) special relativity simulator, visualizer, and educational tool in development based on MIT Game Lab's OpenRelativity package for the Unity game engine. With GPU-based shaders used for graphics in gaming, relativistic effects can be simulated for objects undergoing arbitrary motion. What Is Relativity is intended as a formal and informal educational tool to teach special relativity using laboratory-like experiences, with the speed of light and progression of time controllable to allow for detailed examination of relativistic effects. Here, we present some details of the What Is Relativity engine's adaptation from OpenRelativity and describe the development and initial educational efficacy test results of instructional scenes built in the engine.

*This project is funded by an AAPT Bauder Fund Grant, the ARCS Foundation Seattle Chapter, and the NSF Graduate Research Fellowship Program.

Session DD: My Favorite Demo that Works – How & Why?

Location: Sage Room **Sponsor:** Committee on Apparatus **Time:** 11–11:50 a.m. **Date:** Monday, Jan. 14 **Presider:** Robert Hobbs

DD01: 11-11:10 a.m. Speaker Powered Chladni Plates and SPS Outreach*

Contributed – Amanda Williams, Society of Physics Students, Idyllwild, CA

Ideally, a demo can both elicit a sense of awe from the audience and emphasize a physics concept(s) in a tangible way. Chladni plates are metal plates with sand sprinkled on them that show the plate's various vibrational modes. They're often played with a violin bow, and in front of a crowd. Playing a Chladni plate through a speaker and amplifier elicits a similar response, and is adapted to be interactive with participants. Through Chladni plates, one can reinforce concepts such as resonance, properties of waves, and acoustics. 100 of these demos were made this summer and can be requested for free to SPS chapters across the country, known as the SPS Science Outreach Catalyst Kit (SOCK). Including explanations to different audiences, the SOCK provides all tools necessary to undergraduate students to successfully foster curiosity and passion for physics through public outreach.

*The Society of Physics Students funded the creation of the SOCK and the intern who made it.

DD02: 11:10-11:20 a.m. Simple Centre of Mass Demonstration

Contributed – Tetyana Antimirova, Ryerson University, Toronto, ON M5B 2K3 Canada

Simple demonstrations on centre of mass can be performed by balancing everyday objects. Try to hold a metre stick on the top of your hands when the hands are far apart. What happens if you try to bring your hands together, moving the forefingers supporting the object from beneath towards one another very slowly? It is often assumed that the stick will become unbalanced in the process of moving the fingers. However, the opposite is true: it is rather difficult to make the long stick lose its balance. The session attendees will discuss what physical concepts can be learned from this simple demonstration.

Session DE: Ordering of Topics

Location: Tanglewood **Sponsor:** Committee on Physics in Two-Year Colleges **Co-Sponsor:** Committee on Physics in High Schools
Time: 11 a.m.–12 p.m. **Date:** Monday, Jan. 14 **Presider:** Karie Meyers

DE01: 11-11:10 a.m. Learning Goal Oriented Topic Order

Contributed – Thomas W. Herring, Western Nevada College, Carson City, NV

A description of the motivation and results from a learning goal oriented redesign of a two semester calculus-based physics sequence taught at a small two-year college. The identification of broad concept learning goals such as, "Describe how objects move through space" motivated a change in the usual order of topics compared to that of a typical text. The learning goal oriented order of both first and second semester calculus-based physics courses will be presented. Student gains and losses in both conceptual and quantitative assessments will be addressed as well as changes in student attitudes towards some topics.

DE02: 11:10-11:20 a.m. Learning Physics: Ordering Topics, Concepts and Applications

Contributed – R. Daryl Pedigo, University of Washington, Department of Physics, Seattle, WA

Which should come first? Should it be conservation laws or forces? Should concepts and principles precede, follow, or be integrated with equations and applications? Should we build each topic to generality by studying simple cases first, or begin with the general treatment and then specialize? These considerations are not only related, but are all necessary elements in structuring a coherent physics course to foster learning at any level. The presentation will draw upon anecdotal evidence from four decades of teaching experience almost equally divided between a large community college and a major university. A bit of actual supporting evidence will also be offered.

DE03: 11:20-11:30 a.m. Momentum First and Gauss (nearly) Last

Contributed – Bruce Sherwood, University of North Texas, Argyle, TX

Ruth Chabay, University of North Texas

Aaron Titus, High Point University

Since fundamental physics principles are at the heart of what we want students to learn, our mechanics course is structured around the Momentum Principle, the Energy Principle, and the Angular Momentum Principle. Starting with momentum and 3D vectors establishes the centrality of these concepts, and is surprisingly easy for students. Emphasizing the atomic nature of matter, thermal physics is easily unified with mechanics. E&M starts with the field concept, and this concept remains central throughout the entire semester, even in the analysis of circuits. Gauss's law and Ampere's law are delayed to nearly the end of the semester, to a time when students have become very familiar with patterns of field in 3D space. Magnetic field is introduced very early in the semester, to provide students with a second example of a field, deepening their understanding of the field concept. See matterandinteractions.org.

DE04: 11:30-11:40 a.m. Project-based Introductory Physics Course

Contributed – Ian H. Redmount, Saint Louis University, St. Louis, MO

For two decades I have explored a novel approach to the calculus-based introductory physics course: a series of projects, extensive examples which students explore in as much depth and detail as their mathematical backgrounds will stand, learning the principles of physics along the way. For example: The flight of a model rocket, with and without aerodynamic drag, introduces Galilean kinematics, Newtonian dynamics, the process of approximation, and even Einsteinian kinematics and dynamics. A billiards shot illustrates the mechanics of collisions and rotation; the details of an actual Moon flight the laws of Universal Gravitation and Planetary Motion. Calculating the classical radius and the gyromagnetic ratio of the electron introduces electrostatics and magnetism; the Maxwell equations and their consequences are applied to the problem of radio communication with a submarine. This approach has given rise to a new textbook, and notable student success.

DE05: 11:40-11:50 a.m. Waves Before Mechanics

Contributed – Deborah Roudebush, Fairfax, VA 22033

Beginning the year with waves, sound and light starts things off with topics of personal interest to most students. This approach has the advantage of leading off with constant velocity concepts, saving for later the most challenging topic of all : acceleration

DE06: 11:50-12 p.m. The Order of Topics Doesn't Matter (...But It Really Does)

Contributed – Corey Gerving, United States Military Academy, West Point, NY

In the late 20th Century, student attitudes towards introductory physics at West Point had reached an all-time low. An increasing number of failures were occurring on the final exam that had seen acceptable scores in previous iterations of the course. The assessment was made that students were not seeing the relevance of the material to their future profession. The program director revised the entire two-course sequence around a fictional road to war, where the material in the course was taught in the order one would expect to see it on the battlefield. The topics started with nuclear physics as part of a hostile act towards an ally. Next the students learned geometric and wave optics as part of the reconnaissance of the battlefield phase, and so on. Initial student interest immediately increased, and performance also improved. However, after several years of teaching in this order, we decided to return to the typical order of teaching introductory physics. This talk will explore the decision making process of both sequences.

Session DF: PhysTEC in 50 States

Location: Bellaire **Sponsor:** Committee on Teacher Preparation **Co-Sponsor:** Committee on Physics in Undergraduate Education
Time: 11 a.m.–12:20 p.m. **Date:** Monday, Jan. 14 **Presider:** Scott Paulson

DF01: 11-11:30 a.m. PhysTEC: Building a Solution to the National Physics Teacher Shortage

Invited – Monica Plisch, American Physical Society, 1 Physics Ellipse, College Park, MD

There is a severe national shortage of qualified high school physics teachers in the U.S. Since 2001, the Physics Teacher Education Coalition (PhysTEC) project has been working to engage physics departments in establishing the infrastructure needed to address the national physics teacher shortage. The project has developed model teacher preparation programs, disseminated information on effective practices, and advocated for teacher preparation within the physics community. PhysTEC Supported Sites have more than doubled their production of highly qualified physics teachers; they have also demonstrated considerable success in sustaining their programs beyond the funding period. The project has established a national coalition of more than 300 Member Institutions located in all 50 states, which collectively educate over half of the nation's highly qualified physics teachers. PhysTEC is a project of the American Physical Society and the American Association of Physics Teachers, with support from the National Science Foundation (#1707990).

DF02: 11:30-11:40 a.m. PhysTEC Comprehensive Site at Rowan University – What Worked

Contributed – Karen P. Magee-Sauer, Rowan University, Department of Physics & Astronom,y Glassboro, NJ

Trevor I. Smith, Patrick L. Chestnut Phillip R. La Porta, David R. Klassen, Rowan University

Rowan University was selected as a PhysTEC Comprehensive site 2015 – 2018. During this period Rowan started an LA program and Rowan Area Physics Teacher (RAPT) network, established undergraduate research opportunities in PER, and created a strong voice in the department to promote high school physics teaching as a career path. In this talk, we will present the successes and challenges during our funding period as well as present how we plan to sustain all programs now that our funding period is completed. Rowan University is a public institution in Glassboro, NJ, with 18,500 students and 160+ physics majors and is a member of the 5+ club for graduating more than five certified high school physics teachers per year.

DF03: 11:40-11:50 a.m. PhysTEC's Contribution to Physics and Science Education at Boston University

Contributed – Andrew G. Duffy, Boston University, Department of Physics, Boston, MA

Peter Garik, Mark D. Greenman, Nicholas Gross, Manher Jariwala, Boston University

Starting with the Boston University (BU) Department of Physics joining PhysTEC, significant changes have occurred at BU in physics education, science education generally, and the preparation of science teachers. PhysTEC introduced us to the Learning Assistant program. BU now has 20+ physics LAs each semester and over 125 LAs across all science courses, transforming science education at BU. In 2011, BU received a comprehensive PhysTEC award, enabling us to fund a Physics Teacher in Residence (TIR). The TIR and LA Program strengthened our grant applications for Robert Noyce NSF awards. Two successful Noyce grants have resulted in an increase in the number of physics teachers BU prepares, and greater attention in their preparation for high-need schools. The TIR also acted for social justice with a NSF award (Project Accelerate), a high school – university partnership to bring AP Physics 1 to students whose schools do not offer it.

DF04: 11:50 a.m.-12 p.m. PhysTEC Growing UTeach in West Virginia

Contributed – John C. Stewart, West Virginia University, 135 Willey St., Morgantown, WV

Gay B. Stewart, West Virginia University

Ongoing PhysTEC support for physics teacher preparation at West Virginia University provides a model of how the PhysTEC program can support the implementation of broader initiatives in STEM teacher preparation. These broader initiatives and the partnerships they foster will feed back into the physics program providing badly needed physics teachers for West Virginia. PhysTEC has supported a Teacher-in-Residence (TIR) who has transitioned to the role of a master teacher in the WVUteach program. The TIR was instrumental in developing recruiting efforts and improving introductory physics labs. As a master teacher, he supports a more rapid implementation of the full WVUteach program.

DF05: 12:00-12:10 p.m. PhysTEC: Kicking off Physics Teacher Preparation at University of Arkansas*

Contributed – Gay B. Stewart, West Virginia University, Department of Physics, Morgantown, WV

John C. Stewart, West Virginia University

University of Arkansas, Fayetteville was one of the six primary program institutions in this new thing called PhysTEC in 2001 (growing out of NSF grant 0075528, funded by 0108787). We had three core beliefs: 1. If there is a reason teachers should teach like that, why aren't we? 2. You never know who is going to be a future teacher. 3. In better-serving all students, a department also benefits. UA has seen a drastic change in number of majors, the number of students active in research and the number of graduates pursuing graduate work while also increasing the number of majors who decide to teach. In this talk we will discuss some of the highlights of the program that we believe contributed to its success.

*PhysTEC has been generously supported by the National Science Foundation, the Department of Education FIPSE program, adopting programs, and the APS 21st Century Campaign.

DF06: 12:10-12:20 p.m. Multiple Representations and NGSS-based Curriculum Design for In-service Physics Teachers

Contributed – Christopher Moore, University of Nebraska Omaha, Omaha, NE

We have adapted PhysTEC learning modules on multiple representations and curriculum design into an online graduate course for in-service physics teachers. In-service teachers in the Omaha metro area learned how to use proven tools and strategies to adapt/develop standards-aligned curriculum on topics in motion, force, and energy. Specifically, participants completed modules initially developed by the Physics Education Research Group at Rutgers University, and then adapted existing NASA curriculum materials for use within Nebraska Career and College Ready Science Standards (NCCRSS). This resulted in the adaptation of NASA materials to Nebraska standards, generating classroom-ready NASA-based materials for Nebraska teachers, and the training of new physics teacher-leaders to help their districts prepare for NCCRSS implementation. Participant work was assessed using the Educators Evaluating the Quality of Instructional Products (EQuIP) rubric to assess adapted materials and we report on changes in participant beliefs using the Colorado Learning Attitudes about Science Survey (CLASS-Phys).

Session DG: PER: Student Content Understanding, Problem-Solving and Reasoning

Location: Plaza Ballroom I **Sponsor:** AAPT **Time:** 11 a.m.–12 p.m. **Date:** Monday, Jan. 14 **Presider:** Alexandru Maries

DG01: 11-11:10 a.m. Physics Students' Familiarity with Mathematical Facts and Procedures*

Contributed – David E. Meltzer, Arizona State University, College of Integrative Sciences and Arts, Wanner Hall, Mesa, AZ

Dakota H. King, Arizona State University

As part of our continuing investigation into mathematical difficulties of introductory physics students, we have incorporated new questions on elementary geometry and graphing on our diagnostic tests, and extended our exploration of difficulties with symbolic operations. Our results suggest specific areas in which additional practice by students may be needed to facilitate their problem-solving activities, and warrant additional caution that students' familiarity with basic mathematical facts and procedures cannot necessarily be presumed.

*Supported in part by NSF DUE #1504986

DG02: 11:10-11:20 a.m. Investigating Student Difficulties in Solving Basic Mathematics Problems*

Contributed – Dakota H. King, Arizona State University, Mesa, AZ

David E. Meltzer, Arizona State University

In order to study students' mathematical difficulties in introductory university physics courses, we have administered written diagnostics and conducted one-on-one problem-solving interviews. During the past three years, we have found that students in both algebra- and calculus-based courses have significant difficulties with solving basic high-school-level mathematics problems. These problems include basic trigonometry and algebra, and are posed in both numeric and symbolic form ("numeric" and "symbolic" refer to the nature of the constant coefficients). We will report our most recent findings on these items, but will focus on a new set of problems which include basic geometry, quadratic equations, and knowledge of trigonometry facts. Student work will be analyzed in detail to identify specific difficulties.

*Supported in part by NSF DUE #1504986

DG03: 11:20-11:30 a.m. Investigating Student Understanding of the Inverse Square Law

Contributed – Rabindra R. Bajracharya, Missouri Southern State University, Joplin, MO

The inverse-square law is an extremely important concept widely observed in numerous physical contexts. Various instructional strategies have been used to teach the law in physics and other fields. However, there has not been much research on student understanding of the inverse-square law. We investigated student difficulties with

the multiple representations of the law, including graphical, numerical, and symbolic. We constructed two survey versions, one without any physical context and the other with various physical contexts. The questions were presented in multiple representations. We administered the surveys in several mathematics and science courses including second semester algebra- and calculus-based introductory physics. We found that students lack deep understanding of the multiple representations of the inverse-square law, specifically the graphical representation. One common difficulty students manifested was that they were unable to distinguish between the inverse-square and the inverse relationships between two variables.

DG04: 11:30-11:40 a.m. Applying the Energy Conservation Principle: Two Contrasting Reasoning Frames

Contributed – Luke Westbrook, Western Washington University, Bellingham, WA

Andrew Boudreaux, Emily Borda, Western Washington University

The principle of conservation is an important component of a basic model for energy. From informal classroom observations and think-aloud problem-solving interviews, we have identified two reasoning frames, or approaches, students seem to adopt when solving energy conservation scenarios. The first, referred to as "system-frame reasoning," involves defining a system and then tracking energy inputs and outputs and relating them to energy changes within the system. This approach is familiar to physics instructors and is found in many textbooks. The second approach, "energy-frame reasoning," involves identifying an amount of energy at a particular time and "following" that energy as it transfers and transforms. This reasoning approach does not necessarily include the strong definition of a system. In this talk, we give a rich description and some examples of these reasoning frames, with some speculation about implications for the learning and teaching of energy.

DG05: 11:40-11:50 a.m. Strategy Flexibility: Choosing Different Systems to Apply the Work-Energy Principle

Contributed – Grace E. Baker, Western Washington University, Communications Facility 385, Bellingham, WA

Thanh K. Le, Western Washington University

An important goal of physics courses is helping students become adaptive problem solvers so that they can approach a wide range of situations. One aspect of adaptive problem solving is strategy flexibility — knowing multiple ways to approach a problem and choosing the most appropriate approach. In this study, we explore students' strategy flexibility in the context of energy. Specifically, we focus on students' meta-strategic judgements when choosing a system to apply the work-energy principle in various scenarios. College students enrolled in an introduction mechanics course were interviewed about their rationales of their system choices and asked to compare different options. Preliminary results and analysis will be presented.

DG06: 11:50 a.m.-12 p.m. Methods of Computing Expectation Value: Investigating Students' Choices and Preferences*

Contributed – Gina Passante, California State University Fullerton, Physics Department, Fullerton, CA

Benjamin Schermerhorn, Homeyra Sadaghiani, California Polytechnic University, Pomona

Steven Pollock, University of Colorado Boulder

In a previous study across multiple universities using a similar spins-first quantum mechanics curriculum, we have analyzed students' written exams for the method they use when solving expectation value problems. Findings revealed that many students prefer using matrix multiplication to solve for the expectation values in contexts when the arguably simpler summation method could be used instead. As part of further investigation, we categorize the methods for solving for the expectation value using the structural features framework of Gire and Price and postulate why certain methods seem to be preferred by students when experts prefer a different method. Individual student interviews provide insight on the aspects of students decision-making while solving expectation value problems across various contexts and assess if students can recognize and apply additional methods.

*Supported my NSF DUE-1626594

Session DH: Making Out-of-School STEM Welcoming Across Languages

Location: Post Oak **Sponsor:** Committee on Science Education for the Public **Co-Sponsor:** Committee on Physics in High Schools
Time: 11 a.m.–12:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Jacquelyn Chini

DH01: 11-11:30 a.m. Strategies to Promote Materials Science and Engineering: A Community-University Collaboration for Graduate, Undergraduate and K12 Students

Invited – F. C. Robles Hernandez, University of Houston, Houston, TX

A. Reyes, J. Ortiz, University of Houston

M. Galindo, Migrant Education Program

Here we provide an overview of pedagogical strategies used to develop "A Community-University-Pubic School Collaboration for Graduate, Undergraduate and K-12 Students." This project was guided by federal, state, and local policies and criteria. The purpose of the project was to expose at-risk and high-poverty secondary, migrant and second-language learning school students to career and college readiness grounded in Texas Standards in ECH-12 College Readiness and University College of Technology Science, Technology, Engineering, and Mathematics Education (STEM). Instructional strategies were used to stimulate the learners' inquiry, critical thinking, collaboration and communication skills using hands-on, science, technology, engineering, and math-based activities. Communication skills, self-esteem, racially based success identify and role modeling were foundation strategies used to promote success in higher education for first-generation college students. The use of international, Spanish-other language speaking graduate students and faculty are crucial to this project. A brief introduction to graduate school education is also provided.

DH02: 11:30-12 p.m. District Supported K-12 STEM-Embedded Learning for All

Invited – Kevin H. Thomas, Orange County Public Schools, Orlando, FL

Jennifer Borges, Orange County Public Schools

This presentation will highlight strategies implemented by Orange County Public Schools (OCPS) to foster student success in Science, Technology, Engineering, and Mathematics (STEM) subjects. As a large, diverse school district in Central Florida, with over 31,000 English Language Learners, OCPS has set a high goal of addressing equity in all schools and narrowing the achievement gap in STEM for its most vulnerable student populations. Instead of keeping STEM initiatives localized to its highest performing schools, OCPS invests resources into establishing successful programs for all schools district-wide. Several school-based programs will be highlighted with a focus on how they are supported by the district through a digital-blended learning platform designed to increase access for all students district-wide. With a further emphasis on K-8, district-led initiatives include coding in science and STEM labs, along with Project-Based Learning (PBL) and Promoting Science Among English Language Learners (P-SELL) programs embedded in the curriculum.

Session DI: Goals and Assessment for Computational Work in Physics Classes

Location: San Felipe Room **Sponsor:** Committee on Educational Technologies **Co-Sponsor:** Committee on Physics in Undergraduate Education
Time: 11 a.m.–12:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Marie Lopez del Puerto

In this session speakers will share their goals for integrating computation into their classes as well as ways in which they assess computational work.

DI01: 11-11:30 a.m. Making Computation Normal: The Computational Initiative at IUPUI

Invited – Andrew Gavrin, Department of Physics, IUPUI, Indianapolis, IN

The Department of Physics at IUPUI has begun a multi-year effort to make computational methods a centerpiece of our undergraduate degree programs. Our plans currently include creating a sequence of computational physics courses, incorporating computational methods in all majors' courses, and creating a computational physics degree track in cooperation with our colleagues in the Department of Computer Science. The plans are well under way, with a first course in computational methods currently offered, computational methods incorporated to some degree in all courses, and the computational track approved at the college level. This talk will stress the change process in the department, major decisions taken, internal and external resources that have supported our efforts, assessment plans, and preliminary results.

DI02: 11:30-12 p.m. What Do I Want Students to Get from Coding and How Do I Know

Invited – Dwain Desbien, Estrella Mountain Community College, Peoria, AZ

At EMCC I utilize computational modeling to allow students to solve more realistic problems that are beyond their analytic skills. However, what is it I hope students get out such problems and more importantly how do I know what students get out of them. I will share my answers to these questions and examples of both activities and how I assess the students.

DI03: 12-12:10 p.m. Computational Modeling in Intro Physics: Assessing Student Learning

Contributed – Ruth Chabay, University of North Texas, Denton, TX

Bruce Sherwood, University of North Texas

Aaron Titus, High Point University

In order to improve our instruction in computational modeling in physics, we need to assess what students have learned and identify areas where our instruction could be improved. In a calculus-based introductory physics course that integrates computational modeling, portions of our lab practical exams at the end of both first and second semester focused on computational modeling. We discuss our goals for student learning and the tasks we used to assess them, and compare the performance of students with no previous computing experience with that of experienced computer science majors.

DI04: 12:10-12:20 p.m. Computational Modeling in Physics First

Contributed – Rebecca E. Vieyra, American Association of Physics Teachers, One Physics Ellipse, Washington, DC

Colleen Megowan Romanowicz, American Modeling Teachers Association

Kathi Fisler, Shriram Krishnamurthi, Brown University

Ben Lerner, Northeastern University

Joe Gibbs Politz, University of California at San Diego

Good physics teaching and learning is dependent upon the use and coordination of representations: graphs, algebra, diagrams, etc. Our computational modeling project aims to research the use of computational modeling as an additional representational tool. In our project, teachers learned evidence-based Modeling Instruction pedagogy for teaching physics with representations while also learning to write programs with Bootstrap:Algebra (see bootstrapworld.org). Preliminary findings suggest that students of teachers in this program are learning to think through physical problems differently when using computational models, and we have noted that the biggest challenge to integrating computing with science are not students' ability or interest, but teachers' confidence.

DI05: 12:20-12:30 p.m. Typed Functional Programming and Physics*

Contributed – Scott N. Walck, Lebanon Valley College, Annville, PA

I describe the goals and assessment techniques for a sophomore-level computational physics course using the Haskell programming language. The principal goal of the course is to deepen a student's understanding of the structure of basic physical theories (mostly Newton's second law, waves, and electromagnetic theory) by expressing them in a new language. The language has types (so that scalars, vectors, and vector fields, for example, each have a distinct type) that help to organize and clarify our thinking. The language also has higher-order functions (functions that take other functions as input), which eases the syntax needed to express ideas like numerical integration and the Euler method. A book in progress that develops Haskell from scratch and uses it to express basic physical theories is available at the author's web site (see footnote).

*http://quantum.lvc.edu/walck/

Session EA: First Billion Years of a Solar System

Location: Tanglewood **Sponsor:** Committee on the Interests of Senior Physicists **Time:** 3:30–5:30 p.m. **Date:** Monday, Jan. 14
Presider: Tom O'Kuma

EA01: 3:30-4 p.m. Accretion: Building New Worlds

Invited – Allan Treiman, Lunar and Planetary Institute, Houston, TX

The formation of our solar system, 4.6 billion years ago, is understood fairly well because many meteorite samples contain material unaltered since that time. There is agreement on the basic framework -- gravitational collapse of a cloud of gas and dust. Better understanding of the processes of solar system formation relies on physics across a huge range of length and energy scales: from interstellar clouds to lattice defects in ancient crystals, and from nucleosynthesis in supernovae to adhesion among dust grains.

EA02: 4-4:30 p.m. Planetary Differentiation in the Early Solar System

Invited – Walter Kiefer, Lunar and Planetary Institute, Houston, TX*

Earth, Venus, Mars, and Mercury are all differentiated planets, with dense metallic cores at their centers surrounded by rocky mantles and crusts. However, intense early heating either from the radioactive isotope aluminum 26 or by energetic impacts allowed some much smaller objects to also differentiate. Examples include the Moon, which on the basis of Apollo sample evidence had a "magma ocean" in its outer several hundred kilometers and the asteroid 4 Vesta, whose surface is partially covered with rocks formed by erupting magma. This presentation will use evidence from meteorites to explore the process of planetary differentiation and will also discuss how NASA spacecraft such as the Dawn mission to asteroid 4 Vesta, the InSight mission to Mars, and the forthcoming Psyche mission to the metallic asteroid 16 Psyche are contributing to our understanding of planetary differentiation.
*Sponsored by Tom O'Kuma

EA03: 4:30-5 p.m. Bombardment: Shaping Planetary Surfaces and Their Environment

Invited – David Kring, Lunar and Planetary Institute, Houston, TX*

Apollo missions to the lunar surface and the samples that were returned to Earth revealed the Earth-Moon system was severely bombarded by asteroids and comets during the first billion years of Solar System history. The bombardment resurfaced the Moon, producing the immense impact basins visible from any school. The oldest and largest impact basin is, however, hidden from view on the lunar farside. High-priority goals for NASA's scientific exploration of the Moon are to determine the age of that impact basin and the cadence of the other impact basins. The Earth was similarly bombarded, but the geologic record of those processes is erased. We rely on the Moon to uncover the early evolution of our own planet, including the environmental conditions during the origin and evolution of life on Earth.
*Sponsored by Tom O'Kuma

EA04: 5-5:30 p.m. Habitability: Producing Conditions Conducive to Life

Invited – Edgard Rivera-Valentin, Lunar and Planetary Institute, Houston, TX*

The physical process (e.g., accretion, differentiation, and bombardment) that created the worlds we observe today also led to the creation of at least one world where life has emerged and thrived. Understanding these early processes can help us investigate how habitable environments arose and how such environments evolved over time. The chemical, thermodynamic, and biogeochemical process that led to the emergence of life on Earth within its early habitable environments, may have also occurred on other bodies in our Solar System, such as Mars and the ocean worlds of Jupiter and Saturn. An interdisciplinary understanding of the emergence of life and the environments it developed on can help narrow our search for life in extrasolar systems
*Sponsored by Tom O'Kuma

Session EB: Assessing the Effectiveness of Laboratory Curricula

Location: Bellaire **Sponsor:** Committee on Laboratories **Co-Sponsor:** Committee on Research in Physics Education
Time: 3:30–5:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Robert Hobbs

EB01: 3:30-4 p.m. Assessing the Transformation of Introductory Physics Labs at Cornell

Invited – Emily M. Smith, Laboratory of Atomic and Solid State Physics, Cornell University, 315 Clark Hall, Ithaca, NY

Martin M. Stein, N.G. Holmes, Laboratory of Atomic and Solid State Physics, Cornell University

At Cornell University, we are in the process of transforming the labs for the calculus-based introductory physics sequences. The redesign aligns with the Laboratory Guidelines by AAPT and has focused on shifting the labs from ones that reinforce physics content to ones that emphasize experimentation. In this talk, I will discuss results from a single course where all students attended the same lecture and discussion sections, had the same homework and exams, but attended one of the two types of labs. I will describe how we compared these two lab curricula on the impacts on students' physics content knowledge, how students spent their time in lab, and students' attitudes and beliefs about experimental physics. We find that labs designed to teach experimentation did not impact students' knowledge of physics content, and, encouragingly, engaged students in expert-like experimentation practices and improved their attitudes and beliefs about experimental physics.

EB02: 4-4:30 p.m. Assessing Scientific Practices (and Concepts!) in the Lab

Invited – James T. Laverty, Kansas State University, Manhattan, KS

Many recent national reports in K-12 and higher education have highlighted the importance of students learning to do science, not just know science. This elevation of doing physics to the same level of importance as the concepts of physics is significantly shifting the way we think about what we want students to learn. This change in learning goals pushes us to think differently about what we assess: It's not just what students know, but also what they can do with their knowledge. Lab courses provide an opportunity to assess what our students can do with their physics knowledge, sometimes in ways that we can't assess them in a lecture course. In this talk, I will discuss the idea of scientific practices, how we can assess them (when paired with physics concepts) in a lab, and what this implies about how we might change lab instruction.

EB03: 4:30-4:40 p.m. Using Assessments to Develop Thinking Habits and Determine Lab Effectiveness

Contributed – Kathleen M. Koenig, University of Cincinnati, 400 Geo/Phys Building, Cincinnati, OH

Krista E. Wood, Larry Bortner, University of Cincinnati

Lei Bao, The Ohio State University

Many years ago we revised our physics labs from verification labs to those which are inquiry-based. The learning outcomes were rewritten around the AAPT Laboratory Guidelines as well as our own set of outcomes for specific scientific reasoning abilities. This presentation will showcase the variety of formative and summative assessments used throughout the course. These include scoring rubrics provided to students to guide their in-class lab records and lab report writing, pre-lab quizzes, final lab course exam, and a scientific reasoning assessment. Data will be presented which demonstrates the importance of these assessments for guiding students' behavior and

building thinking habits, as well as measuring the effectiveness of our labs in meeting the desired outcomes.
*Partially supported by NSF IUSE DUE 1431908

EB04: 4:40-4:50 p.m. Assessment of Scientific Reasoning Sub-skill: Control of Variables*

Contributed – Krista E. Wood, University of Cincinnati, Cincinnati, OH

Kathleen Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Scientific reasoning (SR) skills are necessary for conducting scientific inquiry. To evaluate student development of SR skills, we developed an assessment grounded in the Lawson Classroom Test of Scientific Reasoning (CTSR) that measures a group of SR sub-skills. We are focusing on the control of variables (COV) sub-skill because it is foundational for engaging in scientific inquiry as well as for decision making. We will present a set of nine COV questions that were tested at an R-1 institution and a two-year college. This set of COV questions can be utilized to assess students' development of COV skills at low, intermediate, and high levels, which is a finer grain measurement than available on the CTSR.
*Partially supported by NSF IUSE DUE 1431908

EB05: 4:50-5 p.m. The Physics Lab Inventory of Critical thinking

Contributed – Natasha G. Holmes, Cornell University, Physical Sciences Building, Ithaca, NY

Cole Walsh, Katherine N. Quinn, Cornell University

Many instructors and education researchers are developing new lab curricula and pedagogies for teaching scientific practices such as critical thinking and experimentation skills. As we develop ways of teaching these skills, we must also consider ways of evaluating them. I will introduce the Physics Lab Inventory of Critical thinking (PLIC), a closed-response assessment for probing student development of critical thinking skills as related to introductory physics experimentation. I will outline the development and validation of the PLIC and present preliminary results of data collected from thousands of students across the country.

EB06: 5-5:10 p.m. Introductory Physics Laboratory Curriculum on West Campus at Valencia College

Contributed – Irina Struganova, Valencia College, Orlando, FL

I am going to share an "open lab" approach we are using for the lab components of all introductory physics courses offered on West Campus at Valencia College. The approach allows to afford a better equipment, simplifies modernization of the curriculum, and promotes engaging and collaborative learning. Specific details will be shared during the presentation.

EB07: 5:10-5:20 p.m. Taxonomy of Teaching Practices During Group Projects in Lab Courses*

Contributed – Dimitri R. Dounas-Frazer, University of Colorado Boulder, Department of Physics, Boulder, CO

Laura Ríos, University of Colorado Boulder

Heather J. Lewandowski, University of Colorado Boulder

Compared to other formal learning environments in undergraduate physics programs, multiweek group projects in lab courses give rise to unique interactions between students, their peers, their instructors, and apparatus. What does teaching look like in these contexts? How do instructors change their teaching practices as students transition from proposing project topics to carrying out experiments and reporting on results? To answer these and related questions, we conducted a multiple case study of group project implementations in upper-division labs at five universities. In this presentation, we draw on data from interviews and surveys with instructors and students to identify a variety of teaching practices. We further describe the intended purposes and perceived impacts of these practices. Preliminary data analysis suggests that group projects may be a shared endeavor in which students and instructors have asymmetric apprenticeship-style roles and responsibilities.
*This material is based upon work supported by the NSF under Grant No. DUE-1726045.

EB08: 5:20-5:30 p.m. Developing an Assessment Plan for Upper-Division Laboratory Courses

Contributed – Patricia E. Allen, Appalachian State University, Physics and Astronomy, Boone, NC

"AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum" and "Phys21: Preparing Physics Students for 21st Century Careers" offer tangible outcomes that can be adapted to individual programs and courses. However, developing or modifying an assessment plan for a course or program can be a daunting task, especially if it is the first time doing so. In-house rubrics for lab courses developed by the author, together with external measures (like E-CLASS: Colorado Learning Attitudes about Science Survey for Experimental Physics), help evaluate student performance in upper-level physics labs. An example of how a recommended outcome from AAPT/APS can be tailored to a specific lab course, along the appropriate rubric and sample results, will be presented and discussed. Suggestions for those starting to assess lab courses will also presented.

Session EC: Assessment Practices in Introductory Courses for the Life Sciences

Location: Westchester Room **Sponsor:** Committee on Physics in Undergraduate Education **Time:** 3:30–5:30 p.m. **Date:** Monday, Jan. 14
Presider: Juan Burciaga

The session will focus on assessment practices and strategies in the course for introductory physics for the life sciences.

EC01: 3:30-4 p.m. Feedback Loop Connecting IPLS Course Transformation and Assessment Data

Invited – Patricia Soto, Creighton University, Omaha, NE

Course transformation benefits from the feedback loop connecting to assessment data. The challenge in the process stems from the choice of the assessment tool, the interpretation of the output metrics, and the mechanisms to re-design each iteration of the course based on assessment outcomes. At Creighton University, we have implemented a standalone lab IPLS course that incorporates best practices from physics education research and recommendations from the American Association of Physics Teachers. The students enrolled in the course score at or above the historical average in our physics department in standardized assessment tests and show a positive outlook of the physics lab course as indicated by attitudinal surveys. Also, students' performance meets the expectations of the institutional requirements of core courses. The course has demonstrated to be instructor transferable. I will discuss the strategies implemented to reach the current level of course transformation with an emphasis on the role of assessment.

EC02: 4-4:30 p.m. Does it Stick? Assessing the Long-term Impact of IPLS

Invited – Catherine H. Crouch, Swarthmore College, Swarthmore, PA

Benjamin Geller, Nathaniel Peters, Jonathan Solomon, Chandra Turpen, University of Maryland

Introductory Physics for Life Science (IPLS) courses seek to (1) equip life science students with skills and reasoning strategies that will be important for their later work in upper level biology courses and biology research environments, and (2) foster attitudes that physics is relevant and connected to the life sciences. Although assessment of whether these goals are accomplished has been done within IPLS courses, little has been done of the long-term impact of an IPLS course. In this talk we describe results from the first year of an exploratory three-year study that examines student reasoning (from written biology coursework) and attitudes (from surveys and case study

interviews) in intermediate biology courses, comparing students with and without IPLS. Preliminary results suggest that the skills and attitudes that IPLS is designed to cultivate do persist into later courses, although the sample size from one year of data is small.

EC03: 4:30-5 p.m. Design, Implementation, and Assessment of a New IPLS Course at UNC-CH

Invited – Duane Deardorff, University of North Carolina at Chapel Hill, Chapel Hill, NCu

Laurie McNeil, Alice Churukian, Colin Wallace, Daniel Young, University of North Carolina at Chapel Hill

At UNC-CH we have completely redesigned our IPLS sequence that enrolls ~500 students each semester. Our new courses operate in an interactive lecture/studio format, in which students spend nearly all their class time in pairs or small groups working on activities designed according to PER findings. We eliminated topics with little or no connection to biology (e.g. projectile motion) in favor of topics highly relevant to the life sciences (e.g. nonlinear stress-strain). Whenever possible the class activities make use of authentic biological data. Assessment in this course includes a variety of formative and summative measures. Student learning gains on concept inventories show significant improvement over those in the previous version of the courses. Feedback from students and instructors has been generally positive, and student performance on course exams has met or exceeded that in previous years. Details of these assessment practices and instructional materials will be shared in this talk and are also available for use at other institutions.

EC04: 5-5:30 p.m. Assessing Self-directed Project-based Learning in the Introductory Physics for Life Science Course

Poster – Nancy Beverly, Mercy College, Dobbs Ferry, NY

In a project-based course, with a diverse spread of self-selected life phenomena of student inquiry, competencies in larger critical skills are the common assessment denominator. Devising assessment strategies that provide timely and useful feedback to students about progress in these skills in a time-efficient manner is challenging, primarily due to the unique content and nature of student approaches in these self-directed works.

Session ED: Astronomy Education Research

Location: Plaza Ballroom I **Sponsor:** Committee on Space Science and Astronomy **Time:** 3:30–5:30 p.m. **Date:** Monday, Jan. 14
Presider: Timothy Slater

ED01: 3:30-4 p.m. Creating Simulated Astronomical Experiences for Students in a Portable Planetarium

Invited – Beau Hartweg, Tyler Junior College, Tyler, TX

A qualitative case study was conducted to understand the experiences of undergraduate students who participated in a live-interactive portable planetarium program that used a simulated immersive visual environment. To that end, the study specifically looked at the ways students participated in and interacted with the planetarium; how they described their experiences; what connections to outside events or experiences could they make after participating in the program; and in what ways were their experiences educative, miseducative, or noneducative. The findings showed that students interacted with the planetarium program in a variety of ways that allowed them to develop an understanding of the content. Participants also made several connections between the planetarium lesson and their prior life experiences, which led to new insights. The data showed that the majority of experiences were educative, which resulted in participants having improved perceptions of astronomy, and engaging in related activities independently of the lesson.

ED02: 4-4:30 p.m. The Benefits of Collaborative Exams in Promoting Student Learning

Invited – Scott T. Miller, Sam Houston State University, Dept of Physics, Huntsville, TX

Collaborative, two-stage exams are becoming more popular in physics and astronomy courses, and their benefits in terms of collaborative learning have been reported in the field of physics. In a two-stage exam, students first complete the exam individually, then retake all or part of the exam within a group, where peer discussion ensues before arriving at a common answer. I'll present data collected from over 500 students enrolled in introductory astronomy courses at Sam Houston State University. First, I'll compare student learning gains for two question sets (one set asked as part of a group exam and the other only answered individually), administered first during semester exams, then again during a final exam. I'll also discuss student interactions during the group portions of the exams in an effort to investigate the processes in play that lead students to arrive at a group consensus before choosing an answer.

ED03: 4:30-5 p.m. Univ. of North Texas Astronomy Laboratory Program…Providing Hands-On Astronomy to Over 2000 Students Yearly

Invited – Ron Dululio, Department of Physics, University of North Texas, Denton, TX

Twenty years ago, the astronomy program at the university of North Texas, located in Denton, Texas- just north of Dallas, matriculated just over 300 students through an undergraduate, non-science major astronomy course. Over the past decade, an average of 2,000 students completed the series of laboratory exercises in conjunction with their class lectures. This growth provides a testament to the success of the model that we've developed. I will share some the lab techniques we utilize, as well as the equipment that we've assembled to complete the task of providing hands-on laboratory experiences to teach each, and every one of, the students. Included within my presentation will be examples of how we hope to expand using internet technology blended with face-to-face, hands on experiences.

ED04: 5-5:10 p.m. Astronomy and Physics to Non-Specialist Audiences: An Informal Approach

Contributed – Edio da Costa Junior, Instituto Federal de Minas Gerais - IFMG, Rua Pandia Calogeras, , Minas Gerais 35400-000 Brazil*

Bruno S. Fernandes, Universidade Federal de Ouro Preto - IFMG

João P. T. P. Cordeiro, IMarina G. Santos, Instituto Federal de Minas Gerais - IFMG

Several astronomical topics are taught in basic education. Also, researchers have shown that astronomical observations can contribute to science dissemination and teaching of Astronomy and Physics and can support teachers and students. In this way, the debate on the topic is important and should be instigated both in an non-academic scope as well as in the scope of teachers and students training. Based on this, a popular project about astronomy has been in development since 2012. More than 8000 people with different levels of scientific knowledge have attended the activities. This article's main objective is to identify elements that can culminate with the effectiveness of the observation activities performed with a lay audience. In addition, it seeks to share empirical knowledge obtained with the development of the project and to encourage groups, academic or otherwise, to develop similar astronomical activities in formal and non-formal educational environments.
*Sponsored by Ramon Edgardo Lopez

ED05: 5:10-5:20 p.m. What Was Kepler Looking for, and Why Didn't Galileo Respond?

Contributed – Richard P. Hechter, Unviersity of Manitoba, Winnipeg, MB

An examination of the literature reveals that Kepler wrote to Galileo asking for assistance in measurements of the, 'second star in the handle of the big dipper'. That's pretty cool! In a Grade 9 general science class we used Kepler's letter, and Galileo's lack of response to him, as the context to introduce a story behind the science of some basic astronomical concepts. Using accessible astronomy software, and coupled with a critical evaluation of the historical record to locate where Kepler may have been when he wrote Galileo, we began to explore the night sky as Kepler would have seen it. Through these experiences students learned and related astronomical concepts to Kepler's letter to develop hypotheses as to what may have interested him in Mizar, and rationalize why Galileo did not respond. This presentation will share the tenets of this activity, and briefly share the student experiences within it.

ED06: 5:20-5:30 p.m. Engaging Physics Students in Aerospace Engineering Through Model Rocketing

Contributed – Osman Guler, Harmony Science Academy, El Paso, TX

Learn how to engage students in Aerospace Engineering and defense industry, training the next generation of talent which will enable them to design their own space crafts, commercial airliners, unmanned airplanes, and be the first astronauts who will be going to Mars by using existing makerspace technology tools, such as laser cutter, 3D printers etc. The presenter will also be showing a couple of model rockets that was built by the students and share some best practices of how to start, support, keep track, and successfully maintain the sustainability of the effective student recruitment for students team.

Session EE: Best Practices in Educational Technology

Location: Plaza Ballroom II **Sponsor:** Committee on Educational Technologies **Time:** 3:30–5:30 p.m. **Date:** Monday, Jan. 14
Presider: Josh Samani

EE01: 3:30-4 p.m. The Physics of MRI with Classroom Experiments

Invited – Sanaz Taghizadeh, Hoag Hospital, Newport Beach, CA

Throughout the past year I have worked with both clinical and desktop MRIs. With many students planning to pursue a career in medicine, it is the responsibility of physics teachers to instruct upon the concepts of Magnetic Resonance Imaging. In this talk we investigate the physics and clinical details of MRI. I provide an overview of Nuclear Magnetic Resonance and discuss how nuclei interact with magnetic fields to produce images. I also share my results from working on a desktop MRI apparatus and demonstrate how it can be used to create MR Images with students during a single class period. Included are answers to common questions, a review of safety hazards, and interesting facts that only insiders know.

EE02: 4-4:30 p.m. Writing 100 Introductory Physics Simulations in a Year?

Invited – Andrew G. Duffy, Boston University, Department of Physics, Boston, MA

At the last winter meeting, I got the crazy idea of writing 100 HTML5 simulations in a year (the count was at 64 as of late August). In this talk, I will report on whether I reached that goal of 100, show some examples of the simulations, and discuss how they are used at Boston University. Uses include bringing physics to life in the classroom, incorporating them into homework assignments, integrating them into an e-book on the TopHat platform, and also adding to the interactive nature of a free online course for high school students on edX. This work also relates to a NSF-funded project involving A/B testing of simulations vs. no simulations, or simulations vs. hands-on labs, and I will report on the outcomes of some of that work. Simulations available in the HTML5 section of http://physics.bu.edu/~duffy/classroom.html

EE03: 4:30-5 p.m. Developing a Project-based Computational Physics Course Grounded in Expert Practice

Invited – Timothy J. Atherton, Tufts University, Medford, MA

Christopher J. Burke. Tufts University

We describe a project-based computational physics course developed using a backwards course design approach and based on a research study of expert computational problem-solving in physics. These insights were distilled into a rubric for professional practice in computational physics, which enabled us to design a course intended to allow students to acquire these skills. We will report on the initial iterations of the class and identify items for further improvement. Additionally, broader implications for how teaching computation can be informed by professional practice will be discussed.

EE04: 5-5:10 p.m. Designing Smartphone Physics Experiment

Contributed – Sally Akca, Harmony Public Schools, Grand Prairie, TX

Sibel Ozturk, Turkan Argin, Harmony Public Schools

Smartphones have been an important part of modern life. They have been also used as learning tools to aid school assignments as a calculator, clicker or timer. In this presentation, we will share different smartphone physics experiments, which can be done at home or during class time by students. The initial results of the experiments show the students' engagement and creativity of using daily life materials as lab materials are positively increased during these lab activities. The students showed their creativity not only during the experiment design process but also during the video presentation phase. During the presentation, we will share how students can use smart phones to collect data and data analysis process. In addition to that, the experiment list will be shared which includes the lab activities of elevator acceleration measurement, free fall calculation, pendulum analysis, circular motion and, centrifugal acceleration.

EE05: 5:10-5:20 p.m. High School Physics Lab Curriculum Using Smartphones

Contributed – ShengChiang Lee, Mercer University, Macon, GA

Savannah Grunhard, Zainil Charania, Mercer University

The purpose of our research was to develop a low-cost and sustainable physics lab curriculum for implementation in Bibb County, GA, public high schools. The lack of sufficient funding for proper lab equipment and qualified teachers disadvantages students. The pedagogical approach of our curriculum is student-centered and inquiry-based. These activities utilize smartphone sensors in place of typical laboratory sensors. The use of existing smartphones in an educational setting serves to engage students and encourages them to explore physics in their everyday lives without adding any financial burden to school budget. We gathered data from volunteers in order to assess our curriculum and adjust it to meet students' needs. The curriculum includes student activities (with instructor manuals) and instructions for both class demonstrations and construction of DIY apparatuses.

EE06: 5:20-5:30 p.m. Creating Sites of Disciplinary Knowledge: Integrating Physics and Oral Communication

Contributed – Jonathan Weidow, Chalmers University of Technology, Göteborg,Sweden

Hans Malmström, Magnus Karlsteen Chalmers, Chalmers University of Technology

Jonas Enger; University of Gothenburg

The integration of physics with communication education has the potential to create a symbiotic relationship where students learn to communicate physics, while also communicating to learn physics. This paper presents pedagogical reflections from a first-year physics course combining the application of CAD, 3D-printing and oral communication. Students were tasked with conceiving, designing, and printing a plastic toy demonstrating a specific physical/mathematical phenomenon. Concurrently, the students prepared an A0-poster presentation focusing on the process from conception to finished toy, highlighting the physics and/or mathematics in question. Here, the teacher team discuss how the poster, the presentation, and the learning process leading up to it enabled students to co-construct "sites of disciplinary knowledge" and how, at a fundamental level, "the norms, epistemologies, and values" of the physics discipline were appropriated by the students.

(1) Dannels, D. (2002). Communication across the curriculum and in the disciplines: Speaking in engineering. Communication Education, 51(3), 254-268.

Session EF: John Hubisz: Celebrating 59 Years of AAPT Distinguished Service
Location: San Felipe Room **Sponsor:** AAPT **Time:** 3:30–5:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Chuck Stone

In his 59 years of AAPT distinguished service, John Hubisz touched students, faculty, staff, and friends in K-12 public and parochial schools, two- and four-year colleges, and research universities. Peers and protégés will share fond memories of John's achievements, and what current AAPT members can do, through the camaraderie, support, and opportunities AAPT offers. John served over 35 AAPT Committees, brought attention to deficiencies in middle school science texts, promoted diversity, raised awareness of senior physicists, and inspired AAPT Sections. He was active in his church, his local community, and a ravenous collector and reader of fine books.

Panelists *Chuck Stone (Colorado School of Mines), Tom O'Kuma (Lee College), Chris Gould (North Carolina State University), Joe Heafner (Catawba Valley Community College), Aaron Titus (High Point University), Steve Iona (University of Denver), and Jola Hubisz will discuss John's gentle yet effective character. Audience members will be invited to share personal perspectives.*

Session EG: PTRA: A Holistic Approach to Physics Instruction: Integrating Common Core Mathematics Standards, Common Core ELA and NGSS in a 5 E Learning Cycle **Location:** Galleria III **Sponsor:** Committee on Physics in Pre-High School Education
Time: 3:30–5:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Jan Mader

With the increased emphasis on literacy in the instruction of all core classes, teachers need to "double" dip. The purpose of this session is to provide 5 E learning cycle examples that integrate NGSS, Common Core Mathematics and Common Core ELA standards. Examples of learning cycles for elementary, middle school and high school will be provided.

EI01: 3:30-3:40 p.m. Investigating Equity in the Physics Department at an HSI

Contributed – Nicholas Hernandez, Humboldt State University, Arcata, CA

Ruth Saunders, Humboldt State University

Humboldt State University has recently acquired the status of Hispanic Serving Institution (HSI). The demographics of the university do not reflect the demographics of the surroundings area, this creates unique challenges. The demographics within the physics department at Humboldt State University has changed substantially over the past few years. While diversity overall has increased, equity has yet to be realized. This talk aims to quantify equity through data analysis of grade distributions from Humboldt State University. By diagnosing imbalanced equity, we can begin to develop strategies to ensure that a how a student identifies will not predict their outcome.

EI02: 3:40-3:50 p.m. STEM-ER

Contributed – Atilla Kaya, Harmony School of Excellence, Laredo, TX

Bilal Sengez, School of Technology-San Antonio

STEAM - ER: Science Technology Engineering Art Math - Escape Room. Did you hear about escape rooms, where you are locked in a room and have an hour to escape from the room that is full of riddles. Think about all of the riddles are STEAM related. Furthermore, your students are setting up the rooms. I will also show couple of examples of how it looks like. We will also discuss benefits of this project.

EI03: 3:50-4 p.m. Corpus Callosum: The Advantages of Art and Science Superposition

Contributed – Michael Welter, High Point University, Durham, NC

The intersection of art and science has a history dating as far back as the Renaissance with revolutionaries like Da Vinci and Michelangelo, but what is the current state of that relationship? During my summer with the Society of Physics Students as the Communications Intern, I got a first-hand look into the role that graphic design plays in the seemingly unartistic world of physics research and outreach. Composition and context play an integral role in an audience's perception of information, but is often overlooked as insignificant by STEM researchers. By examining how the general public responds to visual media and incorporating design concepts to scientific media we can begin to diminish the commonly assumed "right/left-brain" view of art and science–which, in turn, benefits both the public by making complex data more digestible, and the scientific community by allowing the public/governing bodies to make more informed decisions.

EI04: 4-4:10 p.m. STEM Through Amateur Radio (HAM Radio)

Contributed – Muhammed Y. Benli, Harmony Science Academy, Beaumont, TX

Amateur Radio (ham radio) is a popular hobby and service that brings people, electronics and communication together. People use ham radio to talk across town, around the world, or even into space, all without the Internet or cell phones. It's fun, social, educational, and can be a lifeline during times of need. You can set up a ham radio station anywhere! In a field, at a club station, or at home. Although Amateur Radio operators get involved for many reasons, they all have in common a basic knowledge of radio technology and operating principles, and pass an examination for the FCC license to operate on radio frequencies known as the "Amateur Bands." These bands are radio frequencies allocated by the Federal Communications Commission (FCC) for use by ham radio operators. Amateur Radio has long been fertile ground for gaining knowledge and skill with electronics technology, as well as for hands-on experimentation and application of technology. Using Amateur Radio in the classroom is a proven and effective way to teach both fact and theory and align with state and national learning objectives-- in STEM curricula-- as well as other content areas. Amateur Radio is communication via a variety of methods across social, political, cultural, geographic and physical handicap boundaries. Amateur Radio integrates math, science, geography, reading and writing. Amateur Radio encourages hands-on investigation and experimentation as a basis for understanding technical subjects. Amateur Radio experiences are a motivating influence for many careers in computer sciences, consumer electronics, broadcast engineering, research sciences, medicine, telecommunications and more! Amateur Radio also enriches the lives of thousands of people as a way to meet and make friends, have fun and pursue a path of lifelong learning.

EI05: 4:10-4:20 p.m. Texas A&M Physics Show

Contributed – Tatiana Erukhimova, Texas A&M University, Department of Physics and Astronomy, College Station, TX

The Texas A&M Physics Show started in 2007 and has been attended by 22,000 people since then. We offer 40-50 shows per year. The target audience for the Physics Show is preK-12. The show lasts 90 min and consists of three parts: 45-60 min show in the Auditorium, 20 min interactive Hands-on activities in the lobby, and the depth charge outside. Examples of demonstrations that we share with children include clouds, lightning, and magic bubbles, solid air and liquid oxygen, racquetballs fragile like glass and bananas as rigid as hammers, levitating trains and floating toilet paper and many more. The presentation is tailored to groups of different ages and "attention spans." We'll discuss pros and cons of starting a similar program and what it takes to run it all year round.

EI06: 4:20-4:30 p.m. STEM Instruction in the Pop Culture Classroom

Contributed – Marco D. Machado, Harrison, NJ

STEM instruction has seen graphic representations be used alongside text to improve student comprehension and retention for decades. With the rising popularity of comics, manga, and graphic novels in pop culture, an opportunity to further engage students by combining this pedagogical strategy with characters and themes students are familiar with has presented itself in the science classroom. Come see specific examples of how new media can be used to improve student interest, assessment variety, and content literacy, as well as learn about some of the best comics and graphic novels for teaching STEM.

EI07: 4:30-4:40 p.m. Undergraduates Designing Demos for Science Outreach*

Contributed – Michael T. Cone, Rice University, Physics & Astronomy Department, Houston, TX

Robert P. Beaird, Rice University

We will describe a new program at Rice University wherein undergraduate students design and develop high quality science demos for use in both the classroom, and outreach activities. The program runs over the span of an academic year (e.g., Fall 2018/Spring 2019), and involves a group of approximately twenty undergraduate students, and two faculty mentors. The students design and develop their own demo ideas in a process that is very similar to a research project. The same group then uses these demos in outreach activities, both on campus, and in the surrounding community. Thus, there is a twofold educational benefit for the program participants. We will also discuss the benefits such a program brings to a physics department, and the successes and difficulties we have experienced in implementing the program.

*The program described in this talk was originally inspired by the DEEP program in the Department of Physics & Astronomy at Texas A&M University. Details on that program can be found here: https://physics.tamu.edu/outreach/deep/

EI08: 4:40-4:50 p.m. Detecting Solar Eclipses with Rooftop Solar Panels

Contributed – Jordan K. Steckloff, University of Texas at Austin, Whitmore Lake, MI

Photometers, devices that count photons and measure wavelength, are a very commonly used tool in astronomy. Astronomical photometers are ideally highly sensitive, accurate, and calibrated. However many other photosensitive systems record light activity, and can therefore act as a crude photometer. For example, rooftop solar panels

detect events that affect the intensity of solar radiation, such as the Sun's changing position in the sky, passing clouds, and the solar eclipse of August 21st, 2017. In this talk, I discuss how to read the photometric signals in a rooftop solar panel array. The solar panel system I used is a 7.2 kW array for residential energy production, and records average power production at 15 minute intervals. The resulting power production curve contains clear signals of events that affect solar radiation intensity on the ground (solar flux). I will show how to read the signals in such power production curves, to determine cloud cover on a given day, and to detect solar eclipses. Finally, I use these measurements to estimate the "carbon footprint" of the August 21, 2017 solar eclipse.

EI09: 4:50-5 pm. Bringing Power Grid Discussions into the Physics Classroom

Contributed – Jack A. Dostal, Wake Forest University, Winston Salem, NC

I teach a seminar for first-year students at Wake Forest University entitled, "Power and the U.S. Electrical Grid." It is naturally interdisciplinary, drawing from physics, engineering, public policy, marketing, and other disciplines. No particular expertise in physics or mathematics is assumed of the students. Students come from all majors, not just the physical sciences. Course topics include estimation, circuits, power transmission, the history of DC and AC with Thomas Edison and Nikola Tesla, as well as a broad range of student-chosen topics. This talk will describe the seminar as well as the export of one of its modules regarding power transmission to a large-lecture general education physics class. Results from the larger class will be described as well as thoughts on implementing additional topics from the seminar class.

EI10: 5-5:10 p.m. The Confusing Appearance of the Naked-Eye Planets

Contributed – Todd K. Timberlake, Berry College, Mount Berry, GA

Ptolemaic and Copernican planetary theories predicted that the distances of Venus and Mars should vary by a factor of about 7. Thus, the angular diameter of these planets should vary by the same factor and their apparent areas should vary by about a factor of about 50. To the naked eye, though, these planets appear as circular disks with an apparent size that changes little, if at all. We now know that the appearances of the planets to the naked eye are affected by phases (for inferior planets), but mostly by the limitations of human vision. This talk will explore the history of this topic, show how modern measurements of the performance of the human eye explain why the planets appear as they do, and discuss how Galileo's telescope exceeded the limitations of the eye and revealed the true size and shape of the planets.

EI11: 5:10-5:20 p.m. The Secret Physics of the Periodic Table

Contributed – James Lincoln, PhysicsVideos.com, Newport Beach, CA

Far from just chemistry lab wallpaper, the periodic table's periodicity has been shown to be caused by the underlying physics of the nucleus. The perspective of physics helps us answer many questions that chemists cannot! Why are most elements metals? Why are there three noble metals all in the same column? Why are the three ferromagnetic elements neighbors? Where do the names S, P, D, F come from? Discovery the physics behind these questions and more as we investigate The Secret Physics of the Periodic Table.

Plenary: My 60 Year Romance with the Warped Side of the Universe – And What It Has Taught Me about Physics Education – Kip Thorne (2017 Nobel Laureate)

Location: Galleria Ballroom I **Time:** 5:30–6:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Chandralekha Singh

Kip Thorne

Already in the 1950s and 60s, when I was a student, Einstein's general relativity theory suggested that there might be a "warped side" of our universe: objects and phenomena made not from matter, but from warped spacetime. These include, among others, black holes, wormholes, backward time travel, gravitational waves, and the big-bang birth of the universe. I have devoted most of my career to exploring this warped side through theory and computer simulations, and to developing plans and technology for exploring the warped side observationally, via gravitational waves. Most of my classroom teaching, mentoring, writing, and outreach to nonscientists has revolved around the warped side; and from this I have developed some strong views about physics education. In this talk I will discuss those views, in the context of personal anecdotes about my warped-side research, teaching, mentoring, writing, and outreach.

Session FA: Effective Practices in Educational Technology

Location: Tanglewood **Sponsor:** Committee on Educational Technologies **Time:** 6:30–8:20 p.m. **Date:** Monday, Jan. 14 **Presider:** Andy Gavrin

FA01: 6:30-6:40 p.m. Effective and Efficient Feedback on Lab Reports Using Video Comments

Contributed – Bradley K. McCoy, Azusa Pacific University, Azusa, CA

Competent writers hone their craft by receiving and incorporating feedback on their writing. This applies to technical writing as well as any other form of writing. Yet, on writing assignments in physics classes, such as lab reports, students often receive little usable feedback. In this talk, I will demonstrate how to use video comments captured by the software Snagit to give students direct feedback on their lab report. Video comments take approximately the same amount of time as written comments, while giving much more detailed comments, allowing students the opportunity to make more significant strides in their technical writing skills.

FA03: 6:50-7 p.m. Engaging Students with Interactive Astronomy iPad Tutorials

Contributed – Kristen L. Thompson, Davidson College, Davidson, NC

Physics and astronomy education research has shown that students exhibit larger conceptual gains when they are actively engaged rather than passive learners. As a result, interactive pedagogical tools have revolutionized the way that physics and astronomy are both taught and learned. One such tool that is becoming more prominent in classrooms is the iPad. If used thoughtfully, iPads can facilitate student learning by affording students the opportunity to explore astronomy in new and interactive ways. In this talk, I will present how this technology can be used in combination with lecture tutorials to encourage students to deeply connect with course material and gain a lasting understanding of astronomy concepts.

FA04: 7-7:10 p.m. New York Times CENTRIPETAL FORCE Articles that Help Teach Physics

Contributed – John P. Cise, Austin Community College, Austin, TX

The New York Times has had over the past few years many news articles that use the Centripetal Force Concept. Some examples are: Black holes and neutron stars spiraling into collision producing gravitational waves, trains speeding off tracks on turns, tilting single passenger cars, dancers dancing in circles, spinning X game athletes, orbiting satellites, orbiting asteroids and comets, orbiting exoplanets,etc. The website these applications are located at is: http://CisePhysics.homestead.com/files/NYT-CisePhysics.pdf

FA05: 7:10-7:20 p.m. Integrating Video Creation Activity in a General Physics Class

Contributed – Amtul M. Chaudry, University of La Verne, La Verne, CA

Videos have been used in a physics classroom to facilitate learning of concepts. This idea has been employed in a slightly different format in an algebra-based lower division physics classroom, where students create their own videos. Students have the option of choosing any concept from the topics taught during the semester. This exercise is integrated in the syllabus and graded. The development of this idea over the past few years and student feedback about the activity is presented here.

FA06: 7:20-7:30 p.m. Kinesthetic Learning Using a Local Positioning System

Contributed – Cora Siebert, Portland State University,, Portland, OR

Paul DeStefano, Thomas Allen, Ralf Widenhorn, Portland State University

Fundamental concepts taught at the introductory undergraduate level include position, velocity, and acceleration, as well as the physical relationships between these concepts. Addressing these key physics principles with a kinesthetic approach has been shown to have powerful effects in various ways, from positive learning outcomes to the development of inclusive and engaging classroom environments. With this as our goal, we have developed kinesthetic laboratory exercises using a local positioning system, allowing students to act out various position, velocity, and acceleration vs. time graphs using their bodies and remote controlled cars. The presented activities promote the growth of scientific reasoning through the practice of making predictions and observations, as well as establishing qualitative models that apply to their everyday experience.

FA07: 7:30-7:40 p.m. The Teacher's AR-Assistant in the Physics Classroom

Contributed – Oleg Yavoruk, Yugra State University ul. Krasnoarmeyskaya, KhMAO-Yugra 628007 Russian Federation

There are many technical solutions for applying of the augmented reality (AR) technologies to the daily educational process. Through the AR-device (with an inserted smartphone) the teacher obtains the completely new spectrum of teaching instruments: the Lecturer's AR-Assistant, the Teacher's AR-Assistant in Practical Classes, and the AR-Labs Assistant. The mobile AR-application allows to see the current time, the time after the start (and until the end) of the lecture, subtitles or the lesson plan, procedural recommendations, text-notifications; it permits to operate the timetable, the list of students, the list of problems with solutions, the list of animated models, and any texts, pictures, videos, etc., with the possibility of private viewing or demonstrating on a public screen. In addition, the radically new technologies of teaching, the unusual appearance of the teacher attract the students' attention.

FA08: 7:40-7:50 p.m. Analysis of Meta-Modeling Knowledge and Modeling Ability Change through Model-based Inquiry of High School Students

Contributed – Cha Jiseon, Korea National University of Education, South Korea

Yoon Sung Hyun, Korea National University of Education

The purpose of this study is to analyze the changes of meta-modeling knowledge and modeling ability of high school students through model-based inquiry activities and to grasp the relation and singularity between meta-modeling knowledge and modeling ability. The model-based inquiry was conducted for a total of 17 hours, beginning with a lesson on the development of the model's scientific history. We analyzed the changes of meta-modeling knowledge of four students who completed the whole process and analyzed the change of modeling ability through model output and students' language.

FA09: 7:50-8 p.m. 3D Printing Fabrication in the Teaching and Research Laboratory

Contributed – Joshua A. Yount, Southwest Baptist University, Bolivar, MO

Daniel L. Letner, Perry A. Tompkins, Southwest Baptist University

3D Printing (aka additive manufacturing,) is a technology that has vast implications to modern society. Some of the most important and useful applications of 3D Printing technology in physics education are as a tool in the teaching and research laboratory. In this presentation we examine some of the potential benefits of 3D printing technology as a focus of instruction, a supplement to instruction, and a supplement to research. Computer proficiency is strengthened via Computer-Aided Design (CAD) tools (for designing objects to be printed) and through programming the microcontrollers used to control the printer itself. Electronics and mechanical knowledge can be enhanced through the building improving and maintenance of DIY printers. Unique objects that can be used in the classroom and laboratory can be printed. Some designs are for a specific use and others are more broadly applicable. Most designs presented are available on Thingiverse.com through the account "SBUPhysics."

FA10: 8-8:10 p.m. Acoustic Characteristics on Material and Shape of Tubes

Contributed – Jo Mi-Sun, Korea National University of Education, Department of Physics Education, Cheongju, South Korea

Kim Jung Bog, Korea National University of Education

The tube is a basic experimental tool for teaching the generation of the standing wave and the resonance phenomenon. In this study, we investigated the acoustic characteristics of cylindrical tubes(straight tubes), conical tubes, and bell-shape tube made of silicon tubes and 3D printers. In order to analyze the acoustic characteristics, we used an oscilloscope and an excel program for Fourier transformation, and investigated the acoustic characteristics of transmission vs frequency graphs and Fourier transforms. Larger diameter tube shows smaller Q-factor. Bell-shape tube shows transmission in broader frequency range. By understanding the acoustic characteristics of a pipe with a simple structure, it will be possible to expect the acoustic characteristics of many surrounding wind instruments.

FA11: 8:10-8:20 p.m. We have 3D Printer, Now What?

Contributed – Dwain M. Desbien, Estrella Mountain Community College, Avondale, AZ

The physics program at EMCC has had a 3D printer for a 3 years now. Early last year a few former students (still at EMCC) approached me and asked if they could help me and use the engineering design skills they had been learning. So we embarked on working together to create lab equipment to enhance existing labs, repair broken equipment (even though Vernier would have they students wanted to try). This talk will share what they have made and provide access to the .stl files.

Session FB: Gender Considerations in the Laboratory

Location: Plaza Ballroom I **Sponsor:** Committee on Laboratories **Co-Sponsor:** Committee on Women in Physics
Time: 6:30–8:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Dimitri Dounas-Frazer

FB01: 6:30-7 p.m. The Laboratory as a Historically Gendered Space

Invited – Joanna F Behrman, Johns Hopkins University, Dept. of the History of Science and Technology, Baltimore, MD

From their beginning in the late nineteenth century, secondary school and college-level educational laboratories have been highly gendered spaces. Both consciously and unconsciously crafted, laboratories have worked as part of a larger process of shaping the identities of the students. The laboratory has also functioned as a gatekeeping mechanism for scientific occupations. In this presentation I will outline how the gendering of educational laboratories in the physical sciences has changed over time, covering trends from the 19th through the mid-20th century. I will argue that certain metaphors, such as the laboratory as a frontier, have been particularly exclusionary. While the laboratory as "frontier" is one example of a masculinized space, I will also discuss instances in which the laboratory was gendered and criticized as a feminine space - as in "cookbook" laboratories.

FB02: 7-7:30 p.m. Doing Gender and Doing Physics in the Lab

Invited – Chris Gosling, McGill University, Saranac Lake, NY

Allison Gonsalves, McGill University

This presentation examines students' interactions with laboratory materials (equipment/instruments) in graduate programs and considers implications for physics teaching at secondary levels. Taking a close look at doctoral students 'doing physics' in an experimental setting, we explore how students' interactions with laboratory materials produce new understandings of how students 'do gender' in the lab. We then consider the consequences these interactions may have for students' positionality (e.g. who and what matters in lab practices) and identity work in the laboratory. We will conclude this presentation with a reflective discussion of how engagement with laboratory materials in the secondary physics classroom may (re)produce gendered pedagogic practices.

FB03: 7:30-8 p.m. Agency and the Equity of Lab Groups

Invited – Natasha G. Holmes, Cornell University, Ithaca, NY

Katherine N. Quinn, Emily M. Smith, Zachary Whipps, Cornell University

Building from previous talks in this session, this presentation will focus on the ways in which different lab environments encourage 'doing gender'. In college physics labs, we have identified gender differences in the ways groups coordinate the equipment, computers, and notebooks along with their ideas. We have also found that as labs become less structured and students are making more of the experimental decisions (higher agency), the need for coordinated decision making adds a layer of complexity to the group dynamics and the equity of those groups. This builds on the previous talk's discussion of students' positionality and identity in the laboratory. We will also discuss how these roles are being allocated in these high-agency activities and present questions as to the associated issues and solutions.

FB04: 8-8:30 p.m. Gender and Physics Anxiety in Studio Physics Labs

Invited – Susan M. Fischer, DePaul University, Chicago, IL

Elise Agra, University of Chicago

In this presentation we explore gender in a college studio classroom, where students are asked to actively engage with small groups of their peers in many different types of hands-on activities, in an environment that is much more lab-like than that of a traditional classroom. Research has shown that men outperform women on concept inventories. A factor that may be relevant to students' physics performance is physics anxiety, which can be described as the feeling of fear and apprehension about physics-related activities. We used the Physics Anxiety Rating Scale (PARS), which has 32 items in four categories: general course/test anxiety, anxiety about the lack of physics knowledge, math anxiety, and physics laboratory anxiety. We modified the scale, which was created for traditional physics classrooms, to fit the studio environment. We investigate the relationship between students' gender, physics anxiety, and physics performance in a studio-style introductory physics course.

Session FC: Hands-on Outreach

Location: San Felipe Room **Sponsor:** Committee on Science Education for the Public **Time:** 6:30–8:30 p.m. **Date:** Monday, Jan. 14
Presider: Paul Williams

"Hands-on On the Road" is a style of outreach where the public engages in direct scientific investigation and inquiry. This style of outreach can have many forms ranging from engineering exercises such as bridge building and egg drops to traveling hands-on science museums. In this panel discussion, practitioners of Hands-on On the Road will share their experience about such programs including topics such as how to get started, the type of activities that they include, how they run and maintain their program, as well as others. Sample activities from the Austin Community College Hands-on Science program will be available for exploration.

Session FD: Integration of Computation into the Curriculum on the Departmental Scale

Location: Galleria III **Sponsor:** Committee on Educational Technologies **Time:** 6:30–8:30 p.m. **Date:** Monday, Jan. 14
Presider: Walter Freeman

It is relatively straightforward to integrate computational thinking and numerical simulation into a single course. Integrating computation into a larger course of study poses new challenges, among them coordination between faculty members, coherence and consistency in the curriculum, and clearly defined computational learning objectives. This session will explore these challenges and how departments have overcome them, and discuss strategies for weaving computational thought and insight through numerical simulation throughout a physics curriculum. If the session length permits, a panel discussion will follow the talks.

FD01: 6:30-7 p.m. Computation in the Physics/Astronomy Curriculum at the University of Arizona

Invited – Drew Milsom, University of Arizona, Tucson, AZ

The physics and astronomy departments at the University of Arizona collectively teach two courses covering programming and numerical methods. Some mixture of C/C++ and Python is generally used. Three-fourths of the numerical methods curriculum is fixed and the remaining one-fourth is left up to the specific instructor. These courses are prerequisites for some upper division courses in each department. In those courses, students may have computational problems on their homework assignments and/or longer computational projects. Additionally, many students will use their computational skills in research credits which are required for each degree. Thus, the students have ample opportunities to practice these skills throughout their degree programs.

FD02: 7-7:30 p.m. Computational Physics at Francis Marion University

Invited – Larry Engelhardt, Francis Marion University, Florence, SC

At Francis Marion University, we have offered a concentration in Computational Physics for the last 20 years. I will talk about how this program has evolved and what we are doing today, and I will provide some tips of "dos and don'ts" for integrating computation.

FD03: 7:30-8 p.m. Computation for Physics Careers: Developing and Promoting Essential Skills

Invited – Crystal Bailey, American Physical Society, One Physics Ellipse, College Park, MD

Many physics students and faculty are aware that computation is a foundational skill for physics research in academic contexts. What many don't realize is that it is also tremendously valuable in non-academic, private sector environments – which is where over 60% of physics PhD graduates and over 95% of physics BS graduates will eventually pursue careers. In this talk, I will explore some specific computational skills that are widely used by physicists in the private sector, and provide some advice on how students can best market those skills to potential employers.

FD04: 8-8:10 p.m. The Upper-division Two-semester Computational Physics Sequence at TLU

Contributed – Calvin J. Berggren, Texas Lutheran University, Seguin, TX.

I will present the recently renovated two-semester sequence in computational physics at Texas Lutheran University, covering design goals, student learning objectives, course strategies, content coverage, integration into departmental plans, and results so far.

FD05: 8:10-8:20 p.m. Department Wide Integration of Computation in the Curriculum at a Small Liberal Art University

Contributed – Timothy A. Duman, University of Indianapolis, Indianapolis, IN

Steve Spicklemire, University of Indianapolis

In recent years, the department of physics and earth-space science at the University of Indianapolis has been integrating computation into all of the courses taken by physics majors. This talk will present the steps taken to implement our strategy.

FD06: 8:20-8:30 p.m. Emphasizing Computation for Physics Majors at Western Kentucky University

Contributed – Richard Gelderman, Western Kentucky University, Bowling Green, KY

Western Kentucky University has revised the curriculum required for its physics majors. One of the changes is that our majors will be meaningfully involved in computational solutions all through their undergraduate career. The introductory course for majors, requiring only algebra and trigonometry as a prerequisite, presents the foundations of relativity and the quantized atom. Our calculus-based physics sequence, also taken by other science majors and engineers, recently changed over to the Matter & Interactions textbook and its integrated use of programming. Junior level modern physics, mechanics, and E&M courses require students to use Mathematica for computation and visualization. Instructors for upper level topical classes are now able to go deeper into their material, without having to take time to familiarize students to computation.

Session FE: Panel: PER and Student Motivation: Beyond Single Course Content

Location: Sage Room **Sponsor:** Committee on Research in Physics Education **Time:** 6:30–8:30 p.m. **Date:** Monday, Jan. 14
Presider: Gary White

FE01: 6:30-8:30 p.m. Motivation Enhances Conceptual Learning, Not Procedural Training

Panel – Eric Kuo, Pittsburgh, PA

Kelly Boden, Quentin King-Shepard, Timothy J. Nokes-Malach, Tanner L. Wallace, University of Pittsburgh

A student's motivation for learning impacts how they approach learning in the classroom and, ultimately, what they learn. Motivational factors such as self-efficacy and achievement goals have been shown to predict students' academic performance generally. Yet, little work has been done to investigate how motivation impacts different types of learning. In a study of 6th-grade science students, we looked at how different motivational factors predict different learning outcomes, finding that self-efficacy predicted conceptual learning and transfer while performance goals (i.e., aiming to perform better than others on school tasks) predicted use of proportional reasoning. No motivational factors investigated predicted procedural application of a formula. These results suggest that successful attainment of more challenging learning goals may depend on students' motivation to learn.

FE02: 6:30-8:30 p.m. How Students Perceive an Instructor's Emphasis on Limiting Case Analysis

Panel – Tiffany-Rose Sikorski, Washington, DC

Limiting case analysis is important to practicing physicists. Yet, there is little concrete guidance for physics educators, and a lack of consensus in the research community, about how to help students learn, and learn from, limiting case analysis. This study first reviews existing literature to find commonalities and variations in how instructors encourage and assess students' limiting case analysis. Then, the study considers the students' perspective, examining written work and interviews with successive cohorts of physics students, all of whom have completed a course with the same instructor who emphasizes limiting case analysis in his teaching. Overlap between student and instructor perspectives adds further support to the claim that limiting case analysis could play a pivotal role in the development of physics expertise.

FE03: 6:30-8:30 p.m. Motivation of Physics Students' Self-checking Behavior*

Panel – David E. Meltzer, Arizona State University, Mesa, AZ

Dakota H. King, Arizona State University

For an investigation into physics students' mathematical difficulties, we have administered written diagnostic tests to over 3000 students. Students' responses to elementary questions on trigonometry, algebra, and graphing reflected a large number of operational errors, to a degree that could significantly interfere with success in an introductory physics course. However, individual problem-solving interviews with students revealed that, when simply asked to explain their solutions to the problems, students would very frequently discover and correct a large proportion of their errors with no additional input from the interviewer. Consequently, we propose that integrating multiple "self-checking" steps into guided quantitative problem-solving exercises may help habituate students to perform simple checks that could significantly impact their problem-solving success.

*Supported in part by NSF DUE #1504986

FE04: 6:30-8:30 p.m. Assessing Physics Quantitative Literacy Development

Panel – Suzanne Brahmia, University of Washington, Department of Physics, Seattle, WA

Alexis Olsho, University of Washington

Trevor Smith, Rowan University

Andrew Boudreaux, Western Washington University

Physics can play a central role developing quantitative literacy, helping students bridge the "math world" and "physical world." Physics Quantitative Literacy (PQL) is a set of interconnected skills and habits of mind that support quantitative reasoning about the physical world. In this poster, we present the PIQL, Physics Inventory of Quantitative Literacy (currently under development), which assesses students' proportional reasoning, co-variational reasoning, and reasoning with signed quantities. PIQL is a reasoning inventory that can provide snapshots of student ideas that are continuously developing. Item distractors are constructed based on the different established natures of the mathematical objects in physics contexts (e.g. the negative sign as a descriptor of charge type and the negative sign as the operation of subtraction). An analysis of student responses on PIQL will allow for assessment of hierarchical reasoning patterns, and thereby potentially map the emergence of flexibility between the various natures throughout the introductory sequence.

FE05: 6:30-8:30 p.m. Fluidity in Epistemic Games

Panel – Mark Eichenlaub, Art of Problem Solving, San Diego, CA

Edward F. Redish, University of Maryland

We began analyzing problem-solving data imagining that students went into a particular stage of the problem (e.g. the "check your answer" phase) with a fairly fixed set of ideas about what would happen, what types of evidence were relevant, and what steps were allowed. We described these expectations and how students used them to solve problems using the framework of epistemic games. Here, we present cases where students seemed to break the underlying rules of epistemic games or repurpose them to entirely new goals (e.g. using them to help find an unknown answer rather than check an answer candidate). We conclude that student reasoning was more fluid than we previously appreciated and that an approach using dynamic finer-grained epistemological resources might be more appropriate.

FE06: 6:30-8:30 p.m. Change in Multivariable Functions*

Panel – Corinne Manogue, Oregon State University, Corvallis, OR

Paul Emigh, Elizabeth Gire, David Roundy, Michael Vignal, Tevian Dray, Oregon State University

For 22 years, the Paradigms in Physics project at Oregon State University has been taking a holistic approach to the entire upper-division physics curriculum for majors. How do we plan for students' understanding of concepts to build across time and across physics subdisciplines? How do we choose representations to teach early on that maximize the powerful links to what students need to know later? How do we design activities that engage students with key foundational ideas or that challenge students to expand on their current level of understanding to tackle ever more complicated tasks? We will address these questions, using as our exemplar the ways in which we explore the concept of change and rates of change in physical situations that involve more than two interrelated variables.

*This work was supported in part by NSF grant DUE-1323800.

FE07: 6:30-8:30 p.m. What Basic Skills Should Introductory Physics Students Have?

Panel – Andrew F Heckler, Columbus, OH

Both anecdotally and empirically, it is a familiar observation that many students are not proficient in very basic skills used in STEM courses at all levels. A natural reaction to such a deficit is to help students improve proficiency in such skills. I will present results from our highly successful efforts to help students practice, master, and retain some "essential skills" via computer-based learning, and some guidelines for building practice content and structure. But this issue is not so straightforward. For example, which basic STEM skills will be useful beyond STEM courses? What are realistic goals for proficiency and retention in a one-year course? Does learning such basic skills help with other instructional goals such as conceptual understanding and complex problem solving? An investigation into answers to these questions seems critical to meaningful progress.

Session FF: Panel: Results from the First Safe Space for People of Color Meeting In PERC

Location: Westchester Room **Sponsor:** Committee on Diversity in Physics **Co-Sponsor:** Committee on Research in Physics Education
Time: 6:30–8:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Alexis Knaub

This session will be a report out on the 2017 and 2018 Spaces for People of Color in Physics Education Research held at the 2017 and 2018 Physics Education Research Conferences. The panelists in this session will be sharing the collective ideas of the groups participating in the two PERC meetings. In addition to presenting major themes from the spaces the panelists will engage in question and answer. We encourage all interested in hearing the findings from those spaces to attend both this session and the following session on policy impacting physicists from different marginalized groups.

FF01: 6:30-8:30 p.m. First Safe Space for People of Color Meeting Experience from a Junior Faculty

Panel – Carolina U. Alvarado, CSU Chico, Department of Science Education, CSU Chico Chico, CA

Finding my place in the multiple environments I participate in has always been an interesting process. I attended my first PER conference as an international graduate student who was aiming to see her role in a bigger community. After five years of attending the conference, I found myself attending the First Safe Space for People of Color. This showed me a different perspective of PER and my own role in this community. I will share my personal take from this first meeting and the implications as a Junior Faculty going from my journey and linking it to the bigger system in which we are existing and performing PER. In order to understand the value of the creation of this safe space, we need to explore what factors in other spaces can make people of color not feel safe.

FF02: 6:30-8:30 p.m. Reporting Out on Professional Opportunities and Allies

Panel – Simone Hyater-Adams, University of Colorado Boulder, Boulder, CO

Alexis V. Knaub, Western Michigan University

Ayush Gupta, University of Maryland, College Park

Geraldine Cochran, Rutgers University

On this panel, I will talk about two topics of discussion from the Safe Space for People of Color sessions at PERC 2017 and 2018 Meetings. As a session participant and a contributor to the sections in the document, I will provide a summary of the conversation, along with some ideas of ways the community can address some of the concerns brought up. The first topic is about professional opportunities. I will summarize the discussion from the sessions about personal and group experiences with facing barriers to professional opportunities stemming from our identities as people of color. The second topic is about the Allies Group. I will summarize the collective experiences with, feedback for, and concerns about the group that were raised during the sessions. I will also speak to some personal experiences with these topics, and give deeper insights from the conversations at each session.

FF03: 6:30-8:30 p.m. People of Color in PER Dealing with Racism in Society

Panel – Brian Zamarripa, Roman University of Central Florida, Orlando, FL

Geraldine Cochran, Rutgers University

Alexis Knaub Michigan State University

As a society, we are aware of more instances of police brutality and everyday discrimination from businesses towards People of Color. It's been going on for a while, but technology and the political climate have made it more prominent in the public eye. In addition to making it more prominent, the political climate and the current administration has allowed racism to be more overt and more violent. People of Color may not often experience blatant racism within the AAPT community; however, racism is expected once they step outside of the hotel/conference center and interact with local people, businesses, and authorities. While no place is genuinely safe from racism, some places, some locations are less safe than others. In this talk we have a more detailed discussion on the instances of racism and discrimination that may be experienced by conference attendees who are People of Color and ways that you can support your colleagues who experience this.

Session FG: Space Science in Introductory Courses

Location: Bellaire **Sponsor:** Committee on Physics in Two-Year Colleges **Time:** 6:30–8:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Robert Brazzle

FG01: 6:30-7 p.m. Drop Tower Physics

Invited – Toby Dittrich, Portland Community College, Portland, OR

Greg Mulder Linn, Benton Community College

Drop Tower Physics is a space science classroom tool that will challenge and interest students and professors alike. The Dryden Drop Tower at Portland State University creates micro-gravity for 2.1 seconds, and has been used to videotape various physics demonstrations as they undergo a transition from g= 9.8 m/s2 to zero. How does a floating cork, stack of coins, pendulum, mass spring oscillator, and chaotic pendulum behave as the acceleration due to gravity seemingly, for the falling non- inertial reference frame, disappears? Drop Tower Physics asks the students to postulate the behavior of these examples and to test that against their knowledge of physics. If the postulate conforms with physical laws, the videos constitute the experimental branch of physics. Of course, theory and experiment must match. The actual behavior often surprises and amazes them, leading to a deeper understanding of the demonstrations. Drop Tower Physics will do this for you, too.

FG02: 7-7:30 p.m. Space Center Houston: Gateway for Space Science Exploration and Learning

Invited – Phyllis Friello, Space Center Houston, Houston, TX

Phyllis Friello, Education Manager at Space Center Houston will present an overview of the Center's education programs and resources for students and adults. Understanding both the importance and often difficulty of keeping current on space exploration programs and content, a focal point of the presentation will be strategies to provide authentic and topical learning experiences to students and adults. Featured will be Space Center Houston's Space Center University programs which bridge the gap between NASA's scientists and engineers and the public, providing accessible and timely transfer of content to educators and students.

FG03: 7:30-8 p.m. From Thermonuclear Fusion to Rocket Propulsion, a Physics Journey of Challenge and Opportunity

Invited – Franklin R. Chang, Diaz Ad Astra Rocket Company, Webster, TX

Responding to the world oil shortage of the early 1970s, the US Government invested heavily on new energy research, including controlled thermonuclear fusion. This became a formidable motivator for advancing the field of plasma physics. New knowledge was quickly gained and, albeit indirectly, the VASIMR® engine* became an

early product of the scientific bonanza. In this talk I shall present the fundamental physics of the VASIMR® engine and describe how these principles have guided the evolution of the technology from its formative years at MIT and NASA, to its technological maturation at the Ad Astra Rocket Company. I shall comment briefly on some of the challenges, opportunities and plans for its commercial deployment in cislunar space and eventually as an option for fast human interplanetary transportation.
* Variable Specific Impulse Magnetoplasma Rocket

FG04: 8-8:30 p.m. Techno-Stories from Space

Invited – Donald Pettit, NASA Astronaut, Lyndon B. Johnson Space Center, Houston, TX

Frontiers are interesting places; they offer the possibility to make observations outside our normal range of experience; the International Space Station is such a frontier. A smattering of my observations will be presented in story form. There will be many questions and few answers, which of course is a characteristic of being in a frontier and why we venture there.

Session FH: High School

Location: Plaza Ballroom II **Sponsor:** AAPT **Time:** 6:30–8:30 p.m. **Date:** Monday, Jan. 14 **Presider:** Kenneth Cecire

FH01: 6:30-6:40 p.m. Solar Car Challenge to Experience Physics on Track

Contributed – Ahmet Afsin, Harmony Science Academy - Euless, TX

This is a nationwide challenge where high school students build man size solar vehicles. To get in and ride, one year at Dallas Motor Speedway, one year cross country, from Dallas to California. This is a real challenge for team members where they learn team work, apply electric circuits, apply dynamics, torque, energy...etc. The car really stays in between physics and real world engineering. It requires 3D design and calculation approaches and skills, of course welding, precise measurement..to build a car and make it work. Even the project's name and advertisement fire student curiosity. And when they finish, they are full with vast knowledge and self confidence of achieving to create a working dynamic system.

FH02: 6:40-6:50 p.m. OnRamps Physics: Experiencing UT-Austin at Texas High Schools

Contributed – Jonathan Perry, University of Texas at Austin, Austin, TX

Jason E. Dowd, Elyse Zimmer, Jennifer Porter, University of Texas at Austin

OnRamps is an innovative dual-enrollment and professional development program in which UT-Austin faculty, learning specialists, and experts in college success partner with Texas high school (HS) districts for students to authentically experience university courses. An overarching goal of the OnRamps program is to increase the number and diversity of students who are prepared to excel at the university level. OnRamps currently offers two 3-credit-hour introductory physics courses through distance education that are delivered with their respective HS equivalents. Student learning is driven by Peer Instruction and Modeling Instruction pedagogies, with college assignments administered and submitted online. Course content, developed by UT-Austin Physics faculty members, aligns to the residential university course and the expectations of leading universities. We will discuss the logistics and challenges of delivering a distance learning UT course alongside a corresponding HS course. For the 2018-2019 academic year, OnRamps has partnered with approximately 150 HS physics instructors enrolling nearly 6000 physics students across Texas.

FH03: 6:50-7 p.m. From Constant Velocity to Astrophysics: Computation in the HS Classroom

Contributed – Charlie K. Payne, North Carolina School of Science and Mathematics, Durham, NC

The learning of physics concepts can be augmented by computational models. Using GlowScript, fundamentals of programming in Python can be learned while creating models that produce three dimensional representations and simulations that also include graphs and data tables. While physical labs should be a primary method for hands-on learning, programming can produce results not achievable in a lab. Examples of a sequence of learning, from constant velocity through force interactions, will be demonstrated. The use of programming in AP Physics courses will also be shown, as well as more advanced topics such as binary black hole inspirals that produce gravitational waves and planetary interactions such as in our Solar System. Some examples of student programs from NCSSM will also be shown and discussed. The use of iPython notebooks and data analysis involving both LIGO and CERN data will be also be shown.

FH04: 7-7:10 p.m. A Free Yet Effective Way of Implementing Peer Instruction in a Physics Class

Contributed – Mehmet Ozgun, Harmony Public Schools, Houston, TX

Peer instruction is an interactive teaching technique works well to address students' struggle to apply factual knowledge to conceptual problems. In my Physics classes I started using this technique with some paid web-based platforms where each student needs to access a computer, tablet or a phone. But this is an expensive and time-consuming way so I started using Plickers! This assessment tool allows you to collect on-the-spot formative assessment data without the need to have students use devices or paper and pencil. The only things a teacher needs are a computer, a cell phone and printed Plickers cards which can be used over and over again in different classes. I would like to share how am I implementing the use of technology via the Plickers method to my peer instruction sessions in my Physics classes.

FH05: 7:10-7:20 p.m. A New Mindset: Physics and 21st Century Skills

Contributed – Erol Dede, Harmony Public Schools, Sugar Land, TX

Physics and Engineering Projects provides practical methods and fruitful alternatives to gain the 21st century skills. The inclusion of Physics and Engineering projects helps students develop skills such as analytic reasoning, complex problem solving, and teamwork. Besides, it also provides educators with the easily applicable methods to fulfill the requirements of special programs such as Career and Technical Education (CTE). We believe that our practice to reach the objectives guided by the 21st century skills and CTE curriculum by using some specifically chosen Physics and Engineering projects is quite inspirational and will introduce you a new mindset for a new approach.

FH06: 7:20-7:30 p.m. From Friendship to Tech-Savviness: Benefits of a Club

Contributed – Mehmet Ozgun, Harmony Public Schools, Houston, TX

Studies relating to the impact of extracurricular activities on students show that educational grades, study habits, and school-based behavior improve once youngsters attend regular after-school clubs. One such club is our Rocketry Club! This club nurtured social skills and confidence of my students and taught them the value of working as a team to achieve a mutual goal. We've been meeting twice after school, launching rockets every other Saturday, having breakfast before and lunch after our launches. Students mastered in aerospace engineering by using the modern technology such as laser cutters and 3D printers to create their fins and the shipment box to ship their rocket to Washington, D.C., after being invited to the finals of the world's largest rocketry competition "Team America Rocketry Challenge, TARC". I will have two of my team captains share their experience and motivate and encourage the audience to establish similar clubs in their schools.

FH07: 7:30-7:40 pm. How to Create STEM Culture in School Using Project Based Teaching Strategies?

Contributed – Abdulkadir Akti, Harmony Public Schools, Fort Worth, TX

STEM fields have been seen as hard by most of students, so much so, that drawing their attention to STEM always becomes an issue for educators. In our STEM SOS (Students on the Stage) Model, we use PBL, as an after school club, to create a STEM culture. Students conduct research and create video presentations. As part of their after school club activities, students organize events, as well as, invite guest speakers, that are experts in their field, to present events at our school. This type of PBL strategy helps educators to promote STEM in our school system.

FH08: 7:40-7:50 p.m. Physics Olympiads

Contributed – Nebi Sahin, Harmony School of Innovation, 15312 West Airport, Sugar Land, TX

Drawing boundaries where physics is valid is very difficult because innovations, technology, and engineering advancements and inventions are continually expanding these boundaries. In most new theories and engineering designs, basic philosophical and physical ideas are based on models, equations and physics laws. The purpose of my presentation is to emphasize the necessity and the applicability of Physics Olympiads training in the U.S. To be successful in the field of Science Olympiads, going beyond the training methods we know may be a must. These studies should be offered to individual talented and relevant students with an earlier provision of high school algebra and calculus support. I have had very successful results in different countries where I have worked as a Physics Olympiad instructor for many years. My students received acceptance from the best universities and earned their professors' respect in a short period and contributed to the world of science.

FH09: 7:50-8 p.m. Houston, We Have AP Physics 1 Problem

Contributed – Oguz Celik, Harmony School of Advancement, Houston, TX

I am teaching AP Physics 1 since it started. According to CollegeBoard data, AP Physics 1 has the lowest average score and the lowest proportion of students that score a 5 out of all current AP subjects. In this presentation, I will try to introduce why AP Physics 1 has the lowest average score. Does the new AP Physics curriculum affect the average scores? What are the students and teacher challenge of the course? Also, I will compare Texas and nation average score of AP Physics 1.

FH10: 8-8:10 p.m. Physics in the 21st Century – A Tool for Teaching Physics

Contributed – Michael Agermose Jensen, Christianshavns High School, Copenhagen, K 1422 Denmark

In 2005 the high school system was reformed in Denmark. The curriculum for the physics course at the senior (12th grade) level was supplemented by a new component, titled Physics in the 21st century. The purpose of this was two-fold: Provide students with a window to modern physics, while simultaneously providing a lever for post-graduate teacher training. Resources for in service teacher development are both limited, and divided between pedagogical and physics topics. The Danish Association of Physics Teachers has been instrumental in implementing the second objective. With experience, a parallel track model emerged. A group of teachers gathered to work in two tracks: developing a 2-day teacher course in conjunction with a University, and writing a textbook tailored to the extra curriculum. Experiences with the model have been good. Participating in the development of such courses has proven a valuable experience for the teachers involved.

Session FI: Introductory Labs/Apparatus

Location: Post Oak **Sponsor:** AAPT **Time:** 6:30–8 p.m. **Date:** Monday, Jan. 14 **Presider:** Debroah Roudebush

FI01: 6:30-6:40 p.m. Interference Fringe and Diffraction by Using Two Glass Plates

Contributed – Jung Bog Kim, Korea National University of Education, Dept. of Physics Education, Cheongju, CB 28173 S. Korea

Chang-won Kang, Hong Gwang Elementary School

Hyen-Jung Nam, Dongmyung Elementary School

A double-slit interference fringe can be produced by using just two glass plates. A laser passes through a small gap between two close panels. A part of the laser beam is diffracted, and other part is refracted. We are able to produce a diffraction pattern by a single slit or interference fringe by a double slit by controlling the angle between two plates. We can change very easily interference fringe spacing by changing this angle. We are able to measure the wavelength of the laser by measuring this fringes.

FI02: 6:40-6:50 p.m. Implementing Non-Prescriptive Experiments in the Introductory Laboratory

Contributed – Nicholas A. Mauro, St. Norbert College, 100 Grant St., Gehl-Mulva Science Center, De Pere, WI

Michael Olson, St. Norbert College

Introductory laboratories offer unique opportunities to practice experimentation, reasoning and critical thinking skills. When a non-physics major takes a physics class that has a laboratory, the development of these skills have been cited as one of the most important experiences by that student's home department. The laboratory experience must provide the student with the opportunity to make fundamental decisions, analyze the results of those decisions, revise thinking based on observational evidence, and learn from the process. In light of recent studies suggesting that experiments without a prescriptive experimental procedure can be effective, we present results from a pilot study modifying the laboratory experience in an introductory algebra-based physics course at a small college to include non-prescriptive experiments. In this talk, we discuss the development of the laboratory, the structure of a two-week experiment with three opportunities for student-driven critical analysis, and our initial results on the efficacy of this approach.

FI03: 6:50-7 p.m. More MATLAB Labs Using Mobile Phone and Public Data

Contributed – Duncan L. Carlsmith, University of Wisconsin - Madison, Madison, WI

Mobile phone inertial sensor, optical, and acoustic data, and public data, all analyzed with MATLAB, enable beginning physics students to engage in science in new ways. This talk will describe a few novel examples including: 1) A mobile phone camera calibration lab with computer vision analysis through which students can understand 3d Ruler apps and operationally how we see the world. 2) An analysis of mobile phone recordings of acoustic N-waves from a spark generator to augment and test a systematic error in a standard free fall experiment. 3) Downloading and fitting observations of orbits of stars around the Sagittarius A* black hole and statistical analysis of 1/2 million rock, paper, scissors games as examples of verifying claims and discovery through public data. Technical details and learning goals will be described.

FI04: 7-7:10 p.m. Producing Cold Atomic Beam Using a Pyramidal Mirror

Contributed – Sunyoung Seo, Korea National University of Education, Dept of Physics Education, Cheongju, CB 28173 S Korea

Eunkang Kim, Ashish Kumar Sharma, Juntae Koh, Jung Bog Kim, Korea National University of Education

Uniform low-speed atomic beams can be applied to atomic optics such as atomic clock or atomic interferometer. In order to generate a slow atomic beam, we use the Magneto Optical Trap (MOT) method to create atomic gas that is kept very close to absolute zero. Magneto optical trap is achieved with both pairs of three orthogonal laser beams and a magnetic quadrupole field. In the case of using a pyramidal mirror, three orthogonal laser beams can be performed by only a single beam, which is a relatively simple structure. In this study, the pyramidal mirror of 20X20 mm^2 was used to generate magneto optical trap and atomic beam of Rb atomic gases. The cooling beam for the magneto optical trap consists of three pairs by a pyramidal mirror out of a circularly polarized single incident light. Both a quarter wavelength plate and a mirror are installed to form a pair of light pressure for the light passing through the hole of 6X6 mm^2 made at the apex of the pyramidal mirror. At this time, the number of captured atoms is 1.52X10^7atoms. After the magneto optical trap was formed, using a mirror with a 1mm hole at the center to form a donut-shaped retro-reflected light. Therefore, in the region where there is no reflected light through the hole, the atoms are subjected to the light pressure in the direction of gravity by the incident cooling beam to form an atomic beam eventually. At this time, the average velocity of the atomic beam is 11.3m/s, the velocity distribution component of atomic beam is 4.25m/s, and the temperature of atomic beam is 89mK.

FI05: 7:10-7:20 p.m. Using Effective Tools to Increase TAs Consistency in Grading Physics Lab Reports

Contributed – Merita Haxhia, Washington University in St. Louis, Saint Louis, MO

Traditionally, the physics lab reports are written in a lab notebook and graded by TAs. The students produce individual reports . The huge time dedicated to grading them jeopardised the consistency in grading. Replacing it with electronic submission and a group work (one report per group) reduced the time needed to grade the reports. However, consistency was still a concern until we implemented Gradescope. It is an online tool that provides transparency, flexibility, and the most important, consistency. The variety of its features has made the TAs work enjoyable and productive. Entering rubrics, posting grades, and syncing the rosters is simple. In addition, Gradescope has made it easier for the instructor to supervise the graders and check the statistics.

FI06: 7:20-7:30 p.m. Two Birds with One Stone: Engineering Design and Physics Lab

Contributed – Bob Brazzle, Jefferson College, 2019 Brutus Ct., Fenton, MO

In this talk, I'll describe an assignment I give my Engineering 101 (computer-aided design) students, in which they design an apparatus I can use for my Introductory Physics course, which most of them will take the following year. The challenge is to design a pocket-sized device that combines the classic bicycle wheel gyroscope demonstrator (using 3/4" ball bearings for rim masses) with an AC generator in which the bearings are replaced by 3/4" magnets. Teams design the device using AutoDesk Inventor software and a MakerBot 3-D printer. Although these students typically don't know how a generator works, they choose some aspect of the coils to test (number of windings, orientation relative to the rotating magnets, etc.) for my open-ended exploratory generator lab during the E&M semester of Introductory Physics. This benefits students in both courses. I'm happy to share these designs with the attendees.

FI07: 7:30-7:40 p.m. A New Inexpensive Wireless Multisensor for Introductory Labs

Contributed – Charles D. Lane, Berry College, 2277 Martha Berry Hwy., Mount Berry, GA

Vedant Mehta, Georgia Tech

We have developed a compact multisensor device that measures around 20 different physical quantities in real time and relays the measurements to a nearby computer via wireless Bluetooth. The set of measurements includes acceleration (3 components), angular velocity (3 components), magnetic field (3 components), temperature and luminosity. The complete set of measurements may be exported to a .csv file for use in a spreadsheet or other data-analysis application. This device may be built by an undergraduate student for around $120. We present sample data collected during the 2017 solar eclipse, from a rotating stool, and from the end of a simple pendulum.

FI08: 7:40-7:50 pm. A Modified Car Collision Lab Activity

Contributed – Pei .. Xiong-Skiba, Austin Peay State University, 601 College St., Clarksville, TN

Students in introductory physics courses tend to be "happy" as long as they can solve a problem. They rarely challenge themselves to interpret the results of their calculations. In our collision lab, we ask students to do various simple calculations to predict what will happen when two carts collide elastically or in-elastically, then verify their predictions through experiment. Students responded to this lab activity more positively, comparing with most of the other lab activities in the lab course. Our post-lab tests revealed that students were able to master and retain the key concepts reasonably well.

FI09: 7:50-8 p.m. Implementing Service Learning into the Introductory Astronomy Lab

Contributed – Tracy Hodge, Berea College, Berea, KY

Jon Saderholm, Berea College

Service Learning is a form of experiential learning that integrates meaningful community service with content instruction. The weekly laboratory section of an introductory astronomy course was re-designed to facilitate a service-learning project. Students worked in small groups to learn cycles of diurnal and annual motion, coordinate systems, seasonal constellations, and phases of the moon using an opensource desktop planetarium. Students also learned how to operate a small telescope and plan an observing session. During weeks 10 and 11 of the 14-week semester, students held a series of public star parties for local schools, scouting groups, and families of non-traditional students. We discuss the impact of the project on students' disposition towards science, sense of personal efficacy, and engagement in the course. We will also include discussion around the feasibility of implementing service learning into larger lecture courses.

Session: Poster Session II
Location: Woodway Hall **Sponsor:** AAPT **Time:** 8:30–10 p.m.
Date: Monday, Jan. 14

Persons with odd-numbered posters will present their posters from 8:30 to 9:15 p.m.; those with even-numbered posters will present from 9:15 to 10 p.m. Posters may be posted after 4 p.m.

PST2A01: 8:30-9:15 p.m. Adapting NASA Curricular Materials to Support New Nebraska Standards in Physics

Poster – Maggie J. Reed, University of Nebraska Omaha, Omaha, NE

Christopher Moore, University of Nebraska Omaha

This project utilized pre-existing NASA Office of Education educator resources and curricular materials within graduate-level coursework for in-service physics teachers. Specifically, in-service teachers used the American Museum of Natural History's "Five Tools and Processes for Translating the NGSS Into Instruction and Classroom Assessment" and research on multiple representations in physics to adapt these curricular materials to meet Nebraska's new College and Career Ready Standards for Science (NCCRSS) and current research on student learning through physics representations. We have used the Educators Evaluating the Quality of Instructional Products (EQuIP) rubric to assess adapted materials and we report on changes in participant beliefs using the Colorado Learning Attitudes about Science Survey (CLASS-Phys).

PST2A02: 9:15-10 p.m. New Approach to Physics Education Professional Development: Online Mini-courses

Poster – Rebecca Lindell, Tiliadal STEM Education Solutions, Lafayette, IN

Joseph Kosminiski, Lewis University

Rebecca Rosenblatt, Raymond Zich, Illinois State University

Ethan Stanle,y Tiliadal STEM Education Solutions

The face of higher education is changing and many faculty are struggling to keep up. While many faculty seek to improve their teaching, they are limited in their professional development opportunities. Often they can work with their office of instructional excellence, but many of these offices are unaware of the unique learning situations within the STEM fields. Faculty must seek the professional development outside the university, which often increases the cost of said professional development. As an alternative, we have created an online mini course offered through The Course Networking platform (http://www.thecn.com). This course meets once a week and faculty work through assignments, reading and activities guided by the facilitator leading to the completion of a project related to the theme of the mini-course. In this poster, we discuss the positives and negatives of such a course, as well as provide an example of one such mini-course.

PST2A03: 8:30-9:15 p.m. Integrating Computation: What's New from PICUP*

Poster – Larry Engelhardt, Francis Marion University, Florence, SC

Marie Lopez del Puerto, University of St. Thomas

Danny Caballero, Michigan State University

Kelly Roos, Bradley University

Norman Chonacky, Yale University

The purpose of this poster is to provide some updates about exciting opportunities that are available to you from "PICUP" (the "Partnership for Integration of Computation into Undergraduate Physics"). These opportunities include week-long workshops during the summer, single-day workshops at AAPT meetings and at various locations around the country, and editable curricular materials that can be downloaded from the PICUP Collection of the ComPADRE Digital Library: www.compadre.org/PICUP. Do you already integrate computation into your courses? If so, you should submit your materials for publication in the PICUP Collection, which gives you the opportunity to both (1) contribute to the broader physics community, and (2) get some peer-reviewed publications in the process!

*This project is funded by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

PST2A04: 9:15-10 p.m. Effectiveness of Mitchell Institute Physics Enhancement Program for Teacher Development

Poster – Fu-Anne Wang, Texas A&M University, San Antonio, TX*

Matthew Dew, Tatiana Erukhimova, Texas A&M University

Jonathan Perry University of Texas at Austin

The Mitchell Institute Physics Enhancement Program (MIPEP) is a two-week professional development program for in-service high school physics teachers with a limited background in the subject area. Typically, teachers in the program have had 0-8 credit hours of college-level physics courses. The MIPEP curriculum is taught by Texas A&M University faculty from the Department of Physics & Astronomy along with two master high school physics teachers. MIPEP, which started in 2012, includes two weeks of intense training in both subject matter and implementation. Content and materials used in the program are informed by the Physics TEKS requirements. A detailed assessment of teacher knowledge and confidence was performed for each cohort. Analysis of pre and post-program evaluations will be presented to comment on the effectiveness of the program. Data from a recent follow-up survey will be assessed to evaluate the long-term effects of MIPEP.

*Sponsored by Jonathan Perry & Tatiana Erukhimova

PST2A05: 8:30-9:15 p.m. OnRamps Physics: Enhancing Physics Education for Diverse Students in Texas

Poster – Jonathan Perry, University of Texas at Austin, Austin, TX

Jason E. Dowd, Elyse Zimmer, Jennifer Porter, University of Texas at Austin

OnRamps is an innovative dual-enrollment and professional development program in which UT-Austin faculty, learning specialists, and experts in college success partner with Texas high school (HS) districts for students to authentically experience university courses. Physics 1 is in its third year of implementation, and Physics 2 is in its second year; in this brief time, the courses have grown from a pilot program of 16 HS instructors and approximately 500 students to a current cohort of nearly 150 instructors and almost 6000 students across Texas. As the program continues to grow, we look back on previous years to determine (1) how we have created a pathway for students to experience college Physics content and pedagogy aligned to the expectations of leading universities and (2) lessons learned regarding enhancements that have the most impact.

PST2A06: 9:15-10 p.m. Good Vibrations: Using the Acoustic Guitar to Teach Physics Concepts

Poster – Debbie A. French, Wilkes University, 84 W. South St., Wilkes-Barre, PA

Richard M. French, Purdue University

Sean Hauze, San Diego State University

Doug Hunt, Southern Wells High School

Thomas Singer, Sinclair Community College

The NSF-Funded, "STEM Guitar Project" has been training teachers for the past 10 years on the construction of solid-body electric guitars and how to use the guitar as a tool to teach interdisciplinary science, technology, engineering, and mathematics (STEM). New workshops training teachers in the construction of acoustic guitars will be available this summer. New curriculum materials have been developed to accompany the new instrumentation. This poster showcases the new curriculum materials which use the acoustic guitar as a vehicle to teach integrated STEM lessons that are aligned with the Next Generation Science Standards. These curriculum materials can be adapted to a variety of grade levels and subject areas. Particular emphasis, however, is placed on STEM lessons with physics connections.

Labs/Apparatus

PST2B01: 8:30-9:15 p.m. A FAN-C Exploration of RC Circuits

Poster – Robert Charles Ekey, University of Mount Union, Alliance, OH

Brandon Mitchell, West Chester University

Recently, small computer fans have been demonstrated to be an effective method for teaching simple resistive circuits both qualitatively [1] and quantitatively [2]. The current through the fans is related to the rotational speed of the fans and allow multiple senses to be engaged (touch, sight, and hearing). The linear relationship between the operational current and applied voltage, provides a nearly constant effective resistance for the fan. This suggests that fans can also be used to explore RC circuits both qualitatively and quantitatively, where the fans act as the resistive elements as well as the indicator. In this poster, we will demonstrate that computer fans can be used to qualitatively explore the charging and discharging times for RC circuits. By monitoring the voltage across the capacitor as a function of time, we will also show that fans can be used for qualitative RC analysis. Fans, capacitors and battery packs will be available for playing with the FAN-C circuits for those that prefer a hands-on approach.

1. Robert Ekey, Andrea Edwards, Brandon Mitchell, Roy McCullough, and William Reitz, "A fan-tastic alternative to bulbs: learning circuits with fans," Phys. Teach. 55, 13 (2017). 2. Brandon Mitchell, Robert Ekey, Andrea Edwards, Roy McCullough, and William Reitz, "A fan-tastic quantitative exploration of ohm's law," Phys. Teach 56, 75 (2018).

PST2B02: 9:15-10 p.m. High School Physics Lab Curriculum Using Smartphones

Poster – Sheng-Chiang Lee, Mercer University, Macon, GA

Savannah Grunhard, Zain Charania, Mercer University

The purpose of our research was to develop a low-cost and sustainable physics lab curriculum for implementation in Bibb County, GA, public high schools. The lack of sufficient funding for proper lab equipment and qualified teachers disadvantages students. The pedagogical approach of our curriculum is student-centered and inquiry-based. These activities utilize smartphone sensors in place of typical laboratory sensors. The use of existing smartphones in an educational setting serves to engage students and encourages them to explore physics in their everyday lives without adding any financial burden to school budget. We gathered data from volunteers in order to assess our curriculum and adjust it to meet students' needs. The curriculum includes student activities (with instructor manuals) and instructions for both class demonstrations and construction of DIY apparatuses.

PST2B03: 8:30-9:15 p.m. How to Develop an Assessment Plan for Upper-Level Lab Courses

Poster – Patricia E. Allen, Appalachian State University, Physics and Astronomy Department, Boone, NC

"AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum" and "Phys21: Preparing Physics Students for 21st Century Careers" offer tangible outcomes that can be adapted to individual programs and courses. However, developing or modifying an assessment plan for a course or program can be a daunting task, especially if it is the first time doing so. An overview of this author's experience with developing assessment plans consistent with AAPT/APS outcomes will be presented along with suggestions for first-time assessment coordinators. Sample rubrics and assessment timelines will also be presented.

PST2B04: 9:15-10 p.m. Making Something Old into Something New: Advanced Optics Light Scattering Experiments

Poster– Toni Sauncy, Texas Lutheran University, Seguin, TX

Calvin Berggren, Megan Drown, Texas Lutheran University

An old but very precise spectrometer used for introductory physics labs has been re-purposed to accommodate an advanced lab optical scattering experiment. Using an Arduino interface, a light sensing add-on and a fiber optic, relative light intensity can be obtained as a function of angle. An experiment to examine various scattering media to discern differences between Mie and Rayleigh scattering can be accomplished at a very low cost and makes use of an otherwise obsolete piece of equipment.

PST2B05: 8:30-9:15 p.m. Mechanics Activities with a Local Positioning System

Poster – Cora Siebert, Portland State University, Portland, OR

Paul DeStefano, Zachary Dale, Eduardo Martins, Ralf Widenhorn, Portland State University

Using a local positioning system in conjunction with commonly used lab apparatuses can present both teachers and students with the opportunity to evolve their current introductory mechanics exercises. With the ability to collect both one- and two-dimensional position, acceleration, and rotation data, we present several activities that focus on physics fundamentals taught in introductory physics at the college and high school level. In one activity, students are presented with various motion graphs and challenged to act them out, while in another, students release objects from rest and use experimental data to compare free fall and drag models. Also shown is a brief exploration of two-dimensional collisions using "hover" disks, in which students can investigate the behavior of colliding objects.

PST2B06: 9:15-10 p.m. Improving Student Problem Solving Skills with Interactive Multimedia Tools

Poster – Reginald A. Bain, University of Houston, Houston, TX

Donna Stokes, University of Houston

This project aims to improve student success in the algebra-based introductory physics course sequence at the University of Houston, focusing primarily on the first-semester algebra-based mechanics course. Through the development of innovative multimedia resources using TopHat, our objectives include reducing DFW rates, improving student performance on exams, and, more broadly, improving students' problem solving skills. A flipped, SCALE-UP-style version of the introductory algebra-based course has been implemented that incorporates electronic workbooks where students work through scaffolded problem sets in groups that emphasize the development of key problem solving skills. These workbooks integrate the course text, multimedia, interactive simulations, and questions. The creation of these resources is part of a broader initiative to improve the problem solving techniques used by students on computer-based exams and to compare the techniques used on electronic exams versus those used on in-class paper exams.

Pre-college/Informal and Outreach

PST2C01: 8:30-9:15 p.m. The Effects of a Citizen-Science Program – The Pulsar Search Collaboratory

Poster – John C. Stewart, West Virginia University, Morgantown, WV

Kathryn Williamson, Cabot Zabriskie, West Virginia University

The Pulsar Search Collaboratory is a citizen-science program to engage middle and high school student in radio astronomy. The project reserves a set of radio astronomy data for the students that has not been examined by scientists. The students receive online training in radio astronomy, pulsar science, and the identification of pulsars. The students then examine plots of radio astronomy data to determine whether the data represents an unknown pulsar. Over 2 million pulsar plots have been scored resulting in the discovery of eight new pulsars; a significant scientific discovery. Students and participating teachers are eligible to be invited to summer camp at the Green Bank Observatory home to the world's largest fully steerable radio telescope.

PST2C02: 9:15-10 p.m. Using Fractal Music in Educational Performances

Poster – Timothy L. McCaskey, Columbia College Chicago, Science and Mathematics Department, Chicago, IL

Luis Nasser

A previous poster showed ways in which we have composed music where the forms of each piece are based on fractals, astronomy, and cellular automata. We have worked on producing studio versions of this material, where in some cases, we modified the original compositions to make them more pleasing to perform and listen to. More importantly, we discuss ways this music can be used for outreach to various audiences. We will focus on developing a combined lecture/concert format where mini-lectures can introduce the math and science used before each song. We can also present the pieces in an audiovisual format without breaks for lecture where a background movie artistically relates to the underlying concepts.

PST2C03: 8:30-9:15 p.m. PhysicsWOOT: Where High School Students Explore Olympiad Problem Solving Online

Poster – Mark Eichenlaub, Art of Problem Solving, San Diego, CA

Art of Problem Solving (AoPS) presents Physics Worldwide Online Olympiad Training (PhysicsWOOT). In PhysicsWOOT, high school students from around the world meet online to prepare for competitions including the F=ma exam, the US Physics Olympiad (USAPhO), and the International Physics Olympiad (IPhO). Building on the success of WOOT, the AoPS math olympiad preparation course, PhysicsWOOT builds a community of problem-solvers using live, interactive classes in the Art of Problem Solving online classroom and message board discussions of challenge problems and practice exams. Students interact directly with a teacher, teaching assistants, and each other while solving progressively more-challenging problems from a broad calculus-based physics curriculum. PhysicsWOOT creates a place for kids who love thinking about hard problems to meet each other and share the excitement of tough challenges. Here, we present the goals, implementation, and early results of the PhysicsWOOT program, and invite you to try out some of our challenging problems!

Physics Education Research II

PST2D01: 8:30-9:15 p.m. Face and Convergent Validity of the Omaha Assessment of Problem-Solving

Poster – Mark A. Kruger, University of Nebraska Omaha, 4 Elkhorn, NE Chris Moore, University of Nebraska Omaha

We have begun the development and validation of the Omaha Assessment of Problem-Solving (OAPS), which is a rubric for the assessment of problem-solving process in introductory physics courses. The initial rubric consisted of 12 criteria based on research in expert-like problem-solving practice and aspects of Cooperative Group Problem Solving (CGPS) pedagogy. In contrast to recent work on problem-solving assessment for use in research and curriculum development, this rubric was specifically designed for instructor use in the assignment of grades and for student use as a scaffold. We report on the face and convergent validity of the OAPS. Specifically, preliminary face validity was measured by survey of physics faculty at the high school and college levels. Convergent validity was established by correlating scores on the OAPS with the Minnesota Assessment of Problem-Solving (MAPS), which is a research instrument for measuring expert-like problem-solving ability.

PST2D03: 8:30-9:15 p.m. Student Difficulties with the Corrections to the Energy Spectrum of the Hydrogen Atom for the Intermediate Field Zeeman Effect

Poster – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA

Christof Keebaugh, Emily Marshman, University of Pittsburgh

We discuss an investigation of student difficulties with the corrections to the energy spectrum of the hydrogen atom for the intermediate field Zeeman effect using the degenerate perturbation theory. The investigation was carried out in advanced quantum mechanics courses by administering free-response and multiple-choice questions and conducting individual interviews with students. We find that students share many common difficulties related to relevant physics concepts. In particular, students often struggled with mathematical sense-making in this context of quantum mechanics which requires interpretation of the implications of degeneracy in the unperturbed energy spectrum and how the Zeeman perturbation will impact the splitting of the energy levels. We discuss how the common difficulties often arise from the fact that applying linear algebra concepts correctly in this context with degeneracy in the energy spectrum is challenging for students.

PST2D04: 9:15-10 p.m. Impact of Combining Pre-Class Reading with Peer Instruction Using Clickers on Learning Quantum Mechanic

Poster – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA

Ryan Sayer, Bemidji State University

Emily Marshman, University of Pittsburgh

Just-in-Time Teaching (JiTT) is an instructional strategy involving feedback from students on pre-lecture activities in order to design in-class activities to build on the continuing feedback from students. We investigate the effectiveness of a JiTT approach, which included in-class concept tests using clickers, in an upper-division quantum mechanics (QM) course. We analyze student performance on pre-lecture reading quizzes and in-class clicker questions answered individually and then again after group discussion and compare those performances with open-ended retention quizzes administered after all instructional activities on the same concepts. In general, compared to the reading quizzes, student performance improved when individual clicker questions were posed after lectures that focused on student difficulties found via electronic feedback. The performance on the clicker questions after group discussions following individual clicker question responses also improved, as did the performance on retention quizzes administered at a later time. We discuss some possible reasons for the improved performance at various stages, e.g., from pre-lecture reading quizzes to post-lecture clicker questions, and from individual to group clicker questions and retention quizzes.

PST2D05: 8:30-9:15 p.m. Improving Student Understanding of the Many-Particle Hamiltonian and Stationary-State Wavefunction for Non-interacting Identical Particles

Poster – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA

Christof Keebaugh, Emily Marshman, University of Pittsburgh

We discuss an investigation of upper-level and graduate students' difficulties with fundamental concepts involving a system of identical particles. The investigation was carried out in advanced quantum mechanics courses by administering free-response and multiple-choice questions and conducting individual interviews with students. We find that students share many common difficulties related to these concepts. We describe how the research on student difficulties was used as a guide to develop and evaluate a Quantum Interactive Learning Tutorial (QuILT) which strives to help students develop a functional understanding of these concepts. We thank the National Science Foundation for support.

PST2D06: 9:15-10 p.m. Investigating Students' Understanding of the Inverse Square Law

Poster – Rabindra R. Bajracharya, Missouri Southern State University, Joplin, MO

The inverse-square law is an extremely important concept widely observed in numerous physical contexts. Various instructional strategies have been used to teach the law in physics and other fields. However, there has not been much research on student understanding of the inverse-square law. We investigated student difficulties with the multiple representations of the law, including graphical, numerical, and symbolic. We constructed two survey versions, one without any physical context and the other with various physical contexts. The questions were presented in multiple representations. We administered the surveys in several mathematics and science courses including second semester algebra- and calculus-based introductory physics. We found that students lack deep understanding of the multiple representations of the inverse-square law, specifically the graphical representation. One common difficulty students manifested was that they were unable to distinguish between the inverse-square and the inverse relationships between two variables.

PST2D07: 8:30-9:15 p.m. Is There a Gender Gap in Performance in Introductory Physics Courses?

Poster – Matthew A. Dew, Texas A&M University, The Woodlands, TX

Fu-Anne Wang, Jonathan Perry, Tatiana Erukhimova, William Bassichis, Texas A&M University

Previous studies have shown evidence of a gender gap in performance in introductory physics courses for conceptual assessments, course grades, exams, and homework. It is not currently know, however, whether the gender gap for in-course tasks are a transient or persistent effect over a whole term. This study explores potential factors between gender and performance in the calculus-based introductory physics course sequence at Texas A&M University for multiple faculty who taught between 2008-2016. Investigation of these potential factors is done using analysis of variance, regression, and other statistical methods. By examining the performance of students during the entire term, we may better understand the gender gap in introductory physics.

PST2D08: 9:15-10 p.m. Mindset and Sensemaking in Courses for Elementary Education Majors

Poster – Matthew P. Perkins Coppola, Purdue University Fort Wayne, Fort Wayne, IN

Physical science courses tailored to the needs of elementary educations majors are not new, but are new to our university. The decision was made to design a curriculum with a heavy emphasis on sensemaking. A pre- and post-test was constructed from questions on sensemaking and effort borrowed from the Colorado Learning Attitudes about Science Survey (CLASS) and the Mindset Assessment Probe. Data were collected from five sections of the course over two semesters in an attempt to better understand how the mindset of elementary education majors impacted their ability to improve their sensemaking in approaching physics problems. Focus groups conducted after the course with groups of students provided further insights.

PST2D09: 8:30-9:15 p.m. Statistical Analysis of Factors Impacting Success in Interactive Introductory Physics

Poster – Jean-Michel Mailloux-Huberdeau, Texas State University, San Marcos, TX*

Eleanor Close, David Donnelly, Texas State University

The Texas State University physics department transitioned from lecture based classes to group-based active engagement in 2012. We have administered the Force Concept Inventory (FCI) in introductory calculus-based mechanics courses since spring 2011 in order to study learning gains across instructional methods and student groups. In this study we use multivariate linear regression to understand how different factors affect a student's FCI post-score, including pre-score (incoming knowledge), instructor experience, student gender, and student ethnicity. Our preliminary analysis suggests that both instructional method and instructor experience are positively related to student learning gains, and underserved students (females and underrepresented minorities) in our courses have lower pre-scores on average than overserved students but similar learning gains.

Sponsored by Dr. Eleanor CLose Acknowledgments: NSF DUE-1557405 (RADIANS) NSF DUE-1431578 (TXST STEM Rising Stars) NSF PHY-0808790 (PhysTEC) TXST Office of the Provost TXST COSE

PST2D10: 9:15-10 p.m. Program Identification for Determining the Informal Physics Landscape

Poster – Dena Izadi, Michigan State University, East Lansing, MI

Issac Ward, Kathleen Hinko, Michigan State University

Claudia Fracchiolla, University College Dublin

Noah Finkelstein, University of Colorado Boulder

Many informal and outreach physics programs are facilitated and supported by academic institutes, such as colleges and universities, and national labs. As part of our project to determine the informal physics landscape in the United States, we developed some strategies to identify and evaluate informal physics efforts. These strategies are being tested on programs attempted in all well-known institutes in the Midwest area and we will expand our search nationwide eventually. The search started with programs our group is in direct contact with them, or those that are searchable via the internet. We categorized the potential deliverables extracted from all the programs and will use that to map the informal physics efforts in a heatmap. We invite groups to share their information directly with us and help expand our study.

PST2D11: 8:30-9:15 p.m. How Do Student Groups Design Their Own Methods in Lab?

Poster – Luke D. Conlin, Salem State University, Salem, MA

Chiara H. Carmolli, Salem State University

Laboratories are designed to support learning of physics experimental practices. Traditionally, labs do this by guiding students through a series of experimental procedures to confirm the concepts and equations discussed in lecture. Evidence is mounting that this traditional approach is inefficient. Recent research on quantitative inquiry labs, in which students develop their own experimental and analytical methods to answer a question, suggests that they are much more effective at developing students' critical thinking skills. More research is needed to understand the process by which students develop these skills. In this poster, we present research on video records of student groups in quantitative inquiry labs. We analyze student discourse to demonstrate key aspects of the processes by which groups develop their own methods to collect and analyze data. This research highlights how lab groups learn to think collaboratively, creatively, and critically, in alignment with the practices of physics.

PST2D12: 9:15-10 p.m. Summer Transition Program Impacts on Science Students' Success*

Poster – Peter A. Sheldon, Randolph College, Lynchburg, VA

Sarah Sojka, Randolph College

Randolph College instituted a recruitment and retention program boosted by two NSF S-STEM grants that has doubled the number of science majors and increased retention. Randolph College is a small, liberal arts college that produces significant numbers of successful students in the sciences. While the NSF grants have provided scholarships to two cohorts of 12 students and two cohorts of 18 students, we have exceeded our goal to recruit 24 science students into our Step Up to Physical Science and Engineering at Randolph (SUPER) program each year since 2011, and to retain those students at a higher rate. We are researching the impacts of each part of our program: scholarships, summer transition program, living & learning community, mentoring program, research and internships, and overall effects of the program. In this presentation, we will address initial data on the impact of scholarships and of the summer transition program.

*This project is supported by the National Science Foundation under Grants No. DUE- 1153997 and DUE-1564970. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

PST2D13: 8:30-9:15 p.m. Where do Students Get their Ideas about What Physics Is?

Poster – AJ Richards, The College of New Jersey, Ewing, NJ

Cynthia Reynolds, The College of New Jersey

In a previous study investigating middle- and high-school students' attitudes towards physics, we found that most students had strong feelings (often negative) about physics, yet many of them indicated that they had never formally taken any physics courses. This made us curious about how these students developed notions about what physics is and what a physicist does. Since it appears students arrive at the secondary level with these ideas already formed, we have chosen to examine 5th- and 6th-graders' attitudes about physics. In this poster, we will present preliminary findings from this research and speculate on possible explanations and implications.

PST2D14: 9:15-10 p.m. Early Intervention and Engagement in First-Year Physics Classes

Poster – Callie Rethman, Texas A&M University, Department of Physics and Astronomy, College Station, TX*

Jonathan Perry, University of Texas - Austin

Tatiana Erukhimova, Texas A&M University

Introductory physics courses serve as a gateway to the majors for all STEM undergraduate students. Unfortunately, a large fraction of first-year students are either delaying their graduation or dropping out of STEM altogether because they fail to master first-year physics. At the Texas A&M University Department of Physics & Astronomy, we ran a pilot program to increase retention in introductory physics classes by boosting student engagement, motivation, and confidence. This program employs early intervention and the creation of student led learning communities. Learning communities are facilitated by recruited undergraduate physics majors who excelled in their first year courses, in active collaboration with faculty currently teaching the introductory courses. We will describe the structure of this program and results from its first term of deployment.

*Sponsored by Tatiana Erukhimova

Session GA: Early Career Teacher Experiences – Voices from the Field

Location: San Felipe Room **Sponsor:** Committee on Teacher Preparation **Co-Sponsor:** Committee on Physics in High Schools
Time: 8:30–10 a.m. **Date:** Tuesday, Jan. 15 **Presider:** Hunter Close

Come hear the various experiences of new physics teachers in the region as they reflect on the beginning of their careers. What experiences have been the most rewarding, or the most challenging? What aspects of their physics teacher preparation have turned out to be the most valuable, or the least valuable? What advice do they have for physics teacher candidates? What advice do they have for faculty working in physics teacher preparation?

Speakers:

Tri Duong, Cypress Ridge High School, Houston, TX

Kameron McCall, Scarborough High School, Houston, TX

Shahrzad Hesaaraki, Department of Physics, Texas State University, San Marcos, TX

John LeBlanc, St. John Paul II Catholic High School, New Braunfels, TX

Joshua Kerr, Memorial High School, Houston, TX

Session GB: Panel: Effective Departmental Self Study and External Evaluation

Location: Westchester Room **Sponsor:** Committee on Physics in Undergraduate Education **Time:** 8:30–10 a.m.
Date: Tuesday, Jan. 15 **Presider:** Toni Sauncy

As departments approach the self-study and external review processes, there are several resources that should be considered as essential to building a thriving program. Several resources, developed through federally funded research projects, have been developed by AAPT, APS and AIP. This session is intended for faculty from departments of all sizes and types who are looking for ways to develop strategies for reform aimed at incorporating the findings, results and suggestions in these resources, including the Effective practices for Physics Programs (APS/AAPT) (in progress), AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum, AAPT Recommendations for Computational Physics in the Undergraduate Physics Curriculum, Phys21: Preparing Physics Students for 21st Century Careers report (APS/AAPT), and The Career Pathways Project (AIP), with focus on using these resources as guides for program self-study and/or the external review process. Panelists will facilitate discussion aimed at developing a strategy for incorporating these community-endorsed guides into physics programs, and how these strategies might be used in developing long term goals for the department through the self-study and external review processes.

Speakers:

Michael Jackson

Aaron Titus

Brad Conrad

Gubbi Sudhakaran

Session GD: Physics Teacher Preparation in Different Countries throughout the World

Location: Plaza Ballroom I **Sponsor:** Committee on International Physics Education **Co-Sponsor:** Committee on Teacher Preparation

Time: 8:30–10 a.m. **Date:** Tuesday, Jan. 15 **Presider:** Genrikh Golin

GD01: 8:30-9 a.m. An Overview of Physics Teacher Preparation in Ireland

Invited – Leanne Doughty, Denver, CO

Secondary education in Ireland consists of a three-year Junior Cycle and a two-year Senior Cycle. Physics teachers are responsible for teaching a Senior Cycle physics course (optional for students at most schools) and typically an integrated science course for Junior Cycle (mandatory for students at most schools). Revisions to the national syllabi for both these courses have placed an emphasis on student inquiry and investigation. There are two main pathways to becoming a physics teacher through multiple institutions. One is through a 4- or 5-year concurrent qualification which combines the study of physics with teacher education courses, methods courses, and school placement. The other is through consecutive qualifications, obtaining a physics degree followed by a Professional Masters of Education. This talk will discuss and compare the different pathways and the unique challenges faced for physics teachers within the Irish secondary school system.

GD02: 9-9:30 a.m. Developing and Preparation Physics Teachers in the United States

Invited – Robert C. Zisk, Rutgers University, New Brunswick, NJ

Eugenia Etkina, Rutgers University

Physics teacher preparation in the United States is evolving in response to a national shortage of qualified physics teachers. In this talk, I will review the recent research on physics teacher preparation programs in the United States, which has identified the areas of need within physics teacher preparation and highlighted the characteristics and practices of model teacher preparation programs. I will then describe the physics teacher preparation program at Rutgers University, a program that is consistently one of the top producers of physics teachers in the United States, and focuses on the development of pre-service teachers' content knowledge for teaching physics through repeated and continuous immersion in courses and teaching experiences that are centered on the same philosophy of learning and teaching physics.

GD03: 9:30-10 a.m. Physics Teacher Preparation in India – An Overview

Invited – Mashood KK Homi, Bhabha Centre for Science Education Mumbai, Maharashtra 400088 India

The Indian education system broadly follows the 10+2+3 pattern. Physics is taught as a separate subject from grade 11 onwards. Minimum qualifications to teach physics in grades 11 and 12 are a masters degree in physics along with a bachelors degree in education (BEd). The latter is a mandatory 2 year professional degree. In-service teacher training at school level (10 + 2), is primarily carried out by a network of federal and state funded institutions. Minimum qualifications to teach undergraduate physics in colleges/universities are a masters degree along with passing a national eligibility test which mainly focuses on problem solving. In-service teacher training at undergraduate level happens mainly in the form of refresher courses, workshops etc., in core topics in physics. This paper, in addition to providing an overview of physics teacher preparation in India, will also discuss insights from physics education research we carried out in this regard.

Session GE: Success Stories of Female Physicists

Location: Tanglewood **Sponsor:** Committee on Women in Physics **Time:** 8:30–9:30 a.m. **Date:** Tuesday, Jan. 15 **Presider:** Fatma Salman

GE01: 8:30-9 a.m. The Allure of Atoms: Finding Success as a Condensed Matter Physicist

Invited – Kristen M. Burson, Clinton, NY

Kristen M. Burson, Hamilton College

How can we see the atoms in glass and what patterns do they form? Glass is widely used in daily life, from windows, to fiber optics, to kitchenware, yet questions still remain about its atomic structure. In this talk, I will describe my experiences as a condensed matter physicist specializing in high-resolution atomic force microscopy. I'll talk about how to "take pictures" of atoms using scanning probe microscopy and share some of the highlights of my research on the atomic-scale structure of two-dimensional amorphous silica (also known as glass). Charting out a career in physics can seem similarly amorphous. Throughout the talk, I will reflect on core elements of my success as a physicist: personal attitudes, effective mentors, and positive peer communities.

GE02: 9-9:30 a.m. STEP UP 4 Women: Supporting Teachers to Encourage the Pursuit of Undergraduate Physics for Women*

Invited – Robynne M. Lock, Texas A&M University-Commerce, Department of Physics and Astronomy, Commerce, TX

Zahra Hazari, Raina Khatri, Florida International University

Theodore Hodapp, American Physical Society

Rebecca Vieyra, Beth Cunningham, American Association of Physics Teachers

Geoff Potvin, Laird Kramer, Kathryne Woodle

Only 20 percent of the students pursuing bachelor's degrees in physics are women despite the fact that almost half of high school physics students are women. STEP UP 4 Women is an ambitious project with the goal of increasing the representation of women in physics by mobilizing and supporting high school physics teachers nationwide to recruit young women to become physics majors. This project develops, refines, and propagates research-based strategies that support the physics identity development of young women. This session will describe these strategies and the results of our pilot study. For more information or to join the movement, visit www.stepup4women.org.

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

Session GF: Successful Online Astronomy Labs

Location: Galleria III **Sponsor:** Committee on Space Science and Astronomy **Time:** 8:30–10 a.m.
Date: Tuesday, Jan. 15 **Presider:** Toby Ditterich

GF01: 8:30-9 a.m. Creating Successful Online Astronomy Labs

Invited – Rodney G. Lee, Portland Community College, Portland, OR

Portland Community College (Portland, Oregon) in cooperation with the Oregon NASA Space Grant have made it possible for our physical science faculty to design three 100-level online lab science courses: The Solar System, Stars and Stellar Evolution, and Galaxies and Cosmology. These courses have made it possible for students to earn science lab credits at a distance. Creating quality, well-designed online labs that are interactive, experiential, meaningful, and accessible are keys to student success and retainment. We will explore some excellent tools now widely available to course designers including open educational resources, online simulations, remote instrument use, and astronomy software. In addition, we will look at modifying traditional astronomy labs for the online world of science education. We will provide a list of astronomy lab resources to all who attend this talk.

GF02: 9-9:30 a.m. The Rankin Astronomy Facilities, Online Laboratory Activities and Remote Observing

Invited – David J. Sitar, Appalachian State University, Boone, NC

The Rankin introductory astronomy laboratory and observatory is a truly unique and cutting-edge facility. It could possibly be the only one of its kind in the U.S., and it provides an extraordinary experience for our students, as well as the public during on-campus outreach programs. Fifteen permanently mounted Celestron CPC1100's are under a roll-back roof, allowing for last-minute decision making when it comes to weather. In addition, all scopes have a back-mounted STF8300C CCD camera attached, providing astrophotography opportunities for all students. Each of these telescope stations can be controlled manually out on the roof deck or remotely from the comfort of our indoor laboratory.

GF03: 9:30-10 a.m. Discovering Physical Properties and Evolution of Asteroids using Large Data Sets in the Classroom

Poster – Jordan K. Steckloff, University of Texas at Austin,, Whitmore Lake, MI

Rebecca Lindell, Tiliadal STEM Education

Steven Dail, Harrison High School

Modern astronomy has produced large data sets of small planetary body behavior, which exhibit gravitational and circular motion under ideal (i.e. frictionless) conditions. Modern high school students enrolled in Advanced Placement (AP) or International Baccalaureate (IB) Physics courses are already familiar with the software and skills needed to manipulate these large data sets. Here we present an inquiry-based classroom activity in which students use Microsoft Excel to manipulate the Minor Planet Center's most recent light curve-based asteroid data set. The students use Excel to plot different variables within the data set against one another, and look for obvious trends (size vs. spin rate). This pair of variables shows that asteroid spin rates pile up at a period of ~2.2 hours, but seldom spin faster. The students then determine that this spin barrier is the result of a critical spin rate above which gravity fails to hold the asteroid together.

GF04: 9:30-10 a.m. Incorporating Exoplanet Radial Velocity Detections to Teach Simple Harmonic Motion

Poster – Jordan K. Steckloff, University of Texas at Austin, Whitmore Lake, MI

Rebecca Lindell, Tiliadal STEM Education

All planets and stars orbit about their mutual center of mass (barycenter). Although, most planetary systems cannot be directly imaged using current technologies, the orbital motion of the host star induces a detectable doppler shift in its emitted light. Because the star's circular motion is generally unresolvable, its motion instead appears to be a mass undergoing simple harmonic motion along the line of the observer. Thus, this radial velocity method (RVM) of detecting exoplanets is an excellent method to be understood as a simple harmonic oscillator. However, whereas most harmonic oscillators are understood by detecting the change in their position, the RVM instead directly detects the velocity of the oscillator. We describe how the mass and orbital radius of the orbiting planet can be determined by measuring the harmonic velocity of the star, and understanding the forces that contribute to its acceleration. Suggestions for instruction will also be provided.

Session GG: Introductory Courses

Location: Sage Room **Sponsor:** AAPT **Time:** 8:30–9:30 a.m. **Date:** Tuesday, Jan. 15 **Presider:** Toby Ditterich

GG01: 8:30-8:40 a.m. Engaging Introductory Physics Students in Experimental Design: Achievements and Challenges

Contributed – Rex N. Taibu, Queensborough Community College, City University of New York, Bayside, NY

Vazgen Shekoyan, Queensborough Community College, City University of New York

William Cobern, Western Michigan University

We reformed verification labs into deductive design labs in which introductory level physics students were first introduced to the theory, terminology and equipment and then guided to design and carry out their own verification experiments. Two instructors taught both the experimental (deductive design labs) and control sections (verification labs) for four semesters. Normalized gains in science process skills were significantly higher in the experimental group. Although there was no indication of improved critical thinking skills on the assessed 7 question pairs of Lawson test, the experimental group performed significantly higher on two of the seven question pairs that are directly related to control of variables. Written surveys indicated the various lab design skills the experimental group learned as well as challenges and experiences going through the design processes. Our study informs another approach to engage students in scientific inquiry aside from the common inductive inquiry approach.

GG02: 8:40-8:50 a.m. Incorporating Service Learning and HACD into College Physics Curricula

Contributed – Stephanie L. Bailey, University of California Santa Cruz, Department of Physics, Santa Cruz, CA

As part of an introductory physics course for life science majors at UC Santa Cruz, students learn about the physics behind musical instruments. The sounds made by musical instruments are possible because of standing waves, which come from the interference between waves traveling in both directions along a string or a tube. This presentation describes an effort in spring 2018 to incorporate service learning and humanities, arts, crafts, and design (HACD) practices into the college physics curricula. Students were tasked with designing and building musical instruments to donate to a K-6 school in Southern Leyte, Philippines. Service learning is a philosophy by which students make meaningful contributions to the benefit of others while at the same time developing their own knowledge in an area of study. Consistent with the university's commitment to sustainability and environmental responsibility, instruments were made from recycled "junk" materials. Grading was based on creativity, innovation, workmanship, and performance of a standard musical scale and tune.

GG03: 8:50-9 a.m. The Cognitive Space in Introductory Physics

Contributed – Sergio Flores, Universidad Autonoma de Juarez, Juarez, Chihuahua 31320 Mexico

Mario Ramirez, Instituto Politecnico Nacional

Maria Dolores Gonzalez, Instituto Tecnologico de Juarez

Natividad Nieto, Maria Cruz Quiñones, Univesidad Autonoma de Juarez

Many introductory physics students have understanding problems. One possible reason is a lack of versatility to transit among several kinds of mathematical representations. In addition, students need to handle reasoning abilities to move about situations based on a context-concept understanding design. This conceptual physics students' understanding depends on the ability to use of: 1) mathematical representations, 2) concepts, and 3) contexts. The combination of these three cognitive variables help students to develop a functional understanding. This combination is called the cognitive space. Some students develop conceptual understanding through a didactic process designed on the three planes that structures this cognitive space. We believe that a semiotic-conceptual-context learning proposal could help students through an important physics understanding process.

GG04: 9-9:10 a.m. Models for Coin Resonance-Frequency Analysis

Contributed – Isaiah Owen McElvain, Citrus Heights, CA

Little research has been done to study the mathematical relationship between the resonance frequencies and the physical properties of a coin. This work describes our exploration of that relationship. We began by measuring the resonant frequencies of a large number of different coins. We then used dimensional analysis to create a model that agrees with the measured frequencies of quarters, dimes, and pennies with approximately 5% error. We aim to refine this model so it can be used to predict the frequencies of any coin, as well as predict the resonance frequencies of any thin metal disk.

GG05: 9:10-9:20 a.m. 10 Reasons to NOT Use the Matter and Interactions Textbook

Contributed – James B. Clarage, University of St. Thomas, Houston, TX

The author used the modern "Matter and Interactions" textbook and curriculum for a one-year trial in one section of his Introductory Physics course. This talk documents 10 reasons you should NOT use this alternative textbook and curriculum with your students. A larger message of this (tongue in cheek) talk is my hope to reaffirm that introductory physics education is just fine using the time-tested approach, and that most proposed innovations (e.g. increased focus on fundamental principles, changing the standard order of topics, inclusion of ideas from modern physics, acknowledging the existence of atoms, using computational solutions to problems) are unnecessary. To those considering modernizing their approach to teaching, this talk serves as a cautionary (and hopefully entertaining) tale. To those dead-set against changing how and what they teach, this talk serves as a potent confirmation bias.

GG06: 9:20-9:30 a.m. Tackling Belongingness Uncertainty in Physics

Contributed – Ruth Saunders, Humboldt State University, Science A, Laurel St., Arcata, CA

Carla Quintero, Humboldt State University

Participation of women in physics is still very low (~20%-APS data). This paper describes some of the methods being used at Humboldt State University, a Hispanic-serving institution in rural California. In particular looking at other ways to embrace your scientific identity and develop self efficacy, rather than traditional science culture. It discusses Crafternoon and the Paranormal Physics Society, both of which are well attended by majors from all STEM disciplines.

GG07: 9:30-9:40 a.m. Conservation of Momentum and Constraints on Energy Loss

Contributed – Asim Gangopadhyaya, Loyola University Chicago, Chicago, IL

Jonathan Bougie, Loyola University Chicago

We reflect on several examples in which loss of energy is easily computed, starting with the inelastic collision of two objects. For these examples, we find that the systems have two well-delineated parts that exchange energy with each other until they reach a shared equilibrium with an overall loss of energy. The equilibrium energy in each case is uniquely determined by a constraint imposed by another conservation law, regardless of the dissipation mechanism. In particular, we discuss how this feature manifests in a suite of four well-known and disparate problems, and show that all four share a common mathematical formalism. We demonstrate application of this formalism to determine the energy loss for a final example.

Session GI: The Wonderful World of AJP

Location: Post Oak **Sponsor:** Committee on Physics in Undergraduate Education **Time:** 8:30–10:30 p.m. **Date:** Tuesday, Jan. 15
Presider: Richard Price

GI01: 8:30-9 a.m. Insights into Reversible and Irreversible Thermodynamic Cycles

Invited – Harvey S. Leff, California State Polytechnic University-Pomona and Reed College, Portland, OR

Cycles are a traditional part of thermodynamics coverage, and although actual heat engines and refrigerators are irreversible, most cycles in textbooks are reversible. I'll examine irreversible quasistatic Carnot, Kelvin, and Stirling cycles and compare them with their reversible counterparts. The irreversible versions of reversible heat engines or refrigerators, especially ones with variable-temperature paths, more closely represent real cycles that operate between high and low temperatures. I'll use temperature vs. entropy graphs to help clarify energy flows and to obtain efficiency bounds. One little known such bound is that the coefficient of performance of an arbitrary reversible refrigerator cycle is greater than or equal to that for a reversible Carnot cycle operating between the arbitrary cycle's maximum and minimum temperatures.

GI02: 9-9:30 a.m. Measuring General Relativistic Time Dilation; An Undergraduate Lab

Invited – Shane Burns, Colorado College, Dept. of Physics, Colorado Springs, CO

General relativity predicts that clocks run more slowly near massive objects. The effect is small—a clock at sea level lags behind one 1000 m above sea level by only 9.4 ns/day. Here, we demonstrate that a measurement of this effect can be done by undergraduate students. Our paper describes an experiment conducted by undergraduate researchers at Colorado College and the United States Air Force Academy to measure gravitational time dilation. The measurement was done by comparing the signals generated by a GPS frequency standard (sea-level time) to a Cs-beam frequency standard at seven different altitudes above sea level. We found that our measurements are consistent with the predictions of general relativity.

GI03: 9:30-10 a.m. A Compact Disc Under Skimming Light Rays

Invited – Roberto De Luca University of Salerno, Fisciano (SA) 84084 Fisciano, SA 84084 Italy amjphys@gmail.com

The optical properties of a compact disc (CD) under "skimming" light rays have been analyzed. We have noticed that a clear green line can be detected when the disc is irradiated with light rays coming from a lamp in such a way that only those skimming the CD, held horizontally, are selected. We provide a physical interpretation of this phenomenon on the basis of elementary optics concepts. Extension of these concepts to digital versatile discs (DVDs) is given.

GI04: 10-10:30 a.m. Water Bottle Flipping Physics

Invited – Alvaro Marin Physics of Fluids, University of Twente P.O. Box 217 Enschede, AE 7500 The Netherlands amjphys@gmail.com

The water bottle flipping challenge consists of spinning a bottle, partially filled with water, and making it land upright. It is quite a striking phenomenon, since at first sight, it appears rather improbable that a tall rotating bottle could make such a stable landing. In this talk I will show you how a group of first year students came up with this idea for a student project and how together we ended up unraveling the physics behind the water bottle flip. In a very instructional process for both students and the senior scientists, we performed experimental measurements taking advantage of their bottle flipping skills, and together develop a simple model. Such a model captures most features of the flipping process but most importantly, it allows for predictions for the most optimal bottle filling ratio. Overall, the "water bottle flipping experience" is an excellent and playful example to illustrate conservation of angular momentum, solid body rotations and a great way to introduce the complexities of non-solid rotations.

Awards: Homer L. Dodge Citations for Distinguished Service to AAPT

Location: Galleria Ballroom I **Time:** 10:30–11:30 a.m. **Date:** Tuesday, Jan. 15.. **Presider:** George A. Amann

Janelle Bailey
Temple University

Heather Lewandowski
University of Colorado, Boulder

Sherry Savrda
Seminole State College of Florida

Robert Tees,
Rochester Institute of Technology

Aaron Titus
High Point University

Awards: AAPT Presidential Transfer

Location: Galleria Ballroom I **Time:** 10:30–11:30 a.m. **Date:** Tuesday, Jan. 15.. **Presider:** George A. Amann

Gordon P. Ramsey
Loyola University
2018 President

Mel Sabella
Chicago State University
2019 President

Awards: Melba Newell Philips Medal – Awarded to Jack Hehn

Location: Galleria Ballroom I **Time:** 10:30–11:30 a.m. **Date:** Tuesday, Jan. 15.. **Presider:** George A. Amann

Jack G. Hehn
AAPT

May the Work I Have Done Speak for Me

Jack Hehn has a wide range of experience in physics and science education having taught and worked with students in elementary school through graduate school. He was reared and educated in Texas completing a Bachelor of Science in Physics at the University of Texas in Austin (1971), a Master of Science Degree at Texas A & M University (1976), and the Ph.D. (1990) from the University of North Texas.

He has served in administrative staff and instructional roles within physics departments for 19 years and has spent much time developing and teaching the freshman physical science course for pre-service teachers, developing mentoring and training programs for teaching assistants, and developing instructional laboratory programs using multimedia and interactive computer technologies.

In 1992, Hehn joined the American Association of Physics Teachers (AAPT) as the Associate Executive Officer. Two of the efforts he helped to direct included a high school textbook, "Active Physics," and a college physical science course for pre-service teachers, "Powerful Ideas in Physical Science." He was also active in the effort to create national science standards and in the development of a large-scale networking project for two-year colleges, TYC21.

Hehn served three years (1996-1999) as a program director with the Division of Undergraduate Education (DUE) in the National Science Foundation (NSF). In August of 1999, Hehn joined the American Institute of Physics (AIP) as the Director of Education. He was a Co-Principal Investigator on the Physics Teachers Education Coalition (PhysTEC) a partnership of the American Physical Society (APS), AAPT, and AIP. He worked in support of earth systems education efforts; and encouraged and supported the development of a physics digital library for educational resources, ComPADRE. He also served on the National Task Force on Undergraduate Physics and has been involved with the Physics New Faculty Workshop.

Awards: AIP Science Writing Award – Writing and Publishing Science for Kids

Location: Galleria Ballroom I **Time:** 11:30 a.m.–12:30 p.m. **Date:** Tuesday, Jan. 15.. **Presider:** Bo Hammer

Claire Eamer

Claire Eamer is a freelance writer, reporter and an award-winning children's author with a long-standing interest in science, particularly environmental science. She has authored 10 children's books, including five books on science and history and three books on evolution, biodiversity and adaptation and one picture book. She holds two degrees in English.

Awards: Hans Christian Oersted Medal – Awarded to Gay Stewart

Location: Galleria Ballroom I **Time:** 11:30 a.m.–12:30 p.m. **Date:** Tuesday, Jan. 15.. **Presider:** George A. Amann

Gay Stewart
Eberly Professor of STEM Education, West Virginia University

A Spectacular Opportunity for the Physics Community to Broaden Its Community of Learners

Research supports that a high-quality, strongly conceptual, rigorous introductory physics course improves student confidence and narrows performance gaps. Such courses are a doorway, not a gatekeeper. Years of anecdotal evidence strongly supports these findings. The redesign of the AP Physics B course, resulting in AP Physics 1 and 2, was an over-ten-year process, involving a substantial group of physics educators, physics education researchers, and stakeholders. The resulting courses were designed to be doorways. The initial result was to open the door to almost twice as many students, and to more than double the number of underrepresented students receiving college credit. Schools with an educator prepared, or adequately supported, to teach such a course are seeing excellent results. Overall, however, students are not being supported in developing the depth of understanding the curriculum framework was designed to provide and assess. Too many students are still trained to memorize and solve problems in a rote fashion. "Simplified" concepts force students to memorize many things that seem unrelated that are just aspects of a single more sophisticated idea. A brief history of how I got involved, the redesign process, and what we can do to better seize this opportunity will be discussed.

Session HA: A Day at a School, K-12

Location: Tanglewood **Sponsor:** Committee on Physics in Pre-High School Education **Time:** 12:30–2:30 p.m. **Date:** Tuesday, Jan. 15
Presider: Ed Hasenohr

HA01: 12:30-1 p.m. Physics and After School Programs – Hands On Fun

Invited – Jason Hammond, Children's Museum of Houston, Houston, TX

Physics is an unknown science to most elementary school children even though they deal with the laws of physics each and every day. Through robust, hands on after school activities, The Children's Museum of Houston teaches the fundamentals of physics by having our students make rockets, cars, gliders and boats. As they make their machines they are asked to think about such things as Newton's laws of motion, universal gravitation, speed, acceleration, buoyancy and the forces of aerodynamics. Because they are able to engineer a machine and see the machine in action, the physics behind the actions become less abstract and more relatable. Starting in fall 2018, the A'STEAM program will be in 154 sites weekly serving over 6000 kids each week. The age range is 3-12 with two separate curriculums -- one for Pre-K and one for K-7th grade. Each curriculum will have activities related to physics.

HA02: 1-1:30 p.m. Portal to the Public at the Children's Museum of Houston

Invited – Gretchen Schmaltz, Houston, TX

Portal to the Public Network (PoPNet) represents a system of over 50 museums, informal science education (ISE) institutions, and universities that are united in their effort to connect scientists with their public audiences. The program, created in 2007 with support from the National Science Foundation (NSF), assists more than 50 ISE centers in North America seeking to create opportunities for researchers to engage in face-to-face conversations with their visitorship. Through these outreach efforts, scientists can foster a deeper appreciation for science and its practical applications in society. PoPNet provides a malleable framework that ISE institutions can adapt to suit their unique needs and goals. In this talk, I'll discuss implementation of PoPNet at the Children's Museum of Houston which includes the building of relationships with scientists within the Houston Community, professional development offered to assist them in communicating complex concepts, and the types of science-specific events that best serve children and families at our museum.

HA03: 1:30-1:40 p.m. Taking Solar Cookers to Schools

Contributed – Shawn Reeves, EnergyTeachers.org, Cambridge, MA

The author has taken solar cookers to middle and elementary schools as an outdoor lesson to study topics such as infrared and visible light; measuring power, temperature, and light; ray-tracing; reflection, transmission, absorption, and emission of light; pasteurization; cooking; and engineering. Solving problems like making food and pasteurizing water shine a different light on physics than its war-era traditional topics and thus appeal to different interests. We can (should?) flavor experiences in physics education before formal introduction to change the expectations and even the trajectory of the field.

HA04: 1:40-1:50 p.m. Improving Visual Spatial Reasoning in Middle Schoolers Using Minecraft

Contributed – Barrett M. Frank, Montana State University, Bozeman, MT

The Minecraft Gaming Engine is an expansive virtual space that appeals to a wide range of users. With few in game limitations, and support for server administrators, Minecraft is potentially the perfect medium for interactive curriculum development. In particular, visual spatial reasoning curricula could greatly benefit from the use of a virtual space for students to explore. Prototype modules which test rotations and 2D to 3D transformations were developed and play-tested by middle school students in two-day summer camps. These modules, which will be improved upon in future iterations, received positive and negative feedback which will be considered in future iterations.

HA05: 1:50-2 p.m. No Paper Here: Leverage Computers Full Time in Physics Instruction

Contributed – Brian Geyer, Pomfret School, Pomfret Center, CT

An overview of how a teacher in a one to one device school uses a LMS, Google applications, and symbolic manipulation software to completely eliminate paper from the classroom. The talk will cover lectures, group work, classic problems, large real-world datasets, classic inquiry labs, and all other aspects of classwork and teaching duties.

HA06: 2-2:10 p.m. LIGO in the Classroom

Contributed – Amber D. Strunk, LIGO Hanford Observatory, Richland, WA

The LIGO Hanford Observatory has a long history of outreach in the Pacific Northwest and beyond. An important part of our outreach is going into schools and working with students in their classrooms. Approximately half of the outreach performed by staff at LIGO Hanford is performed outside of the observatory and in classrooms themselves. From Infrared cameras with First Graders to Gravitational Waves with High Schoolers outreach in schools is a powerful experience for students and scientists. Learn about the types of activities we do, why these visits are so important and how to get someone from LIGO to visit your school.

HA07: 2:10-2:20 p.m. The Sanford Underground Research Facility School Presentation Program

Contributed – Peggy A. Norris, Black Hills State University, Sanford Lab, Lead, SD

June Apaza, Becky Bundy, Julie Dahl, Debra Wolf, Black Hills State University

The Education and Outreach Team at the Sanford Underground Research Facility in Lead, South Dakota, brings science to life for students in classrooms across the region. Students may spin marbles to model particle accelerators, explore the bending of light in gravitational fields, or learn about the science of boreholes. Elementary students may even dress like scientists and imagine themselves working nearly a mile underground. Both teachers and students enjoy the dynamic, engaging presentations delivered by the Education and Outreach Team. Our nine (and counting) school presentations are part of a three-pronged approach to inspire and prepare students for the science and engineering careers of the future.

Session HB: Implementing Research-based Instructional Strategies

Location: Post Oak **Sponsor:** Committee on Women in Physics **Co-Sponsor:** Committee on Research in Physics Education
Time: 12:30–2:20 p.m. **Date:** Tuesday, Jan. 15 **Presider:** Sarah Formica

HB01: 12:30-1 p.m. JiTT and Peer Instruction Using Clickers in a QM Course

Invited – Ryan T. Sayer, Bemidji State University, Bemidji, MN

Emily Marshman, Chandralekha Singh, University of Pittsburgh

Just-in-Time Teaching (JiTT) is an instructional strategy involving feedback from students on prelecture activities in order to design in-class activities to build on the continuing feedback from students. We investigate the effectiveness of a JiTT approach, which included in-class concept tests using clickers in an upper-division quantum mechanics course. We analyze student performance on prelecture reading quizzes, in-class clicker questions answered individually, and clicker questions answered after group discussion, and compare those performances with open-ended retention quizzes administered after all instructional activities on the same concepts. In

general, compared to the reading quizzes, student performance improved when individual clicker questions were posed after lectures that focused on student difficulties found via electronic feedback. The performance on the clicker questions after group discussion following individual clicker question responses also showed improvement. We discuss some possible reasons for the improved performance at various stages, e.g., from pre-lecture reading quizzes to post-lecture clicker questions, and from individual to group clicker questions.

HB02: 1-1:10 p.m. A Comparison of the Use of Demonstrations in Introductory Physics

Contributed – Kathy Shan, University of Toledo, McMaster Hall, Toledo, OH

I discuss a comparison of the use of demonstrations in multiple sections of introductory, calculus based physics (Physics 1 and Physics 2) for science and engineering majors at an open enrollment, public university. Due to local circumstances, some sections of Physics 1 and Physics 2 took place in classrooms that made using demonstrations all but impossible. This study presents a comparison of student performance in classes where demonstrations were used and in classes where they were not. All sections were taught by the same instructor, using interactive methods in lecture and recitation, including Peer Instruction and physics tutorials. FCI Pre- and Post-test scores were used along with student grades on midterm and final exams for comparison in Physics 1. Student grades on midterm and final exams were used for comparison in Physics 2.

HB03: 1:10-1:20 p.m. "Semi-Flipping" Introductory Electricity/Magnetism: Improving Effectiveness of Instructor Face Time

Contributed – Jennifer L. Gimmell, College of DuPage, Glen Ellyn, IL

Tom Carter, College of DuPage

We present our ambitious adaptation of the fully flipped classroom: the "semi-flipped" environment. Our "semi-flipped" environment allocates half of the available instructor face time to a personalized, community-building interactive problem-solving session. These sessions consist of instructor-chosen exercises to bridge the gap between lecture examples and assessments, target specific conceptual misunderstandings, and to promote discussion among the students. Our approach builds a sense of community between students and their instructor, evokes a personalized level of differentiated instruction, and provides a versatile platform to address a variety of student needs, serving those who prefer to work individually with minimal intervention to those who need extensive outside assistance. Data from our ongoing multi-semester study has shown an increase in out-of-class student engagement in addition to positive feedback from a diverse population of sophomore-level community college engineering students.

HB04: 1:20-1:30 p.m. Understanding Student Motivation and Attitudes to Enhance Learning

Contributed – Kate E. Dellenbusch, Bowling Green State University, Department of Physics & Astronomy, Bowling Green, OH

Matthew L. Partin, Bowling Green State University

Motivation and attitudes about a particular subject or learning in general can influence student conceptual gains and course performance. We have been examining relationships between student motivation, attitudes, and course performance in the context of the growth versus fixed mindset model for learners. We administered selected scales from the Motivated Strategies for Learning Questionnaire (MSLQ) and the Growth Mindset Assessment (GMA) instruments to hundreds of Bowling Green State University students in various physics, astronomy, chemistry, biology, and communications courses to explore these connections. Using these data, we have begun developing a path model relating factors such as growth mindset, control of learning beliefs, intrinsic goal orientation, and self-efficacy. Can we leverage these connections to enhance student learning?

HB05: 1:30-1:40 p.m. The NEIU PEERS Project: Embedding Research in the University Physics Sequence

Contributed – Paulo H Acioli, Northeastern Illinois University, Chicago, IL

Rachel Trana, Elisabet Head, Joseph Hibdon Jr., Northeastern Illinois University

Ken Nicholson

We present results of the implementation of mini-research components in the Undergraduate University Physics curriculum at Northeastern Illinois University (NEIU). These are results of a funded NSF-IUSE grant to engage students, enhance learning, and improve retention in STEM. The primary emphasis in the modified Physics courses was in the research process. We dedicated three of the traditional laboratory sessions to developing a research project that mimics the experience in a traditional research setting. We evolve from deciding on a research topic to planning to execution of the project. Students develop not only their research skills but also their written and verbal communication. The challenges and successes of the implementation and assessment of learning gains for each course will be presented.

HB06: 1:40-1:50 p.m. A Curriculum to Implement NGSS for Engagement, Equity, and Agency

Contributed –Shannon I. Wachowski Platte Valley High School / University of Colorado, Boulder, Fort Collins, CO

Alisa Grimes, Roaring Fork High School / University of Colorado, Boulder

This talk introduces high school physics teachers and teacher educators to a new physics curriculum, PEER, for implementing NGSS practices in the classroom. In addition to understanding physics and scientific practices, teachers of NGSS must also recognize their roles as curating transformative educational experiences among students. As students make claims from evidence and establish principles from consensus (often for the first time), they undergo a kind of transformation in their understanding of the role of science education in their lives. In this talk, teachers learn to manage the multiple demands of supporting students through this transformation while providing meaningful laboratory experiences and consensus building opportunities. Participants will discuss their roles as teachers in helping students integrate physics content and scientific practices as they develop models, explanations, and principles that explain the physical world. Presenters will share data regarding how this curriculum has increased engagement, equity, and agency in their classrooms.

HB07: 1:50-2 p.m. Culturally Responsive Pedagogy in Physics Teacher Preparation

Contributed – Mariam Manuel, Richmond, TX

Paige Evans, Donna Stokes, Leah Shields, University of Houston

The teachHOUSTON and Physics faculty at the University of Houston developed and implemented two physics courses, Physics By Inquiry (Physics 4342) and Physics for Preservice Middle School Teachers (Physics 4345), to engage secondary pre-service teachers in interactive, researched-based, teaching strategies. The instructional team has recently infused culturally responsive pedagogical (CRP) practices into the coursework, thus, preparing future STEM teachers to provide dynamic physics instruction that both student-centered, and, culturally-centered. CRP is a major concept in urban and multicultural education that stresses the ability of teachers to respond to their students by incorporating elements of students' culture in their teaching. This session will explore the implementation and use of culturally responsive pedagogy in physics instruction. Presenters will highlight activities utilized in courses including the employment of the Culturally Responsive Mathematics/Science Teaching Lesson Analysis Tool. This self-reflective tool promotes discussion and critical reflection through combining content, students' thinking, and an equity focus.

HB08: 2-2:10 p.m. Supplemental Activities to Transform Traditional Exams Into Powerful Learning Experiences

Contributed – Jordan M. Gerton, University of Utah, Salt Lake City, UT

Brianna Montoya, University of Utah

Traditional introductory physics exams are designed to probe efficacy across a range of topics, but may also challenge students in unintended ways. For example, the time-bound nature of most exams may disadvantage language learners, students who process information more deliberately, and those with test anxiety. Non-traditional assessment approaches, such as group exams/quizzes, engage students in learning as part of the assessment process and may address some of these issues, but may also

be difficult to implement in some contexts. We present some supplemental activities that are meant to transform traditional exams into powerful learning experiences for all students. Some examples include publishing the authentic exam scenarios well in advance of the test date, having students produce exam solutions in small groups immediately after an exam, and having students participate in a gallery stroll of the group-produced solutions. We seek feedback on how to study the efficacy of this approach.

HB09: 2:10-2:20 p.m. Scaffolding Predictions Students Make, and Reflect On Given Experimental Data

Contributed – Adebanjo Oriade, University of Delaware, Newark, DE

Making predictions, documenting them, reflecting on them in the light of interaction with peers, and considerations of fresh experimental data is a complex learning process that requires scaffolding. This realization comes from reflecting on implementation of components of Interactive Lecture Demonstrations (ILD) [Sokoloff and Thornton(1997)] in a physics course for non-science majors. We discuss two dimensions of scaffolds for the initial prediction students make. In one dimension the required prediction ranges from purely qualitative in nature to the quantitative predictions. Quantitative predictions we think are more challenging for our students than qualitative predictions. The other dimension depends on the nature of change in the value of the dependent physical quantity involved. This aspect considers a spectrum from static predictions to dynamic predictions. The authors of Prospect theory [Kahneman and Tversky(1979)] , describe how perceptual representations highlight changes and differences, while being largely insensitive to the level of a state maintained over a period of time. We engage questions about intuitive thinking and observed systematic biases.

Session HC: Integrating Computation Into Laboratories at All Levels

Location: Sage Room **Sponsor:** Committee on Laboratories **Co-Sponsor:** Committee on Physics in High Schools
Time: 12:30–2:20 p.m. **Date:** Tuesday, Jan. 15 **Presider:** Joe Kozminski

HC01: 12:30-1 p.m. Computation, Experimentation, and Analytical Theory: The 3-Legged Stool

Invited – Kelly Roos, Bradley University, Jobst 408, Peoria, IL

Computation, Experimentation, and Analytical Theory are NOT mutually exclusive tools for educating students in the STEM disciplines. The union of these three tools invokes the picture of three-legged stool that is stable because each leg plays a crucial, irreplaceable part in the stools' stability. In introductory labs, the idea of integrating computation invokes typical data analysis; but, the introductory labs also provide opportunities for taking students deeper into computation, including the building of basic computational models to verify (and refine) model predictions with the real data. In advanced labs, providing computational activities beyond the canonical advanced data analysis and reduction, can achieve educational enlightenment that the combination of experiment and analytical theory, alone, cannot accomplish. In this talk, along with making the case for integrating computation beyond basic data analysis in undergraduate laboratory experiences/courses, I shall provide some detailed examples of effective implementations of the three-legged stool approach to physics education.

HC02: 1-1:30 p.m. A Walk on the Random Side*

Invited – Norman Chonacky, Yale University - Department of Applied Physics, New Haven, CT

Laboratories are excellent venues for learning about numerical modeling of physical systems because the results of numerical simulations can be applied directly to designing experiments, and understanding and evaluating their results. A significant class of such simulations uses Monte Carlo methods, whose algorithms embody random numbers. In this talk I describe examples of such simulations for specific physical systems that could be explored in experiments at several different course levels. Applications range from experimental fluctuations to diffusive processes. There are considerable benefits from early student engagement with such integrated computation-experiment exercises. Understanding experimental uncertainty and predicting probabilities for outcomes are omnipresent tasks in SMET activities. Less obvious may be the roles Monte Carlo methods play in artificial intelligence and in data mining. Finally, these exercises will serve those who wish to learn some useful things about the digital computers for their professional futures.

*This work was partially funded by the National Science Foundation under the IUSE program grants DUE-1505278 and DUE-1524963.

HC03: 1:30-1:40 p.m. Of Bugs and Features: Synergistic Learning of Physics and Computation

Contributed – Luke D. Conlin, Salem State University, Salem, MA

Computational modeling of physical systems is a core disciplinary practice of physics, yet students in high school physics classrooms rarely get opportunities to learn or engage in this practice. One challenge is that learning computational modeling often means learning a computer language, which can distract from learning the physics. C2STEM is a simulation environment and embedding curriculum designed for synergistic learning, such that students' learning of physics and computation is mutually reinforcing. We present results from several classroom studies where C2STEM served as the students' laboratory. We find that moments of synergistic learning emerged in surprising ways as students built simulations. For instance, all students encountered the need to debug their code, and often the debugging process proceeded at the intersection of computational thinking and physics disciplinary practices. Debugging involved practices like making predictions based on a model, controlling variables, and refining a model based on empirical observation.

HC04: 1:40-1:50 p.m. Building Experimental Skills Using Arduino, Jupyter, and LabVIEW

Contributed – Troy C. Messina, Berea College, Berea, KY

Physics undergraduates need to be prepared for a wide variety of careers. The latest AIP data shows approximately half of physics bachelor's degree earners go on to careers or graduate studies in areas other than physics. To prepare students for this future, we have been incorporating laboratory activities that aim to develop a wide range of skills and appeal to a broad set of student interests. It is also our intention to continue preparing students for graduate study in physics. The activities include developing sensing systems with Arduinos and modeling with Glowscript at the introductory level. As students progress to higher level courses such as Modern Physics and Advanced Laboratory, we introduce them to Jupyter notebooks and LabVIEW. In this presentation, we will detail some activities and how we scaffold student learning from introductory to upper-level courses.

HC05: 1:50-2 p.m. Using Jupyter Electronic Notebooks in Introductory Physics Laboratories

Contributed – Tatiana A. Krivosheev, Clayton State University, Morrow, GA

We present the pros and cons of conversion of the traditional laboratory manuals used in the Introductory Physics courses into an integrated Jupyter notebook: a web-based interactive computational environment to combine code execution, text, mathematics, plots and rich media into a single document. The electronic notebooks are provided to students as a free of charge, electronically shareable file. The Jupyter environment also generates additional student learning opportunities such as numerical simulations and programming.

HC06: 2-2:10 p.m. Graphing Challenge and Graph Matching Game

Contributed – Ersin Tangil, El Paso Harmony Science Academy, , El Paso, TX

Students have hard times to learn graph questions on kinematics or they just don't like to learn velocity vs. time, acceleration vs. time, position vs. time graphs with old-school methods. Therefore, teaching graph with motion sensors and graph game will be demonstrated.

HC07: 2:10-2:20 p.m. Modeling Vessels Filling Pattern Using Video Analysis

Contributed – Rony A. Yarden, Bayside High School, Bayside, NY

In this activity, the participants start with developing the theoretical background of filling patterns of different vessels,starting with simple vessels such as graduated cylinders and ending with more complex ones such as Erlenmeyer or bottom round flasks. Given the volume as a function of height and flow rate, the participants will develop the height vs. time function, predict and sketch the graph and perform a set of experiments using actual flasks, dyed water, and video analysis tools to collect the data of the height of the liquid vs. time and match it to their prediction. The activity can be performed in a classroom with available and cheap technology (cell phone camera, stopwatch, spreadsheet and possible video analysis software, Such as Vernier Logger-Pro, Optional).

Session HD: Panel: Professional Skills for Graduate Students

Location: San Felipe Room **Sponsor:** Committee on Graduate Education in Physics **Co-Sponsor:** Committee on Research in Physics Education
Time: 12:30–2:30 p.m. **Date:** Tuesday, Jan. 15 **Presider:** Lisa Goodhew

This interactive panel focuses on developing professional skills for graduate students and other early-stage researchers. Our panelists will discuss important professional skills they have gained as graduate students, including how to become integrated with the community, develop specific research skills, and disseminate work. This session will feature time for discussion in order to foster peer mentoring between students. While this session is aimed toward graduate students, we welcome undergraduates who are interested this professional development opportunity or curious about life as a graduate student.

Speakers:

J.T. Laverty, Kansas State University

Dena Izadi, Michigan State University

Session HE: The Living Physics Course: New Ideas and Old Tricks

Location: Galleria III **Sponsor:** Committee on Physics in Undergraduate Education **Time:** 12:30–3 p.m. **Date:** Tuesday, Jan. 15
Presider: Juan Burciaga

HE01: 12:30-1 p.m. IPLS at an Engineering School

Invited – Nicholas Darnton, Georgia Institute of Technology, Atlanta, GAdu

JC Gumbart, Jennifer Curtis, Georgia Institute of Technology

Georgia Tech recently implemented a new IPLS "flavor" of our calculus-based introductory physics sequence. In adapting the University of Maryland, College Park framework to our target audience (biology, chemistry and neuroscience majors), we increased the number of online and written problems while reducing the scope of labs to allow for longer recitation sessions. A major motivation for the creation of the IPLS course was the alarming failure rate of life science majors in GA Tech's traditional intro physics courses (30% DFW in recent years); we reduced the DFW rate by a factor of three while modestly raising average grades in the course by roughly half a point. Anecdotally, we observe enthusiasm for this approach, with enrollment growing with each subsequent offering. However, problems arise for students switching between IPLS and the traditional sequence mid-year.

HE02: 1-1:30 p.m. Bringing Biology to Physicists and Physics to Biologists

Invited – Ching-Hwa Kiang, Rice University, Houston, TX

Biological physics is an emerging field of physics. In fact, biology and medicine-related sciences have been growing in almost all areas of science and engineering. The Nobel Prize in Physics 2018 recognized the accomplishment in biological physics, and awarded optical tweezers and their application to biological systems along with other inventions in laser physics. I initiated teaching of biological physics in the Department of Physics & Astronomy at Rice University more than 15 years ago, by offering introductory biological physics courses at both undergraduate and graduate levels. The students came from a variety of backgrounds, including physics, chemistry, biochemistry, engineering, and religion majors. Unlike most other traditional physics course, biological courses have evolved over the years and continued to be updated. In this talk, I will share my view of the importance and my experience in teaching biological physics courses.

HE03: 1:30-3 p.m. Nurturing Student Inquiry in the Introductory Physics for Life Science Course

Poster – Nancy Beverly, Mercy College, Dobbs Ferry, NY

In the project-based course at Mercy College, students consistently explore their own inquiries about the life phenomena of interest to them, sustaining that inquiry with modeling and quantitative analysis to make inferences regarding the phenomena. They pose their own questions, get their own data, and solve their own problems in mini-project homework assignments that lead to a semester-long project. Strategies to nurture this inquiry include starting with a larger, human inquiry for which a personal motivation is required. Narrowing this larger inquiry to the possible underlying physical mechanisms is key. Framing the inquiry in terms of comparison eases making quantitative analysis meaningful.

HE04: 1:30-3 p.m. Teaching of Physics in Criminalistics: A Practical Approach to Collisions

Poster – Mario Humberto Ramirez Diaz, Instituto Politécnico Nacional Legaria 694, Col. Irrigación Mexico, MEX 11500 México

José Augusto Bustamante Benítez, Instituto Politécnico Nacional

Isaias Miranda Viramontes

This proposal shows the results of applying a teaching strategy based on the 4MAT system, this time having an experimental variant, in order that the students of the degrees related to the forensic sciences and Criminalistics, visualize the importance that Physics has in its professional development and as one of these applications is the explanation of the phenomena that can be observed during a vehicular collision and how this explanation serves to reconstruct a criminal act committed by the driving of a vehicle. The experimental group in which this system was applied was based on students from the second to the eighth semester of the degree in criminology, thus relating the system to the real problem faced by these students during their professional lifetime. For each proposed teaching activity, an evidence of learning was requested, students would demonstrate their ability to understand and solve problems.

Session HF: The Physics of Extreme Mineral Exploration

Location: Westchester Room **Sponsor:** Committee on Science Education for the Public **Co-Sponsor:** Committee on Space Science and Astronomy
Time: 12:30–2 p.m. **Date:** Tuesday, Jan. 15 **Presider:** Richard Gelderman

HF01: 12:30-1 p.m. Lunar Mining: A Primer

Invited – Kurt Klaus, Lunar Planetary Institute, Houston, TX

All space faring nations have interest in lunar exploration many with an eye towards lunar resource prospecting and exploitation. As we humans turn our sights to exploration beyond the earth-moon system, the moon becomes attractive for many reasons, not the least of which is its potential for refueling and replenishment of water and oxygen for life support as well as construction materials. We will outline sources of lunar resources, prospecting and production methods. We will consider the challenges of the lunar environment for exploration by humans and machines. We will outline NASA's plans for commercial lunar exploration and provide a glimpse at the next 10-20 years of lunar exploration.

HF02: 1-1:30 p.m. Fractured Energy

Invited – Priscilla Villa, Earthworks, Washington, DC

In Shale regions across the U.S., the oil and gas 'fracking' boom has made a lasting impact. Hydraulic Fracturing (Fracking), combined with horizontal drilling, are a technological combination that requires millions of gallons of water, sand, and chemicals to break through shale rock formation to extract oil and gas. Development of these shale wells emits methane, a greenhouse gas 86 times more potent than carbon dioxide, and volatile organic compounds that are known to cause human health impacts. Through Earthworks' Community Empowerment Project, we utilize optical gas imaging technology to detect emissions from oil and gas production and make the invisible visible to communities across the U.S. From earthquakes to waste water to climate change, I'll discuss how shale development and fracking have disrupted our environment and why they are not part of a sustainable energy future.

HF03: 1:30-2 p.m. Oil and Gas Methane Emissions

Invited – Shareen Yawanarajah, Environmental Defense Fund, Houston, TX

Methane is a gas that can come from many sources, both natural and man-made. It is the primary component of natural gas, a common fuel source. The largest source of industrial methane emissions is the oil and gas industry. If methane leaks into the air —from a leaky pipe, for instance—it absorbs the Sun's heat, warming the atmosphere. For this reason, methane is considered a greenhouse gas, like carbon dioxide. While methane does not linger as long in the atmosphere as carbon dioxide, it is initially more devastating to the climate because of how effectively it absorbs heat. In fact, about 25% of the man-made global warming being experienced today is caused by methane emissions. Environmental Defense Fund studies have transformed our understanding of methane emissions from the oil and gas industry, and we now know that reducing emissions from this sector is the fastest, most cost-effective way we have to slow the rate of warming today.

HF04: 2-2:30 p.m. The Outlook for Energy

Invited – Irene Chang, Exxon Mobil, 22777 Springwoods Village Pkwy, Spring, TX

To support economic progress and make substantial progress on the climate goals identified in the Paris Agreement, well-designed and transparent policy approaches are needed that carefully weigh costs and benefits. Such policies are likely to help manage the risks of climate change while also enabling societies to pursue other high-priority goals – including clean air and water, access to reliable, affordable energy, and economic progress for all people. Technological innovation will also be vital to improve living standards while addressing climate risks. Advances continue to reshape the energy playing field. Many technologies not prevalent five to ten years ago have a more significant role today, and their impacts will continue to expand.

Session HG: Upper Division and Graduate

Location: Bellaire **Sponsor:** AAPT **Time:** 12:30–2:10 p.m. **Date:** Tuesday, Jan. 15 **Presider:** TBA

HG01: 12:30-12:40 p.m. Self-Sustained Oscillator Experiments

Contributed – Randall Tagg, University of Colorado Denver, Physics Dept., Denver, CO

Masoud Asadi, University of Colorado Denver

Self-sustained oscillation, in which a steady energy source is used to maintain a nonlinear system in steady limit-cycle oscillation, is literally at the "heart" of living systems and much of technology. Deep understanding of the fundamental ideas of such systems is accessible within the frame first presented in courses on the physics of vibrations and waves when this frame is extended with fundamental tools of dynamical systems theory. The electronic Wien Bridge oscillator - often seen as a quick throw-together audio sine wave oscillator - is a potent source of insights into the practical realization of self-sustained oscillators. It also reveals some surprises in the dynamics, such as a phenomenon called "squegging". We present experiments and numerical simulations organized within a Jupyter notebook. The learning approach demonstrates an advanced technical competency in practical skills identified as one of the major goals of the recent AAPT guidelines for laboratory courses. Also, several pathways into contemporary research will be described.

HG02: 12:40-12:50 p.m. Modeling Sensitivity to Initial Conditions of Rotational Dynamics

Contributed – Joseph Phillip Gutheinz, University of Saint Thomas, , Houston, TX

Madeline Carter, James Clarage, University of Saint Thomas

Classical Dynamics, although simplistic in its elegance, poses many questions yet to be answered. One such problem begs the simple question: why does a book wobble erratically in flight when flipped about one of its sides? In light of this phenomenon, our research group has conducted research concerning a parallelepiped's rotation in three-dimensional space, integrating both dynamic drag effects due to air friction and kinematic initial conditions to plot the motion of a parallelepipedal object in space as a function of time. This model was then compared to accelerometer data collected from a sensor-enabled PASCO Smart Cart with identical geometry to the computational model. Comparison with our experimental data sets led to the development of a physically predictive computational model for the motion of a parallelepiped in three-dimensional space, thus further shedding light on the original mystery of rotational instability under particular conditions.

HG03: 12:50-1 p.m. Green Light, Red Light: NV Center Diamond Magnetometry

Contributed – Joshua Bridger, Harvard University / Dover Sherborn High School, Dover, MA

Research into the optical properties of color centers in diamonds has recently led to the development of precise quantum sensing instruments and offers promise in the field of quantum computing. In an effort to bring contemporary research techniques and topics to advanced placement and undergraduate physics students, an exploration of optically detected magnetic resonance (ODMR) in an NV rich diamond was developed {and described in the American Journal of Physics – AJP 86, 225 (2018)}. Recently, a low-cost, portable, exhibit version of this experiment was developed, with the aim of bringing ODMR in NV rich diamonds to a wide range of students, from middle school to undergraduate. Detailed component lists, multi-level explorations and setup instructions were developed and are now available to institutions wishing to create similar setups. An overview of the setup, theory and associated curriculum will be presented.

HG04: 1-1:10 p.m. Building Confidence in the Delta-Dirac Function

Contributed – Constantin N. Rasinariu, Loyola University, Chicago, IL

Asim Gangopadhyaya, Loyola University Chicago

We present an example from undergraduate quantum mechanics designed to highlight the versatility of the delta-Dirac function. Namely, we compute the expectation value of the Hamiltonian of a free-particle in a state described by a triangular wave function. Since the first derivative of is piecewise constant, and because this Hamiltonian is proportional to the second order spatial derivative, students often end up finding the expectation value to be zero –an unphysical answer. This problem provides a pedagogical application of the delta-Dirac function. By arriving at the same result via alternate pathways, this exercise reinforces students' confidence in the Dirac-delta function and highlights its efficiency and elegance.

HG05: 1:10-1:20 p.m. Student Understanding of Spin in Graduate Quantum Mechanics

Contributed – Christopher D. Porter, The Ohio State University, Columbus, OH

Andrew F. Heckler, The Ohio State University

Spin is a topic integral to many areas of physics and to emerging technologies. Spin also encompasses much of the "strangeness" of quantum mechanics and can be non-intuitive, a fact that has led many instructors to advocate teaching spin even before wave functions. In this work we investigate student understanding of spin at the graduate level. In many cases, data are included from pre-tests and post-tests. Data are included from three large, Midwestern universities, and multiple cohorts. We identify a number of deficits and student difficulties. We also find that results from different universities are comparable, which suggests our findings may be general. We examine student understanding of orthogonality of spin states, spin addition, and exchange symmetry.

HG06: 1:20-1:30 p.m. Design of Fresnel Acoustic Lens

Contributed – Yan Cen, Fudan University, Room 369, Physics Building, Shanghai 200433, China

Fangting Chen, Yongkang Le, Jinglin Lv, Fudan University

Teachers can easily show students the phenomenon of light focusing by optical lenses or Fresnel zone plates. However, there is no suitable device for acoustic focusing to be presented. In this paper, an acoustic lens is designed based on the principles of Fresnel zone plate and fabricated with acrylic. We propose a model similar to thin lens imaging to explain the focusing of sound waves by Fresnel acoustic lenses. The focal length of the lenses is mainly determined by the geometric parameters and the frequency of sound wave. Higher frequencies and shorter focal length correspond to lens of smaller size. To verify our theoretical model, an experiment is carried out and the results are in good agreement with our theoretical model. Such an acoustic lens has the advantages of easy producing and low costs which make it a good teaching device to impart the knowledge of acoustic focusing to students.

HG07: 1:30-1:40 p.m. Exploring Novel Experiment Methods for Accurately Measuring Relative Permittivity

Contributed – Yan Liang, University of Science and Technology of China, Hefei, China

This manuscript primarily introduces three experimental methods for accurately measuring the relative permittivity of solids employing parallel plate capacitors. By designing various measuring circuits elaborately, the systematical errors caused by material extrusion deformation, marginal effect resulted from limited parallel plate capacitors, and distributed capacitance derived from the measuring circuits are solved, respectively. Furthermore, it was found in experimental process that adjusting parallel plate capacitor to be absolute parallel is difficult. Therefore, we further improved the experiment method and creatively proposed a three-plate system to solve this problem, efficaciously enhancing the measurement accuracy of relative permittivity in parallel plate capacitors.

HG08: 1:40-1:50 p.m. Two-Dimensional Classical Analog for Quantum Band Structure

Contributed – Parker J. Roberts, Berry College, Mount Berry, GA

Cameron Bensley, Shawn A. Hilbert, Berry College

In condensed matter physics, quantum band structure is a vital framework for understanding how the Hamiltonian of a system of many atoms contributes to macroscopic material properties. Band structure is typically introduced through a level-splitting approach, in which it is shown that the addition of overlapping Coulomb potentials causes splitting of the allowed electron energies. When more atoms are added to the system, energy levels continue to split to the point of forming continuous regions of allowed energies, or bands. This phenomenon can be better understood and taught with analogies from classical mechanics, and it has been experimentally shown that both level-splitting and band formation occur in the frequency spectrum of a system of many coupled harmonic oscillators. This research seeks to extend this analogy to two dimensions, using an array of oscillators to show the 2D lattice-based interactions of frequencies. Both computational simulations and an experimental apparatus are utilized.

HG09: 1:50-2 p.m. A New Survey: Faculty Perceptions of Teaching as a Profession

Contributed – Savannah L. Logan, Colorado School of Mines, Eugene, OR*

Richard Pearson, Wendy K. Adams, Colorado School of Mines

Following the development of the Perceptions of Teaching as a Profession (PTAP) survey, which measures students' interest in and view of teaching as a career, we are developing a new instrument to measure college faculty's perceptions of teaching as a profession. We have conducted faculty interviews and collected survey responses from a range of institutions and STEM disciplines. Results of the faculty interviews will be shared. This project is supported by NSF DUE-1821710.

*Sponsored by Wendy K. Adams.

HG10: 2-2:10 p.m. Electrified-Efficiency Analysis of Wimshurst Machine

Contributed – Xiaoyu Niu, Ocean University of China, Qingdao City, Shandong Province, China

Generally, Wimshurst Machines are used to display static electricity phenomenon. Most learners are willing to attribute efficient electrification to friction. In fact, it is induction that enables Wimshurst Machine to produce an astonishing number of charges in an instant. In this paper, we present the process and theory of the electrification by induction and verify it both theoretically and experimentally. In addition, in order to explain the authentic mechanism of Wimshurst Machine, we design three funny experiments: 1) Opposite-Directed Rotating Experiment; 2) Same-Foils Experiment; 3) Angle of Brushes Experiment. Based on above experiments, the mechanism of efficient electrification could be explained into "Model of Exponential Explosion". Finally, we contribute creatively the process of electrification to Circle System of Positive Feedback or Circle System of Negative Feedback, which could fairly interpret the phenomenon of efficient electrification.

Session HH: PER: Diversity, Equity & Inclusion

Location: Plaza Ballroom I **Sponsor:** AAPT **Time:** 12:30–1:20 p.m. **Date:** Tuesday, Jan. 15 **Presider:** TBA

HH01: 12:30-12:40 p.m. Individual vs Social Perspectives of Disability: Impact on Postsecondary Learners

Contributed – Jacquelyn J. Chini, University of Central Florida, Orlando, FL

Caroline Bustamante, Kamryn Lamons, Westley James, University of Central Florida

Instructors' interpretations of disability may impact the experiences of students with disabilities in their classes. Individual perspectives situate disability within the individual by focusing on impairment as a personal deficit to be fixed, cured or addressed through individual adjustment. On the other hand, social perspectives situate disability within the interaction between an individual and an environment, shaped by social, cultural, historical, economic, relational and political factors; in this view, disabling experiences are mitigated by removing barriers and increasing accessibility. We use interviews with three students with disabilities enrolled in postsecondary science courses to demonstrate how individual and social perspectives, held by either the students themselves or their instructors, impact their learning experience. Specifically, we find that the individual perspective is tied to disability stigma and argue that students are better supported by instructors who take on a social perspective of disability.

HH02: 12:40-12:50 p.m. Explicating Definitions of Success through Women's Metaphors of Success in Physics

Contributed – Brian Zamarripa Roman University of Central Florida, Orlando, FL

Jacquelyn J. Chini, University of Central Florida

While our community strives to support individuals from groups underrepresented in physics to achieve "success," our definitions of success are often unexamined. We characterize success in physics through metaphor analysis of expressions generated by women physicists. We focus on women's perspectives because feminist standpoint theory posits that members of nondominant groups have a more complete understanding of reality. Interviewees participated in co-analysis to interpret and code their metaphors for causal factors that play a role in attaining success and their characteristics (i.e., stability, locus of causality and control). We construct structural metaphors from themes in the participants' metaphors and identify similarities in the highlighted attributions. For example, responses with the structural metaphor SUCCESS IN PHYSICS IS A PERPETUAL TASK emphasized their dynamic, internal, controllable effort as a factor leading to success in physics. Explicating these perspectives of success in physics can help the community facilitate the success of all individuals.

HH03: 12:50-1 p.m. Identity Performances of Minority Students at MSIs

Contributed – Xandria R. Quichocho, Texas State University-San Marcos, San Marcos, TX

Jessica Conn, Erin M. Schipull, Ian Anderson, Eleanor W. Close, Texas State University-San Marcos

Existing research on underrepresented/minority students focuses mainly on gender or race/ethnicity and largely ignores both the intersection of identities embodied by women of color and the experiences of lesbian, gay, bisexual, or queer (LGBQ) students. In addition, the research typically is conducted at Predominately White Institutions. Our current project examines the personal narratives of women of color and LGBQ physics students at a Hispanic Serving Institution (HSI) through semi-structured interviews. We use the Critical Physics Identity framework developed by Hyater-Adams and colleagues, and the framework of identity as performance developed by Ong, to analyze the interviews in order to better understand how minority students negotiate their multiple intersectional identities in their academic environments. Our analysis focuses on the way students fragment or enhances their minority identities in the physics setting and how this may affect their view of themselves as physicists.

NSF DUE-1557405 NSF DUE-1431578 NSF PHY-0808790

HH04: 1-1:10 p.m. The Under-Representation Curriculum: Impacts and Possibilities

Contributed – Chris Gosling, McGill University, Saranac Lake, NY

The Under-Representation Curriculum Project is a modular, student-centered curriculum designed to examine and address equity and inclusion in science. In this session, I will share preliminary observations about the impact that the curriculum has on student participants in the form of data and student responses. I will also discuss possibilities for future research designed to gauge how participating in this curriculum affects student thinking about issues of social justice and their own trajectories relative to science, whether it be physics or another field.

HH05: 1:10-1:20 p.m. Using Autoethnography, a Critical Research Methodology, with Physics Learning Assistants

Contributed – Myrtle Jones, Rochester Institute of Technology, Rochester, NY

Geraldine L. Cochran, Rutgers University

Autoethnography, a qualitative research method that allows members of a culture to represent their account of the culture, is used in a variety of disciplines including anthropology, sociology, and education (McIlveen, 2008). In authoethnography, "it is the meaning of the story that is important" (McIlveen, 2008)." It is a powerful and liberating research tool in that it allows the autoethnographers to speak against dominant narratives and show how "persons produce history and culture" in concrete situations (Denzin; 2003; Adams, Ellis, and Holman Jones, 2017). In this presentation, we will differentiate between autoethnography and narrative analysis, discuss the goals of autoethnography, and describe contexts in which it is an appropriate research methodology. Finally, we will discuss how autoethnography has been used as a tool for Learning Assistants in an introductory physics course for engineering students to provide an account of their experience as Learning Assistants.

Session HI: PER: Assessment, Grading and Feedback
Location: Plaza Ballroom II **Sponsor:** AAPT **Time:** 12:30–1:20 p.m. **Date:** Tuesday, Jan. 15 **Presider:** TBA

HI01: 12:30-12:40 p.m. Identifying Test Bias in Graduate Physics Written Qualifying Exams

Contributed – Mary K. Chessey, University of Maryland, College Park, MD

Measurement and testing in education provide useful strategies and techniques for understanding how to gauge levels of cognitive attributes of students. Assessments that are used to determine degree attainment, such as qualifying exams in physics graduate programs (the Preliminary Exam), are high-stakes and warrant careful consideration in their design and implementation. In physics, where success is often believed to be the result of innate brilliance, stereotypes about intelligence contribute to underperformance and under-evaluation of members of groups that are underrepresented in physics. High-stakes assessments, such as the Preliminary Exam, are often places where differences in average group performance are found. To ascertain whether the exam is free from bias and accurately measures physics knowledge and skills for various groups of students, techniques for estimating differential validity of the exam are used, namely investigation of the relation between Preliminary Exam performance and other measures of academic and physics preparation.

HI02: 12:40-12:50 p.m. Overview of Research-based Assessments that Go Beyond Physics Content

Contributed – Adrian Madsen, American Association of Physics Teachers, Longmont, CO

Sarah B. McKagan, American Association of Physics Teachers

Cassandra Paul, San Jose State University

Eleanor C. Sayre, Kansas State University

There is a large corpus of research-based assessments that go beyond physics content, for example, assessments of attitudes and beliefs about physics, epistemologies and expectations, problem solving, self-efficacy, reasoning skills, lab skills, and assessments from cognate fields to physics such as math. These assessments capture many aspects of "thinking like a physicist" that physics faculty care about. However, faculty often don't know that these assessments are available and which to use in their course. We have written a resource letter where we discuss the details of these non-physics-content research-based assessments and research-based teaching observation protocols, including the research validation, instructional level, format, and themes, to help faculty find the assessment that most closely matches their goals. We also compare related assessments and give recommendations on when to use each. In our talk, we will give an overview of these assessments, all of which are available on www.physport.org, paying particular attention to those that are less well known.

HI03: 12:50-1 p.m. A Rubric for Assessing Thinking Processes in Free-Response Exam Problems

Contributed – Beth Thacker, Texas Tech University, Physics Dept., Lubbock, TX

We designed a rubric to assess free-response exam problems in order to compare thinking processes evidenced in exams in classes taught traditionally and non-traditionally. The rubric is designed based on Bloom's taxonomy. We have data on a number of classes taught by the same instructor, one class more traditionally and one taught in an inquiry-based, laboratory-based setting with Socratic dialog pedagogy. We discuss the instrument, present results and present plans for future research.

HI04: 1-1:10 p.m. Developing Instruments to Survey the Informal Physics Landscape

Contributed – Dena Izadi, Michigan State University, East Lansing, MI

Claudia Fracchiolla, University College Dublin

Noah Finkelstein, University of Colorado Boulder

Issac Ward, Kathleen Hinko, Michigan State University

Informal physics, often called physics outreach, is an opportunity for people to learn physics in non-school settings. Audiences of all ages explore physics by participating in different activities, visiting institutions, or using media to pursue their interests in physics. However, there is no systematic understanding of how informal physics programs are facilitated or assessed. Thus, to gain an understanding of the landscape of informal physics, we have begun to map informal physics education efforts attempted by physics departments in academic institutes and physics national labs in the U.S. Here, we present the development of a survey and an interview protocol designed to produce a preliminary taxonomy of informal physics. We analyze responses from number of institutes during fall 2018 and discuss feedback from this initial data collection. Additionally, we describe best strategies for recruiting and invite groups to contribute to the study.

HI05: 1:10-1:20 p.m. Using Quantitative Analyses to Rank Incorrect Responses to FMCE Questions*

Contributed – Trevor I. Smith, Rowan University, Glassboro, NJ

Kyle J. Louis, Bartholomew J. Ricci, Rowan University

In an effort to value the ideas that students express by selecting particular responses to multiple-choice assessment questions, we have used various quantitative analyses of data from the Force and Motion Conceptual Evaluation (FMCE) to rank the incorrect responses to each question from better to worse. Our overarching goal is to be able to demonstrate growth in understanding if students choose different incorrect responses before and after instruction. Through these analyses we have identified several different categories of questions including: a) questions with no ranking because the vast majority of students choose either the correct or a single incorrect response, b) questions with responses that are better than the most common incorrect response, and c) questions with multiple incorrect responses that are equally likely for low-performing students. We present an overview of these results and discuss similarities and differences between the questions that fall into each category.
*Supported by NSF grant DUE-1836470

HI06: 1:20-1:30 p.m. Dellow Gain, to Analyze FCI Data in Active Learning

Contributed – Azita Seyed Fadaei, KLA Schools, Seattle, WA

The purpose of this study is comparing Hake gain and Dellow gain to analyze the effects of active learning method (Interactive Conceptual Instruction :ICI) on level of students' understanding in Newton's laws. The main study was calculated by Hake Method. In this paper the results are analyzing by Dellow's Method. Testing the effectiveness of research's idea by FCI and presenting the data on which it was constructed as Hgain(g), Dgain(G), Dloss and Retention is the goal of this paper. Results show differences in understanding of students in ICI.

Session: Poster Session 3 – Post deadline Posters
Location: Woodway Hall **Sponsor:** AAPT **Time:** 2:30–4 p.m.
Date: Tuesday, Jan. 15

Persons with odd-numbered posters will present their posters from 2:30 to 3:15 a.m.; those with even-numbered posters will present from 3:15 to 4 p.m. Posters will be available until 4 p.m.

PST3A01: 2:30-3:15 p.m. A Polarization Optics Laboratory for Computational Analysis of Collagen Fibers

Poster – Sarah Erickson-Bhatt, Morgridge Institute for Research, UW Madison, Madison, WI

Adib Keikhosravi, Laboratory for optical and computational imaging

Kevin Eliceiri, Morgridge Institute for Research

A liquid-crystal polarization microscope (LC-PolScope) is described which images the birefringent nature of collagen in biological tissues. Differences in density and structural organization of collagen fibers can be indicative of diseases such as cancer. The PolScope uses near circular polarized light and a liquid crystal based universal compensator to detect all fibers in all directions with very high sensitivity. Two computational packages, CT-FIRE and CurveAlign developed at the Laboratory for Optical and Computational Microscopy (LOCI), are used to extract the individual fibers and calculate the alignment and orientation. This imaging system is introduced as a laboratory exercise for an upper-level undergraduate course in optics. Through this lab, students engage in inquiry-based examination of biological tissues using principles of polarization optics.

PST3A02: 3:15-4 p.m. Physics of Light and Food: Enabling a Physics Girls Camp

Poster – Kristiana Ramos, Haddonfield Memorial High School, Haddonfield, NJ*

Roberto C. Ramos, University of the Sciences

The Physics Wonder Girls Camp aims to sustain girls' interest in science during middle school years – which is when research shows girls are likely to lose interest in science. On its sixth year, the free camp has been featured on Philadelphia's ABC News and Fox News television networks, SPS Observer, Miss USA Website, and international science blogs. Two select cohorts of girls were recruited to experience four intense days of project-building, physics experiments, lab and plant tours, and conversations with women physicists. The theme of the 2018 camp is the Physics of Light and Food - featuring experiments probing the properties of light and food processing. Women from Intel Corporation, Bryn Mawr College's Physics Dept, and Puratos Corporation visited the camp. The capstone activity was a Girls' Physics Presentation to parents, teachers, and friends. We report feedback from campers, crew, and parents, from blind surveys, letters and daily debriefings.
*Sponsored by Dr. Roberto Ramos; funding from SPIE - the Int'l Society for Optics and Photonics and Puratos Corporation and for prior years, NSF DMR #1555775 and the Lindback Foundation.

PST3A03: 2:30-3:15 p.m. Redesigning the Introductory EM Physics Laboratory Course at Kettering University using Backwards Design and Incorporating the AAPT Recommendations for the Undergraduate Physics Laboratory Currciculum*

Poster – Ronald Tackett, Kettering University, Flint, MI

Gregor Hassold Kettering University

Helen Cothrel Kettering University

This poster presents the preliminary results of attitude surveys (E-CLASS - U. Colorado) given to students taking the current PHYS-225 - Electricity & Magnetism Laboratory at Kettering University as well as the beginnings of work done in redesigning the course around a set of skills-based learning outcomes and design activities to progress students toward achieving these goals. These outcomes will encourage students to: ask and answer scientific questions through experimental design and implementation; develop technical and practical laboratory skills; generate, analyze, and interpret data; incorporate uncertainty in measured values, calculated values, and graphical representations; and write effective technical reports that articulate the reasoning that connects theoretical models to laboratory activities and use appropriate style and voice. Our goals are to produce a more authentic laboratory experience through the use of open-ended activities, building reflection into assignments, and allowing students to have more of a say in what they are investigating.
*The presenters would like to thank the authors of the E-CLASS survey

PST3A04: 3:15-4 p.m. What Influenced the Classroom Behavior of Chinese Science Teachers*

Poster – yin zhang, Guangxi Normal University, Lexington, KY

Xin Ma, Department of Educational, School, and Counseling Psychology, University of Kentucky,

Xingkai Luo, Guangxi Normal University

Developing critical thinking is an important goal of science education. This study investigated classroom teaching behavior of 4,002 middle school Chinese science teachers along with six aspects of critical thinking: Truth-seeking, Open-mindedness, Analyticity, Systematicity, Confidence in Reasoning, and Inquisitiveness. The data shows that Chinese science teachers have the lowest scores on open-mindedness and truth-seeking in the critical thinking survey. Critical thinking does not increase as teachers move up in rank. Teaching behavior such as evidence-based argument that cultivate critical thinking rarely occur. The results of hierarchical multiple regression show that critical thinking disposition is more important to predict inquiry-based teaching behavior compared with individual characteristics. Curiosity has had the largest and positive effect on the prediction of inquiry-based teaching behavior. Truth-seeking has had the largest and most negative effect on the prediction of duck-filling teaching behaviors.
*We acknowledge the financial support from the Collaborative Innovation Center of Assessment toward Basic Education Quality at Beijing Normal University

PST3A05: 2:30-3:15 p.m. Electrophysiology Measurement and Sense-Making in University IPLS Laboratories

Poster – Elizabeth Mills, UCLA, Los Angeles, CA

Natalie Rotstein,Chris Dao, Steve Mendoza, Katsushi Arisaka, UCLA

Colleges and universities are currently revising introductory physics for life science (IPLS) curricula to better meet student needs for improved content gains, enhanced physics attitudes, and increased abilities to apply physics concepts in life science, medical and real world experiences. Last year, UCLA piloted its revised IPLS series with life-focused textbook, human-centered laboratories, and cohesive structure between faculty, TAs, and LAs. Here, we discuss EKG & EMG human-centered applications in E&M labs, where students use Arduino circuit boards, electrodes, and open source software to measure, analyze, and make sense of their own physiology. We show our experimental setup, activity instruction, and lab objectives, discuss the human-centered perspective on electric potentials in EKG and EMG, and present preliminary assessment data. Some students appreciate this experience; other students are discontent from confusion and/or inability to relate this lab experience to lecture content. Revisions are currently running in response to student feedback.

PST3A06: 3:15-4 p.m. Problem Solving and Critical Thinking in Introductory Physics Course by Correct use of Simple Resources

Poster – Susmita Hazra, Cameron University, Lawton, OK

This poster will focus on how few simple study skills can make a big change in students learning abilities in physics courses. With adequate mathematical skills, students can still do well in physics as long as they are willing to do hard work in proper direction and want to be successful. This research contains data from a moderate size introductory physics class with 30 students. Initial survey shows a correlation in performance of open book, open notes quizzes with poor notes taking skills. The question in the quizzes involve critical thinking to connect integrated concepts in different areas of physics. Several important tips in writing notes during lecture and re-writing

detail notes using class notes, textbook and other reference materials within same day after the class can help significantly in students' learning. With having better-organized resource, it is easy to refer and understand effectively. Students participate in classroom discussion better, and show improvement of performance in quizzes involving both conceptual and numerical problems.

PST3A07: 2:30-3:15 p.m. Characteristics of STEM Success: Surveying Undergraduate Attributes Impacting STEM Persistence

Poster – Kimberly A. Shaw, Columbus State University, 4225 University Ave., Dept of Earth & Space Science, Columbus, GA

Allison Aebi, Columbus State University

Chloe Chambers, Harris County High School

David Rosengrant, University of South Florida St. Petersburg

Retaining female and minority students in STEM is a continuing challenge, as these students leave the field at disproportionate rates. Semi-structured interviews were conducted at two regional comprehensive universities using questions developed to examine factors in STEM persistence. The authors then used a cross-sectional survey design and mixed-methods approach to assess the role of demographic factors and academic tenacity on student STEM persistence. Results from the surveys suggest self-efficacy and mindset vary significantly between persisters and switchers. A binomial logistic regression was performed to ascertain the effects of ethnicity, self-efficacy and mindset on the likelihood that participants persist, determining that odds of persistence are less for underrepresented ethnic groups. The odds of persisting were found to increase significantly as mindset and self-efficacy scores increased. While neither gender nor student belonging added to the regression model, there is some data to support further examination of these factors in STEM persistence.

PST3A08: 3:15-4 p.m. Comparative Analysis of a Redesigned Upper-Division Physics Lab.

Poster – Charles L. Ramey, Texas Tech University, Physics & Astronomy Dept., Lubbock, TX

Beth Thacker, Texas Tech University

Dimitri R. Dounas-Frazer, University of Colorado Boulder

Communication is an important skill in all fields of STEAM, including physics lab courses. At Texas Tech University, we have recently redesigned the Modern Physics Lab to develop students' written communication competence, among other goals. To support students' writing skills, we implemented the activity Letters Home in the lab, and conducted a case study of 6 students to characterize the impact of a transformed laboratory. We used the AAPT guidelines to inform our development of an a priori coding scheme with 8 unique categories that highlight learning outcomes. We also used a linguistic software called LIWC to assess the data's language variables. From our analysis, we found the coding scheme characterizes the dimensions of scientific communication that is suggest by AAPT, and that there are structural and content similarities between the letters and lab reports.

PST3A09: 2:30-3:15 p.m. Comparison of Verification versus Guided-Inquiry in Lab for Pre-Service Teachers*

Poster – Roger A. Key, California State University, Fresno, Department of Physics, Fresno, CA

Dermot Donnelly, California State University, Fresno, Department of Chemistry

Sara Meadows, Jennifer Click, California State University, Fresno, Kremen School of Education and Human Development

The Next Generation Science Standards (NGSS) call for a three-dimensional view of science learning that includes disciplinary core ideas, science and engineering practices, and cross-cutting concepts. An important strand of the science and engineering practices is that students both plan and carry out investigations. As such, there is a need for new laboratory structures at the undergraduate level for future teachers. Using the knowledge integration framework, this mixed-method study investigates the pre/post physical science learning outcomes of a new guided inquiry-based laboratory curriculum compared to an existing verification-based laboratory curriculum for preservice elementary teachers (n = 98). Using additional laboratory observations and student questionnaires, findings indicate no significant difference in the disciplinary chemistry and physics items for the two treatments. However, there is a significant difference in integrated items in favor of the guided-inquiry laboratory.

*This work supported by NSF IUSE award #1712279

PST3A10: 3:15-4 p.m. STEM Courses: Online vs. Hybrid vs. In-Person

Poster – Eddie C. Red, Morehouse College, Atlanta, GA

Wesley D. Sims, Morehouse College

In an effort to address the need for expanded curriculum delivery methods, make course content more readily available, and reduce course costs, online courses have emerged as a leading option for universities as compared to traditional in-person courses. However, there are growing concerns among faculty and administrators as to whether online courses can foster true learning and academic success in STEM courses. At Morehouse College, an introductory STEM course served as a pilot course to test the feasibility of developing an "online" environment that nurtured student academic development and improved success rates in STEM courses. In this study, a comparison is made between a traditional in-person, a hybrid, and a fully online STEM course. Each course version was identical in structure and content. The only true varying factor was in the delivery of course content. Results are shown demonstrating which delivery method may be better suited for STEM courses.

PST3A11: 2:30-3:15 p.m. Student Responses to University Flipped Physics Classes with Feedback Quizzes

Poster – Roberto Ramos, University of the Sciences,Sewell, NJ

I present and analyze student responses to multiple physics classes in a university setting, taught in a "flipped" class format. The classes included algebra- and calculus-based introductory physics. Outside class, students viewed over 100 online video lectures prepared by this author and in some cases, by a third-party lecture package available over YouTube. Inside the class, students solved and discussed problems and conceptual issues in greater detail. A pre-class online quiz was deployed as an important source of feedback and validation. I will report on the student reactions to the feedback mechanism, student responses using data based on anonymous surveys, as well as on learning gains from pre-/post- physics diagnostic tests. The results indicate a broad mixture of responses to different lecture video packages that depend on learning styles and perceptions. Students preferred the online quizzes as a mechanism to validate their understanding. The learning gains based on FCI and CSEM surveys were significant.

PST3A12: 3:15-4 p.m. TA Beliefs About Computation in the Physics Classroom

Poster – Thomas Finzell, University of Michigan, Ypsilanti, MI

Sameer Barretto, University of Michigan

Computation has become a fundamental pillar of science; despite this, it is a topic that few in the STEM community explicitly teach to their students. To get a better understanding of what factors influence the opinions of physics instructors regarding computation, we probe the views of graduate student Teaching Assistants regarding their history with computation, and how that has influenced their beliefs about the utility of computation in teaching physics.

Session IA: Post-deadline Abstracts I

Location: Post Oak **Sponsor:** AAPT **Time:** 3–4:30 p.m. **Date:** Tuesday, Jan. 15 **Presider:** TBA

IA01: 3-3:10 p.m. An Interesting Demo for Static Electrification—Wimshurst Machine

Contributed – Xiaoyu Niu, Ocean University of China, Shandong Province, Qingdao, Qingdao, Laoshan District 266100 China

Generally, Wimshurst Machines are used to display static electricity phenomenon. Most learners are willing to attribute efficient electrification to friction. In fact, it is induction that enables Wimshurst Machine to produce an astonishing number of charges in an instant. In this paper, we present the process and theory of the electrification by induction and verify it both theoretically and experimentally. In addition, in order to explain the authentic mechanism of Wimshurst Machine, we design three funny experiments: 1) Opposite-Directed Rotating Experiment; 2) Same-Foils Experiment; 3) Angle of Brushes Experiment. Based on above experiments, the mechanism of efficient electrification could be explained into "Model of Exponential Explosion". Finally, we contribute creatively the process of electrification to Circle System of Positive Feedback or Circle System of Negative Feedback, which could fairly interpret the phenomenon of efficient electrification.

IA02: 3:10-3:20 p.m Updates to the AP Physics 1 & Physics 2 Courses

Contributed – Tanya Sharpe, The College Board, Duluth, GA

Angela Jensvold, Diamond Bar High School

Mark Hossler, Landmark Christian School

This session consists of three distinct segments: 1) The Course, 2) The Exam, and 3) New Resources. In both the course and exam segments, participants are provided opportunities to share best practices and learn of instructional strategies and approaches for enhanced teaching and learning. Using the new curriculum frameworks, participants will model and practice scaffolding physics content and science practices as they integrate formative and summative assessments. At the end of each segment presenters and participants will engage in Q&A. Participants will learn of new resources for the AP Physics 1 and 2 courses available in August 2019. This includes the new online AP Classroom resources (item bank, personal project checks, unit guides, quiz and exam creator, AP Physics 1 Workbook, etc.). Presenters will provide an overview of each new resource as participants share how each could be used to effectively implement the curriculum frameworks.

IA03: 3:20-3:30 p.m. Updates to the AP Physics C: Mechanics & Electricity and Magnetism Courses and Exams

Contributed – Tanya Sharpe, The College Board, Johns Creek, GA

Ricardo Markland, Coral Park Senior High School

This session consists of three distinct segments: 1) The Course, 2) The Exam, and 3) New Resources. In both the course and exam segments, participants are provided opportunities to share best practices and learn of instructional strategies and approaches for enhanced teaching and learning. Using the new curriculum frameworks, participants will model and practice scaffolding physics content and science practices as they integrate formative and summative assessments. Participants also will learn of new resources and share activities and ideas for how to incorporate them instructionally. At the end of each segment presenters and participants will engage in Q&A.

IA04: 3:30-3:40 p.m. Investigation on Chinese Teachers' Categorization of Kinematics and Mechanics Problems

Contributed – Elva Chen, East China Normal Universit, Shanghai, China

Novices and experts choose different strategies to categorize the physics problems, which reflects their different expertise in problem solving. Since the students' categorization is affected by their teachers, we conducted a study to investigate the physics teachers' method of categorization. Over 60 Chinese teachers from different schools were involved in our study. In general, the teachers can categorize problems of kinematics and mechanics into suitable categories based on the underlying principles.

IA05: 3:40-3:50 p.m. The Hiperwall Tiled-display Wall System for Big Data Research

Contributed – Muhammad Saleem, Bellarmine University, Louisville, KY

In the era of Big Data, with the increasing use of large-scale data-driven applications, visualization of very large high-resolution images and extracting useful information (searching for specific targets or rare signal events) from these images can pose challenges to the current display wall technologies. At Bellarmine University, we have set up an Advanced Visualization and Computational Lab using a state-of-the-art next generation display wall technology, called Hiperwall (Highly Interactive Parallelized Display Wall). The 16 ft x 4.5 ft Hiperwall visualization system has a total resolution of 16.5 Megapixels (MP) which consists of eight display-tiles that are arranged in a 4 x 2 tile configuration. Using Hiperwall, we can perform interactive visual data analytics of large images by conducting comparative views of multiple large images in Astronomy and multiple event displays in experimental High Energy Physics. Users can display a single large image across all the display-tiles, or view many different images simultaneously on multiple display-tiles. Hiperwall enables simultaneous visualization of multiple high resolution images and its contents on the entire display wall without loss of clarity and resolution. Hiperwall's middleware also allows researchers in geographically diverse locations to collaborate on large scientific experiments. In this paper we will provide a description of a new generation of display wall setup at Bellarmine University that is based on the Hiperwall technology, which is a robust visualization system for Big Data research.

IA06: 3:50-4 p.m. Research on Chinese College Students' Learning Attitudes to Physics Experiments

Contributed – Yunlin Chen East China Normal University Shanghai, China

Physics experiments, as the core section of the physics education, have already become the main contents of the higher education. And students' attitudes to physics experiments play a significant role in physics teaching and learning. So this research focuses on the learning attitudes of Chinese college students towards physics experiments. The research objects are college students who major in physics in East China Normal University in Shanghai, China. And the measurement tool is the Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). The original E-CLASS was translated into Mandarin through a rigorous process. We found that students' learning attitudes to physics experiments were ordinary in general and they varied from different grades and genders.

IA07: 4-4:10 p.m. The Research on Students' Preconceptions about Rigid Body Rotation

Contributed – Candice Bian, East China Normal University, Shanghai, China

The study is about the students' preconceptions in the process of learning the concepts of rigid body rotation. The sample of the study consists of 30 students who had not learned the concepts of rigid body rotation at the east of china normal university. we deeply understand the students' thinking about the problem of rigid body rotation through the Think-aloud interviews, and discover the students' preconceptions in the process of learning the concepts of rigid body rotation. We find that student always think mass will affect the rolling motion. They often cannot know whether objects can be regarded as the point or not.

IA08: 4:10-4:20 p.m. A Low Cost XRF Lab For Undergraduate And High School Students*

Contributed – Daniel K. Marble, Tarleton State University, Stephenville, TX

Chris B. Marble, Kassie S. Marble, Texas A&M University

Brian Salge, Stephenville High School

A lab on X-ray Fluorescence (XRF) in an undergraduate physics curriculum can be extremely beneficial. The lab reinforces the physics (emission of specific energy photons from a bound system) concepts from optical and gamma ray spectroscopy labs. Furthermore, the lab provides the students with an introduction to a powerful analyt-

ical technique that can non-destructively analyze samples from soils to semiconductors. XRF is usually performed using either high activity sources requiring a radiation materials license combined with an expensive x-ray detector or using a dedicated XRF system constructed using an x-ray machine. Since most smaller undergraduate institutions lack these expensive resources, XRF labs are often not performed. This talk will show how to perform an XRF lab without these expensive resources using just an exempt gamma source, a small NaI detector based counting system already available at many of these institutions and a judicious choice of unknown samples. A discussion of our use of the lab in our high school summer physics camp will also be presented.

*Funding provided by the Nuclear Power Institute and the Texas Work Force Commission

IA09: 4:20-4:30 p.m. Anatomy of a Question: Lessons on Collaboration from Making Exams

Contributed – Jared R. Stenson, Rice University, Houston, TX

On a recent exam to a calculus-based introductory physics class for pre-med students 3 faculty agreed to give a rather standard question. Afterwards they dissected it to find that there is much going on in the question, in their collaboration, and in how they view the purpose of their teaching. This is their story.

IA10: 4:30-4:40 p.m. A Comparative Study on Performance and Conceptual Understanding in Physics Introductory Courses between U.S. and Pakistani Undergraduate Students

Contributed – Muhammad Riaz, Karakorum International University, West Chester, PA

Manzoor Ali, Syed Agha Hadi, Sadat Rahim, Karakorum International University Gilgit

Introductory physics courses act to serve as a gatekeeper function for careers in physics and engineering fields. Students must perform well in order to continue their careers in these fields. This study investigated students' performance and conceptual understating in introductory physics courses between U.S. and Pakistani physics undergraduate students. A comparative study was conducted during the years 2017 and 2018. The data collection was performed in U.S. during spring semester 2017 at private scientific and technical university, at Melbourne, Florida. Whereas, the data collection in Pakistan was performed during spring and fall semester 2018 at Karakorum International University (KIU), Gilgit. Moreover, within the context of this study, students' conceptual understanding is measured as the students' scores on Force Concept Inventory (FCI) and student's performance was measured by Mechanics Baseline Test (MBT). Objective The purpose of this study is to determine the relationship between two different populations: U.S. vs. Pakistani undergraduate physics students, on conceptual understanding and performance as measured by FCI and MBT in Physics. Method A quasi-experimental study design was used to conduct a comparative study between two different groups of undergraduate students belong from different regions of U.S. and Pakistan. I used convenient samples of introductory physics and physics lab sections selected from the accessible population. The accessible population for the US undergraduate students was all students' who registered for Physics Lab-1 in Spring 2017. The accessible population for Pakistani undergraduate students was all students' who registered for Mechanics and physics Lab 2/4 in spring and fall 2018.

Session IB: Post-deadline Abstracts II

Location: Sage Room **Sponsor:** AAPT **Time:** 3–4:30 p.m. **Date:** Tuesday, Jan. 15 **Presider:** TBA

IB01: 3-3:10 p.m. Designing a Dark Matter Particle Detector

Contributed – Lionel D. Hewett, Texas A&M University-Kingsville, Kingsville, TX

A few years, ago the decay of dark matter was apparently observed to occur in the halos of several distant galaxies. More recently, the fluorescence of dark matter was apparently observed in the vicinity of at least one active galactic nucleus. By duplicating these conditions in the laboratory one can hope to observe individual dark matter particles and confirm some of their properties as predicted by various theoretical models. This talk presents several dark matter particle detector designs (based upon one or more of the conditions where dark matter apparently has already been detected in deep space) and discusses what we could reasonably expect to observe by using each of these designs.

IB02: 3:10-3:20 p.m. Gram It! Using Images and Video Clips to Engage Students

Contributed – Walter Thompson University of Houston-Clear Lake, Houston, TX

Most algebra-based physics students are in the course for one reason--it is a requirement for their degree plan. That means that as instructors we have an obligation to create a sense of excitement for the subject matter. One way to do this is by deploying the same social media tools that students already use for communication, information gathering, and entertainment. I will present examples of how you can use images and short video clips from Vine, Instagram, and YouTube to increase student engagement and demonstrate how physics applies to almost everything around us.

IB03: 3:20-3:30 p.m. Certification or Undergraduate Major: A Search for Efficacious Physics Teacher

Contributed – Philomena N Agu, University of Houston, Richmond, TX

Texas verifies subject content knowledge of science teachers in public schools by certification examination. The physics teachers with undergraduate degree major in most academic fields obtain certification by either subject-specific or composite science test which contains 20 percent physics contents. The composite teachers may have little academic preparation in physics. Their sense of efficacy may be impacted. Studies have used personal efficacy and outcome expectancy subscales in Science Teaching Efficacy Belief Instrument (STEBI) to measure teacher effectiveness. Few scales exist specifically for physics teachers. Hence, STEBI was adapted. This study assessed the psychometric properties of modified STEBI using data from 510 in-service physics teachers. The validity was examined using Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA), and the reliability established with Cronbach's alpha. The PCA supported the validity. The subscales were reliable; alpha was .84 and .75. STEBI could be adapted to study efficacy beliefs of physics teachers.

IB04: 3:30-3:40 p.m. Teaching the Next Gen PET Curriculum at a Small Liberal Arts College.

Contributed – Deepshikha Shukla, Rockford University, Rockford, IL

I will talk about the implementation of the Next Gen PET curriculum at Rockford University, a small Liberal Arts college in Northern Illinois. The class was taught studio-style with only laboratory credits and with an integrated community-based learning component. I will present feedback from students and colleagues from the Education department and discuss plans to further improve the delivery of the course.

IB05: 3:40-3:50 p.m. A Novel System for Teaching Lab on Vacuum Physics

Contributed – Yongkang Le, Fudan University, Shanghai, Shanghai

Vacuum physics and related technique is very important topics for graduate students in physics. Unfortunately, we don't have enough teaching labs in this area. Here, we report on a novel system for teaching lab on vacuum physics. The apparatus consists mainly of two spherical chambers connected with specially designed flanges. The connection design enables installation of different vacuum components. On this new system, the following teaching labs can be carried out: 1) Calibration of different vacuum gauges; 2) Flow conductance measurement of different tubes in vacuum.

IB06: 3:50-4 p.m. Comparative Analysis of a Redesigned Upper-Division Physics Lab.

Contributed – Charles L. Ramey II, Texas Tech University, Physics & Astronomy Dept., Lubbock, TX

Beth Thacker, Texas Tech University

Dimitri R. Dounas-Frazer, University of Colorado Boulder

Communication is an important skill in all fields of STEAM, including physics lab courses. At Texas Tech University, we have recently redesigned the Modern Physics Lab to develop students' written communication competence, among other goals. To support students' writing skills, we implemented the activity Letters Home in the lab, and conducted a case study of 6 students to characterize the impact of a transformed laboratory. We used the AAPT guidelines to inform our development of an a priori coding scheme with 8 unique categories that highlight learning outcomes. We also used a linguistic software called LIWC to assess the data's language variables. From our analysis, we found the coding scheme characterizes the dimensions of scientific communication that is suggest by AAPT, and that there are structural and content similarities between the letters and lab reports.

IB08: 4:10-4:20 p.m. Flipping Introductory Physics: Impact of Feedback Quizzes and Student-generated Videos

Contributed – Roberto Ramos, University of the Sciences, Sewell, NJ

I present the results of flipping multiple Introductory physics classes in a university setting, focusing on the impact of employing of post-video, feedback quizzes and student projects consisting of student-generated teaching videos. The classes included algebra- and calculus-based introductory physics. Outside class, students viewed over 100 online video lectures on introductory physics prepared by the instructor. Inside the class, students solved and discussed problems and conceptual issues in greater detail and utilized tutorial worksheets. A pre-class online quiz was deployed as an important source of feedback and validating student understanding. As part of their grades, students were required to produce teaching videos graded on the basis of correctness, creativity, and delivery. I will report on the student reactions to the feedback mechanism, student responses using data based on anonymous surveys, as well as on learning gains from pre-/post- physics diagnostic tests.

IB09: 4:20-4:30 p.m. Shifting Introductory Physics Labs from Lecture Support to Scientific Reasoning

Contributed – Roger A. Key, California State University, Fresno, Department of Physics, Fresno, CA

John R Walkup, Stephan Squire, Patrick Talbot, California State University, Fresno, Department of Physics

Physics departments have long entrusted physics labs to reinforce lectures, but research indicates that the traditional lab is ill-suited for this purpose. The question then arises: Can the physics lab be re-purposed to target other learning objectives? Recently, we have shifted the focus of introductory calculus-based labs toward professional science and engineering practices. Drawing from the ?eld of industrial manufacturing, we developed lab activities that elevated statistical analysis as a decision-making tool. To span a full semester, we incorporated a new lab model developed at the University of Cincinnati that focused on scientific reasoning. We are currently conducting a controlled study of this new lab curriculum involving over 100 Fresno State students. The following research questions guides the project design: (1) Does the new curriculum design promote scientific reasoning and statistical analysis? (2) Does shifting from concept-based labs diminish student performance on lecture content?

TEACHING PHYSICS?

"AAPT has been incredibly beneficial to my career. I cannot emphasize enough just how much I have learned and continue to learn from my peers. That knowledge made me an invaluable member in my department at Syracuse. Ultimately too, my students reap huge benefits from my activities in AAPT."

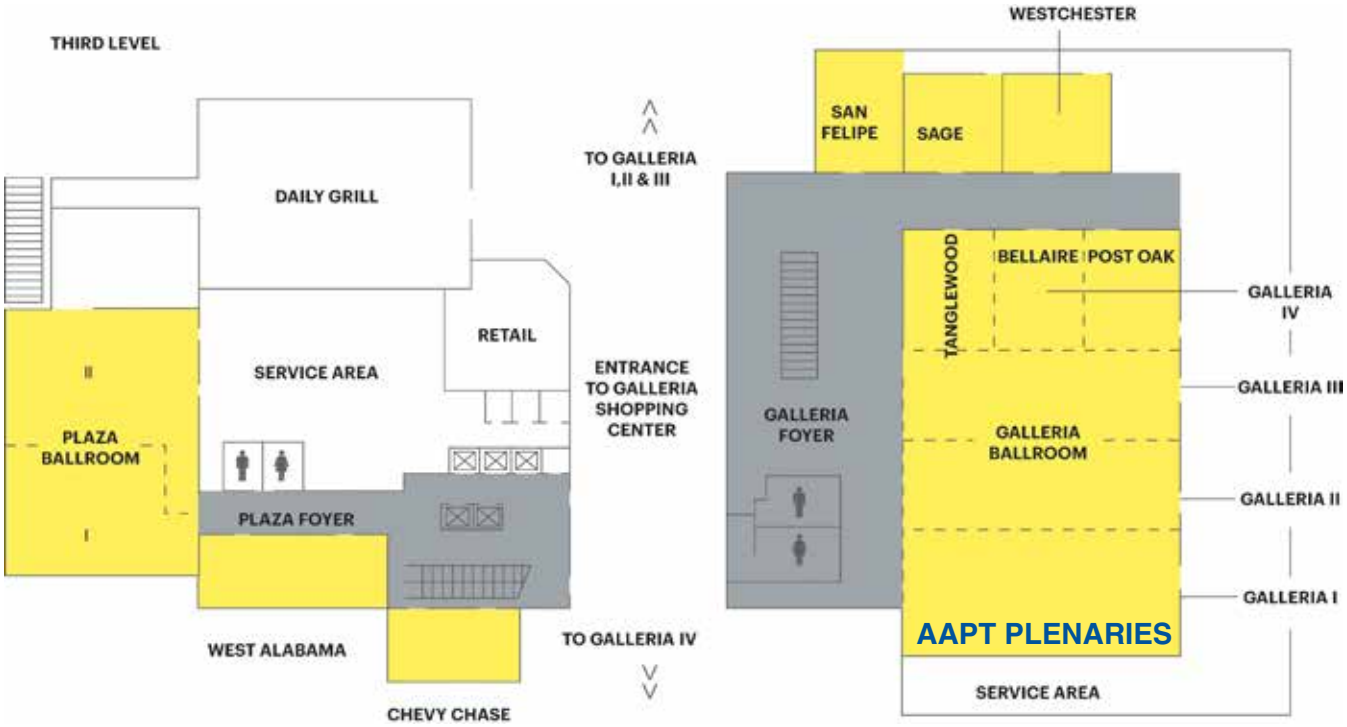
SAM SAMPERE
Instructional Lab Manager
Syracuse University

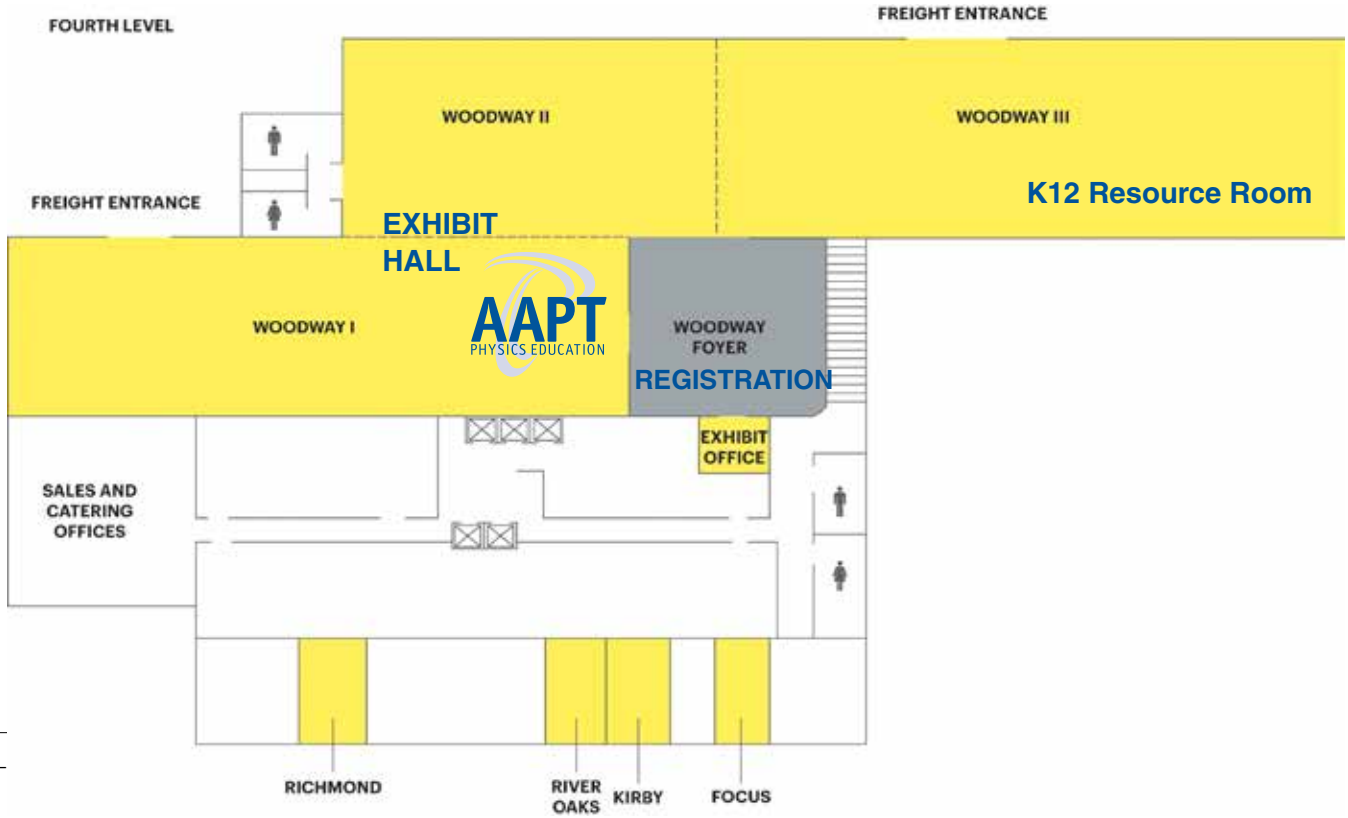
AAPT
PHYSICS EDUCATION

DON'T DO IT ALONE.

Join today at aapt.org.

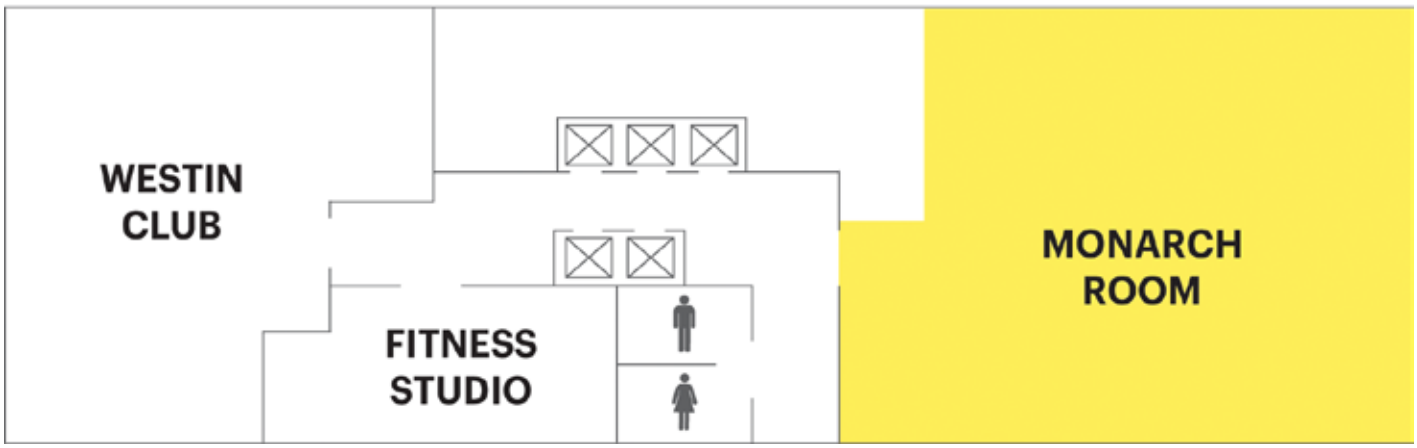
Westin Galleria Hotel Maps



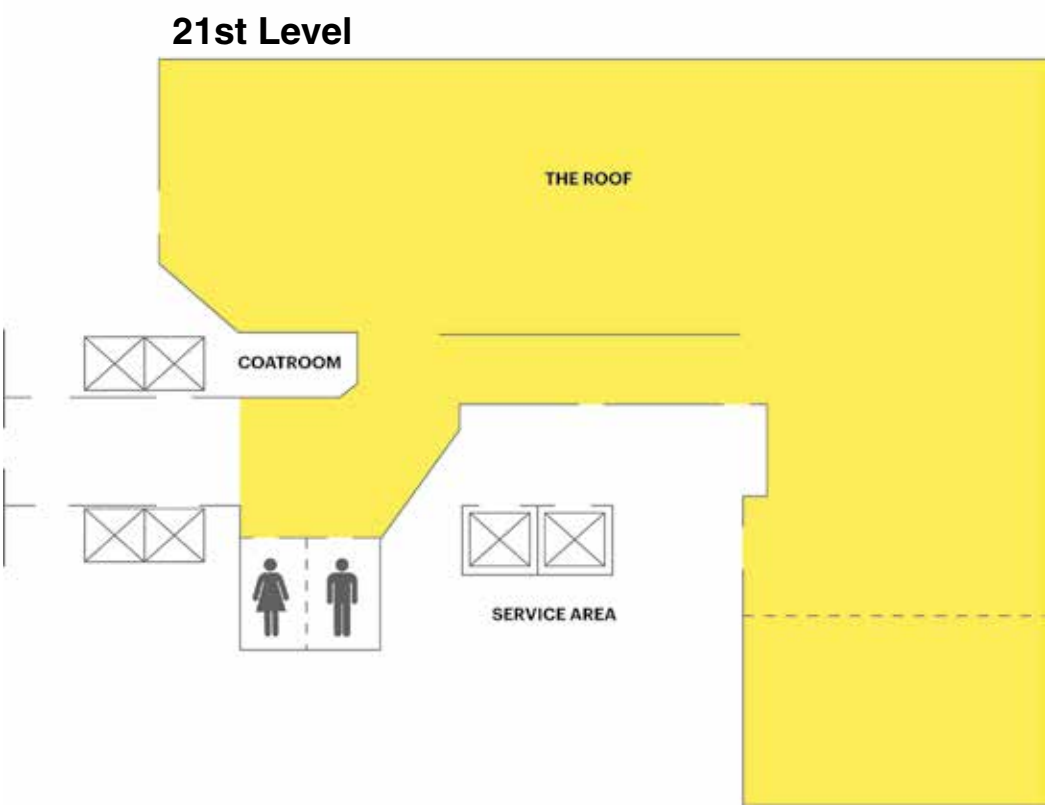


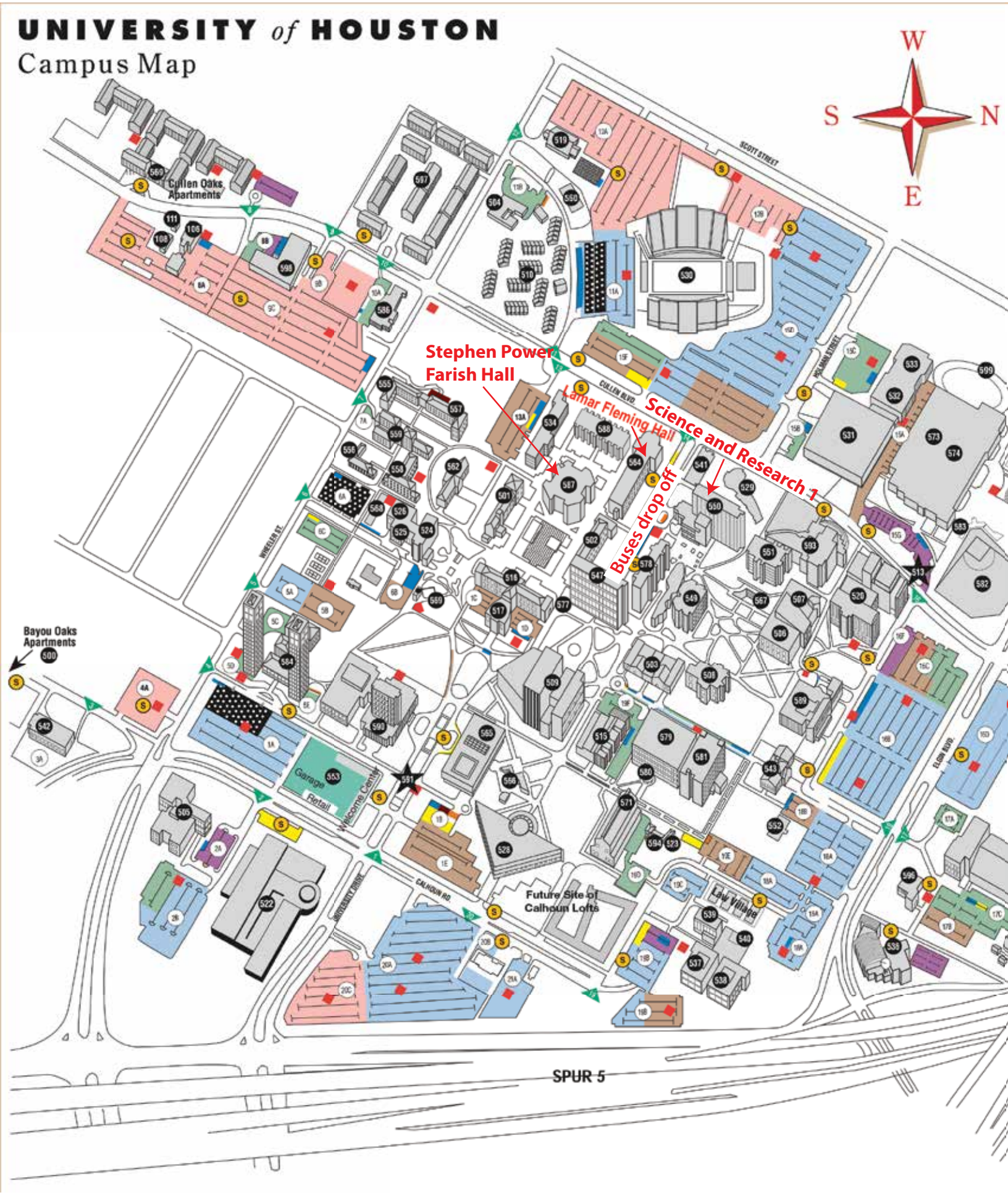
Westin Galleria Hotel Maps

TWENTY FOURTH LEVEL



Westin Oaks Hotel Maps




UNIVERSITY of HOUSTON
Campus Map
W
S
N
E
Stephen Power
Farish Hall
Lamar Fleming Hall
Science and Research 1
Buses drop off
Cullen Oaks
Apartments
Bayou Oaks
Apartments
Garage
Retail
Welcome Center
Future Site of
Calhoun Lofts
Law Village
SPUR 5
SCOTT STREET
CULLEN BLVD
WHEELER ST.
CALHOUN RD.
ELGIN BLVD.

Restaurants Near UH Campus

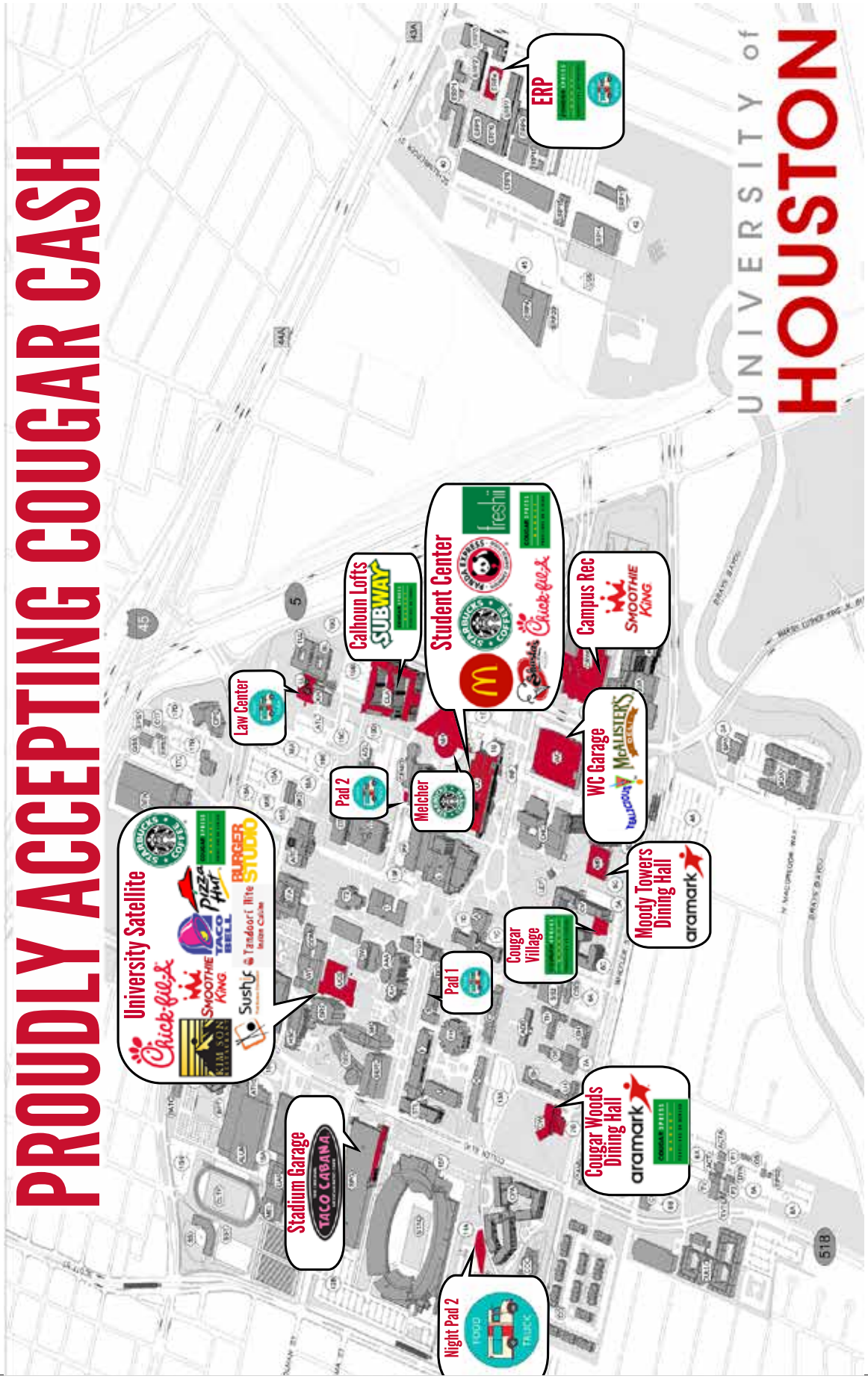
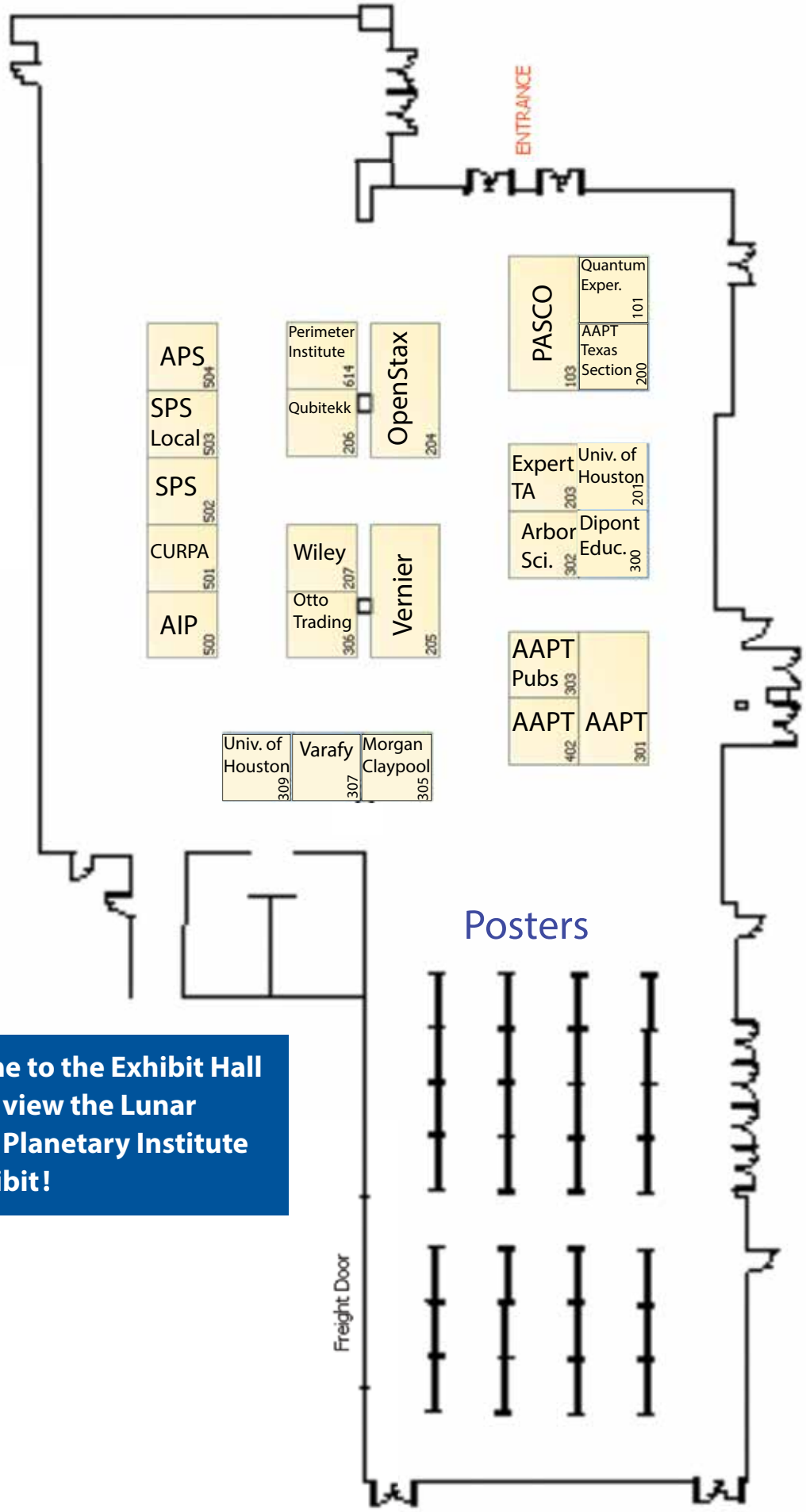


EXHIBIT HALL
WOODWAY I & II



Come to the Exhibit Hall and view the Lunar and Planetary Institute Exhibit!