2020 AAPT WINTER MEETING

Orlando Florida

AAPT
PHYSICS EDUCATION

2020 AAPT Winter Meeting

Orlando, Florida
January 18–21, 2020

American Association of Physics Teachers®

One Physics Ellipse
College Park, MD 2040
www.aapt.org
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Special Thanks

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

Rollins College Workshop Organizers:

Anne Murdaugh and Samantha Fonesca of the Physics Department.

Paper sorters:

Larry Cook
Jose Kozminksi
Duane Merrill
Mary Winn
Elaine Gwinn
Janie Head
Ann Robertson
Nancy Easterly
Randy Peterson
Stacey Gwartney
Nina Daye
Gen Long
David Cook
Charles Winrich
Karen Jo Matsler
Tommie Holsenbeck
Kelly O Shea

Orlando Attractions

Buses will depart on the hour and run a continuous loop from the hotel to attractions from 6:30 pm–11:30 pm, with final pickup at 11 pm from venue.

Bus location: Convention Center Porte-Cochere

- **Universal City Walk** on Monday, January 20, 6:30 pm–11:30 pm (last pickup at Universal City Walk back to hotel will be at 11:00 pm)
- **Disney Springs** on Tuesday, January 21, 6:30 pm–11:30 pm (last pickup at Disney Springs back to hotel will be at 11:00 pm)

Wireless for Meeting area and Exhibit Hall:

Network: aapt
Password: aaptwm20

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Facebook/Twitter at Meeting

We will be posting updates to Facebook and Twitter prior to and during the meeting to keep you in the know! Participate in the conversation on Twitter by following us at **twitter.com/AAPTHQ** or search the hashtag **#aaptwm20**. 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

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Download steps:

- Download the CrowdCompass AttendeeHub from your Apple "App" store or Android "Play" store.
- Once the app is downloaded, search for AAPT.
- Password: aapt2020

Event URL: https://crowd.cc/wm20

App URL: https://crowd.cc/s/3EZli

David Sokoloff

"If Opportunity Doesn't Knock, Build a Door - My Path to Active Dissemination of Active Learning "

Tuesday, January 21
10:30 a.m.–12:30 p.m.
Grand Sierra E

2020 Oersted Medal Awarded to David Sokoloff

David Sokoloff has been named as the 2020 recipient of the prestigious Hans Christian Oersted Medal, presented by the American Association of Physics Teachers (AAPT). The Medal will be awarded at a Ceremonial Session of the 2020 AAPT Winter Meeting, in Orlando, Florida. The Oersted Medal recognizes his outstanding, widespread, and lasting impact on the teaching of physics through his contributions to the development of active learning strategies and materials to motivate students—especially those using computer-based tools—and his extensive dissemination activities. In connection with the award, Sokoloff will deliver a talk, "If Opportunity Doesn't Knock, Build a Door: My Path to Active Dissemination of Active Learning," at the Orlando meeting.

Sokoloff is Professor of Physics, Emeritus at the University of Oregon. He earned his B.A. at Queens College of the City University of New York and his Ph.D. in AMO Physics at the Massachusetts Institute of Technology. For over three decades, he has studied students' conceptual understandings, and developed active learning approaches (with NSF and FIPSE support). These include Interactive Lecture Demonstrations (ILDs) and the four modules of RealTime Physics: Active Learning Laboratories (RTP), both published by Wiley and co-authored by Priscilla Laws and Ronald Thornton. His work has been published in the American Journal of Physics, the European Journal of Physics, Physical Review, Physics Education Research and The Physics Teacher. He has conducted numerous international and national workshops to disseminate these active learning approaches to secondary and university faculty. Since 2004, he has been a member of the UNESCO Active Learning in Optics and Photonics (ALOP) team, presenting workshops in more than 30 developing countries in Africa, Asia and Latin America. He is contributor to and editor of the ALOP Training Manual. The ALOP Team was awarded the 2011 SPIE Educator Award. He was awarded the American Physical Society (APS) 2010 Excellence in Physics Education Award (with Priscilla Laws and Ronald Thornton) and the American Association of Physics Teachers (AAPT) 2007 Robert A. Millikan Medal. He has been a Fulbright Specialist in Argentina (2011) and Japan (2018), is currently a member of IUPAP Commission 14 (International Commission on Physics Education), and has served in AAPT's Presidential Chain (2009-2012).

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.

Richard W. Peterson

"Changed . . . by a high and humbling calling"

Tuesday, January 21
10:30 a.m.–12:30 p.m.
Grand Sierra E

2020 Melba Newell Phillips Medal Awarded to Richard W. Peterson

The 2020 Melba Newell Phillips Medal will be awarded to Richard Peterson, University Professor of Physics – Emeritus, Bethel University, St. Paul, Minnesota. Peterson has brought to AAPT's executive level leadership a passion for experimental physics and its impact on the lives of students in high school, introductory and advanced laboratories. Following work with the AAPT Apparatus Committee (starting in 1976), he was NSF Principal Investigator for AAPT's Lab Focus-'93 that sought to reinvigorate all physics teaching lab experiences. Later he helped form the AAPT Laboratories Committee with its emphasis on encouraging more effective physics laboratories. While an AAPT leader, he worked with others in the formation of ALPhA (Advanced Laboratory Physics Association) as a charter ALPhA Board member - helping organize the first ALPhA national conference (2009) at the University of Michigan. He received the American Physical Society's (APS) prize for outstanding research at an undergraduate school and was elected an APS Fellow in 2005. He was recognized with the Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction in 2017.He served six years on the AAPT Executive Board as Secretary and four years (2003-2007) within the Presidential track - followed by three years as the first AAPT Meetings Committee Chair. His many years of dedicated and creative leadership have had a lasting impact on AAPT, how we do advanced labs as physics faculty, and on the lives of countless students.

He was an undergraduate at the U. of Wisconsin - River Falls, with a Ph.D. in physics earned at Michigan State - followed by postdoctoral positions in the Physics Division at Los Alamos. His formative decade in physics teaching was at Western Illinois U., with the last 40 years at Bethel U. In 2006 he was appointed the first University Professor at Bethel University for his research, teaching, and physics community service. He served in a 2010-2012 appointment as a Program Director within NSF's Division of Undergraduate Education (DUE) in Arlington, VA. In 2010 the Optical Society of America (OSA) recognized him as a Senior Member for work in optics, and he has served as a Traveling Lecturer for the OSA. He especially enjoys the development of new apparatus for interactive physics demonstrations and laboratories and has widely shared these demonstrations. His presentations on lecture demonstrations, advanced laboratories, and undergraduate research include those in S. Korea, N. Korea, China, Latvia, and Kenya.

On being recognized with this award, Peterson said: "My professional life has been made possible by physics teaching. This includes all those teachers who have sacrificially believed in me, and also the ways my life has been transformed by the joys and challenges of my own teaching efforts.

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.

Sylvester James Gates, Brown University

S. James Gates

Monday, January 20
10:15–11:15 a.m.
Grand Sierra E

Book Signing
AAPT Booth
11:15–11:45 a.m.

Sylvester James "Jim" Gates, Jr., (born December 15, 1950) is an American theoretical physicist. He received two BS degrees and a PhD degree from the Massachusetts Institute of Technology, the latter in 1977. His doctoral thesis was the first one at MIT to deal with supersymmetry. In 2017, Gates retired from the University of Maryland, and is currently the Brown Theoretical Physics Center Director, Ford Foundation Professor of Physics, an Affiliate Mathematics Professor, and a Faculty Fellow, Watson Institute for International Studies & Public Affairs at Brown University. While at the University of Maryland, College Park, Gates was a University System Regents Professor, the John S. Toll Professor of Physics, the Director of the String and Particle Theory Center, and Affiliate Professor of Mathematics. Gates served on the U.S. President's Council of Advisors on Science and Technology, contemporaneously on the Maryland State Board of Education from 2009-2016, and the National Commission on Forensic Science from 2013-2016. He is known for his work on supersymmetry, supergravity, and superstring theory. In 1984, working with M.T. Grisaru, M. Rocek, W. Siegel, Gates co-authored Superspace, the first comprehensive book on the topic of supersymmetry. In 2017, working with Frank Blitzer and Stephen Jacob Sekula, he co-authored *Reality in the Shadows (Or) What the Heck's the Higgs*? In 2019, together with Cathie Pelletier, he co-authored *Proving Einstein Right: The Daring Expeditions that Changed How We Look at the Universe.*In 2006, he completed a DVD series titled Superstring Theory: The DNA of Reality for The Teaching Company composed of 24 half-hour lectures to make the complexities of unification theory comprehensible to non-physicists. In 2012, he was named a University System of Maryland Regents Professor, only the sixth person so recognized in the system's history. He is a past president of the National Society of Black Physicists, and is a NSBP Fellow, as well as a Fellow of the American Physical Society, the American Association for the Advancement of Science, and the Institute of Physics in the U.K.

Jonathan Smith, Corporate Director, SeaWorld Parks & Entertainment

Jonathan Smith

Sunday, January 19
6:45–7:45 p.m.
Grand Sierra E

Jonathan provides oversight and direction throughout all phases of selection, design development, engineering procurement, installation, commissioning and on-going operation of amusement rides and devices for the 12 SeaWorld Parks. His most recent projects include Iron Gwazi at Busch Gardens Tampa Bay, Ice Breaker at SeaWorld Orlando, Emperor at SeaWorld San Diego, Texas Stingray at SeaWorld San Antonio, and Pantheon at Busch Gardens Williamsburg, all debuting in 2020. Notable recent projects include Oscar's Wacky Taxi at Sesame Place and Infinity Falls at SeaWorld Orlando.

Jonathan started his career with SeaWorld Parks in 2012 as a project manager in the design and engineering department at Busch Gardens Williamsburg and Water Country, USA where he played key roles working on projects and attractions such as Verbolten, Tempesto and InvadR.

Jonathan is a registered Professional Engineer and LEED Accredited Professional and holds a bachelor's degree in Mechanical Engineering at the Ohio State University.

2020 AIP Science Writing Award

Raman Prinja

Tuesday, January 21
10:30 a.m.-12:30 p.m.
Grand Sierra E

Raman Prinja won the 2019 AIP Science Communication Award in the Writing for Children category for his *Planetarium*, published by Bonnier Books in the U.K. and Big Picture Press in the U.S. He is a professor of astrophysics and head of department at University College London, and his research has focused on the evolution and properties of the most massive stars in the galaxy and their progression into supernovae. Prinja has been awarded the Pol and Christiane Swings research prize as well as UCL faculty and department teaching awards. When he's not teaching and researching, Prinja is an active public speaker and regularly presents lectures to a wide audience range. He has made it his personal goal to bring the subject of astronomy to more diverse audiences, including children, and has written over 20 successful outreach-level science books.

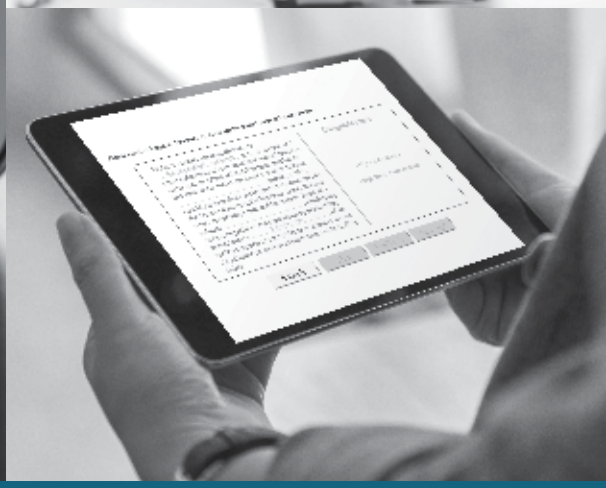
Prinja will be signing his books immediately following the session.

AAPT Fellowship Awards: Dan Burns, Jose D'Arruda

Developments in the International System of Units (SI) **January 19 4–6:30 p.m. Grand Sierra A**

Peter J. Mohr, National Institute of Standards and Technology, Gaithersburg, MD 20899-8420, USA

The recent change in the International System of Units (SI) and prospects for future changes will be briefly reviewed. The recent change was the redefinition of units in the SI, so they are now based on values of constants of nature. A possible future change concerns the role of angles as units in the SI. Angles are currently viewed as dimensionless derived quantities with units that are optional or omitted in most cases. The possibility that angles be given the role of independent quantities with associated units has been a subject under consideration for some time. The pros and cons of such a change will be addressed. Most of the time for this event will be open to discussion concerning either of the above topics, with opinions on all aspects being welcome.



GREATER COMPREHENSION.

Lunch & Learn
Hibiscus Room
12 PM–1 PM
Sunday 1/19/20

Expert TA's problem library offers an abundance of multi-step questions, including symbolic parts and automatically graded Free Body Diagram drawings, to help reinforce the problem-solving process to students. Based on a six-year data-mining initiative, students also receive specific and meaningful feedback for their incorrect answers. We understand that no matter how great the material is, the experience isn't meaningful if students are cheating. Because of this, we have made academic integrity a core consideration for all the tools we build.

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Booth 101

http://theexpertta.com | main@theexpertta.com

Committee Meetings at Winter Meeting

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

Friday, January 17

New Board of Directors Orientation	5:30–7:30 p.m.	Antigua 1-2
Finance Committee	7:30–8:30 p.m.	Antigua 1-2

Saturday, January 18

Meetings Committee	8–9:30 a.m.	Antigua 3
Publications Committee	8–9:30 a.m.	Antigua 4
Board of Directors I	10 a.m.–4:30 p.m.	Antigua 1-2
Resource Letters Committee	11:30 a.m.–2:30 p.m.	Antigua 3
Nominating Committee I	2:30–4:30 p.m.	Antigua 4
Section Representatives and Officers	4:30–5:30 p.m.	Bonaire 4
New Chairs Orientation	5:30–6:30 p.m.	Bonaire 1
ALPhA Open Meeting *	6–7 p.m.	Bonaire 2
Programs and Planning I	6:30–8 p.m.	Bonaire 1

Sunday, January 19

Review Board	7–8 a.m.	Curacao 3
Executive Programs Committee	8–9 a.m.	Curacao 4
Governance Structure Committee	8–9 a.m.	Curacao 6
Membership and Benefits Committee	9–10 a.m.	Curacao 3
Physics in High Schools Committee *	10–11:30 a.m.	Grand Sierra F
Apparatus Committee *	10–11:30 a.m.	Grand Sierra G
Physics in Undergraduate Education *	10–11:30 a.m.	Grand Sierra H
Contemporary Physics Committee *	10–11:30 a.m.	Grand Sierra I
Diversity in Physics Committee *	10–11:30 a.m.	Grand Sierra C
Professional Concerns Committee *	10–11:30 a.m.	Bonaire 3-4
Venture Fund Review Committee	5:30–6:30 p.m.	Curacao 4

Monday, January 20

PTRA Oversight Committee	7–8:30 a.m.	Grand Sierra C
Laboratories Committee	7–8:30 a.m.	Bonaire 8
International Physics Education Committee *	7–8:30 a.m.	Antigua 1-2
Investment Advisory Committee	7–8:30 a.m.	Presidential Suite
Research in Physics Education Committee	7–8:30 a.m.	Antigua 3-4
Physics Bowl Advisory Committee	7:30–8:30 a.m.	Grand Sierra F
Physics in Pre-High School Education *	8:30–10 a.m.	Curacao 5
Teacher Preparation Committee *	8:30–10 a.m.	Curacao 6
Women in Physics Committee *	8:30–10 a.m.	Bonaire 1-2
Interests of Senior Physicists Committee *	8:30–10 a.m.	Grand Sierra G
Graduate Education in Physics *	5–6:30 p.m.	Curacao 3-4
Educational Technologies Committee *	5–6:30 p.m.	Bonaire 7
History & Philosophy of Physics *	5–6:30 p.m.	Antigua 1-2
Physics in Two-Year Colleges Committee *	5–6:30 p.m.	Antigua 3-4
PERLOC *	5–6:30 p.m.	Curacao 6
Science Education for the Public *	5–6:30 p.m.	Bonaire 5-6
Space Science and Astronomy Committee *	5–6:30 p.m.	Curacao 5
Awards Committee	7–8:30 p.m.	Grand Sierra A

Tuesday, January 21

Programs and Planning II	7–8:30 a.m.	Curacao 3-4
PERTG Town Hall	7:30–8:30 a.m.	Grand Sierra E
Paper Sort Summer 20 Meeting	2:30–3 p.m.	Bonaire 5-6
Board of Directors II	3–5 p.m.	Antigua 1-2

Commercial Workshops at 2020 AAPT Winter Meeting

CW01 Expert TA

• Location: Hibiscus • Time: 12-1 p.m. • Date: Sunday, January 19 • Sponsor: Expert TA

Leader: Jeremy Morton

We all want the same thing. We want well-crafted materials students can learn from, engaging exercises that help them master the concepts, and we want them doing the work themselves rather than looking up answers online. Expert TA was founded as an online homework company, and for the past seven years has been trusted and used departmentally at hundreds of major universities. Expert TA has now developed learning resources such as a physics video series comprehensive enough to be used as lecture replacements for the flipped-classroom. To supplement our own learning materials, Expert TA works with select University and Institutional partners like OpenStax to develop a diverse collection of custom educational resources that can be leveraged directly from within the Expert TA system. After students review these learning resources, they gain ownership of concepts by working problems themselves. Our independent library is designed to reinforce the problem-solving process. It includes an abundance of multi-step questions that involve symbolic answers, as well as engaging question types like our interactive Free Body Diagrams. Based on a six-year data-mining initiative, students receive specific and meaningful feedback for their incorrect answers as they work. We understand that no matter how great your educational exercises are, they aren't meaningful if students are cheating. Because of this, we have made academic integrity a core consideration for all of the tools we develop. Join us for lunch to learn more.

CW02 CogBooks – Personalizing Introductory Physics Instruction with Machine Learning s

• Location: Bonaire 1-2 • Time: 12.-1 p.m. • Date: Sunday, January 19 • Sponsor: CogBooks

Leaders: Priya Jamkhedkar, Nic Rebne

Physics faculty at Portland State University in partnership with CogBooks have developed introductory physics courses that improve student learning outcomes while decreasing the amount of students who drop or fail. Please join us for a discussion on adaptive learning and improved outcomes in introductory physics courses. The CogBooks courseware is built using dynamic content with engaging and interactive assessment items. The CogBooks adaptive learning platform leverages the power of machine learning to personalize the support for individual students making their study more effective and efficient. Faculty receive automatic grade transfers into their LMS grade book as well as key insights from CogBooks dashboards to better understand student progress and performance. These courses are available for adoption as is or can be modified and tailored to meet your course sequence. Come see why CogBooks adaptive learning is miles beyond the static textbook and homework solution.

CW03 PASCO scientific: Advanced Circuits Made Easy: Modular Circuits

• Location: Curacao 3-4 • Time: 11:30 a.m.-12:30 p.m. • Date: Monday, January 20 • Sponsor: PASCO scientific

Leaders: J J Plank, Dan Burns

PASCO's new Advanced Expansion Kit and new wireless AC/DC function generator module combine to complement the existing Modular Circuits Kit so that students can now explore more complex circuits without tangled wires! In this workshop we will use the new wireless AC/DC module and expansion kit to build and analyze RC and LRC circuits. We'll also build and explore a simple transistor amplifier circuit to detect and analyze the infrared signals from a remote control. At the end of the workshop we will give away a complete Modular Circuits Kit including a Wireless AC/DC Module.

CW04 PASCO scientific: Advanced Optics: Computer-Based Diffraction and Interference Experiment: Advanced Optics: Computer-Based Diffraction and Interference Experiment

• Location: Curacao 3-4 • Time: 1-2 p.m. Date: Monday, January 20 • Sponsor: PASCO

Leader: Dan Burns, J J Plank

Join us in this workshop for a hands-on look at PASCO's new Wireless Diffraction System used to perform labs and lecture demonstrations on diffraction and interference. The wireless design and smooth scanning transit of the system allows students to study many interference patterns with high precision during a single lab period. In the workshop we will explore differences in interference patterns caused by changing slit width, slit separation, number of slits, and changes due to differences in laser wavelength. At the end of the workshop we will give away a Wireless Diffraction System.

CW05 PASCO scientific: Beginner to Advanced Mechanics Using PASCO's Smart Cart, Smart Fan, and Other Accessories

• Location: Curacao 3-4 • Time: 2:30-3:30 p.m. • Date: Monday, January 20 • Sponsor: PASCO

Leaders: Dan Burns, J J Plank

PASCO's award winning Wireless Smart Cart and Smart Fan Accessory enable students to investigate mechanics using real-time data collection with no strings attached! The wireless Smart Fan Accessory gives students the freedom to use constant and variable thrust in any mechanics experiment, from beginner applications to advanced. In this workshop we will explore the unique functions of the combined Smart Cart and Smart Fan Accessory while collecting force and motion data using PASCO Capstone software. We will also spend time exploring some of PASCO's other accessories for the Smart Cart such as the new Ballistic Cart Accessory, new Smart Cart Vector Display, and sense and control functionality! At the end of the workshop we will give away a Smart Cart with a Smart Fan Accessory.

CW06 Spreadsheet Lab Manual LLC (SLM)

• Location: Grand Sierra A • Time: 12:30-1:30 p.m. • Date: Monday, January 20 • Sponsor: Spreadsheet Lab Manual LLC (SLM)

Leader: Michael McConnell

Spreadsheets are widely used, versatile and programmable. Students can automate the performance of calculations with simple commands making them ideal for learning how to analyze data by building models. Compared to hand-held calculators, a spreadsheet model increases a student's computational power by many orders of magnitude. This makes learning in STEM more efficient, interactive and intuitive as students gain fluency and skills necessary to succeed in higher education and future careers. Spreadsheets have standardized layout, cell referencing and formula writing conventions, and virtually every function fundamental to data analysis uses the same language across all leading brands. Skills are in-demand and the foundation for computer and data fluency. This workshop experience engages teacher participants with SLM pedagogy for spreadsheet modeling applications that are NGSS aligned on top of adding value to the Physics curriculum. Participants will explore their choice any of the following quantitative spreadsheet models simulating (1 & 2 dimensional) freefall motion with drag force, dynamic heat transfer using Newton's Law of Cooling, and quantitative simulation of variable mass and drag rocket flight. Objective: Utilizing Microsoft Excel or Google Sheets to perform numerical modeling methods. Participants are permanently licensed for classroom use of instructional materials for their chosen topic. Bring a laptop, tablet or Chromebook that can run Excel or Sheets.

CW07: Introducing Pivot Interactives from Vernier

• Location: Curacao 6 • Time: 11:00 a.m.-12:00 p.m. • Date: Sunday, January 19 • Sponsor: Vernier Software & Technology

Leaders: Fran Poodry 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: Vernier Video Analysis on Chromebooks, Computers, and Tablets

• Location: Curacao 6 • Time: 12:00-1:00 p.m. • Date: Sunday. January 19 • Sponsor: Vernier Software & Technology

Leaders: Fran Poodry, John Gastineau

Bring your Chromebook (or use one of ours) to quickly and easily analyze videos in our new Video Analysis app for ChromeOS, macOS, Windows, iOS and Android. If you like, bring your own video on a USB flash drive. Sample videos will be provided, as well as a few items for making your own video during the workshop.

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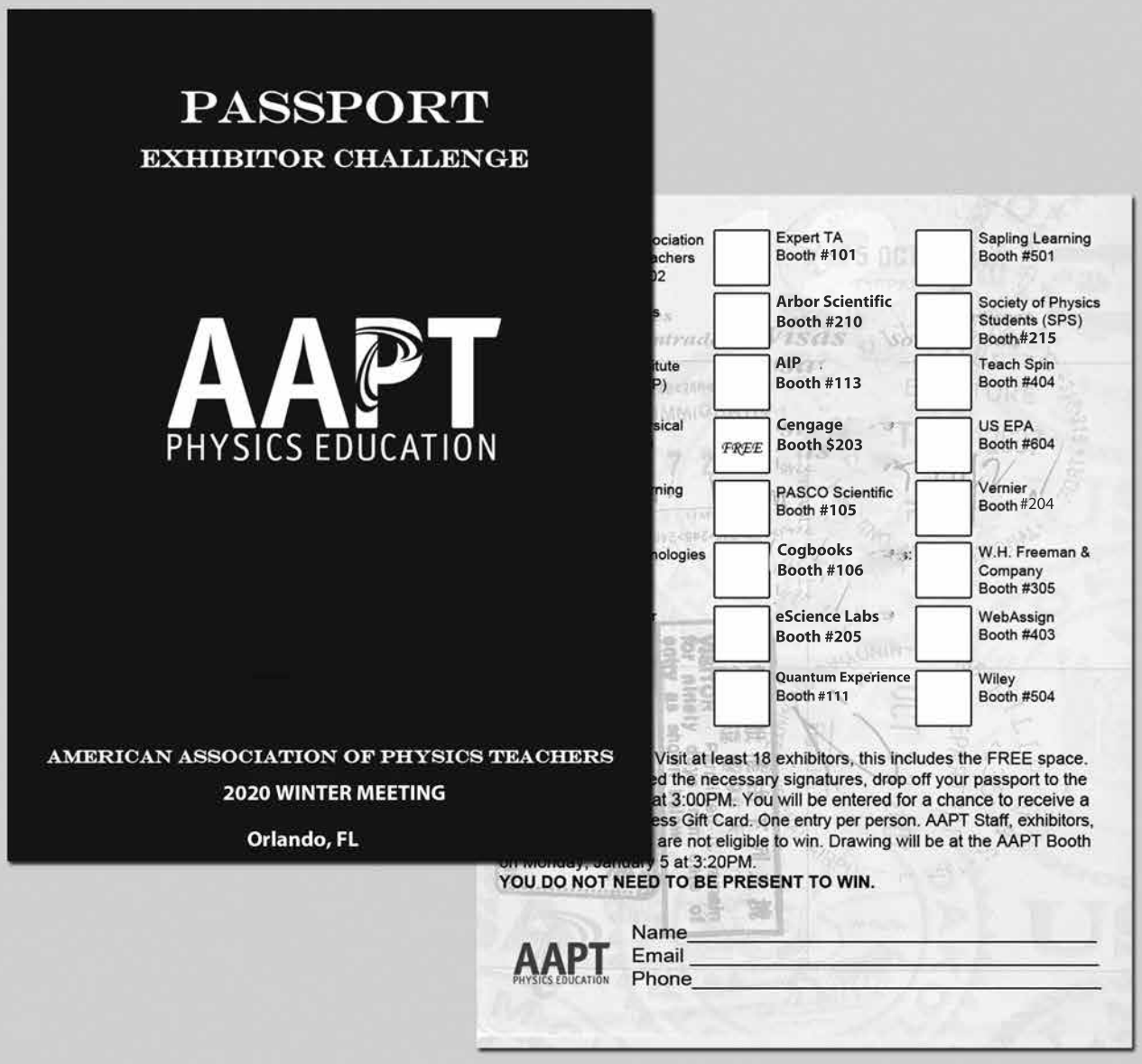

PICK UP YOUR PASSPORT TODAY!

K12 RESOURCE ROOM
Curacao 2

New digital resources from comPADRE

Topical discussions

Interactive labs & lesson plans

Sunday, Jan. 19

12:30-1:30: **Get the Facts Out**

–Drew Isola

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

1:30-3:00: **Local Teacher Gathering**

Join a discussion of innovative techniques and topical discussions from local Orlando teachers.

3:00-4:00: **Science is Elementary**

– Justine Boecker Harren

Join a discussion about the challenges and success stories for elementary educators teaching science.

4:00-5:00: **The Underrepresentation Project**

The Underrepresentation Curriculum (http://underrep.com) is a free, flexible resource designed to help physics teachers bring conversations about science and society into their classrooms.

Monday, Jan. 20

10:30-11:30: **The Question Formulation Technique**

– Matthew Bryant

Experience a mini-workshop with current Einstein Fellow Matthew Bryant on the Question Formulation Technique (QFT) and how it can get your students talking to each other, asking their own questions, and designing their own investigations.

11:30-12:30: **PTRA Information 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.

1:30-2:30: **Digikit Resources**

Come join us to look at new innovative resources from NASA and AAPT for your classroom

2:30-3:30: **Flipping the Physics Classroom**

– Vanessa Logan Wentzloff

Flipping your classroom can save time, energy and help all students succeed. But how do you do this efficiently and effec tively? Join a teacher who has been flipping for 5 years in several different settings and learn how to flip and why to flip and how to helps students at all levels, including how to flip AP classes.

3:30-4:30: **STEP UP**

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.

4:30-5:00: **Feedback Session**

Come share your thoughts in person in a discussion about how AAPT K12 programs is and can better meet your needs.

Bus schedule for workshops

Saturday, January 18

Buses departing Caribe Royale Hotel and dropping off at Rollins College

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

Buses departing Rollins College and returning to the Caribe Royale Hotel

- 12:15 p.m.
- 12:45 p.m.
- 1 p.m.
- 5:15 p.m.
- 5:30 p.m.
- 5:45 p.m.

Sunday, January 19

Buses departing Caribe Royale Hotel and dropping off at Rollins College

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

Buses departing Rollins College and returning to the Caribe Royale Hotel

- 12:20 p.m.
- 12:30 p.m.

Caribe Royale
8101 World Center Drive
Orlando, FL 32821

Rollins College
Department of Physics
1000 Holt Avenue – 2743
Winter Park, FL 32789

Sunday • 10:20 a.m. Celestron 70EQ Telescope

Sunday • 3:20 p.m. Gskyer Telescope

Exhibit Hall Raffles

Sunday and Monday

Echo Spot

Celestron PowerSeeker 70EQ Telescope

Celestron PowerSeeker 127EQ Telescope

Gskyer Telescope, 80mm AZ Space Astronomical Refractor

Nintendo Switch Lite

(Must be present to win)

Purchase tickets at Registration desk!

Monday • 11:30 a.m. Celestron 127EQ Telescope

Monday • 3:20 p.m. Nintendo Switch Lite

AAPT Exhibitors

Grand Sierra D: ***Saturday, 8-10 p.m., Sunday, 10 a.m.–5 p.m., Monday, 10 a.m.–4 p.m.***

American Association of Physics Teachers

Booth #110
One Physics Ellipse
College Park, MD 20740
301-209-3300, www.aapt.org
Welcome to Orlando! Join us at the AAPT and Journals booth where you can chat with fellow members and board members, enter raffles, and spin our prize wheel for your chance to win free prizes. This year, there will be a book signing for plenary speaker Jim Gates. There will also be interactive demos based on lesson plans created from *The Physics Teacher*, along with a variety of educational resources to support teaching.

AAPT – Publications

Booth #108
One Physics Ellipse
College Park, MD 20740, www.aapt.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.

American Institute of Physics

Booth #113
One Physics Ellipse
College Park, MD 20740
301-209-3100, www.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 Public Engagement

Booth #212
One Physics Ellipse
College Park, MD 20740
301-209-3206, www.physicscentral.org
The American Physical Society supports various projects aimed at inclusive representation and expansion of the physics community. Stop by to learn more about our efforts in diversity and inclusion, our superhero Spectra, and Physics Education Research. aps.org

Arbor Scientific

Booth #210
PO Box 2750
Ann Arbor, MI 48106
800-367-6695, www.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.

Cengage

Booth #203
www.cengage.com
Cengage is the education and technology company built for learners. The company serves the higher education, K-12, professional, library and workforce training markets worldwide. Cengage creates learning experiences that build confidence and momentum toward the future students want. The company is headquartered in Boston, MA.

Cogbooks

Booth #106
www.cogbooks.com
Our online learning minimizes the time you spend managing students and maximizes their preparedness for class, freeing you up to do more of what you do best — teach. Because it's built on our Advanced Adaptive Learning platform, CogBooks courseware is different to any you've tried before and miles ahead of your static text books. The results speak for themselves, with much greater student success and significantly lower dropout. Plug our courseware into your existing system – Blackboard, Canvas, D2L, or any other – and transport yourself to the forefront of learning. You can customize one of our readymade titles to fit your individual approach, or work with us to develop a whole new course.

eScience Labs

Booth #205
www.esciencelabs.com
eScience Labs works with over 400 institutions nationwide to provide comprehensive, tactile lab kits and engaging digital lab curriculum that allow online students to have a robust, safe lab experience without having to go to campus.

Expert TA LLC

Booth #101
www.theexpertta.com
Expert TA is an online homework and physics learning platform. Emphasizing problem-solving by allowing students to show work has always been central to Expert TA. We have an intuitive interface for students to enter symbolic expressions, a robust math engine that recognizes mathematically equivalent answers, and specific data-mined feedback of the most common student mistakes and misconceptions. Instructors can utilize automatically-graded Free Body Diagram drawing problems, both as stand-alone or included as an intermediate part. Our Physics Video Series is robust enough to support the flipped classroom but can also be used as a course supplement. The video series includes complete topical coverage with detailed derivations, application of fundamental equations, and worked-out problem examples. Finally, we recognize that educational exercises are only meaningful if students do the work themselves. We have a comprehensive suite of Academic Integrity tools, and we keep solutions to our problems off the internet.

Exploring the Invisible Universe

Booth #207
www.nanograv.org
NANOGrav stands for North American Nanohertz Observatory for Gravitational Waves. As the name implies, NANOGrav members are drawn from across the United States and Canada and our goal is to study the Universe using gravitational waves. Gravitational waves are ripples in the fabric of space and time that cause objects to shrink and stretch by very, very small amounts. NANOGrav uses the Galaxy itself to detect gravitational waves with the help of objects called pulsars — exotic, dead stars that send out pulses of radio waves with extraordinary regularity. This is known as a Pulsar Timing Array, or PTA. NANOGrav scientists make use of some of the world's best telescopes and most advanced technology, drawing on physics, computer science, signal processing, and electrical engineering. Our short term goal is to detect gravitational waves within the next decade. But detection is only the first step towards studying our Universe in a completely new and revolutionary way, and we are sure to make unexpected discoveries in the process. NANOGrav cooperates with similar experiments in Australia (the Parkes Pulsar Timing Array) and Europe (the European Pulsar Timing Array). Together, we make up the International Pulsar Timing Array, or IPTA. By sharing our resources and knowledge, we hope to usher in the era of gravitational wave astronomy more quickly and with greater impact. NANOGrav was founded in 2007 and has since grown to over 100 members at over 40 institutions. The NANOGrav Physics Frontiers Center is supported through a $14.5M award which started in 2015.

4th Law Labs

Booth #213
www.4thlawlabs.com
At the 4th Law Labs booth visitors will find playable copies of our premier product, Sector Vector™. This gamified lab kit teaches vector arithmetic as players face off in a space battle board game. Stop by and experience the thrill of math based space combat as you navigate Sector Vector™.

PASCO scientific

Booth #105
10101 Foothills Blvd.
Roseville, CA 95747
800-772-8700, www.pasco.com
PASCO is celebrating 56 years of serving the physics teaching community! PASCO designs and manufactures apparatus, lab instrumentation, sensors and software for teaching physics concepts. Visit us at our booth or attend a PASCO workshop to see our very latest physics equipment offering.

Quantum Experience Ltd.

Booth #111
www.quantumlevitation
Stimulate and encourage students to learn PHYSICS by teaching them the amazing phenomenon of Quantum Levitation. Quantum Experience develops educational programs using superconductors and quantum levitation. Our experimental kits and supporting material allow students to study Quantum Levitation, experience in a research process of learning and develop important scientific learning skills.

Society of Physics Students

Booth #215
One Physics Ellipse
College Park, MD 20740
301-209-3008, www.spsnational.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).

Spreadsheet Lab Manual LLC

Booth #211
www.spreadsheetlabmanual.com
Since 2009, The Spreadsheet Lab Manual (SLM) has equipped teachers across the USA with a standardized approach for students to program and study computational spreadsheet models in Physics, Chemistry, Biology and Math (years before NGSS). Awarded Phase 1 Funding in June, 2019 by the National Science Foundation Small Business Innovation Research (NSF SBIR) program, Spreadsheet Lab Manual LLC has built and implemented a standardized computational spreadsheet modeling pedagogy. With NSF support we have formed a new Professional Learning Community (PLC) exclusively for engaging professional educators. Proposed and designed based on a theoretical "knowledge engine" concept, we will use teacher incentives to recruit, train and equip members to develop content and share successes. Schools can invest Title II funds to pay their own teachers to access to this diverse learning community, which they will improve by sharing their own unique perspectives.

Teachspin

Booth #102
www.teachspin.com
TeachSpin, Inc. will be displaying a collection of affordable and accessible experiments appropriate for a Modern Physics Lab or intermediate-level laboratory course. Come see our Torsional Oscillator, Foundational Magnetic Susceptibility, and Room-Temperature Hall Effect apparatus. Also, try out our unique Hall Effect Probe. Ideal for advanced-placement high school courses as well as college labs, the Probe allows students to measure and map magnetic fields they otherwise calculate 'blind'.

University Science Books

Booth #209
www.uscibooks.com
University Science Books publishes quality books and textbooks by excellent authors at affordable prices. Please stop by to browse our best-selling titles including COLLEGE PHYSICS by Hellings et al; CLASSICAL MECHANICS and INTRODUCTION TO ERROR ANALYSIS by John Taylor; and A MODERN APPROACH TO QUANTUM MECHANICS and QUANTUM PHYSICS by John Townsend.

Vernier Software and Technology

Booth #204
www.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 Graphical Analysis 4 software.

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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

SPS01: 8:10-10 p.m. Studying Muon Count Rates as Underground Depth Increases

Poster – Paul M. Graham, New Trier High School 1023 Oakwood Ave., Wilmette, IL 60091-3321*

Emmanuel Copeland, Marybeth Senser, Downers Grove South High School

Eleanor A. Winkler, Nathan A Unterman, New Trier High School

Chicago area QuarkNet students worked together to determine the cosmic ray muon flux as a function of depth while descending in the MINOS elevator at Fermilab. Rates were measured at different angles of acceptance. Results and unexpected errors will be presented.

*Sponsored by Nathan A. Unterman

SPS02: 8:10 -10 p.m. Open-Ended Scientific Experimentation in Physics Labs

Poster – Madeline Clyburn, Berry College 2277 Martha Berry Hwy NW Mt Berry, GA 30149

Charles Lane Berry College

Asking a variety of physics professors about the importance of laboratory instruction in undergraduate physics curriculum produces a diverse selection of answers. Are labs intended to reinforce the lecture content from class or to learn how to measure certain physics quantities? Regardless, everyone would agree that physics labs are valuable to students' education and future. Previous research reveals that past "cookbook" labs are ineffective and do not prepare students for the critical thinking and experimentation used in the real scientific world. Thus, we have created open-ended experimental physics labs for the introductory physics course at Berry College and have implemented these labs into the courses, in fall semester 2019. We hope to show that these new lab experiences are more effective than "cookbook" labs, and the implementation of these physics' labs will create an increase in test scores on diagnostic tests compared to the scores obtained through conventional physics labs.

SPS03: 8:10-10 p.m. Optical Characterization of an Overhead Projector Spatial Light Modulator

Poster – Romulo Ochoa, The College of New Jersey 2000 Pennington Rd Ewing, NJ 08628

Rob Conwell, Zachery Andreula, The College of New Jersey

Commercial overhead projectors contain three spatial light modulators (SLM). In the past, we have used these SLMs in 4f Fourier optics experiments and for the formation of optical vortices. These experiments can be easily adapted to upper level physics lab experiences. We optically characterized the SLMs using red, green, and blue lasers. We report the rotation of linearly polarized light as a function of the RGB values in images input to the SLMs. We have found polarization rotations that are dependent on the light source frequency, the specific SLM used, and the projector port to which the SLM was connected.

SPS04: 8:10-10 p.m. Modeling Radiation Trapping in Alkali Vapors

Poster – Oluebubechukwu Onaga, University of Indianapolis 1400 E Hanna Ave Indianapolis, IN 46227

Brian Patterson, Monte Anderson, Jerry Sell, U.S. Air Force Academy

Stephen J. Spicklemire, University of Indianapolis

We present the outcome of an undergraduate capstone project involving the validation of Monte Carlo simulations of radiation trapping in alkali vapors and comparison to experimental data. Radiation trapping is the confinement of light in atomic vapors by successive absorption and reemission of photons. If the vapor is sufficiently dense, the apparent lifetime of the atomic excited state, as observed in the fluorescence decay, may be significantly longer than the natural lifetime. The calculations modeled and visualized the random walk of photons in cesium and rubidium vapors in a small, temperature-controlled cell, from initial absorption using a broadband laser source to eventual escape and detection. The focus of the poster is the validation of the calculations invoked in the Monte Carlo simulation compared to experimental results from an experiment having the same geometry and utilizing a Ti:sapphire pulsed laser for excitation.

SPS05: 8:10 -10 p.m. Developing a Community Outreach Program on the Physics of Smell

Poster – Carissa Giuliano, Adelphi University 1 South Ave Garden City, NY 11530

Matthew Wright, Adelphi

We will present our progress toward developing a public outreach program on the physics of smell to present at local high schools and museums. We have developed interactive exhibits to explain the two primary models that reveal how we smell: the lock and key model and the inelastic electron tunneling model. For the lock and key model, we 3-D printed several receptors for molecules, built from molecule kits, to fit into. For the tunneling model, we have developed various graphical simulations and used a physical example of frustrated total internal reflection to showcase a visible example of tunneling. After presenting this at various maker fairs our main takeaway was that observers will need to understand more about properties of light to grasp this demonstration. Therefore, we plan to incorporate a segment on this in the next version of the presentation.

SPS06: 8:10-10 p.m. Shape/Scale Independent Direct Surface Area Measurement Method from Images*

Poster – Matthew Mancini, New College of Florida 5800 Bay Shore Rd Sarasota, FL 34243

Mariana Sendova New College of Florida

A direct, shape, and scale independent digital image measurement method of the surface area (SA) of individual objects is proposed. The algorithms presented herein utilize the brightness histogram of 8-bit grey scale images, and thus are referred to as Brightness Histogram Surface Area Measurement Algorithm (BHSAMA). The proposed SA measurement technique allows the uncertainty of the single measurement reading to be evaluated by traditional error propagation. This fact alone presents a significant advantage to the current methods utilizing image segmentation and/or edge detection whose measurement uncertainties cannot be quantitatively analysed. For method verification purposes, a series of digital simulations using a control sample of predetermined size is undertaken. The accuracy of the single measured SA reading is between 0.5 % and 1.5 %. The two presented BHSAMA techniques can have wide range of applicability from nanoparticles, to cell biology, to aerial imagery.

*This research was conducted with my adviser and P.I., Dr. Mariana Sendova, at the New College of Florida Optical Spectroscopy and Nano-materials Lab.

SPS07: 8:10-10 p.m. Non-linear Oscillations in Quartz Tuning Forks at Cryogenic Temperatures

Poster – Frank D. DiLello, University of Florida P.O. Box 118440 Gainesville, FL 32611*

Eric Bautista,Yoonseok, Lee University of Florida

We investigated non-linear behavior of commercially available quartz tuning forks. Quartz tuning forks are mechanical resonators whose mechanical oscillations can be actuated and detected electrically. When they are driven at low excitations, the quarts tuning forks can be described by a driven damped harmonic oscillator model with its resonance frequency in the range of 10 kHz. Our previous attempts to investigate these resonators in vacuum at room temperature hit the physical limit of the fork, causing it to display unusual non-linear behavior. It is well known that most of the mechanical oscillators exhibit non-linear behavior called Duffing oscillations. We embarked on conducting the in-depth study on this at cryogenic temperatures down to 4 K where the non-linear effect should be more pronounced. We designed and constructed a 4 K probe for this project. In this paper we will discuss the non-linear behavior of quartz tuning forks at 4 K in vacuum.

*Sponsored by: Shawn Weatherford

SPS08: 8:10-10 p.m. Search for Potential Higgs Boson to Dark Photon Decay

Poster – Sean Kent, University of Florida 2800 SW 35th Place 3003 Gainesville, FL 32608*

The Large Hadron Collider accelerates protons to the order of 10 TeV of energy and smashes them together, enabling an emergence of heavy and short-lived subatomic particles. One such new subatomic particle, the Higgs Boson, was discovered in 2012. The Higgs Boson is vastly different from all other known elementary particles and plays a very special role in the theory, which warrants a broad program of studying its properties, including searches for decays to yet some other new particles that have been otherwise evading detection so far. This poster presents a strategy for one of such searches, namely: decays of the Higgs boson to a pair of ''dark'' photons predicted to exist by some theoretical models.

*Sponsored by Shawn Weatherford

SPS10: 8:10-10 p.m. Student Engagement in a Project-based Electricity and Magnetism Course

Poster – Ayax Santos, Universidad de Monterrey Ave. Ignacio Morones Prieto 4500 Pte San Pedro Garza García, Nuevo León 66238 Mexico

Osvaldo Aquines, Hector Gonzalez, Universidad de Monterrey

Despite the relevance of science in engineering, sometimes engineering students do not see the connection of physics courses to their field of study. As an alternative, a project-based course was designed to engage them into the subject. The course starts by defining a set of projects from which they can choose. In each of them, they have to apply the concepts seen in the course to build the final prototype. The main project deliverables are: a first report in which they detail how will they build their prototype and the physics concepts implied, a second videoreport (youtube) in which they show their first test and finally an oral presentation and demonstration of the working prototype in front of the class. Qualitative results from interviews show that students feel more motivated since they relate the course to the real world and other areas of engineering.

SPS11: 8:10-10 p.m. Physics and Engineering of the Speed Limit Enforcement Devices

Poster – Mikhail M. Agrest, The Citadel 87 Droos Way Charleston, SC 29409-0001

The need of limiting speed is based on multiple reasons related to safety. The practice of use of speed limiting devices (e.g.: speed humps/speed bumps) is very contradicting in terms of achieving the main goals, as safety without increasing pollution. The study also showed that selection of speed limiting devices is often intuitive, but not based on adequate physical model and accurate calculation and design. Actual practice today shows that the safe speed passing a speed hump/bump is often differs from the assigned speed limit. This leads to drivers' slowing down before the speed humps and their acceleration in the space between speed humps. As a result, the purpose is not achieved, the safety is not improved, the environment becomes more polluted and the spent money wasted. The study was made on reasoning of the shape and dimensions of speed limit enforcement devices to match the assigned speed limit.

SPS12: 8:10-10 p.m. Physicochemical Modeling and Optimization of Dissolution Kinetics of Prednisolone Loaded Polyvinyl Alcohol (PVA) Films*

Poster Megan Mouton, High Point University One University Parkway High Point, NC 27268

Pharmaceutical industries spend a tremendous amount of time and money in order to develop a formulation process for the mass production of individual drugs suitable for certain release properties. These industries are spending so much money on the formulation processes because with a faster formulation comes the enabling of a faster transition from the bench to clinical trials to commercial production (translational research). Mathematical models are essential in modern drug development and design research to predict the optimal process design based on physical properties and targeted release profile. Here, a physicochemical model is developed based on Fick's first law of diffusion to describe prednisolone loaded polyvinyl alcohol (PVA) dissolution in aqueous solution, which was solved using Python after simplifying by Noyes-Whitney approximation to predict the transport properties (diffusivity and boundary layer thickness). The model produced a good fit ($R2 > 0.9$) for drug release profile with changing solution volume, film thickness and presence/absence of surfactant Tween80, and was used to predict a lumped rate k and solubility Cs. The model and predicted physical parameters will help in the design of film-based drug formulation systems with optimal properties.

*We were supported by the National Science Foundation REU Program, University of Kentucky (1757354) and Eli Lilly and Company.

SPS13: 8:10-10 p.m. Using an IR Camera to Investigate Power in Simple DC Circuits

Poster Sarah Nowell, High Point University One University Parkway High Point, NC 27268

Megan Mouton High Point University

Traditionally in introductory level physics, simple DC circuits with light bulbs are used to teach current, potential difference, and power. This can be problematic because light bulbs are non-ohmic, which results in unexpected observations. In this set of experiments, we used ceramic resistors, which are ohmic, and an IR camera to investigate power. We used the IR camera to measure temperature and radiance of resistors in series and in parallel, and we measured temperature and radiance of single resistors as a function of time. We found that it took a long time for resistors to reach thermal equilibrium, especially for lower resistance (higher power). We found that radiant power increased with electrical power and that radiance is proportional to temperature. These results can be used to write new introductory physics lab activities that use an IR camera to better understand the Energy Principle applied to a resistor in a circuit.

SPS14: 8:10-10 p.m. Electrochemical Liquid-Liquid-Solid Deposition of Crystalline InGaAs

Poster Mark Moran, Berry College 57 Yale Rd NE Rome, GA 30161

InGaAs is a (III-V) compound semiconductor alloy with tunable optoelectronic properties in the near infrared (NIR) region of the electromagnetic spectrum, making this material an excellent candidate for various applications in NIR sensing and detection. Current methods for producing InGaAs require high-cost experimental setups and toxic gaseous precursors. Thus, this research targets the deposition of crystalline InGaAs via the electrochemical liquid-liquid-solid (ec-LLS) process, in which growth occurs in room temperatures, ambient pressure, and without any toxic precursors. The hypothesis tested in this work says that crystalline InGaAs can be grown via ec-LLS using varied mixtures of In and Ga liquid metals to serve as an electrode, solvent, and coreactant promoting semiconductor crystal growth. The InGaAs crystals will be characterized for crystallographic properties via x-ray diffraction and electrical properties via electrochemical impedance spectroscopy. Obtained results will reveal the efficiency of ec-LLS in growing semiconductor materials.

SPS17: 8:10-10 p.m. How Would a Nearby Kilonova Look on Camera?

Poster – Nihar Gupte, University of Florida 3000 SW 35th Pl, Apt. E110B Gainesville, FL 32608*

Imre Bartos, University of Florida

Kilonovae are cosmic optical flashes produced in the aftermath of the merger of two neutron stars. While the typical radiant flux of a kilonova can be as high as 10e34 W, they typically occur at cosmological distances, requiring meter-class or larger telescopes for their observation. Here we explore how a kilonova would look like from Earth if it occurred in the Solar System's backyard, 1000 light-years from Earth. This is a small distance on cosmological scales, with only one neutron-star merger expected to occur this close every 100,000,000 years. While humans will likely only see kilonovae at much greater distances, showing how such a nearby event would look on camera can help visualize these events, and demonstrate their unique spectral evolution.

*Sponsored by Shawn Weatherford

SPS18: 8:10 -10 p.m. Balloon Borne Investigation Zenith Angle Dependence of Cosmic Rays Showers

Poster – Melissa Graham, St. Catherine University 2004 Randolph Ave. St. Paul, MN 55105

Claire Weinzierl, Judy Panmany, Alisha Wiedmeier, Alynie Walter, St. Catherine University

Galactic Cosmic Rays are high-energy particles from stars or remnants of a supernova. These particles impinge upon the Earth's atmosphere, in the form of positively charged particles, protons. Protons interact with atmospheric nuclei to produce a cascade of high energy secondary particles known as a Galactic Cosmic Ray Shower. This post-collision secondary shower depends on altitude, latitude, solar activity, and air pressure. The Regener-Pfotzer (R-P) maximum, which is between 15-25 km, is the altitude where the maximum number of detections is measured with a Geiger Müller detector. In order to quantify particle collisions, a payload was flown containing four Geiger counters in a cross configuration comparing and measuring vertical, horizontal, and omnidirectional coincidences. Analyzed data showed an R-P maximum occurring at different altitudes depending on the direction of the coincidences, consistent with previous research.

SPS19: 8:10-10 p.m. Balloon Borne Lower Atmosphere Neutron Detection Using Personal Neutron Dosimeters

Poster – Judy Panmany, St. Catherine University 2004 Randolph Ave St. Paul, MN 55105

Claire Weinzierl, Alisha Wiedmeier, Melissa Graham, Alynie Walter, St. Catherine University

Helium filled High Altitude Balloons (HABs) carrying payloads are utilized to explore Earth's atmosphere. These balloons expand until they burst at approximately 32 km due to low pressure. Subatomic particles, such as neutrons can be found within regions of the atmosphere where HABs are flown. Neutrons are challenging to detect because they are electrically neutral. A Personal Neutron Dosimeter (PND) detector can be used to quantify neutrons through the appearance of bubbles, based on the reaction with liquid Freon-12. Two HAB flights were conducted with payloads that consist of a PND, heater circuit, GPS devices, and GoPro camera. Particle counts peak between 15-25 km; this altitude is referred to as the Regener-Pfotzer (R-P) maximum. Data analysis showed a correlation between the altitude of neutrons and the altitude of charged subatomic particles. These flights demonstrated that neutrons were present at lower altitudes than previously demonstrated.

SPS20: 8:10-10 p.m. Cosmic Ray Shower Zenith Angle Measurement by Balloon Borne Apparatus

Poster – Alisha Wiedmeier, St. Catherine University 2004 Randolph Ave St. Paul, MN 55105

Melissa Graham, Claire Weinzierl, Judy Panmany, Alynie Walter, St. Catherine University

High energy particles, mainly protons, from distant stars or supernovae interact with atmospheric particles producing a Galactic Cosmic Ray Shower; these particles can be monitored through High Altitude Balloon (HAB) flights. In past experiments, Aware Electronics RM-80 Geiger Müller (GM) detectors were separated and stacked vertically, to collect particle coincidences aligned at zero and 90 degrees in relation to the zenith angle. The Regener-Pfotzer maximum, an altitude dependent maximum of this measurement, varied for vertical, horizontal, and omnidirectional coincidences. An apparatus built to rotate a pair of stacked GM detectors using a stepper motor was used to collect coincidence data for particles traveling at different angles. The detectors were turned every 15-seconds to collect data for zenith angles of ? = 0°, 45°, and -45° relative to the vertical axis. A HAB flight confirmed that the apparatus prototype could withstand low pressure, low temperature, and continued to collect data after landing.

SPS21: 8:10-10 p.m. A Profile of the Muon Flux in Fermilab's MINOS Tunnel

Poster – Benjamin Z. Grey, Ida Crown Jewish Academy 571 Pleasant Ave. Highland Park, IL 60035*

Jacob Miller, Allen Sears, Ida Crown Jewish Academy

Shoshana Frank Rochelle, Shira Eliaser Rochelle, Zell Jewish High School

The MINOS tunnel at Fermilab is 103 meters in depth to shield the experiment from cosmic rays. High school students hypothesized that the muon flux will decrease as a function of distance in the tunnel from the access shaft. Two detectors were used, one parallel to the tunnel and one perpendicular to the tunnel. An additional stack was on the surface as a control. We varied the distance from the shaft and measured the muon flux. We found influences from the neutrino beam which necessitated normalization of our results. The results gathered over that period proved our hypothesis. Experiment details will be presented.

*Sponsored by Nathan Unterman, In association with all other MUSE collaborators.

SPS22: 8:10-10 p.m. DivYX; Software to Perform Web-based Kinematic Analysis

Poster – Hector Antonio Gonzalez Flores, Universidad de Monterrey Morones Prieto 4500 pte. Monterrey, NL 66238 México

Osvaldo Aquines, Ayax Santos, Universidad de Monterrey

Computer-based analysis tools have proven to be very effective in physics education and their use has become everyday more intensive. However, the analysis tools currently available have technical requirements related to their installation in some combination of hardware and operating system. DivYX, is an analysis tool that works completely online, and is independent of the hardware and operating system used. DivYX is able to provide students with the necessary facilities to perform a kinematic analysis of some phenomenon which has been previously recorded on video. DivYX is part of the Newtondreams project, which it intends to make it available for users; Teachers or physics students, of tools that can be used in the teaching-learning process. DivYX is a tool used regularly in our laboratories, Physics, and Digital Effects Animation courses, as well as various departmental projects.

SPS23: 8:10-10 p.m. Application of AMTI Sports Performance Force Plates in Introductory Physics

Poster – Paul Klippel, High Point University 155 Arbor Circle Basking Ridge, NJ 07920

Aaron Titus, High Point University

An important, yet challenging, concept in introductory physics is contact forces with perpendicular (normal) and tangential (friction) components in both static and dynamic situations. Our new physics classroom includes three recessed, parallel, research grade force plates designed for biomechanics that measure 3D contact forces and position on the plate. Using Python and VPython, we created a custom data acquisition, analysis, and visualization application for introductory physics students to observe and measure contact forces with the plates. In live recording mode students can view the 3D force vector alongside graphs of force components and magnitude. After data is collected, students can select data to analyze. Selecting a single data point displays the corresponding 3D force vector. This unique hardware in an introductory physics classroom creates novel opportunities for education and research.

Workshops at 2020 AAPT Winter Meeting -- Rollins College, Bush Science Center

W01: Arduino Microcontrollers

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on Science Education for the Public
Time: 8:00 a.m.-5:00 p.m. Saturday
Member Price: $205 Non-Member Price: $230
Location: 105 Bio Lab

Greg Mulder, Linn-Benton Community College 6500 Pacific Blvd. SW Albany, OR 97321

Microcontrollers are relatively inexpensive devices that you can program to collect data from a variety of sensor types and control external devices such as motors and actuators. Microcontrollers can be used in a variety of classroom activities and student projects. We will focus our workshop on using an Arduino Microcontroller to construct a mini-underwater vehicle that will seek out to hover at a desired programmed depth. We will also discuss how our students use Arduinos for fun, research, underwater ROV's and general exploration. An optional pool-test of your mini-underwater vehicle will occur after the workshop at a nearby hotel pool. Note: you get to keep your mini ROV with Arduino. No previous microcontroller programming or electronics experience is required. You need to bring your own Windows, Mac, or Linux computer.

W02: Intro to Modeling Instruction, A PER-based Curricula

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-5:00 p.m. Saturday
Member Price: $93 Non-Member Price: $118
Location: 208

Jeff Saul, 12200 Academy Road NE, #312 Albuquerque, NM 87111

Kathleen "Kathy" Harper, Jeff Hengesbach

Modeling is about making and using scientific descriptions (models) of physical phenomena and processes. Modeling Instruction is a guided-inquiry method for teaching science by actively engaging students in all aspects of scientific modeling. The curriculum structures the course material around 6-12 key models. The focus in each unit is developing the model, deploying the model, and extending the model to new situations. 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 students achieving statistically significant learning gains in annual progress and increased physics enrollment within 2-3 years of implementation 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 summer workshops (1-3 weeks long) is worth their time and effort. For more information on Modeling Instruction including summer workshops, go to https://modelinginstruction.org.

W03: Ring Flinger (Make & Take)

Sponsor: Committee on Apparatus
Co-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: 164

Sam Sampere, Syracuse University Department of Physics 201 Physics Building Syracuse, NY 13244

Dale Stille

You may know the classic physics demo PIRA 5K20.30 by one of several common names. If you do not know what PIRA 5K20.30 stands for, then you will also learn about this extremely valuable resource while you build your very own Jumping Ring, Ring Flinger, or Elihu Thomson coil apparatus. The final product measures almost 0.5 m tall, and tosses rings up to 5 or 6 m high! You will be supplied with various rings including aluminum, aluminum with a split, plastic and a couple other various metals. You will also UNDERSTAND how these work! This is not as simple as magnetic repulsion.

W06: Using Augmented Reality, Virtual Reality, and Video Games in the Physics Classroom

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $75 Non-Member Price: $100
Location: 180

David Rosengrant, University of South Florida St. Petersburg 140 7th Ave S, Coquina 215 St. Petersburg, FL 33701

Rongkai Guo

In this session participants will learn how to design and incorporate the latest technologies into their classroom to not only increase student motivation but also critical thinking skills. Specifically, this workshop focuses on virtual reality (observers being completely submersed in a simulated environment), augmented reality (a simulated environment is overlayed on the real world at some level), and video games (how we as physics instructors can utilize the advanced gaming engines found in multiple systems). There will also be a variety of platforms for participants to experience virtual reality to help determine what would work best for them in their classroom settings. Participants will initially go through labs that utilize this technology as students would followed by pedagogical discussions from faculty about how they have been implemented in the classroom. In addition, participants will begin to learn how to create curriculum materials for their own classroom utilizing these technologies.

W07: Updates to AP Physics

Sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: 210

Angela Jensvold, 21400 Pathfinder Rd Diamond Bar, CA 91765

John Pinizzotto, Matt Sckalor, Michelle Strand, Amy Johnson

This session will support the AP Physics 1, AP Physics 2, AP Physics C – Mechanics and AP Physics C – Electricity and Magnetism courses and consist of three distinct sessions: 1) Updates to the Course, 2) The Exam, and 3) New Resources. Each session will provide participants with opportunities to share challenges and successes in implementing the resources, as well as learn of instructional strategies and approaches for enhanced teaching and learning. At the end of each session, presenters and participants will engage in Q&A.

W08: PICUP: Integrating Computation into Introductory Physics

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: 202

Marie Lopez del Puerto, 2115 Summit Ave, OWS 153 Saint Paul, MN 55105

Danny Caballero, Kelly Roos and Larry Engelhardt

In this workshop, we will show you some ways in which computation can be integrated into your introductory courses. The PICUP partnership has developed a variety of computational activities for introductory physics, and we will show you how you can take these PICUP materials and adapt them to fit your needs. PLEASE BRING A LAPTOP COMPUTER. In this workshop, we will focus on computational activities using spreadsheets and web-based "Trinkets" so you do not need to have any specialized software installed. After the workshop, participants who participate fully in this workshop can receive a $40 grant-funded rebate, making the final cost of the workshop $20 for AAPT members and $45 for non-members. This workshop is funded by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

W09: From Intro Labs to Senior Theses: Implementing And Assessing Writing across the Physics Curriculum

Sponsor: Committee on Laboratories
Time: 8:00 a.m.-12:00 p.m. Saturday
Member Price: $65 Non-Member Price: $90
Location: 212

W. Brian Lane, Physics Department 2800 University Boulevard North Jacksonville, FL 32211

Bradley "Peanut" McCoy, D. Blane Baker

Incorporating writing into physics courses offers a number of pedagogical benefits, including reinforcement of conceptual understanding, deeper assessment of student learning, development of students' professional writing skills, and improved prevention and detection of plagiarism. However, developing and assessing writing assignments for a physics course can be a daunting challenge, requiring physics educators to expand their means of assessment and address student expectations. At this workshop, participants will learn more about designing and assessing writing-based assignments for various course contexts, giving students effective and efficient feedback, helping students conduct peer review, scaffolding the writing process, incorporating authentic external audiences into writing assignments, and helping students transfer writing skills from other contexts. The workshop leaders will share writing-based assignments that they have found successful in their courses and help participants adapt and develop writing-based assignments for their own contexts. Participants are encouraged to bring a laptop or tablet to the workshop.

W10: The Architecture of GlowScript VPython

Sponsor: Committee on Educational Technologies
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: 212

Bruce Sherwood, Ruth Chabay, Matthew Craig, Stephen Spicklemire

GlowScript VPython is an open-source browser-based 3D programming environment used widely in physics education. The workshop has two goals: 1) give users of GlowScript VPython an understanding of the technical structure of the application, which can better inform their use of it, and 2) encourage those with extensive programming experience to contribute to the further evolution of GlowScript VPython. The first part of the workshop will feature a tour of the key elements of the software, which is written mainly in JavaScript. Next, participants will make and test changes to the application. Knowledge of JavaScript is not required, but significant experience in using some object-oriented algorithmic language is necessary such as Python or Java or C++. Bring your own laptop with the necessary software installed, as explained in the developer's section of www.glowscript.org/docs/GlowScriptDocs/local.html.

W12: Using RTOP to Improve Physics and Physical Science Teaching

Sponsor: Committee on Professional Concerns
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: 210

Kathleen Falconer

The Reformed Teaching Observation Protocol (RTOP) is a 25-item rubric that provides a percentile measure of the degree and type of student-centered, constructivist, inquiry-based, engagement in an instructional situation. RTOP scores correlate very highly with student conceptual gains. In this workshop, we will score video vignettes of teaching to learn how to use RTOP for guiding personal reflection and improvement and change of our own teaching; for mentoring peers, novice teachers and student teachers; and to establish a vocabulary for discussing reformed teaching practices. If you wish, you may bring a dvd of your own teaching to score.

W18: Pulsar Search Collaboratory for High School Teachers

Sponsor: Committee on Space Science and Astronomy
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 Non-Member Price: $85
Location: 310 Comp L

Ann Schmiedekamp, Physics Dept. Penn State University, Abington 1600 Woodland Rd. Abington PA 19001

Sue Ann Heatherly

The Pulsar Search Collaboratory (PSC) is a collaboration between Green Bank Observatory (GBO) and West Virginia University (WVU), with the goal to increase the scientific and information technology literacy among high school students. The program is also aimed at improving teachers' knowledge of the nature of science, the importance of information technology to scientific discovery, and methodologies for incorporating inquiry-based education into the classroom. The student participants

have the opportunity to make significant scientific discoveries by searching the data obtained with the Green Bank Telescope (GBT), where previously unknown pulsars lie awaiting to be discovered. Through the PSC, the student participants can attend Capstone events at universities in their vicinity, come to the PSC camp at Green Bank in summer, and be eligible for college credit. This workshop is an opportunity for teachers to join the PSC and acquire experience in pulsar astronomy and data analysis, so that they can guide their students through the training. Participants are asked to bring their own laptops for the training and will be able to continue participation in PSC throughout the year through internet connection. Since this project is covered by a NSF grant, teachers who participate in this workshop will be mailed a reimbursement for the fee ($60 for members, $85 for nonmembers) after the workshop is completed.

W19: CMS Collider Physics Masterclass

Sponsor: Committee on Contemporary Physics
Co-sponsor: Committee on Educational Technologies
Time: 1:00 p.m.-5:00 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: 302

Kenneth Cecire, Department of Physics, 225 Nieuwland Science Hall

Shane Wood, Marla Glover

Learn how CERN physicists make discoveries by analyzing real data yourself in an understandable visual format. Learn how to give this experience to your students to help them learn about not only the forefront of physics but the very physics they study in an exciting and interesting context. Bring your laptop!

W20: Improving Pedagogical Content Knowledge

Sponsor: Committee on Graduate Education in Physics
Co-sponsor: Committee on Teacher Preparation
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 210

Alex Maries, 345 Clifton Court

Chandralekha Singh

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 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.

W21: Trinket Workshop: Teach with Code

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $65 **Non-Member Price: $90**
Location: 180

Aaron Titus, Department of Physics High Point University One University Parkway High Point, NC 27268

Trinket (https://trinket.io) is a free web-based coding environment designed for education. A "trinket" is an editable, runnable program that can be embedded within any web page. Teachers and bloggers might embed a trinket in a blog post or LMS web page. Students can run the program, edit the program, save the program to their account, and share their program with others. A Trinket "course" is a web-based environment for teachers to easily create an outline and set of course pages. Authoring is in Markdown, an easy-to-use use markup language common to Jupyter, GitHub and other web apps. For physics teachers, Trinket allows you to easily create full-featured physics instructional pages with coding exercises (in a variety of languages including Python and GlowScript VPython), simulations, images, videos, and PDFs. Furthermore, a Trinket Connect account allows teachers to collect students' programming assignments. Trinket is ideal for teachers who integrate computing in introductory physics. In this workshop, you will create GlowScript VPython trinkets and a Trinket course with physics content (including mathematical markup with LaTeX) and coding exercises.

W22: Computational Physics in Introductory Physics Courses

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 301 Comp L

Tom O'Kuma, Lee College Physics P. O. Box 818 Baytown, TX 77522

Dwain M. Desbien, Nathan A. 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 (GS)(http://www.glowscript.org) as the computational modeling language and will use it in this workshop. Participants will learn some basic GS 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 to have created an account on GS before arrival.

W23: STEP UP

Sponsor: Committee on Women in Physics
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 212

Zahra Hazari, 11200 SW 8th St Miami, FL 33199

Hemeng Cheng, Blake Head

High school physics teachers, in particular, have been found to be critical to inspiring young women who pursue undergraduate physics. 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 #1720810. Participants who complete the workshop may seek full reimbursement of their workshop registration fee.)

W24: Fun and Engaging Labs

Sponsor: Committee on Teacher Preparation
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 Non-Member Price: $85
Location: 164

Wendy Adams, 1700 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.

W25: Coding Integration in High School Physics Courses

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Physics in High Schools
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 Non-Member Price: $85
Location: 308

Chris Orban, 191 W Woodruff Ave

Ever wondered how to integrate a little bit of coding into a high school physics class without overwhelming your students or taking up lots of class time? This hands on workshop will provide an overview of simple, conceptually-motivated exercises where students construct games like asteroids and angry birds using a free in-browser editor that works great on chromebooks or whatever devices you have. Following that we will show you how to use stemcoding.osu.edu which is a free "learning management system" that is designed to facilitate using coding activities in sizable classes. This framework also includes assessment questions designed to probe whether students are building their conceptual knowledge as they complete the activities. We will share with you a full set of lesson guides and solutions for over 17 different simple coding activities for high school physics and physical science, all of which produce PhET-like interactives. If you have enjoyed seeing coding tutorial videos on the STEMcoding youtube channel (http://youtube.com/c/STEMcoding) here is your chance to do a deep dive! The STEMcoding project is led by Prof. Chris Orban from Ohio State Physics and Prof. Richelle Teeling-Smith in the physics department at the University of Mt. Union. The STEMcoding project is supported in part by the AIP Meggers Project Award.

W26: Teaching Introductory Physics in an Earth and Space Science Context

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: 202

Shannon Willoughby, Montana State University 264 Barnard Hall Bozeman, MT 59717

Ramon Lopez, Janelle Bailey, Ximena Cid, Brad Ambrose

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.)

W27: Fun, Engaging, Effective, Research-Validated Lab Activities and Interactive Lecture 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: 310 Comp L

David Sokoloff, Department of Physics University of Oregon 1371 E 13th Avenue Eugene, OR 97403

Ronald K. 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. They 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 mechanics, electricity and magnetism and optics. The following will be distributed: Modules from the Third Edition of RTP, and the ILD book.

W28: PICUP: Integrating Computation into Upper-Level Physics

Sponsor: Committee on Physics in Undergraduate Education
Co-sponsor: Committee on Educational Technologies
Time: 8:00 a.m.-12:00 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: 208

Larry P. Engelhardt

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

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 $40. The total cost of the workshop to each participant is $20 for AAPT members and $45 for non-members of AAPT.

AA PTRA Making Fields Real and Teaching Modern Physics

Time: 1:30–3 p.m. **Date: Sunday, Jan. 19** **Location: Grand Sierra C** **Presider:** *Karen Jo Matsler*

This interactive session will focus on resources designed to help make electric and magnetic fields more tangible. Discussion and activities will highlight how fields store and transfer energy and momentum, making a concrete fabric model for electric fields, and using an LED to detect the electric field between two parallel plates. We will end the session by connecting auroras to fields using iron filings and magnets. Lots of REALLY fun things to do in the classroom.

AB Applications of Deep Learning in Undergraduate Physics

Time: 1:30–3 p.m. **Sponsor: Committee on Educational Technologies** **Date: Sunday, Jan. 19**
Location: Grand Sierra F **Presider:** *Duncan Carlsmith*

AB01: 1:30-2 p.m. Deep Learning for a Deeper Understanding of Physics

Invited – Jeffrey R. Groff, Shepherd University, PO Box 5000, Shepherdstown, WV 25443

Deep learning is a specialized area of machine learning that is enabling amazing advances in areas such as self-driving vehicles, speech recognition, and computer vision. Both physics and deep learning involve developing models that make predictions, but the approaches used are different. For example, a physicist's approach is to start with first principles and add complexity as needed to increase accuracy. On the other hand, the deep learning approach is based on empirical models and parameter fitting. Nevertheless, students who study both approaches may develop a deeper understanding of physics. This talk will discuss the similarities and differences between, and the strengths and weaknesses of a physicist's approach to predictive modeling and the deep learning approach. These two approaches will be explored by comparing how they can be applied to solve a classic physics problem.

AC 21st Century Physics in the Classroom

Time: 1:30–3 p.m. **Sponsor: Committee on Contemporary Physics** **Co-Sponsor: Committee on Physics in High Schools**
Date: Sunday, Jan. 19 **Location: Grand Sierra G** **Presider:** *Shane Wood*

AC01: 1:30-2 p.m. Physics of Space for Young Children

Invited – Rachel Hallett-Njuguna, Goldsboro Elementary Magnet School 1300 W 20th St Sanford, FL 32771-3279

In an elementary magnet school with a Space Science focus, all students participate in standards-based lessons in a one-of-a-kind Kids Space Center. But the challenge tends to be how to make space-related physics accessible for children as young as 5 years old. With moon cars overcoming friction in Kindergarten, building solar sails in First grade, and using digital probes to measure heat and light in 3rd grade, our youngest students are exposed to complex ideas in order to create observations and inferences that will hopefully stay with them for years to come. In this session, these and other lessons will be shared as examples of how to engage young students in physics concepts while meeting their developmental needs.

AC02: 2-2:30 p.m. Modern Research Data to Enrich the K12 Classroom

Invited – Adam A LaMee, University of Central Florida 517 LONDON RD Winter Park, FL 32792

Are you still teaching 2D collisions with billiard balls? Try using Higgs boson decays instead. Why not use gravitational waves to follow up Slinkys in your waves unit? You'll learn about accessible research data from CERN, LIGO, and other experiments to help students learn traditional science content. These are some of the same experiments your students have already heard about on social media, helping connect school to the world outside. We'll also share techniques for embedding the next big experiment's findings in your own curriculum. Options for paper and pencil, spreadsheet, and Python analysis.

AC03: 2:30-3 p.m. Conveying the Science of the Large Hadron Collider

Invited – Darin Acosta, University of Florida, PO Box 118440 Gainesville, FL 32611-8440*

The Large Hadron Collider operating at the CERN laboratory in Europe is the premier facility for the exploration of subatomic physics. The scientific topics it seeks to address range from exploring the structure of matter at its smallest scale, studying the forces by which particles interact, producing and detecting dark matter that permeates the universe, and searching for further symmetries in nature. The research involves thousands of scientists worldwide. In this talk I will describe some approaches taken to convey the excitement and content of this scientific field to students, to other educators, and to the public at large. This includes activities with educators participating in the NSF funded QuarkNet program, which is focused to enable science teachers with research experience and tools. I also will share some personal experiences in outreach, and in teaching and training students from the high school to graduate student level.

*Sponsored by Kenneth Cecire

AD PER from Around the World

Time: 1:30–3:20 p.m. Sponsor: Committee on Research in Physics Education Co-Sponsor: Committee on International Physics Education
Date: Sunday, Jan. 19 Location: Grand Sierra H Presider: *Paul Irvin*

AD01: 1:30-2 p.m. Challenges and Opportunities of Physics Education Research in Canada

Invited – Tetyana Antimirova, Ryerson University 350 Victoria Street Toronto, ON M5B 2K3

While Physics Education Research (PER) has blossomed in the U.S., Europe, Australia and Latin America, very few PER groups and even solo PER researches can be found in Canada. One may ask why. The main reason is the continuing absence of PER-designated funding at both the national and provincial levels. As a result, long-term large-scale research projects cannot be established, PhD-level graduate programs in PER cannot be established and sustained. Almost all PER initiatives in Canada today are still initiated by the enthusiastic individuals and small groups, funded mostly by one-time grants outside of major granting agencies, resulting in mostly short-term PER research projects. Fortunately, the universities began to acknowledge the need to improve teaching and learning in STEM disciplines, so a small fraction of STEM-allocated funds sometimes can be spent on small-scale PER-related initiatives. I will provide a few examples of successful PER-related projects in Canada. Despite the difficulties PER researchers experience in Canada, Canadian PER is slowly shaping up.

AD02: 2-2:30 p.m. How Academic Organizations Promote the Professional Development of Physics Teachers in China

Invited – Wei Yang, Shenyang Normal University Huanghe Street, Huanggu District, College of Teachers Professional Development,Shenyang Normal University Shenyang, Liaoning, China 110034;

Chunmi Li, Beijing Normal University

Lin Ding, Ohio State University

Similar to AAPT, there is also a specialized academic organization for physics teachers in China. As the largest physics teacher organization, the name is the Physics Teaching Professional Committee of the Chinese Institute of Education. It is managed by the Ministry of Education of China directly. The members come from: University teachers and researchers, teaching and research staff, in-service teachers, pre-service teachers (undergraduate and postgraduate), etc. There are three main types of large-scale events: academic annual conferences, series of scientific research projects, and various competitions. Academic organizations also have two academic journals that are distributed nationwide. The academic organization has played a huge role in promoting the professional development of physics teachers in China. This report will introduce the history of the academic organization, the election and composition of the council, as well as academic annual conferences, research projects, and competitions.

AD03: 2:30-3 p.m. An Overview of Physics Education Research at the University of Cologne

Invited – Kathleen Falconer, Universität zu Köln 27 East Girard Blvd. Buffalo, NY 14217

André Bresges, Universität zu Köln

Daniel MacIsaac, Buffalo State College

We will describe several recently completed and currently ongoing PER projects and studies at Universität zu Köln (Uni-Köln). As the largest teacher preparation institution in Europe with about 900 students registered in physics didactics, Uni-Köln PER scholarship is mainly applicable to the preparation of physics teachers. Initiatives in classroom protocol (RTOP) instrument translation and validation, use of action research and design-based research in student praxis projects, Bachelors and Masters theses, use of action research to refine large enrollment lectures, and dedicated media courses for pre-service teachers and more will be discussed.

AD04: 3-3:10 p.m. Finding My Way as an International Teaching Physics at a U.S. Jesuit University

Contributed– Mayuri Gilhooly, Rockhurst University 1100 Rockhurst Rd Kansas City, MO 64110-2561

Teachers play a vital role in educating the future generation in our communities. There are approximately 857,200 immigrant teachers in the United States. These foreign-born teachers make up 22 percent of the total post-secondary teachers in the United States. This study examines challenges faced by a foreign-born teacher, teaching Physics for Life Sciences at a U.S. undergraduate institute. Specific challenges relate to gender, religion, country of origin, and also problem areas such as language barriers and social adjustment are discussed.

AD05: 3:10-3:20 p.m. Analyzing Student Discussions During Clicker Sessions

Contributed – Eliane Merki, ETH Zurich D-Phys, LFKP HPZ G36 Zurich, Zurich 8093 Switzerland*

A study on formative assessment using clicker questions showed that the students' improved their understanding of concepts in kinematics significantly. The goal of this study was to get an insight into the student discussions happening between the clicker questions. Two clicker sessions were implemented in nine high school classes. In every class two microphones were placed randomly near a group of students. The discussions were transcribed and analyzed. It can clearly be said that the students are activated and highly engaged during the discussions. This is due to a peer instruction setting, where students have the ability to vote two times for the same clicker question. Between the votes, students try to persuade their peers of the answers they had chosen in the first round. In the talk, difficulties of evaluating informal student discussions and a summary of found concept and misconcepts, are going to be presented.

*Sponsored by Guillaume Schiltz

AE Perspectives on Environmental Science and Physics

Time: 1:30–3:10 p.m. Sponsor: Committee on History and Philosophy in Physics Date: Sunday, Jan. 19
Location: Grand Sierra I Presider: *Gen Long*

AE01: 1:30-2 p.m. Physics in Climate Change Education

Invited – Allan Feldman, University of South Florida College of Education EDU 105 Tampa, FL 33620

There is an international consensus that Global Climate Change (GCC) is one of the most significant challenges we face (IPCC, 2013). Most of the causes and immediate effects of anthropogenic climate change are due to physical processes. This presentation will identify some of those processes and ways to teach them using curriculum materials developed as part of the NSF-funded Climate Change Narrative Game Education (CHANGE) project (https://climatechange.usf.edu). The materials include an eBook with scientifically realistic text narratives and embedded simulations and games based on scientific data, and hands-on and minds-on activities. It uses a place-based approach that focuses on the built environment (G. A. Smith, 2007). CHANGE has been shown to be affective in increasing students' knowledge of climate change science, and to effect changes in their beliefs about the causes of GCC (Feldman, Smith, Nation, & Besalti, 2017; G. G. Smith, Besalti, Nation, Feldman, & Laux, 2019).

Feldman, A., Smith, G. G., Nation, M., & Besalti, M. (2017). The Use of Complementary Virtual and Real Scientific Models to Engage Students in Inquiry: Teaching and Learning Climate Change Science. In I. Levin & D. Tsybulsky (Eds.), Optimizing STEM Education With Advanced ICTs and Simulations (pp. 30-57). Hershey PA: IGI Global. IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin,

G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge, UK and New York: Cambridge University Press. Smith, G. A. (2007). Place-based education: breaking through the constraining regularities of public school. Environmental Education Research, 13(2), 189-207. doi:10.1080/13504620701285180 Smith, G. G., Besalti, M., Nation, M., Feldman, A., & Laux, K. (2019). Teaching Climate Change Science to High School Students Using Computer Games in an Intermedia Narrative. Eurasia Journal of Mathematics, Science and Technology Education, 15(6). doi:10.29333/ejmste/103570

AE02: 2-2:30 p.m. No Longer a "Guessing Science": Incorporating Physics into Meteorology

Invited – Kristine C. Harper, Florida State University Department of History 113 Collegiate Loop, Bellamy 401 Tallahassee, FL 32306-2200*

Even into the early 20th century, meteorology remained more in the realm of natural history, field sciences dependent upon observations in nature, than the newly defined 19th century "sciences" that depended upon mathematics. Indeed, while natural history topics such as zoology, botany, geology, and meteorology were trying to become sciences throughout the 19th century, their lack of mathematical rigor made them a punching bag for physicists who wanted to make sure that "real" science was "hard" (mathematical) science. Nevertheless, a handful of men were trying to take advantage of the new data available from nascent national weather services and develop a theoretical basis for meteorology. Not much progress was made until a Norwegian physicist, Vilhelm Bjerknes, frustrated by the lack of opportunity in his original research field of electronic resonance, turned his sights to fields he considered appropriate targets for his synthesis of thermodynamics and hydrodynamics: meteorology and oceanography.

*Invited by Gen Long to speak in this session on Perspectives on Environmental Science and Physics.

AE03: 2:30-3 p.m. Sea Level Rise Report 2

Invited – Celia Chung Chow, CSU 9 Andrew Drive Weatogue, CT 06089

A continuation of Report 1 presided at AAPTSM19.

AE04: 3-3:10 p.m. Communicating about Climate Change and Environment through an Interdisciplinary Lens

Contributed – Joseph F. Kozminski, Lewis University 1 University Pkwy Romeoville, IL 60446-2200

Developing scientific communication skills is a critical component of the physics laboratory curriculum. These skills, which include making evidence-based conclusions and recommendations based on research findings and disseminating them appropriately, are highly transferable to other fields like environmental science and climate science. While evidence for human-induced climate change is unequivocal, a multi-disciplinary message may reach more people than presenting just the scientific data and findings. Climate change has environmental, societal, health, economic, political, and justice implications. The changing climate will impact coastlines, habitats, ecosystems, the weather, food production, and public health to name a few, and vulnerable populations will be adversely impacted at a disproportionately higher rate. Moreover, adaptation and mitigation efforts, often grounded in science, have societal, economic, and political sides. An interdisciplinary approach is needed to find innovative solutions to slow climate change and mitigate its impacts and to communicate with people about the realities of climate change.

AF SPS Undergraduate Oral Talks

Time: 3–3:50 p.m. Sponsor: AAPT/SPS Date: Sunday, Jan. 19 Location: Bonaire 1-2 Presider: *Brad Conrad*

AF01: 3-3:10 p.m. Measuring Pressure and Strain with Luminescent Coatings

Contributed – Kimberly Lowndes, Berry College 1395 Wilmington Way Grayson, GA 30017-1075;*

Kyle Chism, Amruthkiran Hegde, James P. Hubner, The University of Alabama

Often, researchers employ probes such as pressure taps and strain gauges to measure the pressure and strain on aerodynamic objects. However, these tools lack high-resolution and full-field capabilities that may be necessary for high-speed aerodynamic testing. A combination of photoelastic coatings (PEC) and pressure sensitive paint (PSP) has the potential to provide researchers with correlated, full-field surface measurements of maximum shear strain and pressure, respectively. Photoelastic coatings use circularly polarized light along with birefringent material properties to provide information about the surface strain of objects, while pressure sensitive paint utilizes oxygen-quenched luminophores to measure pressure. Benchtop test results will be presented of a dual-layer PEC/PSP coating applied to cantilever beams subjected to static and dynamic loading and imaged with a micro-polarizer digital camera.

*Sponsored by Todd Timberlake

AF02: 3:10-3:20 p.m. Analysis of Lorentz-Violation for a Massive Fermion in Curved Spacetime

Contributed – Parker J. Roberts, Berry College PO Box 490628 Mount Berry, GA 30149

Charles Lane, Berry College

Symmetry of physical laws under Lorentz transformations is an important principle of physics that has been tested to a high degree of experimental accuracy. However, some proposed theories, such as those aimed at reconciling inconsistencies between general relativity and the Standard Model, may lead to violations of Lorentz symmetry in high-energy regimes. The Standard Model Extension (SME) is a field-theoretic framework that includes possible Lorentz-violating background terms. These fields lead to asymmetries between reference frames, locally violating special relativity. Calculating low-energy limits of the SME provides insight into which properties of Lorentz-violation may be potentially measurable in the future. This work analyzes the SME for a massive fermion in a weak gravitational field by exploring its non-relativistic limits.

AF03: 3:20-3:30 p.m. Band Structure and Defects in a Simple Quantum System

Contributed – Neilson Charles Woodfield, Berry College 2277 Martha Berry Highway, NW Mount Berry, GA 30149;*

Todd Timberlake Berry College

We explore the energy eigenvalue spectrum of a finite one-dimensional periodic quantum system. In particular, we examine a system consisting of an infinite square well containing a number of evenly spaced Dirac wells. We study the formation of band structure as Dirac wells are added to the infinite square well. In addition, we study the effects of introducing two types of defects: a change in the strength of a single Dirac well, and a change in the position of a single Dirac well. We see that both types of defects can cause energy levels to move out of a band and into a band gap. Our results show that this extremely simple model can be used to clearly illustrate important properties of periodic quantum systems.

*Sponsored by Todd Timberlake

AF04: 3:30-3:40 p.m. Deposition of Crystalline InGaSb by Electrochemical Liquid-Liquid-Solid Growth

Contributed – Raphael P. Francisco, Berry College, PO Box 491385 Mount Berry, GA 30149-1385

Zachary Lindsey, Mark Moran, Quinn, Smith Berry College

Semiconductors are critical to many aspects of modern technology due to desirable electronic and optical properties for a wide range of applications. InGaSb is a ternary semiconductor alloy with tunable optoelectronic properties in the near infrared (NIR) region of the electromagnetic spectrum, making this material a suitable candidate for various applications in NIR sensing and detection. Current methods for producing InGaSb require high-cost experimental setups and toxic gaseous precursors. Thus,

this research focuses on deposition of crystalline InGaSb via the electrochemical liquid-liquid-solid (ec-LLS) process, where growth occurs at atmospheric pressure and near room temperature. The hypothesis tested in this work is that crystalline InGaSb can be grown via ec-LLS using various combinations of In and Ga liquid metals to serve as an electrode, solvent and a coreactant promoting semiconductor crystal growth. As-grown InGaSb crystals will be characterized for crystallographic properties via X-ray diffraction and electrical properties via electrochemical impedance spectroscopy.

AF05: 3:40-3:50 p.m. Developing Leaf-based Electronics

Contributed – James M. Targos, Jacksonville University 2800 University Blvd., N Jacksovnille , FL 32211

Jack D. Terrell, Ramesh Y. Adhikari, Jacksonville University

Over the last decade, there has been an unprecedented global increase in consumption of electronic devices. In addition, the duration for which an electronic device is used continues to decrease as the newer versions are pushed into the market every few years. This has resulted in a growing amount of electronic waste (e-waste) being generated across the world. Despite efforts to recycle, a disproportionate amount of e-waste ends up in landfills, which causes the pollution of soil and water sources. One way to address the issue is to develop electronic components that are biodegradable. We present our work on using leaves of a monocotyledon plant as biodegradable templates to construct electronic components. We convert the vascular conduits of the leaves into conducting channels and construct wires and supercapacitors within them. This demonstrates the possibility of using plant parts as an alternative towards the development of biodegradable electronics.

AG Introductory Labs/Apparatus

Time: 3–3:50 p.m. Sponsor: AAPT Date: Sunday, Jan. 19 Location: Bonaire 3-4 Presider: *TBA*

AG01: 3-3:10 p.m. Ditch the Manual….Free the Lab!

Contributed – Patrice Noel Edwards, College Coastal Georgia One College Drive Brunswick, GA 31520;

Students are often bored by the common laboratory experience. They are used to getting a laboratory assignment, reading the instructions, and replicating the experiment. Turn it in, get a grade, and repeat the process the next week. But what if they actually had the opportunity to be more involved in the lab construction process? In this observation, students were given the opportunity to do such a thing with "Do It Yourself" labs. Students were paired in groups of two and then given a topic such as capacitance. The students were then able to make their own lab reports. They created the procedure, picked out the equipment, and then chose the questions for their lab during the first week. Students then switched the labs with their partner the next week and performed their experiment. Compared to traditional laboratory exercises, the students in this observation were very engaged in the process.

AG02: 3:10-3:20 p.m. Determining Ballistic Pendulum Effective Mass via Varied Projectile Launch Speed

Contributed – James C. Sanders, Troy University 315 McCall Hall (MSCX 315) Troy, AL 36082

A ballistic pendulum launcher is modified so that the launching speed of the projectile can be varied in a controlled manner. A plot of the square root of the maximum displacement height against the launch speed yields a straight line. The slope of this line can then be used to determine the effective mass for the pendulum, and hence its moment of inertia. We have done this for three pendula of varying mass distributions, and in all cases we have obtained an effective mass of within <2% error compared to theoretical calculations of the effective mass.

AG03: 3:20-3:30 p.m. Designing Laboratories for Online Instruction Using the iOLab Device

Contributed – Louis Leblond, Penn State University Davey Lab University Park, PA 16802

Melissa Hicks, Penn State

Scientific laboratories are among the most challenging course components to integrate into online instruction. Available technology restricts the design and nature of experiments and it can be hard to replicate the collaborative lab environment where frequent and immediate instructor feedback is the norm. Here we report on technological and pedagogical aspects of newly developed labs for online courses using the Interactive Online Lab (iOLab) device. We argue that this technology, coupled with an online course design emphasizing teamwork, targeted feedbacks, and self-regulation skills, provides a robust framework for students to do reliable, engaging, inquiry-based and hands-on labs outside the classroom. After describing the implementation and technology, we explain our lab objectives and how the labs were integrated into two introductory physics courses.

AG04: 3:30-3:40 p.m. Density in Nature: A Teaching Opportunity

Contributed – Sytil K. Murphy, Shepherd University PO Box 5000 Shepherdstown, WV 25443-5000

Jacquelyn Cole, Jonathan Gilkerson,Carina Petretta, Nicholas Nunes, Shepherd University

Coastal water mangrove forests represent diverse ecosystems that contribute substantially to the health of the planet. These ecosystems are threatened by global climate change resulting from rising ocean levels; thus, understanding how mangrove trees reproduce and distribute their seedlings is important to predicting how climate change could affect these ecosystems. Mangroves are viviparous: the seeds germinate while still attached to the parent tree. The resulting propagules are mostly stem -- the bottom tip will develop into roots and the top into the shoot. Propagules drop from the parent tree and float vertically, root-tip down, in the water, drifting away from the parent until they become planted. This preferred orientation is caused by a density gradient along the propagule's length and is essential to distribution. Preliminary data will be presented on the density gradient of red mangrove propagules. Discussion will focus on how this system could be adapted into laboratory exercises.

AG05: 3:40-3:50 p.m. Reinvent the Electric Potential Mapping Experiment Using Conductive Papers

Contributed – Jingbo Ye, Department of Physics, Southern Methodist University 3215 Daniel Ave. Dallas, TX 75205-0100

It is a common experiment in E&M labs that uses conductive papers to illustrate electrical equal-potential lines between two electrodes of a DC power supply. Coordinates printed on the conductive paper, or a carbon-copy paper used with a graph paper are used help trace the equal-potential lines. In either case the conductive paper is for single use and there is no calculation and comparison of the measurements with theoretical values. I will present a new measurement of three configurations (point, line and circular potentials), still based on the conductive paper, but with a set of sliding rules to obtain the values of (x,y,V). The setup is for multiple use. I will discuss the guidance to the students on data acquisition and analysis. I offer the students the comparison between measurements and calculations, and the understanding of the measurements with DC current (Ohm's Law) and the analogue to static electric field/potential.

AH Inclusive Communication 101

Time: 1:30–3 p.m. Sponsor: AAPT Date: Sunday, Jan. 19 Location: Bonaire 7-8 Presider: *Jennifer A. Sandoval*

Language is dynamic and powerful, but consistently has tremendous impact on the lived experiences, especially for black, indigenous, people of color and other communities that experience marginalization and oppression. This session focuses on constructing a shared, inclusive vocabulary that is person-centered and uses the most contemporary best practices for equitable and inclusive language. Inclusive Communication 101 covers multiple modes of communication as well as culturally competent and equity minded practices for the intersection of race/ethnicity, sexual/romantic orientations, gender expressions and identities, and disability.

BA PTRA: Helping First Year and Pre-Service Teachers

Time: 3–4:30 p.m. **Sponsor: Committee on Physics in Pre-High School Education** **Co-Sponsor: Committee on Physics in Two-Year Colleges**
Date: Sunday, Jan. 19 **Location: Antigua 1-2** **Presider:** *Ann Robinson*

Using a resource book designed by members of AAPT/PTRA participants will complete activities designed to catch and hold students' interest.

BB Advanced Labs (especially Contemporary Physics or Stat/Thermo)

Time: 3–4:50 p.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on on Educational Technologies**
Date: Sunday, Jan. 19 **Location: Antigua 3-4** **Presider:** *Randy Peterson*

BB01: 3-3:30 p.m. An Advanced Lab Experiment on Measuring Magnetization in Permanent Magnets*

Invited – Biplob Barman, University of Michigan-Flint, 303 E. Kearsley St., 207 MSB Flint, MI 48502

Athos Petrou, State University of New York at Buffalo

Magnetism has been intriguing mankind for centuries now. With the exploration of newer magnetic materials, it became essential to develop techniques to measure magnetization in these, especially from a pedagogical perspective. In this talk, we present a low-cost experimental technique to determine the magnetization of a permanent magnet, using readily available lab equipment. Magnetization M plays a key role in studying the response of magnetic materials to external magnetic field B. The proposed method discusses the effect of B (produced by a pair of Helmholtz coils) on a permanent magnet, suspended by strings and allowed to oscillate under the influence of the torque the magnetic field exerts on the magnet. The arrangement uses mechanical energy conservation principles to measure M via graphical analysis. While this experiment is suitable for both undergraduate Physics and Engineering majors, the extent of exploration rests with the instructor.

*This work was supported by NSF DMR-1305770.

BB02: 3:30-4 pm. 3 for $33: Advanced Experiments in Thermal Physics

Invited – Jed Brody, Emory University, 400 Dowman Dr., Atlanta, GA 30322

I describe three experiments that illustrate surprisingly mathematical thermal physics in simple objects. The equipment is cheaper than a textbook, cheap enough for online students to purchase and use at home. In the first experiment, a water column oscillates in a long plastic tube, sealed at the top. The water column's oscillations mysteriously reach their lowest frequency when the tube is about half full of water. In the second experiment, a laser shines through a block of Plexiglas chilled from below by ice water. The laser beam's deflection increases and then mysteriously decreases as the temperature decreases monotonically. In the third experiment, temperature is measured at the top of a nail whose bottom tip is immersed in ice water. The theoretical fit is a truncated infinite series in which each term requires the numerical solution of a different transcendental equation.

BB03: 4:10-4:20 p.m. Using Magnetism Data to Illuminate the Build-up of the Periodic Table

Contributed – David A. Van Baak, TeachSpin, Inc., 2495 Main St., Suite 409 Buffalo, New York 14214

Every modern-physics textbook feels obligated to teach an atomic-physics justification of the periodic table of the elements, always described via the process of filling s-shells, p-shells, etc. But few textbooks display any actual data that illuminates the filling of the d-shells (in the transition metals) or the f-shells (in the rare-earths and actinides). This talk advocates the simple tabletop measurement of magnetic susceptibility as offering direct experimental evidence for the existence of partly filled d- and f-shells, as that measurement can directly detect the magnetic consequences of the spin-unpaired electrons that occupy a partly-filled shell.

BB04: 4:20 -4:30 p.m. The Rarely Observed Transients in the Damped and Driven Simple Harmonic Oscillator

Contributed – Jonathan F. Reichert, TeachSpin, Inc., 2495 Main St., Suite 409 Buffalo, NY 14214

David A. Van Baak, TeachSpin, Inc.

The driven damped simple-harmonic-oscillator problem is one of the most widely used models in all of physics, and most physicists appreciate the central role of resonance in understanding the solution of this problem. But not everyone appreciates that the textbook plots of resonance apply only to the steady-state solution that eventually applies. What is the character of the transient solution that applies during the wait for steady state? How long does that transient last? What the transient look like if the drive frequency mis-matches the system's resonant frequency? This talk discusses how to think about the transient solution, shows a concrete example of these phenomena in TeachSpin's torsional oscillator, and explains the counter-intuitive features that arise during the transient.

BB05: 4:30-4:40 p.m. Investigating Physical Experiments in USTC

Contributed – Zengming Zhang, University of Science and Technology of China No. 96 Jinzhai Road Hefei, Anhui 230026

After studying experiments of general physics for three semesters, students hold good experimental skills and some measurement methods, have solider fundamental knowledge and understand some data processing methods and uncertainty analysis. During the fourth semester of lab class, they need to study the investigating physical experiments. During the advanced lab course, a group including 3 or 4 members from different majors such as physics, materials and optics focus on a project and finish it based on the sample synthesis, characteristic equipment and DIY for some special parts. These projects involve frontier research, improving experimental item, interesting physical phenomena and building a physical instrument to implement some functions and measurements. The students design the investigating content and method by themselves. Practice shows that the student's operating skill, methods of analyzing and resolving problems are improved. Their active, innovative ability is excited.

BB06: 4:40-4:50 p.m. Modeling Radiation Trapping in Alkali Vapors

Contributed – Stephen Spicklemire, University of Indianapolis Martin Hall 263, 1400 E Hanna Avenue Indianapolis, IN 46227

Monte Anderson, Jerry Sell, Jacob Malloy, Brian Patterson, United States Air Force Academy

We discuss an undergraduate capstone project involving the visualization of Monte Carlo simulations of radiation trapping in alkali vapors and comparison to experimental data. Radiation trapping is the confinement of light in atomic vapors by successive absorption and reemission of photons. If the vapor is sufficiently dense, the apparent lifetime of the atomic excited state, as observed in the fluorescence decay, may be significantly longer than the natural lifetime. The calculations modeled and visualized the random walk of photons in cesium and rubidium vapors in a small, temperature-controlled cell, from initial absorption using a broadband laser source to eventual escape and detection. The calculated effect on the measured lifetime was compared to the results of an experiment having the same geometry and utilizing a Ti:sapphire pulsed laser for excitation. This project has allowed undergraduates to meaningfully integrate numerical and experimental techniques and explore various modes of data visualization.

BC 21st Century Physics in the Classroom II

Time: 3:30–5:10 p.m. **Sponsor: Committee on Contemporary Physics** **Date: Sunday, Jan. 19**
Location: Grand Sierra F **Presider:** *Shane Wood*

BC01: 3:30-3:40 p.m. A Study of Beamline Muon Rates with Multiple Acceptance Angles

Contributed – Alex Bernat, Rochelle Zell Jewish High School 192 South Deere Park Highland Park, IL 60035-5340

Joshua Simon, Shira Eliaser, Rochelle Zell Jewish High School

Chicago area high school students evaluated muon rates in FermiLab's MINOS tunnel. Two detectors were placed in the tunnel, with one horizontally aligned in the beamline and one aligned vertically, toward the access shaft and sky. Data was collected for six weeks as the two detectors were moved down the tunnel and away from the access shaft. We hypothesized that the horizontal detector in the beamline would accept neutrinos only from the beam when the detector was set to require coincidence between the three photomultiplier tubes in the beam line. We examined the muon rate from the detectors whose angle of acceptance included portions of the access shaft. Thus, the certain days of data required normalization for the active beam.

*Sponsored by Nathan Unterman, in association with the MUSE collaboration

BC02: 3:40-3:50 p.m. Infusing 21st Century Physics into the Classroom Using QuarkNet Data-Activities-Portfolio*

Contributed – Deborah Roudebush, QuarkNet 4410 Mariner Lane Fairfax, VA 22033

The QuarkNet Data Activities Portfolio is a compilation of activities designed to infuse 21st century physics into the high school classroom. Features of the web site will be demonstrated, including the updated Pathways feature which allows teachers to search for activities related to the topic of the day.

*This work is supported by NSF and Fermilab.

BC03: 3:50-4 p.m. Facilitating the High School Muon Underground Shielding Experiment (MUSE)

Contributed – Marybeth Senser, Downers Grove South High School 1436 Norfolk Street Downers Grove, IL 60516

Tony Valsamis, Glenbrook North High School

Allan Sears, Ida Crown Jewish Academy

Shira Eliaser, Rochelle Zelle Jewish High School

Nathan Unterman, New Trier High School

A collaboration of 11 high school students from five high schools ran an ambitious experiment called the Muon Underground Shielding Experiment (MUSE) to measure muon flux in the Fermilab MINOS facility 100 meters underground. MUSE teacher sponsors discuss how the student project was managed: generating the research question, mentoring students in committees to address issues and develop solutions, fostering interschool collaboration, submitting a technical scope of work to Fermilab, coordinating with lab scientists and engineers, overseeing safety check, assembling resources from various schools, facilitating data taking, supervising analysis, and mentoring the reporting process. Trials and triumphs will be shared. Key takeaways will include how to cooperate with other schools, connect with STEM related institutions in the region, and direct a diverse group of students in a collaborative research project.

BC04: 4:-4:10 p.m. Teaching and Learning: What I Learned from the ACUE Modules

Contributed – Irene Guerinot, 502 E. Lamar Alexander Pkwy Maryville, TN 37804

Physics is a particularly challenging subject, which demands quality teaching and special attention to the individual learning progress of each student. Both the teaching profession and the field of physics are in a constant state of change. Teaching strategies are emerging constantly and several organizations offer courses on teaching techniques, in an effort to improve student engagement, retention, and academic success. During the 2018-2019 academic year, I participated in an online course designed and presented by the Association of College and University Educators (ACUE) on Effective Teaching Practices. I will be presenting materials, and strategies generated and implemented since the beginning of the 25module course. I will be concentrating on the following topics: growth mindset, engaging under-prepared students, designing effective assignments, and motivating goals.

BC05: 4:10-4:20 p.m. Cosmic Ray Muon Rates Below Ground: Elevator Model

Contributed – Eleanor Anne Winkler, New Trier 350 Willow Road Winnetka, IL 60093*

Emmanuelle Copeland, Marybeth Senser, Downer's Grove South

Paul Graham, Nathan A. Unterman, New Trier High School

High school students measured muon count rates during descent and ascent in an elevator, going 103 meters underground at Fermilab's MINOS access shaft. The vertically oriented detector included three angles of acceptance: six degrees, 21 degrees, and full sky. Students took data on the ascent and descent in the elevator to compare muon count rates vs. depth, in order to examine the immediate impacts of increased burden due to the surrounding rocks, dirt, and concrete, along with the impact of passing through the path of MINOS' neutrino beam.

*Sponsored by Nathan Unterman

BC06: 4:20-4:30 p.m. BiteScis: Engaging Research-based Physics Lessons Through Teacher-Researcher Partnerships

Contributed – Shannon Morey, BiteScis, Abbott Lawrence Academy 70-71 N Parish Rd. Lawrence, MA 01843

Nathan Sanders, ComSciCon

Stephanie Keep Kelsey Lucas, BiteScis

BiteScis (bitescis.org) is dedicated to engaging students by exposing them to current science research that provides context to the content they are expected to master. BiteScis lessons are developed in collaborative partnerships between high school teachers and early career STEM researchers. The development process provides relevant, useful, and unique professional development for both "BiteScientist" partners. The lessons that result are of the highest quality, standards-aligned, easy-to-implement, and are designed to root out misconceptions and provide a good classroom experience for teachers and students. This presentation will describe our model and present BiteScis' physics resources currently available, which are all free and fully-editable, on our webpage. Like all BiteScis lessons, they affirm for students that the knowledge they are gaining in the physics classroom is the foundation for emerging research, from examining swimming dolphins to study conservation of momentum to discussing liver fibrosis to develop an understanding of mechanical waves.

BC07: 4:30-4:40 p.m. Profiling Muon Flux in Fermilab's MINOS Tunnel

Contributed – Jacob M. Miller, Ida Crown Jewish Academy 3837 Greenwood St Skokie, IL 60076*

Benjamin Grey, Ida Crown Jewish Academy

Nathan A. Unterman, New Trier High School

High school students determined the effect of burden on muon flux by collecting data from Fermilab's MINOS tunnel. Flux varied due to a change in burden created by a 103 meter access shaft. A profile of muon flux as a function of distance from the access shaft was created by observing muon flux from different locations within the tunnel. We hypothesized that muon flux would decrease as the detectors moved away from the shaft. The results presented will provide insight into the capacity of burden to shield muons.

*Sponsored by Nathan A. Unterman

BC08: 4:40-4:50 p.m. Determining Effects of a Neutrino Beam on Muon Flux

Contributed – Henry Liam Seiden, Glenbrook North High School 2410 Illinois Road Northbrook, IL 60062-5241*

Max Miller, Allen Sears, Ida Crown Jewish Academy

Tom Blackmore, Downers Grove South High School

Anthony Valsamis, Glenbrook North High School

During an experiment measuring muon flux in the MINOS tunnel at Fermilab, QuarkNet students detected muons from a neutrino beam traveling through their detectors. We will discuss the horizontal beam's impact on the measured vertical cosmic ray muon flux.

*Sponsored by: Nathan Unterman In association with MUSE collaborators

BC10: 5-5:10 p.m. Developments in International Masterclasses

Contributed – Kenneth W. Cecire, University of Notre Dame Department of Physics, 225 Nieuwland Science Hall Notre Dame, IN 46556

International Masterclasses (IMC) have developed since their introduction in 2005. Recent innovations include Masterclasses for International Day of Women and Girls in Science (IDWGS) and World Wide Data Day (W2D2). IDWGS opens new pathways for high school girls to be encouraged in physics; W2D2 brings masterclass activities directly to high school classrooms. IMC has also experimented with masterclasses exclusively for university-level students. In 2019, IMC added the new MINERvA Neutrino Masterclass, the first offering in neutrino physics and the first based on a Fermilab experiment. In the MINERvA measurement, students are able to study interactions of a neutrino beam with carbon nuclei, using conservation of momentum to draw conclusions. Other new masterclass measurements for Belle II, MicroBooNE, and medical imaging planned for 2020. A longer-term goal is the creation of a DUNE masterclass measurement as that facility reaches the data-taking stage.

BD PER: Curriculum and Instruction

Time: 3:30–5:10 p.m. Sponsor: AAPT Date: Sunday, Jan. 19 Location: Grand Sierra G Presider: *TBA*

BD01: 3:30-3:40 p.m. Creating Instructional Content: Tools and Best Practices to Optimize Workflow

Contributed – Zachary Felker, University of Central Florida 4111 Libra Dr. Orlando, FL 32816-2385

Tom Zhang, Geoffrey Garrido, David Wright, Zhongzhou Chen, University of Central Florida

Our group has created multiple sequences of mastery-based online modules for a calculus-based introductory mechanics course. To overcome the challenges of collaborative creation of instructional resources—such as ensuring that the individual contributions of group members can be effectively integrated into a coherent finished product—we utilized a set of free software tools and established best practices to optimize our workflow. Learning modules were implemented on an open-source platform, Obojobo. Git, Slack, and OneNote were used to facilitate communication and achieve effective version control. Inkscape was used to quickly create aesthetically pleasing figures with uniform quality and style, despite varying levels of artistic talent among group members. We also found that, contrary to expectations, a rigorous team hierarchy was not beneficial for productivity. In fact, the group operated most productively when priorities were set and tasks were assigned as a result of discussion and consensus rather than oversight.

BD02: 3:40-3:50 p.m. Examining Affordances and Limitations of Resources-oriented Instructional Materials for Wave Propagation

Contributed – Lisa M. Goodhew, University of Washington - Seattle 3910 15th Ave NE Seattle, WA 98195

Lauren C Bauman, Quest University

Amy D Robertson, Seattle Pacific University

Paula R L Heron, University of Washington - Seattle

Rachel E Scherr, University of Washington - Bothell

Many research-based instructional materials in physics have been informed by investigations of students' common misunderstandings, misconceptions, or difficulties – that is, ways in which student ideas are inconsistent with canonical understandings. Our research team is in the early stages of developing instructional materials that elicit and build on common conceptual resources for understanding physics. In this talk, we will use classroom video to highlight some affordances and limitations of resource-oriented materials on mechanical pulse propagation.

BD03: 3:50-4 p.m. Promoting Theory-Evidence Coordination through Scaffolded Question Prompts*

Contributed – Kathleen M. Koenig, University of Cincinnati 400 Geo/Phys Building 2600 Clifton Ave Cincinnati, OH 45221

Krista E Wood, University of Cincinnati

Lei Bao, The Ohio State University

Theory-evidence coordination (TEC) is an integrative reasoning framework that incorporates student prior knowledge (personal theories) with empirical data and scientific theories as part of the knowledge-generation process. It includes reflection on pre-existing beliefs and seeking those more plausible, particularly in light of inconsistent evidence. This presentation will describe an introductory college physics lab curriculum, Inquiry for Student Thinking and Reasoning (iSTAR), which was developed using the TEC framework as its foundation. A set of question prompts, which guide students through the TEC process during each inquiry cycle, will be showcased along with their impact on student writing of evidence-based claims.

*Partially supported by NSF IUSE DUE 1431908

BD04: 4-4:10 p.m. Three Approaches for Designing Physics Activities

Contributed – Amin Bayat Barooni, Georgia State University One Park Place, Room 431 Atlanta, GA 30302-3999;

Joshua Von Korff, Brian D. Thoms, Zeynep Topdemir, Georgia State University

Jacquelyn Chini, University of Central Florida

In this study, we coded 66 research-based activities from 11 distinct curricula and used K-means cluster analysis to identify themes in activity design. Our results suggest three approaches to instructional design among the selected curricula. By comparing our codes with the goals instructional designers described in interviews, we described the clusters as: Thinking Like a Scientist, Learning Concepts, and Building Models. These three clusters address different design goals. Activities in the Thinking Like a Scientist cluster mainly focus on student experimental design, producing spoken representations, and qualifications. Activities in the Learning Concepts cluster focus on observations and predictions. Activities in the Building Models cluster focus on physics or math questions that do not use data from measurements or observation and involve producing spoken representations. Our results support instructors who want to design their own lab activities by demonstrating methods that align with various instructional goals.

BD05: 4:10-4:20 p.m. The Role of Physics Curriculum in Students' Core Competence

Contributed – Zixin Xiao, East China Normal University East China Normal University, PuTuo District, Shanghai, China Shanghai, Shanghai 200062 China

With the development of economy and society, core competence education has become the consensus in educational community. Physics is the earliest ancestor of natural science, so the study of Core competence of physics subject is significant. The purpose of the study is to explore whether there are differences in the influence of physics curriculum on the internal dimensions of core competence of physics subject. Our research adopts one-group pre-test-post-test design. We did pre-test and post-test with 156 samples. The questionnaire was designed by our researchers according to other relevant literature and PISA test. Our research showed that there are differences in the influence of physics curriculum on the internal dimensions of core competence of physics subject. We can administer more surveys to investigate the reasons behind the result in the future.

BD06: 4:20-4:30 p.m. Instructional Pragmatism: Using a Variety of Evidence-Based Approaches Flexibly to Improve Student Learning

Contributed – Chandralekha D. Singh, University of Pittsburgh 3941 Ohara St Pittsburgh, PA 15260

Paul Justice, University of Pittsburgh

Instructional pragmatism is essential for successfully adopting and adapting evidence-based active engagement (EBAE) approaches in that instructors should view improving teaching and learning as a process and not get disheartened if a particular EBAE approach does not produce the desired outcome. Instructional pragmatism entails keeping a variety of EBAE methods in one's instructional toolbox and using them flexibly as needed to improve student learning and continuously refining and tweaking one's implementation of the EBAE approaches to make them effective. Here we illustrate an example of instructional pragmatism in which a quantum mechanics instructor did not give up when an EBAE method involving implementation of a sequence of clicker questions on addition of angular momentum did not yield expected learning outcomes even though it was found effective earlier. Instead, the instructor remained optimistic, viewing improving teaching and learning as a process, and pulled out another EBAE method from his tool box that did not require him to spend more time on this topic in class. In particular, the instructor created an opportunity for students to productively struggle with the same problems they had not performed well on by incentivizing them to correct their mistakes out of class. Student performance on one of the addition of angular momentum problems posed on the final exam suggests that students who corrected their mistakes benefited from the task and learned about addition of angular momentum better than those who did not correct their mistakes. Encouraging and supporting physics instructors to embrace instructional pragmatism can go a long way in helping students learn physics because it is likely to increase their persistence in using various EBAE approaches flexibly as they refine and tweak their implementation for their students. We thank the National Science Foundation for support.

BD07: 4:30-4:40 p.m. Instructors' Purposeful Modifications to Group Work: The Case of SCALE-UP at Nine Institutions

Contributed – Erin M. Scanlon, University of Central Florida 4111 Libra Drive Orlando, FL 32816

Jacquelyn J. Chini, University of Central Florida

Numerous studies describe the effectiveness of research-based instructional strategies (RBIS) in STEM courses, but many of these studies are predicated on the assumption that instructors implement the RBIS exactly as intended by the developers. However, instructors modify the RBIS to suit their needs and local constraints. The purpose of this study was to investigate how instructors from nine institutions modified their use of SCALE-UP (Student-Centered Active Learning Environment with Upside-Down Pedagogies) and the reasons they cite for these modifications. We implemented the Modification Identification Framework to classify changes discussed by participants during interviews and identified 107 unique modifications related to group work. We then implemented Revealed Causal Mapping to investigate participants' mental models related to their modifications and created causal maps. In this talk, we will present the most common categories of group work changes and the reasons for those changes highlighted by the aggregated revealed causal maps.

BD08: 4:40-4:50 p.m. Research in Students' Understanding of Basis in the Context of Spin-1/2 Quantum Systems

Contributed – Homeyra R. Sadaghiani, Cal Poly Pomona 3801 W Temple Ave Pomona, CA 91768-2557

Benjamin Schermerhorn, CSU Fullerton

Lucas Corsiglia, Steven Pollock, University of Colorado Boulder

Gina Passante

Depending on the information we would like to readily obtain from a given state, we may choose to represent a quantum mechanical state in a variety of different bases. Students' ability to recognize the need and the processes for changing basis is important and allows them to easily predict certain experimental outcomes. Our preliminary interventions show that many upper-division undergraduate physics students interpret changing the basis as creating a new quantum state and have a number of difficulties completing the related mathematical processes. In this talk we describe the research process in the development and implementation of a tutorial that (1) connects a quantum basis change to the rotation of two-dimensional vectors and (2) makes an analogy to coordinate system choice in classical mechanics. We share student feedback from the first implementations in fall 2018 and further describe the revisions and additions made for future implementations.

BD09: 4:50-5 p.m. Investigating the Effects of Short-Term Mindfulness Sessions on Student Learning

Contributed – Rabindra R. Bajracharya, Missouri Southern State University 3950 E Newman Road Joplin, MO 64801

Cade M Hensley, Danielle M Plutino, Daniel Marsh, Missouri Southern State University

The effects of mindfulness on an individual's mind-body have been studied in multiple disciplines including psychology and medicine. Many K-12 schools have already started to implement mindfulness practices in their curricula to foster teaching and learning practices. We are investigating the effects of short-term mindfulness sessions on students' learning processes in physics including reading, responding to conceptual questions, and problem solving. In each experiment, the participants were randomly assigned to either the treatment or the control group. The treatment group completed a five-minute long mindfulness session, during which they were instructed to observe their breathing objectively. After the mindfulness sessions, both the groups read either powerpoint slides, the solution to a problem, or materials from their textbook. The students then answered conceptual questions or solved problems. We present the results from the study to show whether or not short-term mindfulness sessions have any impact on students' learning processes in physics.

BD10: 5-5:10 p.m. A New Description of Mirror Imaging

Contributed – Yi Ding, East China Normal University East China Normal University North Zhongshan Road Putuo District SHANGHAI, CHINA 200333 CHINA

This paper mainly deals with the principle of plane mirror imaging, imaging rules, and description methods. Middle school students have some misunderstandings and improper statements about mirror imaging. But some scenarios involved in the explanation process are not well understood by them. We propose a new description method to help students better understand the knowledge of plane mirror image.

BE How do YOU Outreach?

Time: 3:30–5:30 p.m. Sponsor: Committee on Science Education for the Public Co-Sponsor: Committee on Educational Technologies
Date: Sunday, Jan. 19 Location: Grand Sierra H Presider: *Jeff Groff*

BE01: 4-4:30 p.m. The "SPOT" Model for Training Outreach Ambassadors

Invited – Kathryn Williamson, West Virginia University 135 Willey St. Morgantown, WV 26506-0002

Sophie de Saint Georges Green Bank Observatory

Sue Ann Heatherly

"SPOT," an acronym for both the "Space" and "Science" Public Outreach Team, is an outreach model that leverages a "train the trainer" approach to amplify the outreach impacts of small teams of scientists and educators by training early-career graduate and undergraduate students to become outreach "ambassadors." SPOT was originally developed for Mars mission outreach at Montana State University in 1996, and it has since grown to multiple research settings (ex: solar physics, gravitational waves, and water quality research) and to multiple states (with hubs in Montana and West Virginia), reaching tens of thousands of K-12 students annually and operating at low institutional costs. In this talk, I will describe success and lessons learned from implementing SPOT, as well as provide advice for how to adopt (and fund) the SPOT model for your own outreach settings.

BE02: 4:30-5 p.m. The Seeding Your Future Initiative: STEM Outreach for Grades 5-12

Invited – Sytil Murphy, Shepherd University, PO Box 5000 Shepherdstown, WV 25443

Jordan Mader, University of Arkansas Fort Smith

The Seeding Your Future Initiative started in fall 2014 with the goal of providing STEM outreach in the Eastern Panhandle of West Virgina and surrounding four-state area. The Initiative began with the Seeding Your Future Conference. This conference targets 5th-8th grade girls, with the goal of the participants gaining or maintaining an appreciation for the wide variety of STEM fields, their abilities within these fields, and the applicability of STEM to everyday life. Throughout the day, the participants interact with role-model women in STEM during the panel discussion and during the hands-on workshops they complete. In September 2015, the Seeding Your Future Workshop Series began for 8th-12th grade students. Workshop Series events are held monthly during the academic year and feature a two-hour in-depth hands-on STEM activity. Due to grant funding, all program activities are free of charge to participants.

BE03: 5-5:10 p.m. Physics Workshops for High School Sophomores in Jamaica

Contributed – Michael J. Ponnambalam, St. Teresa's Higher Secondary School Vadakkankulam Tamil Nadu, 627116 India

Physics Outreach was started by this author in Jamaica in 2006. It was multi-pronged, reaching out to students in Primary, Middle and High Schools, Colleges and Universities - as well as the general public. As a result, the number of students in Introductory Calculus-based Physics at the University of the West Indies, Jamaican Campus nearly tripled within four years. This presentation focuses on the work done for the high school sophomores.

BE04: 5:10-5:20 p.m. Giving a Feynman Lecture on Physics as Richard Feynman

Contributed – James Lincoln, PhysicsVideos.com PO Box 11032 Newport Beach, CA 92658-5016

At PhysicsCon, January 4, 2020, I will have portrayed the world-famous physicist Richard P. Feynman and delivered one of his Feynman lectures. In this talk, I share this experience, what motivated it, and how it was received. I also answer logistical questions about the performance and explain how other institutions can also share in the fun of such an impersonation.

BE05: 5:20-5:30 p.m. The Devil's Staircase: Communicating Physics and Math with Music

Contributed – Timothy McCaskey, Columbia College Chicago Science and Mathematics Department, 600 S. Michigan Ave Chicago, IL 60605-1996

Luis Nasser, Columbia College Chicago

This talk will discuss a musical project where the compositional forms are inspired by phenomena in math and physics such as cellular automata and fractals. Our work has allowed us to perform science outreach in different ways: we can play rock shows where the science is communicated informally or present colloquium talks for general undergraduate audiences and musicians. Various visual aids accompany our finished album product. Questions we consider include how to focus material for different audiences and incorporate the ideas into future courses we teach.

BF Communicating Across Difference: Strategies for Navigating Complex Contexts

Time: 4–5:30 p.m. Sponsor: AAPT Date: Sunday, Jan. 19 Location: Grand Sierra C Presider: *Jennifer A. Sandoval*

This workshop focuses on interpersonal and instructional communication contexts walking participants through essential conceptualizations of equity, inclusion, and diversity. This session focuses on increasing self-awareness in order to equip attendees with equity minded competence for the workplace and the classroom. Topics include understanding power and privilege and intersectional identity in order to navigate communication effectively in spaces of difference. Participants will learn how to practice calling out and calling in as well as how to become an accomplice in situations where they can leverage their privilege to amplify others experiences.

BG Success Stories of Female Physicists

Time: 4:30–5:30 p.m. **Sponsor: Committee on Women in Physics** **Co-Sponsor: Committee on Professional Concerns**
Date: Sunday, Jan. 19 **Location: Bonaire 1-2** **Presider:** *Fatma Salman*

BG01: 4:30-5 p.m. Building a Career: Mentoring and Make-ing

Invited – Anne Cox, Eckerd College 4200 54th Ave S St Petersburg, FL 33711

When you get to build a career on what you really love, in my case, teaching physics, working with students, and creating curricular materials, even the grading is worth it (most of the time). My work with students and faculty has evolved in unexpected ways, particularly with regard to Mentoring and the Maker movement. I will discuss the value and impact of these two seemingly disparate activities, the connections between them, and how you might think about them in the context of your career.

BG02: 5-5:30 p.m. Changing the Culture of a Physics Department: Our Story

Invited – Talat Rahman, University of Central Florida 4000 Central Florida Blvd Orlando, FL 32816

When I joined the Physics Department at the University of Central Florida in 2006, I was excited to have the opportunity to help move the department forward in research, education, and service and at the same time overwhelmed by the challenges, some of which were unexpected. It was after all a traditional physics department, with traditional aspirations and traditional reward system. After a hard year of taking stock of things, some pieces fell in place and instructional reform offered itself as a vehicle that could facilitate much needed change in the departmental culture. In this talk I will point to some strategies that we undertook, some collective decisions that we made and some overarching reforms that we put in place that have helped create a student-centered culture which also fosters high faculty research productivity and sound educational gains. The APS PhysTEC and Bridge Program were a boon and helped create a promising, diverse and inclusive environment.

BH The Role of Technical Competency in Undergraduate Physics Education

Time: 4:30–5:30 p.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on Apparatus**
Date: Sunday, Jan. 19 **Location: Hibiscus** **Presider:** *Toby Dittrich*

The AAPT guidelines for laboratory instruction include developing technical and practical skills as a major goal.The purpose of this session is to assemble a panel to lead a discussion on the importance of technical competencies in physics careers and on methods by which these competencies may be taught within the formal and informal physics curriculum. Panelists will briefly present summaries of their particular approaches and then engage in active discussion with session attendees of the broader range of possibilities. A key challenge is the broad range of competencies often needed in physics research and in technical design, ranging across topics such as mechanical design, electronics, optics, vacuum systems, low temperature technique, analytical instrumentation, charged-particle beams, etc. Formal course work can only develop a foundation, so how might it be possible to flexibly assist students in the timely learning of competencies needed for specific projects and for unique career goals? How is it possible to bring students to a high level of sophistication in both the underlying physical modeling and in the skilled execution of technical design, technical procedures, and instrument operation? A special goal of this session is to invite people attending the session to bring and share short summaries of their approaches to these questions.

BH01: 4:30-5:30 p.m. Identifying Technical Competencies Desired for Physics Majors - A Progress Report

Panel – Randall Tagg, University of Colorado Denver Physics Dept - CB 157, P.O. Box 173364 Denver, CO 80217-3364

Students use a lot of specific technical knowledge in research and in work settings. Examples include selection and use of sensors, various fabrication skills, optical setup and alignment, and working with vacuum systems. A list of desired technical competencies is arising through a task force under the AAPT Committee on Laboratories, collaboration on the NSF-funded "PIPELINE" project related to workplace needs, and observation of a large number of student technical projects. Open questions for discussion within this panel session include: how do these competencies serve student career aspirations? How can such competencies be learned effectively, even when they don't fit within the usual physics course sequence? Is there a way to create a shared resource of learning materials so that learning of highly specific competencies can be done more effectively? Can we document and maybe even certify various levels of attainment? How do we make this broadly inclusive?

BH02: 4:30-5:30 p.m. Introductory Undergraduate Course on Experimental Physics Apparatus and Techniques

Panel – Sean P. Robinson, MIT Physics 77 Mass Ave. Rm 4-362, Cambridge, MA 02139-4301

Christoph M. E. Paus, MIT Physics

We describe a new elective course intended to introduce introductory and intermediate physics students to experimental apparatus and techniques. We also describe the relationship of this course to a required advanced laboratory course which focuses on professional development.

BH03: 4:30-5:30 p.m. Technical and Non-Technical Competencies in an Engineering Design Course

Panel – Bruno deHarak, Illinois Wesleyan University, 1312 Park Street, Bloomington, IL 61701

The Engineering Design course at Illinois Wesleyan University is essentially an undergraduate design thinking course meant for physics majors and other students with a technical background. The course's emphasis on design thinking makes it an unusual part of the physics curriculum. This work will present a case study of a minimal set of technical and non-technical competencies needed by students as they progress through the course, and make the case that these competencies are important for physics majors in general.

BI Statistical Physics and Thermodynamics

Time: 5:30–6:30 p.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on Graduate Education in Physics**
Date: Sunday, Jan. 19 **Location: Grand Sierra I** **Presider:** *Andrew D. Gavrin*

BI01: 5:30-6 p.m. The Role of Temperature and Entropy in Thermal Physics

Invited – Jan Tobochnik, Kalamazoo College,1200 Academy Street Kalamazoo, MI 49006

To fully understand a physical concept, students need to know its definition, the many relations in which it appears, how the concept can be visualized in pictures and graphs, how it is measured in experiments and computer simulations, and its role, which is frequently not discussed. I will discuss these ways of knowing for concepts such as temperature and entropy in the context of thermodynamics and statistical mechanics. I will also discuss student misconceptions and what tools may be helpful to overcome them.

BI02: 6-6:30 p.m. Research on Student Learning of Statistical Physics*

Invited – Michael Loverude, California State Univ Fullerton Dept of Physics 800 N State College Fullerton, CA 92834

As part of an NSF-funded project, we have performed research on student learning in upper-division thermal physics and developed associated instructional materials. In this talk, we will describe a subset of this work that relates to statistical physics as opposed to classical thermodynamics. The work was performed in the context of sophomore-level thermal physics, using the text by Schroeder. This text introduces and develops the second law of thermodynamics as a statistical phenomenon using the microcanonical ensemble and thus relies heavily on student understanding of probability and combinatorics. For this paper, we show results for written and interview tasks that probe student understanding of probability, multiplicity, and the concepts of micro- and macrostates. Further, we describe curricular materials designed to support student learning and provide evidence of their efficacy.

*Supported in part by NSF grants DUE-0817335 and PHY-1406035.

BJ 30 Demos in 60 Minutes

Time: 5:30–6:30 p.m. **Sponsor: Committee on Teacher Preparation** **Co-Sponsor: Committee on Physics in High Schools**
Date: Sunday, Jan. 19 **Location: Antigua 1-2** **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.

BK Seeking Sustainable Development of Open-Source Educational Technology

Time: 3:30–4:30 p.m. **Sponsor: Committee on Educational Technologies**
Date: Sunday, Jan. 19 **Location: Grand Sierra I** **Presider:** *Jeffrey Groff*

BK01: 3:30-4 p.m. The PICUP Project – Working Toward Sustainability*

Invited – Larry Engelhardt, Francis Marion University, 4822 E. Palmetto St., Florence, SC Florence, SC 29506

Danny Caballero, Michigan State University

Marie Lopez del Puerto, University of St. Thomas

Kelly Roos, Bradley University

Bob Hilborn, AAPT

PICUP (the "Partnership for Integration of Computation into Undergraduate Education") has been around for more than a decade, but in the last few years, PICUP membership has soared thanks to significant support from the NSF. The question then becomes: how do we continue the success of PICUP after NSF funding runs out? We will discuss the current state of the project, the challenges to sustainability, and some of the potential solutions.

*This work is supported by the National Science Foundation under DUE IUSE grants 1524128, 1524493, 1524963, 1525062, and 1525525.

BK02: 4-4:30 p.m. The Sustainability of GlowScript

Invited – Bruce Sherwood, University of North Texas 3341 Clubview Drive Argyle, TX 76226-2113

VPython makes it easy to write Python programs that generate navigable real-time 3D animations as a side effect of physics computations. It runs in a browser (glowscript.org), with installed Python including in Jupyter notebooks (vpython.org), and as a Trinket (trinket.io). VPython is free, open-source, and widely depended upon by physics students, educators, and researchers. Several people have contributed to building installers for using VPython with installed Python, but for many years only one person has developed and maintained the GlowScript 3D library that is central to all versions of VPython, and the glowscript.org website that has proven particularly appropriate for intro-level students. The Orlando workshop W10 on "The Architecture of GlowScript VPython" is aimed at recruiting more GlowScript developers. Even if additional people contribute, there is a need for long-term institutional support, ideally within AAPT.

Plenary – Jonathan Smith, SeaWorld Parks & Entertainment

Jonathan Smith provides oversight and direction throughout all phases of selection, design development, engineering procurement, installation, commissioning and on-going operation of amusement rides and devices for the 12 SeaWorld Parks. His most recent projects include Iron Gwazi at Busch Gardens Tampa Bay, Ice Breaker at SeaWorld Orlando, Emperor at SeaWorld San Diego, Texas Stingray at SeaWorld San Antonio, and Pantheon at Busch Gardens Williamsburg, all debuting in 2020. Notable recent projects include Oscar's Wacky Taxi at Sesame Place and Infinity Falls at SeaWorld Orlando.

Jonathan started his career with SeaWorld Parks in 2012 as a project manager in the design and engineering department at Busch Gardens Williamsburg and Water Country, USA where he played key roles working on projects and attractions such as Verbolten, Tempesto and InvadR.

Jonathan is a registered Professional Engineer and LEED Accredited Professional and holds a bachelor's degree in Mechanical Engineering at the Ohio State University.

AAPT PHYSICS EDUCATION®

6:45–7:45 p.m.
Sunday, Jan. 19
Grand Sierra E

Plenary –Jim Gates, Ford Foundation Professor of Physics, Brown University

Jim Gates

Sylvester James "Jim" Gates, Jr., (born December 15, 1950) is an American theoretical physicist. He received two B.S. degrees and a Ph.D. degree from the Massachusetts Institute of Technology, the latter in 1977. His doctoral thesis was the first one at MIT to deal with supersymmetry. In 2017, Gates retired from the University of Maryland, and is currently the Brown Theoretical Physics Center Director, Ford Foundation Professor of Physics, an Affiliate Mathematics Professor, and a Faculty Fellow, Watson Institute for International Studies & Public Affairs at Brown University. While at the University of Maryland, College Park, Gates was a University System Regents Professor, the John S. Toll Professor of Physics, the Director of the String and Particle Theory Center, and Affiliate Professor of Mathematics. Gates served on the U.S. President's Council of Advisors on Science and Technology, contemporaneously on the Maryland State Board of Education from 2009-2016, and the National Commission on Forensic Science from 2013-2016. He is known for his work on supersymmetry, supergravity, and superstring theory.

AAPT PHYSICS EDUCATION®

10:15–11:15 a.m.
Monday, Jan. 20
Grand Sierra E

CA Zooniverse: Introductory Workshop for the Classroom Module

Time: 11:30 a.m.–1:30 p.m. **Sponsor: Committee on Space Science and Astronomy** **Co-Sponsor: Committee on Physics in High Schools**
Date: Monday, Jan. 20 **Location: Grand Sierra C** **Presider:** *Laura Trouille*

Working with a national collaboration of astronomy educators and researchers at a range of institution types (R1, SLAC, Community College) with funding from the NSF-IUSE program, we have developed a suite of active learning curricular materials incorporating a citizen science based research experience into Astro 101. The in-class activities and group research experience engage the students in citizen science through Zooniverse.org and employ custom extensions to Google sheets to provide a student-friendly interface for data analysis and interpretation, all while addressing core Astro 101 topics (see classroom.zooniverse.org). In the next phase of this effort, we will enhance the Astro 101 experience (by extending beyond Galaxy Zoo to provide research opportunities in exoplanets, stars, and planetary science). How does participation in citizen science impact students' attitudes towards science and scientists, the role of society in science, and their own science (and citizen scientist) identity development and potential for lifelong engagement and advocacy?

CB Assessing the Effectiveness of Demonstrations

Time: 11:30 a.m.–12:40 p.m. **Sponsor: Committee on Research in Physics Education** **Co-Sponsor: Committee on Apparatus**
Date: Monday, Jan. 20 **Location: Grand Sierra F** **Presider:** *Robert Hobbs*

CB01: 11:30 a.m.-12 p.m. Comparing the Effectiveness of Online vs. Live Lecture Demonstrations

Invited – Kelly Anne Miller, Harvard University 10 Holyoke Pl Cambridge, MA 02138-5006

Greg Kestin, Louis Deslauriers, Logan McCarty, Harvard University

Kristina Callaghan, University of California, Merced

Nearly every introductory physics or chemistry course includes live lecture demonstrations, which can range from simple illustrations of a pendulum to elaborate productions with specialized apparatus and highly trained demonstrators. Students and instructors often consider "demos" to be among the highlights of these classes. Yet in some situations demos may be cumbersome, inaccessible, or otherwise unavailable, and online video demos could offer an effective and convenient alternative. We compared the effectiveness of live demonstrations with online videos under controlled conditions in the first semester of an introductory physics (mechanics) course. Students were randomly assigned to view either a live demo or a video. The same instructor presented both versions of the demo using an identical script. Compared with the students who saw the live demos, the students who watched the online videos learned more, and their self-reported enjoyment was just as high. These results suggest that videos could provide students with an equally effective learning experience when live demos are unavailable.

CB02: 12-12:30 p.m. Meta-demonstration: Choosing a Lecture Demonstration Approach

Invited – Carolyn D. Sealfon, University of Toronto 60 St. George St. Toronto, ON M5S 1A7 Canada

We will experience a familiar physics demonstration three ways: using the Interactive Lecture Demonstration (ILD) approach (Thornton & Sokoloff), using the Investigative Science Learning Environment (ISLE) approach (Etkina et al.), and as a traditional lecture demonstration. The audience will play the roles of students. We will then discuss the different approaches from both the student and instructor perspectives, focusing on learning goals and outcomes.

CB03: 12:30-12:40 p.m. Answering FCI Questions with Student Experiments

Contributed – Charles D. Lane, Berry College 2277 Martha Berry Hwy Mount Berry, GA 30149-5004

Ian Carey, Berry College

"Teaching to the test" is generally not a good thing. We decided to try partially teaching to the Force Concept Inventory (FCI) during one session of an introductory-physics lab. We designed demonstrations/experiments to directly test 14 FCI questions. 47 students spent a two-hour lab session in the first week of classes moving between stations with the different setups. When they took the FCI as a post-test at the end of the semester, their average normalized gain was 0.65, higher than the normalized gain of 0.52 achieved by students in the adjacent 4 years. They fared better than typical on most individual questions, but performed significantly worse on a few.

CC Introductory Courses

Time: 11:30 a.m.–12:50 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Grand Sierra G** **Presider:** *TBA*

CC01: 11:30-11:40 a.m. Playing School: Pros and Cons of Gamifying Your Physics Class

Contributed – Kimberly A. Shaw, Columbus State University 4225 University Ave, Department of Earth & Space Sciences Columbus, GA 31907

At its best, gamification can offer a sense of engagement in learning and higher motivation, but also offer students a sense of challenge, control over their learning, and can provide recognition of different mastery levels. (Faiella and Ricciardi, 2015). Literature on this technique often ties to online learning, but the principles involved are readily adaptable to a lower tech and face to face setting. Something as simple as "levelling up" provides a new reward structure, and a sense of accomplishment, that often is lacking in a STEM classroom. However, to be effective, there must be something valued by the student in that process of levelling up, or the game will not be played. I will present preliminary results from three semesters of using free and low tech methods to gamify introductory level physics courses, including discussion of implementation challenges in addition to successes and failures.

1. Faiella, F., & Ricciardi, M. (2015). Gamification and Learning: A review of issues and research. Journal of E-Learning and Knowledge Society (The Italian -Learning Association Journal), 11(3), 13-21.

CC02: 11:40-11:50 a.m. Camera Obscura: Incorporating HACD and Student-Driven Inquiry into College Physics Curricula

Contributed – Stephanie L. Bailey, Chapman University One University Drive Orange, CA 92866

Rafael Palomino, Asher Wassernan, University of California Santa Cruz

As part of a large introductory physics course on waves and optics for life science majors at UC Santa Cruz, students were challenged to turn a room into a camera obscura. This project describes an effort in spring 2019 to incorporate humanities, arts, crafts, and design (HACD) practices into the college physics curricula. In small groups, they had to choose a hypothesis from a set provided (or one of their own), and design and conduct an experiment to test this hypothesis. The provided hypotheses included a) the clarity of the image formed in a camera obscura varies with the size of the pinhole, b) the clarity of the image formed in a camera obscura varies with the distance between the pinhole and the image plane, and c) the clarity of the image formed in a camera obscura varies with the shape of the pinhole. These hypotheses were provided in order to support students in explicitly engaging in an experimental design process that connects to a hypothesis. Additionally, students had to take digital photographs of the scene outside the window, the image being projected, and the setup. Projects were peer reviewed and grades were based on creativity, thoughtful responses to questions, workflow that demonstrates forethought and planning, results that demonstrate a technical understanding of the pinhole camera model, and photos (scene, image, setup).

CC03: 11:50 a.m.-12 p.m. Reaction Time!

Contributed – Walter Thompson, University of Houston--Clear Lake 3736 Wroxton Rd Houston, TX 77005

Hanging out at the coffee shop, J'onesse challenges her friend: hey Holden, "If you can catch this dollar bill between your fingers, I'll buy desert!" Grasping, it falls gently (but swiftly) through his fingers. In this session I will present a simple classroom activity to apply basic physics to measure reaction time. No stopwatches, no phones, no equipment... just a ruler and inquiring minds.

CC04: 12-12:10 p.m. Understanding Why Validating Our Students Improves Their Learning of Physics

Contributed – Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education 5 N 10th ST Suite A-1 Lafayette, IN 47901

Students in introductory physics courses often express frustration and fear of the course. Faculty often inadvertently reinforce these ideas by how they communicate to the students both inside and outside of the classroom. Examples of this are the well-known example is the physics or math professor who says on the first day "Look to the right. Look to the left. Look in front of you. Look behind you. Only one of you will make it through this course" to simple frustration faculty experience/ and communicate to the students during office hours meeting where the students seem to be unprepared and cannot verbalize their questions. The above two examples are examples of the communication practice of invalidating. Within the field of communication, validation refers to the practice of first acknowledging students' frustrations/ fears, then expressing understanding of why they feel frustrated/ fear and finally working together to overcome students' frustration/ fear.

CC05: 12:10-12:20 p.m. ACES: An Arduino Controlled Exoplanet Simulator

Contributed – Freja Liebach Guttesen, ULAB, University of Copenhagen Fogedmarken 8, 5. tv. København N, København 2200 Denmark

Ian Bearden ULAB, Marta Mrozowska ULAB, University of Copenhagen

We have developed a small model of a planetary system to demonstrate the detection of exoplanets. The apparatus consists of a light bulb at the center (the star), and two orbiting interchangeable 3D printed spheres (the planets). Since an orrery is a representation of our solar system, we call this an exorrery. Students place a light sensor outside the system to measure the "star's" light intensity as a function of time. The decrease in light intensity as the "planets" traverse the star allows students to calculate the size of the planet relative to the star. Allowing students to freely choose both the sizes of the planets and the position of the light sensor quickly leads to very productive discussions regarding differences between our model and the actual physical system, as well as concepts such as solid angle, detection thresholds, and the difference between an eclipse and a transit.

CC06: 12:20-12:30 p.m. Feezya, My Love

Contributed – Taoufik Nadji, Interlochen Arts Academy 4000 Highway M-137 Interlochen, MI 49643

Teaching Feezya (Physix) has to emanate from a deep love for the subject matter. The author shares his personal love journey with physics as described in his TPT article. In the process, the attendees will learn excellent pedagogical methods that should enable their students to appreciate physics and possibly fall in love with it too.

CC07: 12:30-12:40 p.m. GFO PTaP 2019: Preliminary Scores and Analysis*

Contributed – Richard L. Pearson III, Colorado School of Mines 1500 Illinois St GOLDEN, CO 80401

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

In coordination with the "Get the Facts Out" project (GFO), thousands of undergraduate student responses regarding their perceptions of secondary teaching as a profession were collected through an online survey (the PTaP). Responses include students from community colleges, undergraduate-focused universities, and research-focused institutions. Discipline-dependent analysis is also derived for those undergraduates in physics, chemistry, and mathematics, the founding interest groups associated with GFO. The presented 2019 PTaP data will be followed in subsequent years across the same institutions and disciplines to identify the impact of local GFO programs on the overall view undergraduate students have of the teaching profession across the United States.

*This work is supported by NSF DUE-1821710.

CC08: 12:40-12:50 p.m. Using Physics Topics to Teach First-Year College Writing

Contributed – Kristen L Thompson, Davidson College 405 N. Main St., Davidson, NC 28035

The ability to effectively communicate science is an essential skill for early-career scientists to acquire as part of their education. Students are typically introduced to academic writing in one of two ways: in a writing course staffed by humanists with little experience with science writing, or across the curriculum where writing is secondary to course content. At Davidson College, students are required to complete a one-semester writing intensive course taught by faculty across the institution, including those in the natural sciences. Such a model encourages students to self-select a writing course that both interests them and is tailored toward their future career goals. To benefit students interested in the craft of technical writing, the authors have developed writing courses that take a writing-focused approach by allowing physics content to facilitate a knowledge of writing. In this talk, I will describe our experience as physicists participating in our college's writing program.

Lactation Room

(CURACAO 7)

Quiet Room

(CURACAO 8)

Hours:

Saturday – 8 a.m. to 10 p.m.
Sunday – 8 a.m. to 10 p.m.
Monday – 8 a.m. to 10 p.m.
Tuesday – 8 a.m. to 10 p.m.

CD High School

Time: 11:30 a.m.–12:50 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Grand Sierra H** **Presider:** *TBA*

CD01: 11:30-11:40 a.m. History in the Physics Classroom: Teaching Guides Highlighting Marginalized Physicists' Stories and Discoveries*

Contributed – Hannah Pell, Center for History of Physics, American Institute of Physics One Physics Ellipse College Park, MD 20740

The Center for History of Physics at the American Institute of Physics offers a free collection of nearly 60 teaching guides that highlight the invaluable contributions of women and minorities to the history of physics. The lesson plans introduce students to a diverse set of role models whose often-forgotten achievements significantly shaped contemporary physics. The guides are easily adaptable to fit into social and natural science courses from K-12 and satisfy a wide variety of national education standards in science, history, social studies, and writing subjects. Additionally, the lessons are designed to encourage acknowledgement of and discussion about ongoing diversity issues in STEM. In this talk, I provide an overview of the lesson plans and their structure, discuss several examples in-depth, and argue the importance of incorporating historical and sociological contexts into the physics classroom, with the goal of increasing high school students' engagement with and curiosity for the discipline.

*Presentation given on behalf of the AIP Center for History of Physics

CD02: 11:40-11:50 a.m. AP Physics, Language Learners and Multiple Representations

Contributed – Igor V. Proleiko, Linhai Foreign Language School/Dipont Education Group 11-503 Chunfengli Linhai, Zhejiang 318000 PRC

The new format of AP Physics 1 and 2 Exams presented a new set of difficulties to English learners. My experience of teaching in China gave me a perspective of using all representations available in the exam papers: verbal descriptions, graphs and pictures, choices for answers to multiple choice questions. Having students to explicitly establish the correspondence between these representations improves understanding of the statement of the problems even for the students who do not always have all of the requisite vocabulary.

CD03: 11:50-12 p.m. Bridging the Gap Between Research Scientist and Physics Teacher

Contributed – Elmarie C. Mortimer, Trinity Preparatory School 5700 Trinity Prep Ln Winter Park, FL 32792-9414

Stepping into the world of high school physics teaching from a research scientist background can feel like crossing the bridge into an abyss. There is the daunting task of making sense of all the educational buzzwords such as 3 Dimensional Learning and Instructional Scaffolding. There is the doubt of being able to inspire creative thought and infusing research skills such as Argumentation and the Engineering Design Process into a high school laboratory session that is often only 90-minutes. We will discuss how the researcher/ teacher can bridge this gap and help students take charge of the learning process. Emphasis will be placed not only on combining and adapting various techniques to improve the students' content knowledge and skill set, but also on the well-being of the student. The final product should be a learner who can approach any challenge, including research, in a scientific way.

CD04: 12-12:10 p.m. Presenting Student Lab Results Using Posters

Contributed – Suzanne Z. Smedberg, 8328 Georgetown Pike McLean, VA 22102

Studies show that labs are a vital part of the classroom experience, but in inquiry-based courses traditional reports can be difficult. Additionally, an out of class writing assignment adds unnecessary stress that is detrimental to the educational process. The use of white boards or posters allows students to develop, express, and exhibit understanding of the concepts within of the framework of proper science practices. Examples of labs and assessment tools will be provided.

CD05: 12:10-12:20 p.m. Space for All: Building Inclusive Teaching Strategies

Contributed – Kayla Stephens, American Institute of Physics - Society of Physics Students One Physics Ellipse College Park, MD 20740-3843

Clear learning objectives for your course are vital in preparing for a successful academic year. This talk will focus on conscientiously addressing inclusiveness within lesson plans and the classroom environment. Along with suggested best practices, this discussion will emphasize how addressing student backgrounds and learning abilities can result in students feeling equally valued and ultimately leading to academic success.

CD06: 12:20-12:30 p.m. Merging the Gap Between High School and College, a Collaborative Experiment

Contributed – Andrew Maginniss, Chattanooga State Community College 4501 Amnicola Hwy Chattanooga, TN 37406

Since 2015, Chattanooga State Community College has worked closely with the neighboring STEM high school offering physics as a senior science class. It has been co-taught by a college professor and high school teacher such that some students are receiving college credit while others are taking it for high school credit. The mix of students work together in small groups discovering the principles of physics using an inquiry-based curriculum. One of the main goals of this project was to provide students who choose not to take the class for college credit with exposure to a college level curriculum in the company of peers while still being assessed at a high school level. Student performance was evaluated using pre and post testing with the Force Concepts Inventory (FCI). The data has not only demonstrated the success of the project, but has also helped the course adapt into what it is today.

CD07: 12:30-12:40 p.m. STEP UP: Connecting Student Goals to Physics*

Contributed – Thomas B. Head, Florida International University 11200 SW 8th St. Miami, FL 33199

Robynne M. Lock, Texas A&M University - Commerce

Zahra Hazari, Geoff Potvin, Raina Khatri ,Florida International University

We conducted an experimental study in fall 2018 on the effects of STEP UP project interventions, which included a Careers in Physics lesson. In this lesson, students explored the profiles of modern day physicists and the many career options available to physics majors. The students then connected physics to their own career aspirations. In this talk, we discuss how students' perceptions of physics align with their own career goals through the lens of agentic and communal goals. We examine to what extent the lesson communicates that communal goals align with physics and how this perception varies with gender. Data collected include student open-ended survey responses, survey items, and student work such as a career profile in which students envision themselves achieving their career goals with a physics degree.

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

CD08: 12:40-12:50 p.m. Wireless Power Transmission Lesson for AP Physics

Contributed – Elizabeth Hondorf, Oak Ridge High School 1450 Oak Ridge Turnpike, Oak Ridge, TN 37830

In this lesson students will learn about electromagnetic induction then will apply that understanding to develop and optimize wireless electricity transfer devices. Students will research applications of wireless power transmission in modern devices and homes. Students will have to use their prior knowledge of electrical circuits, magnetic fields and the behavior of charged particles in a magnetic field. After participating in a lesson on magnetism and mutual inductance the students should understand how a wireless power transmission (WPT) system works. A guided inquiry activity will prepare students to take their designs further on their own to develop and optimize a functional WPT system. Students will conclude the lesson by researching applications for WPT in modern devices and homes. This session will demonstrate the materials and methods needed to create small wireless power systems.

CE Best Practices in Educational Technology

Time: 11:30 a.m.–1:30 p.m. **Sponsor:** Committee on Educational Technologies **Date:** Monday, Jan. 20
Location: Grand Sierra I **Presider:** *Shahida Dar*

CE01: 11:30-12 p.m. Real-time Data Dashboards with Python

Invited – Andrew Dawes, Pacific University 2043 College Way Forest Grove, OR 97116-1797

With the rise of enterprise data science, many new computational tools exist for gathering and presenting data in real-time. While not designed expressly for use in physics labs, many of these tools are useful for laboratory data collection and presentation. With a particular emphasis on the python language, and associated software packages, we present several use cases, and an overview of possible future applications for these new tools.

CE02: 12-12:30 p.m. Promoting Problem-Solving Abilities through Web-based Interactive Video-Enhanced Tutorials*

Invited – Kathleen M. Koenig, University of Cincinnati 2600 Clifton Ave, 400 Geo/Phys Building Cincinnati, OH 45221

Robert Teese, Michelle Chabot, Rochester Institute of Technology

Alexandru Maries, University of Cincinnati

Interactive video-enhanced tutorials (IVETs) involve web-based activities which lead students through a solution using expert-like problem-solving approaches, such as those needed for solving problems using Newton's second law. The IVETs, which are based in part on the tutorials created at the University of Pittsburgh, are designed using multimedia principles of learning and research on human learning and memory. The tutorials are adaptive and provide different levels of scaffolding depending on students' needs. They are also affect-adaptive, such that additional guidance is provided to students who indicate they are confused, frustrated, or bored while completing the IVET. This presentation will showcase one of the IVETs and it various design features. Research results regarding students' behaviors as they engage with the IVET, as well as the impact of the IVET on student problem-solving ability, will also be presented.

*Work supported by the NSF IUSE Program (DUE #1821396)

CE03: 12:30-1 p.m. Using Jupyter Electronic Notebooks in Introductory Physics Laboratories and Beyond

Invited – Tatiana A. Krivosheev, Clayton State University 2000 Clayton State Blvd Morrow, GA 30260

We present our experience of converting traditional laboratory manuals used in the Introductory Physics Laboratory 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 generates additional student learning opportunities such as numerical simulations and programming. Later on, students are able to transfer these skills to upper division and research courses. In particular, we demonstrate using these opportunities in the Projectile Motion, Brownian Motion, and Millikan Oil Drop experiments.

CE04: 1-1:30 p.m. Dynamic Approach to Lines, Angles and Shapes at Primary Level

Invited – Inge Schwank, Institut für Mathematikdidaktik Gronewaldstraße 2, Köln, NA D-50931 Germany

Physics is, inter alia, based on mathematical concepts. Among these also elementary geometrical concepts. Still, especially the latter are often neglected during primary school time. Mostly, dealing with figures such as squares, rectangles and triangles is being reduced to a perceptual differentiation without developing and discussing their geometrical mathematical properties. This leads to the known difficulties that students e.g. despite their math education don't consider a square to be a rectangle. Developing the angle concept is considered especially difficult. In the framework of STEAM-classes for second graders, we used a hot wire foam cutting machine that allows cutting program-controlled polystyrene panels. Eventually, we're using ideas already introduced by Seymour Papert. By means of a programming language similar to turtle to control the cutting machine, algorithms for designing simple geometry shapes can be created. Certain geometrical figures are associated with distinct production processes combining distances and angles in a certain manner.

CF PER: Diversity, Equity & Inclusion

Time: 11:30 a.m.–1:10 p.m. **Sponsor:** AAPT **Date:** Monday, Jan. 20 **Location:** Bonaire 1-2 **Presider:** *TBA*

CF01: 11:30-11:40 a.m. Evaluating the Effectiveness of Training Instructors in Universal Design for Learning

Contributed – Westley D. James, University of Central Florida 4111 Libra DR Orlando, FL 32816-2385

Sacha Cartagena, Jacquelyn J. Chini, University of Central Florida

Students with disabilities have been an under-investigated and under-supported population in postsecondary STEM courses. Universal Design for Learning (UDL) is a framework for increasing the accessibility of courses by recommending a list of "checkpoints" which identify practices that can support the variability of learners. To address the course barriers students with disabilities experience, we provided training to physics instructors about students with disabilities and UDL. These instructors identified and implemented practices to increase accessibility in one of the introductory physics courses they taught. At the end of the course, we interviewed the instructors and their students about how course content was presented, engaged with, and evaluated in order to document UDL-aligned practices the instructor implemented. In this presentation we will present the UDL checkpoints that were represented by the documented practices, and whether the practices were reported as beneficial, neutral, or negative by instructors and students.

CF02: 11:40-11:50 a.m. Analyzing Discussions of Underrepresentation of Women*

Contributed – Ben Archibeque, Florida International University 11200 SW 8th St, VH 183 Miami, FL 33199;

Zahra Hazari, Raina Khatri, Geoff Potvin, Florida International University

Robynne M. Lock, Texas A&M Commerce

In-class discussions of underrepresentation have been found to increase women's interest in physics and their physics identities. Qualitatively understanding these conversations and their evolution might offer insight into what instructors can do to bolster women's physics identities and interests. To investigate, we recorded two sections of an experienced high school physics teacher implementing a lesson about the underrepresentation of women in physics developed for the STEP UP project. We will present an analysis of students' argument hedging and warranting during this discussion

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

CF03: 11:50 a.m.-12 p.m. Increasing Growth Mindset with a Brief, Interactive, Classroom-based Intervention*

Contributed –Stephanie J. Sedberry, University of North Carolina at Greensboro 321 Petty Building, PO Box 26170 Greensboro, NC 27402-6170

Ian D. Beatty, William J. Gerace, Maha A. Elobeid, University of North Carolina at Greensboro

Jason E Strickhouser, Florida State University

A convincing body of research indicates that psychosocial constructs such as self-efficacy, growth mindset, and perceived academic control predict and affect student performance, persistence, and success in STEM. Interventions designed to increase these factors have proven particularly effective for women and underrepresented minorities. As a part of an NSF-funded project, we have developed and honed a 30-minute interactive, classroom-based intervention aimed at improving students' STEM self-efficacy. Through a combination of short video presentations, live discussions, and short writing prompts, the intervention teaches students about the scientific basis of "growth mindset," stresses the importance of "productive struggle" for getting smarter, and suggests some concrete strategies students can try to take control of their learning and turn struggles into successes. A quasi-experimental study at three universities (n = 853) showed that the intervention significantly increases students' growth mindset, although impacts on self-efficacy and course grades were not statistically significant.

*This material is based upon work supported by the US National Science Foundation under Grant No. DUE-1612053.

CF04: 12-12:10 p.m. Statistics and Student Perception on Gendered Performance in Introductory Courses

Contributed – Matthew Alan Dew, Texas A&M University 4313 Oaklawn Street Bryan, TX 77801;

Tatiana Erukhimova, Lewis Ford, Texas A&M University

Jonathan Perry, The University of Texas

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 known, 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 and algebra-based introductory physics course sequences at Texas A&M University for multiple faculty who taught between 2008-2018. 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. This study also presents student perception of gender's effect on performance from the calculus and algebra-based courses during the fall 2019 semester.

CF05: 12:10-12:20 p.m. A Collaborative Poetic Analysis of a Metaphor for Success in Physics

Contributed – Brian Zamarripa Roman, University of Central Florida, 4000 Central Florida Blvd. Orlando, FL 32816;

Amy Vary Schwandes, Jacquelyn J. Chini, University of Central Florida

Success in PER is usually associated with students getting degrees and high grades, however not much qualitative research explores the concept as conceptualized by students. We analyzed metaphors of success in physics provided by female physics students; however, during the member checking of the metaphor interpretations, some participants noted the interpretations lacked their intended emotions. To center emotions, the researchers (B.Z.R. & J.J.C.) collaborated with a participant-researcher (A.V.S.) and conducted a poetic analysis of her metaphor of success in physics as a dandelion. The poetic analysis consisted of representing the transcript as a poem and interpreting the metaphor with Ricouer's hermeneutic phenomenology which considers the expression's context and possible interpretations. The poetic analysis revealed themes of expressions of hope in the face of negative messaging from professors, the possibility of success in other domains of physics, and the value of providing space for participants to express themselves.

CF07: 12:30-12:40 p.m. Discourse Moves and a Teacher's Dilemmas: Using a SocioPolitical Topic in Physics

Contributed – Clausell Mathis, Florida State University 1130 High Meadow Dr. Tallahassee, FL 32306-9936

Victor Kasper, Sherry Southerland, Florida State University

In an effort to create more inclusive and equitable physics classrooms, the primary goal for this study is to systematically examine an attempt to incorporate a culturally relevant approach (CITE) to physics instruction in a classroom serving largely African American learners. For this, a lesson focusing on the sociopolitical topic was designed and enacted to respond to students' experiences and interests. The resulting classroom discourse was analyzed using a discourse analysis framework developed by Grinath & Southerland (2018) that focuses on student talk and teacher discourse moves. Additionally, the teacher moves during this discussion were examined to explore the dilemmas the teacher encountered using Windschitl's (2002) framework of dilemmas. Data collection included observations, field notes, and semi-structured interviews. Results suggest that the physics teacher showed ambition and inclusivity in her discourse moves. The teacher also encountered pedagogical, conceptual, and political dilemmas as she navigated the discussion to connect with students' norms.

CF08: 12:40-12:50 p.m. STEP UP: Time Series Structure of Students' Physics Identity Development*

Contributed – Hemeng Cheng, Department of Physics, Florida International University 11200 sw 8th street, Miami, FL 33199

Geoff Potvin, Department of Physics, Florida International University

Raina Khatri, Laird Kramer, STEM Transformation Institute, Florida International University

Zahra Hazari, Department of Teaching & Learning, Florida International University

As part of the STEP UP project, we developed two lessons for high school physics teachers to encourage women to pursue physics degrees in college. Students completed an identical attitudinal survey to probe their physics identity, including sub-constructs (recognition, interest, performance/competence, and utility) and future physics intentions before and after each lesson. This talk will present a time series model to understand the longitudinal development of students' physics identity sub-constructs and future intention beliefs. Recognition belief is found to play a significant role in the path of physics identity and future intentions formation. We also use a Multigroup Structural Equation Modeling approach to compare the model between different gender and race/ethnic groups.

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

CF09: 12:50-1 p.m. Cultural Intersections: Gender and Physics Identity of Muslim Women Physicists

Contributed – Saeed Moshfeghyeganeh, Florida International University 11200 SW 8th St, VH 165 Miami, FL 33199

While women are underrepresented in physics programs in the U.S., in many Muslim majority (MM) countries women constitute more than half of the students in physics programs. In order to better understand the intersection between gender and physics identities in U.S. and MM cultures, we used a phenomenological approach through interviews with Muslim women physicists. The goal was to explore the lived experiences of these women who were trained in MM countries and also experienced physics programs/departments in the U.S. We present hypotheses that emerged from this study and highlight the effects of culture on the development of a physics identity for women and subsequent persistence in the field.

CF10: 1-1:10 p.m. Survey-based Investigation of Post-secondary Physics Instructor Use of Inclusive Teaching Practices

Contributed – Jacquelyn J. Chini, University of Central Florida 4111 Orlando, FL 32816

Erin Scanlon, Daniel Oleynik, University of Central Florida

Students with disabilities are underrepresented in STEM, comprising only 10% of employed scientists and engineers. This is likely because post-secondary institutions are not designed to support these students and faculty lack awareness of and training in inclusive teaching practices which support learner variation without requiring individual accommodations. It is important to note that the impact of inclusive teaching practices is to reduce, not to eliminate, individual access needs. We modified the Inclusive Teaching Strategies Inventory (ITSI) to increase its validity for STEM instructors. We used our modified ITSI to investigate physics instructors' views about

and use of inclusive teaching practices by recruiting practicing STEM professionals and students from American Physical Society Division and Section meetings. In this talk, we present preliminary findings about strategies that instructors frequently identified as important/not-important and strategies they self-identified as using/not using.

CF11: 1:10-1:20 p.m. People Like Me:Intersectional Identity Development in a Physics LA Program

Contributed Xandria R. Quichocho, Texas State University 1951 Hunter Rd San Marcos, TX 78666-4735Jessica Conn, Erin M. Schipull, Eleanor W. Close Texas State University

Identity development is critical to student retention in physics degree programs. Historically, studies on physics identity and student retention in Physics Education Research have largely ignored the unique experiences of women of color and LGBTQ+ women. We use a blended theoretical framework of Communities of Practice and Hyater-Adams et al.'s Critical Physics Identity to analyze interviews with women of color and LGBTQ+ women in the Texas State University physics program, all of whom had experience in the Physics Learning Assistant (LA) program. When asked to describe elements supporting their success in physics, all interview subjects named the LA program. Through the narrative analysis of these interviews we examine the effects and impact the LA program has on multiply-marginalized students. We will present data highlighting the academic and social programmatic elements of the LA program that aid in the physics identity development, physics community participation, and academic success of these students.

CG Physics and Art

Time: 11:30 a.m.–1 p.m. **Sponsor: Committee on the Interests of Senior Physicists** **Date: Monday, Jan. 20**
Location: Bonaire 3-4 **Presider:** *David Donnelly*

CG01: 11:30-12 p.m. Celestial Sleuthing and Art

Invited – Donald W. Olson, Texas State University, Dept of Physics Texas State, 601 University Drive San Marcos, TX 78666

Over the last three decades, our Texas State University group has used astronomy to solve mysteries in art, history, and literature, with results published in Sky & Telescope and in two books: Celestial Sleuth (Springer, 2014) and Further Adventures of the Celestial Sleuth (Springer, 2018). Subjects include moonrise photographs by Ansel Adams and night sky paintings by Vincent van Gogh, Claude Monet, Edouard Manet, Edvard Munch, Ford Madox Brown, Canaletto, Caspar David Friedrich, and J.M.W. Turner. We try to determine: where the artist was located; when the artist observed the scene; which way the artist was looking; and what celestial objects were in the sky. For example, we traveled to Auvers-sur-Oise to study van Gogh's White House at Night and determined that this canvas depicts a house on Rue de la Gare, near sunset on June 16, 1890, with brilliant Venus shining in the western sky.

CG02: 12-12:30 p.m. Artists Telling Robots Where to Place Molecules- 3D Printing as a Tool for Creative Mathematical Expression(S)

Invited – Mike Hicks, 501 Brooker Creek Blvd., Oldsmar, FL 34677

Now that the novelty has (mostly) worn off, 3D printing is now another tool in the artist's toolbox, but one whose promise is still being discovered. Join our tour of the explorers who are using 3D printing to bring their inspirations and equations into the tangible.

CG03: 12:30-1 p.m. Color: Physics and Perception*

Invited – Pupa Gilbert, University of Wisconsin - Madison, 1150 University Avenue Madison, WI 53706-1390

Unless we are colorblind or are in the dark, as soon as we look at any object, we know what color the object is. Simple, isn't it? No, not really. The color we see is rarely just determined by the physical color, that is, the wavelength of visible light associated with that color. Other factors, such as the illuminating light, or the brightness surrounding a certain color, affect our perception of that color. Most striking, and useful, is understanding how the retina and the brain work together to interpret the color we see, and how they can be fooled by additive color mixing, which makes it possible to have color screens and displays. I will show the physical origin of all these phenomena and give live demos as I explain how they work. Bring your own eyes! For more information: (1) watch TED talk: "Color: Physics and Perception" and (2) read book: PUPA Gilbert and W Haeberli "Physics in the Arts", ISBN 9780123918789.

*DOE grant DE-FG02-07ER15899

CH Physics Education Conference from Around the World

Time: 11:30 a.m.–1 p.m. **Sponsor: Committee on International Physics Education** **Date: Monday, Jan. 20**
Location: Antigua 1-2 **Presider:** *Geraldine Cochran*

CH01: 11:30-12 p.m. Local vs. Global: The Role of International Physics Education Conferences

Invited – Katemari Rosa, Federal University of Bahia, Rua Barao de Loreto, 65 Salvador, Bahia 40150-270 Brazil

Is teaching physics the same everywhere? There is a widespread idea that physics is inherently international because science works the same way, independently of our geographical location. In this talk, I will argue this colonial mindset can refrain physics educators to increase communication across borders. As a consequence, this hinders our potential to develop better physics teaching practices that could be culturally relevant for our students. Finally, I will discuss how international conferences can help us better understand our local contexts.

CH02: 12-12:30 p.m. Professional Development of Emerging Education Researchers Around the World

Invited – Scott V. Franklin, Rochester Institute of Technology, 1 Lomb Memorial Drive Rochester, NY 14623-5603

Eleanor C. Sayre, Kansas State University

Mary Bridget Kustusch. DePaul University

Quite serendipitously, a collaborative research field school designed to foster work on student metacognition has revealed a broad international interest in professional development for emerging education researchers. Since 2015 we have conducted development workshops in Rwanda, Mexico, Germany, and British Columbia aimed at audiences that range from graduate students to senior faculty looking to change their research focus. PEER (Professional-development for Emerging Education Researchers) is a flexible model that adapts to local interests and constraints, and has proven its ability to generate meaningful partnerships and scholarship in the different environments. I will discuss the guiding principles of PEER and how they manifest in the radically different contexts the different countries bring.

CH03: 12:30-1 p.m. AAPT and GIREP: Synergies and Opportunities

Invited – Stamatis Vokos, California Polytechnic State University Physics Department and CESAME San Luis Obispo, CA 93407

Groupe International de Recherche sur l'Enseignement de la Physique (GIREP) is an international society that promotes knowledge exchange on research in physics teaching at all levels. GIREP organizes annual conferences (often in connection with the European Physical Society, the International Commission on Physics Education, and the Multimedia in Physics Teaching

and Learning Group), offers seminars, and publishes proceedings and special topical volumes. Through a reciprocal registration agreement, AAPT members can attend GIREP meetings at member rates. Eight Thematic Groups (Evaluation of Learning and Instruction, The Learning and Teaching of Energy, Mathematics in Physics Education, Innovative Pedagogical Methods for University Physics, Physics Education Research in University, Problem Solving in Physics Textbooks, Strategies for Active Learning, and Physics Preparation of Teachers in Grades K-6) organize workshops and symposia at meetings. In this talk, specific examples of opportunities for AAPT members to engage with GIREP will be presented.

CI Education Research Meets Contemporary Physics

Time: 11:30 a.m.–12 p.m. **Sponsor: Committee on Contemporary Physics** **Co-Sponsor: Committee on Research in Physics Education**
Date: Monday, Jan. 20 **Location: Antigua 3-4** **Presider:** *Peggy Norris*

CI01: 11:30-11:40 a.m. Angular Displacement as a Vector

Contributed – William A. Dittrich, Portland Community College Box 19000 Portland, OR 97280

Leonid Minkin, Portland Community College

Alexander Schapolov, Saratov University, Russia

Should angular displacement be considered a vector quantity? This question will be discussed, and a new vector definition will be introduced which helps students understand the axial vector nature of all rotational quantities like angular velocity, angular acceleration, torque, angular momentum and angular work. This axial vector definition of angular displacement is capable with the conventional scalar definition, can be used to derive all conventional rotational kinematics and dynamics relations, and since it is an axial vector as well - it helps students see a clear relationship between angular and rotational equations.

CI02: 11:40-11:50 a.m. Study of the Tidal High with Variation of Acceleration Due to Gravitational Force Causing by the Changes of Angular Position of Earth from the Sun and the Moon

Contributed – Baaz Pathan, NES International school Agrawal Rd, Opposite Sardar Pratap Singh Garden, Swapna Nagari, Mulund West, Mumbai, Maharashtra 400082 Mumbai, Maharashtra 400082 India

Present study of "Study of the tidal high with variation of acceleration due to gravitational force causing by the changes of angular position of earth from the sun and the moon" is an effort to form a mathematical modal that relates the variation of tidal heights due to variation of the orientation of vector sum of gravitational forces acting between Earth –Moon and Earth –Sun. In this mathematical model, we are using basic principle of calculus with Newton's law of gravitation. This study is an account of the variation of the heights of tide by mathematical approximation which will be the worth for scientific understanding of Tidal heights and their behaviors.

CI03: 11:50-12 p.m. Student and Faculty Perspectives of Retention in Physics Graduate Programs

Poster – Kelli Shar, The University of Tampa 6727 South Lois Avenue Tampa, FL 33616

Lindsay Owens, Benjamin M. Zwickl, Casey W. Miller, Rochester Institute of Technology

Why do physics graduate students leave their programs? Seventeen faculty from four different institutions and 54 graduate students from 23 institutions were asked this question. Faculty discussed poor work ethic and struggles with coursework and qualifying exams as the primary reasons that graduate students leave their programs. Graduate students cited departmental culture and mentoring not meeting their expectations as well as opportunities in industry as common reasons for withdrawing from Physics Ph.D. programs. Based on this discrepancy between perspectives we recommend that faculty and students actively communicate about the underlying issues of why graduate students leave. Such discussions can aid programs in creating solutions to address issues and improve retention rates.

CJ Technologies

Time: 12:30–1 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Hibiscus** **Presider:** *TBA*

CJ01: 12:30-12:40 p.m. The Development of an Enhanced, Inexpensive Multispectral Imaging System

Contributed – Samuel F. Maruska, Gustavus Adolphus College 800 W College Ave. Saint Peter, MN 56082

Charles F. Niederriter, Gustavus Adolphus College

Multispectral imaging systems have been developed for use on agricultural drones to allow farmers to manage crops, soil, fertilizing and irrigation more effectively. Although there are huge benefits both to the farmer and to the wider environment by minimizing the use of sprays, fertilizers, wastage of water and, at the same time, increasing the yield from crops, the cost of commercial systems is relatively high limiting their use. In addition, current multispectral camera technology uses Green, Red, Red-Edge and Near Infrared wavebands to capture both visible and invisible images of crops and vegetation, leaving out the important Infrared band available with IR cameras. Utilizing Raspberry Pi computers, Pi cameras, and a FLIR Lepton Thermal imager, we developed an inexpensive system that also incorporates data from the 1.4 – 7.5 micron band in the infrared. We will report on the development of the system, its use in measuring Normalized Difference Vegetation Index (NDVI) and other surveying methods, and provide other examples of its usefulness.

CJ02: 12:40-12:50 p.m. Student Acceptance of an Online Physics Problem Solving Tool

Contributed – Bijaya Aryal, University of Minnesota Rochester 111 S Broadway Rochester, MN 55904

This presentation describes introductory-level physics students' attitude about using a web-based computer coach for physics problem solving. Using the Theory of Planned Behavior (TPB), we present the determinants of student behavior and user acceptance of the coaches. Based on interview data of 19 students, we have explored how these determinants can shape students' intention to use the computer coaches. This study has identified that students' math preparation, views about problem solving, views about learning resources and views about coaching are significant determinants of students' intention to use the computer coaches. The study revealed the impacts of students' perception about the usefulness and ease of use of the online system on students' pattern of usage, degree of usage and ultimately to the learning outcomes. The findings of this study provide the guidance for a successful implementation of the online tool for physics problem solving.

CJ03: 12:50-1 p.m. Exploring Ideas in Physics Using Simulation Software and Spreadsheets

Contributed – Shen Yong Ho, Nanyang Technological University, Singapore 21 Nanyang Link Singapore, South West 637371 Singapore

Amir Shakouri, Nanyang Technological University, Singapore

Softwares such as COMSOL can provide realistic simulations of experiments, some which cannot be easily done or repeated in a standard undergraduate laboratory. This year, COMSOL launched a compiler will allows COMSOL simulations to be compiled into .exe files which can run on computers without a COMSOL license. The author will share some of the simulations designed for teaching topics on mechanics and electromagnetism. Examples include producing the force-time graphs of a vehicle crashing into a wall at different velocities and paths of charge particles moving in electric and magnetic fields. The author will also discuss how spreadsheets (e.g. MS Excel) can be used as a tool to help students with little or no programming experience to visualize concepts and problems in 1D and 2D kinematics.

CL Communicating Across Difficulty: Navigating Identity and Conflict

Time: 11:30 a.m.–1 p.m. **Sponsor:** AAPT **Date:** Monday, Jan. 20 **Location:** Bonaire 7 **Presider:** *Jennifer A. Sandoval*

This session specifically addresses the unique challenges of being an effective conflict manager when identify difference in involved. We will engage in discussion about how the notion of "civility" has been used to silence communities of color. Discussion will also highlight ways to expand understandings of our scripts and cultural expectations about conflict in order to be more effective across difference. Participants will walk through challenging real-life scenarios and work to increase their ability to navigate the discomfort of conflict and difficult conversations.

CK Bringing the Stars into the Classroom

Time: 11:30 a.m.–12 p.m. **Sponsor:** Committee on Physics in High Schools **Date:** Monday, Jan. 20
Location: Hibiscus **Presider:** *Katya Denisova*

Join members of the AAPT/PTRA cadre as they share workshop materials and strategies from the Summer Institute on Astronomy held after the Provo meeting.

PST1 Poster Session 1

Time: 1:30–3 p.m. **Sponsor:** AAPT **Date:** Monday, Jan. 20 **Location:** Grand Sierra AB

Those with odd-numbered posters will present from 1:30–2:15 p.m. Those with even-numbered posters present from 2:15–3 p.m.

PST1A01: 1:30-2:15 p.m. Simple Communication Hacks to Improve your Physics Teaching

Poster – Rebecca Lindell, Tiliadal STEM Education: Solutions for Higher Education 5 N 10th St Suite A-1 Lafayette, IN 47901;

Often students express dislike for their physics courses in statements like "it is too hard", "I never knew what was going on" and "I don't understand". Even after successfully completing these courses, former students will often express an "ugh" reaction to physics courses. This may seem like an insurmountable problem to fix, but by simply changing how we communicate inside and outside of our physics courses affects not only our students' learning, but also their overall satisfaction with our course and whether they will decide to take additional courses. As these are the main goals of any physics course, it is important that we adjust our communication style to better serve our students. In this poster I will present multiple simple communication hacks that can easily be adapted into our teaching style that will greatly improve how students perceive us and our courses.

PST1A02: 2:15-3 p.m. BiteScis Physics Lessons: Standards-Aligned Content Through Contemporary Research

Poster – Shannon M. Morey, BiteScis, Abbott Lawrence Academy 70-71 N Parish Rd. Lawrence, MA 01843

Nathan Sanders, ComSciCon

Stephanie Keep, Kelsey Lucas BiteScis

BiteScis (bitescis.org) is a nonprofit dedicated to introducing high school students to current scientific research and providing context for the content they are learning in the classroom. Teachers sometimes hear, "Why are we learning this?" or "When am I ever going to need this?" BiteScis lessons help provide answers to those questions because each lesson links the knowledge students have right now to that which is being used by scientists. In this way, our physics lessons help students master standards-aligned content while also providing accessible introductions to contemporary science as varied as runaway stars and laser cooling. All of our lessons, which are developed through collaborations between classroom teachers and current science researchers, are available for free online and we are continually working to create new content. This poster will briefly explain our model and will introduce the audience to the physics lessons available through BiteScis.org.

PST1A03: 1:30-2:15 p.m. Improving Student Success in Introductory Physics Courses at ERAU

Poster – Richard L. Pearson III, Embry-Riddle Aeronautical University Physical Sciences Department Daytona Beach, FL 32114

Bryan K. Armentrout, Muhammad O. Farooq, John M. Hughes, Terry D. Oswalt, Embry-Riddle Aeronautical University

Nearly half of the first-year students at Embry-Riddle Aeronautical University (ERAU) take an introductory, calculus-based physics course within their first two terms as collegiate learners. Though nearly all enter as high-performing secondary graduates, difficulties completing, understanding, and problem-solving introductory physics concepts are common among them. To better identify, isolate, and improve cognitive processing pertaining to the physics material, research-based changes to ERAU's PS150 course have been made, including the addition of a weekly, instructor-led recitation, a preliminary mathematical assessment, supplemental instruction periods led by graduate students, and course uniformity across the PS150 sections. Qualitative and quantitative data concerning these items will be discussed, as well as some preliminary longitudinal information of the implementation's effectiveness.

PST1A04: 2:15-3 p.m. Case Study of SRL and the CLASS in Introductory Physics Courses

Poster – Richard Luther Pearson, Embry-Riddle Aeronautical University 1 Aerospace Blvd Daytona Beach, FL 32114;

Chad M. Rohrbacher, Embry-Riddle Aeronautical University

Self-regulated learning (SRL) is an important characteristic of successful learners, especially in an introductory physics course. In order to investigate the impact of helping first-year students take responsibility for their own learning, a case study was completed utilizing two introductory, calculus-based physics courses at a private engineering university. Each were asked to complete the Colorado Learning Attitudes about Science Survey (CLASS) at the beginning and end of the term. Additionally, one of the courses was asked to complete an SRL questionnaire before and after each of the three midterm examinations throughout the fall semester. In coordination with those surveys and questionnaires, physics concepts were analyzed in parallel qualitative responses. Correlation between attitudes, perceptions, and conceptual understanding are presented here. Future efforts with a larger scope-of-work will follow.

PST1A05: 1:30-2:15 p.m. An Introductory Short Course Conductors, Semiconductors and Superconductors

Poster – Mark F. Masters, Purdue University Fort Wayne, Department of Physics 2101 Coliseum Blvd E Fort Wayne, IN 46805-1499

Our physics department has introduced a concentration in Materials Science (or Materials Physics if you like). One of the courses we offer is a 5-week, 1 credit hour class on Conductors, Semiconductors, and Superconductors. This course has minimal prerequisites (algebra) and is part of a 3-course sequence with the second being Optical and Magnetic properties of solids, and the third being Thermal properties of solids. All these classes rely heavily on hands-on activities. These activities will be described for the conductors class. We will discuss course goals and learning outcomes.

PST1A06: 2:15-3 p.m. Revisiting the Toy Helicopter

Poster – Arunava Roy, Young Harris College, 1 College St. Young Harris, GA 30582

The flight of a toy helicopter (also known as wacky whirler) through the air is investigated. The various forces acting on the helicopter are considered including a time-dependent lift force. An equation of motion of the toy is constructed taking into account the lift and drag forces and solved using the free open-source software, Tracker.

PST1A07: 1:30-2:15 p.m. Elephants that Help Glaciers Move: A Simple Integrative Activity in Thermodynamics

Poster– Michael A. Waxman, University of Wisconsin - Superior 1800 Grand Ave. Superior, WI 54880*

We consider the movement of glaciers and trace back the main principles used to explain the decrease of the melting point of ice with applied pressure. This activity is designed to help students appreciate the general structure of thermodynamics.

*Sponsored by Dr. Peter Cook

PST1A08: 2:15-3 p.m. Student-Driven Exploration of Sliding on an Arbitrarily Shaped Incline With Friction

Poster – Michael A. Waxman, University of Wisconsin - Superior 1800 Grand Ave. Superior, WI 54880*

We suggest a small series of guided-inquiry exercises involving sliding on an arbitrarily-shaped incline with friction to help students review the basics of vector analysis along with calculus and energy conservation, and apply their physical intuition to analyze and understand the resulting solutions. These solutions turn out to be quite succinct and elegant allowing students to appreciate the beauty of physics.

*Sponsored by Dr. Peter Cook

PST1A09: 1:30-2:15 p.m. Cohort Intervention Impacts on Undergraduate Science Students' Success*

Poster – Peter A. Sheldon, Randolph College 2500 Rivermont Avenue Lynchburg, VA 24503

Sarah Sojka, Randolph College

Randolph College instituted a recruitment and retention program funded by two NSF S-STEM grants that has contributed significantly to doubling the number of science majors, tripling the number of physics majors, and to increased retention. Randolph College is a small, liberal arts college in Central Virginia that produces many successful graduates 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 students into our Step Up to Physical Science and Engineering at Randolph (SUPER) program each year since 2011, and to retain students at a higher rate than the whole college. We are researching the impacts of each part of our program: scholarships, summer transition program, living and learning community, mentoring program, and research/internships. In this presentation, we will address initial data on the impact of the mentoring 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.

PST1A10: 2:15-3 p.m. Affordances and Strategies for Teaching introductory Circuits to Blind Children

Poster – Daniel L. MacIsaac, SUNY Buffalo State College 27 E GIRARD BLVD Buffalo, NY 14217

Kathleen Falconer University of COlogne

Manuela Welzel-Breuer, Pädagogische Hochschule Heidelberg University of Education

Pamela Detrois, Pädagogische Hochschule Heidelberg University of Education

We describe affordances – simple modifications to equipment and procedures, and interventions for teaching an introductory lesson showing the classic one bulb in a circuit, two bulbs in series, then two in parallel sequence. Affordances for partially sighted, visually impaired students are straightforward, with slight but important adaptations to apparatus, lesson flow and timing. Affordances for profoundly blind students include using circuit representations on raised plastic or paper (swell paper) with and without Braille, and rigidly supported concrete circuits created with "Snap Circuits" TM apparatus. Given a second or two for thermal stabilization, sightless students can discriminate by touch between dark, partially lit and brightly lit incandescent subminiature bulbs for the traditional comparisons. We also discuss the need to establish trust and safety for blind children in handling simple circuit elements.

PST1A11: 1:30-2:15 p.m. Takeaways from a Facilitated Introductory Physics Support Network

Poster Daryl McPadden, Michigan State University 567 Wilson Rd. East Lansing, MI 48823

Matthew Hertel Michigan State University

Paul W. Irving Michigan State University

At Michigan State University, we have created a facilitated support network to promote the success and persistence rates of underrepresented minority students who are enrolled in Physics 183 (PHY-183) - Introductory Mechanics, a STEM gateway course. The goals of this initiative are to give students a space to build supportive peer networks and have opportunities to engage in scientific practices that support their success in physics courses. Students are recruited from their PHY 183 classrooms and are invited to attend 1-2 sessions a week, which focus on helping with physics assignments, discussions about study/test strategies, and which includes a shared meal with each other. Each session is facilitated by undergraduate learning assistants (LA) and a graduate teaching assistant (TA). In this poster, we outline the design decisions and structure of the sessions; the impacts on the students; and the takeaway points from implementing this style of support network.

PST1A12: 2:15-3 p.m. Mapping Sound Waves on Octave

Poster – Soumitra Ganguly, Troy University 600 University Ave Troy, AL 36082*

Caroline E Howell, James C Sanders, Troy University

The intensity of a sound wave emitted from a point source in an isotropic region of space will decrease by the square of the distance from the source. However, if boundaries are introduced, then the reflected waves cause interference with the incident wave. Therefore, sound waves emitted from a source in an enclosed room will have an intensity which follows the inverse square law but eventually deviates due to interference from reflections. This project makes use of the GNU OCTAVE to calculate the intensity of a sound wave as a function of distance from a source which is placed in an enclosed room. This calculation considers multiple possible paths along which a wavelet can propagate to reach the detector. It then determines the relative amplitude and phase for each of these paths in order to create a superposition of these wavelets at the position of the detector.

*Sponsored by - Dr. James Sander (117757)

PST1A13: 1:30-2:15 p.m. Infusing Culturally Responsive Practices into Physics/STEM Teacher Preparation Programs

Poster – David Rosengrant, University of South Florida St. Petersburg 208 147th st NE Bradenton, FL 34212

Karina Hensberry, Ann Marie Gunn, University of South Florida St. Petersburg

Allan Feldman, Ruthmae Sears, University of South Florida

One of the issues facing recruiting, training and retaining teachers is culturally relevant practices. Many teacher preparation programs may have a single course or few discussions on how to work with diverse populations but may not truly infuse into their programs. Many school districts across the nation are diverse in several ways yet we do not spend enough time focusing on this aspect when training our teachers. This poster presents our current endeavors of creating this preparation program in partnership with Pinellas County School Districts. This project is part of a Robert Noyce Capacity Building Grant and is funded by the NSF (Grant #1852857). In this project we share examples of what we are doing to infuse culturally responsive practices in the curriculum as well results from a survey where we investigate teachers' dispositions towards culturally responsive practices.

PST1A14: 2:15-3 p.m. Modeling Osmosis for IPLS students

Poster – Peter Hugo Nelson, Guilford College 4512 Grendel Rd Greensboro, NC 27410;

Osmosis is an important topic in IPLS (Introductory Physics for the Life Sciences) courses. However, the standard model of osmosis is based on a thermodynamics argument that's difficult to understand, even for well-prepared physics majors. This poster presents a new model of osmosis that's accessible to IPLS students. It's based on a kinetic model that treats osmosis as the single-file diffusion of water through aquaporins in a manner that's consistent with molecular-level simulations based on the known structure of aquaporins. A key concept is the "effective water concentration," which is the difference between the concentration of pure water and the osmotic concentration (osmolarity) of the solution. In the absence of a pressure gradient, osmosis is modeled by the simple jump-diffusion of water caused by an effective water concentration gradient. A pressure gradient modifies the jump rates in a manner that then successfully predicts the van't Hoff equation for osmotic pressure.
http://www.circle4.com/biophysics/chapters/

Technologies

PST1B01: 1:30-2:15 p.m. Visualizing the Invisible: Viewing 3-D Magnetic Fields with Your Smartphone

Poster – Rebecca E. Vieyra, Vieyra Software, University of Maryland 225 C St. SE Washington, DC 20003 United States

Chrystian Vieyra, Vieyra Software

Colleen Megowan Romanowicz, American Modeling Teachers Association

Mina Johnson-Glenberg, Embodied Games lab

Ramon A. Lopez, University of Texas at Arlington

This poster presents a series of magnetic field concepts and associated protocols for learning about them using Physics Toolbox AR, a smartphone-based app to see field vectors in three dimensions. This work addresses commonly misunderstood or difficult-to-understand aspects of static fields due to the Earth's background field, permanent magnets, and current-carrying wires. Preliminary findings will be shared about the opportunities and challenges of using AR technology to teach and learn about fields, based on the authors' experiences with a variety of age groups.

PST1B02: 2:15-3 p.m. STEM Education Delivery Techniques Using an iPad Pro

Poster – Sarah Sublett, United States Military Academy 3318 E Continental Rd. West Point, NY 10996-2121

Virginia Coghlan, James Bowen, United States Military Academy

Instructors develop innovative content delivery methods inside and outside of the classroom for their students. Through the last two years, the Department of Physics and Nuclear Engineering at West Point purchased iPad Pros for every faculty member as an option for creating and delivering educational content. Instructors generated many unique approaches producing content for, collaborating with, and delivering classroom content to their students, regardless of if their student had an iPad. This study surveys instructors two years after our initial acquisition to determine how faculty are using iPads for their classrooms and consolidate those techniques.
*Adam Talent Fund, Department of Physics and Nuclear Engineering, Sponsored by Pete Chapman, Member # 97392

PST1B03: 1:30-2:15 p.m. Conceptually Mapping Computational Integration in High School Physics

Poster – Rebecca E. Vieyra, University of Maryland 225 C St. SE Washington, DC 20003

Colleen Megowan Romanowicz American Modeling Teachers Association

Melissa Girmscheid

Jess Dykes

This poster will display a series of concept maps to present a visual overview of how a group of 30+ physics teachers have integrated computational modeling into the first five units of Modeling Instruction for Physics First. It will include the flow of computational knowledge-building as it relates to a progression through qualitative energy, constant velocity, uniform acceleration, and balanced and unbalanced forces.

PST1B04: 2:15-3 p.m. Digitally Mediated Team-based Learning Using the Virtual Classroom

Poster – KC Walsh, Oregon State University 301 Weniger Hall Corvallis, OR 97331-8507

Oregon State University recently embarked on a complete re-envision on how to structure and deliver online courses. Following the tremendous success in reforming the traditional face-to-face Introductory Physics sequence we had learned the value of implementing PER approved curriculum. Our greatest hurdle bringing these techniques online lie in the problem statement, "How can we implement real-time engagement pedagogies and Peer Instruction strategies in a distance learning environment?". My poster will introduce you to the Virtual Classroom and AsyncSync system created to facilitate Guided Peer Instruction. Using our Lightboard Studio, communication tools, and real-time polling we believe we've created a first-of-its-kind online learning environment that can bring people together in ways never possible. Come check it out!

PST1B05: 1:30-2:15 p.m. The Smartphone as a Hydrophone

Poster – Martín Monteiro, Universidad ORT Uruguay Aconcagua 5152 Montevideo, 7 11400 Uruguay

Several models of smartphones are currently submersible, and the performance of their microphones underwater is good enough to be used as true hydrophones capable of conducting physics experiments. A very elementary application of the hydrophone, suitable for a basic physics course, is to use it to determine the speed of sound in water. Here we present two related activities, one is to measure the speed of sound in water from the time difference of two signals and the speed of sound in air. The other problem-activity consists in determining the distance of a sound source from the delay between two signals, one that travels through the air and another that travels through the water.

Astronomy

PST1C01: 1:30-2:15 p.m. Authentic Astronomical Research in Educational Settings Using JS9

Poster– Terry Matilsky, Rutgers, the State University of New Jersey Department of Physics Piscataway, NJ 08854-8019*

Pam Perry, Lewiston High School

How can we provide an authentic research experience to students who want to find out what science is REALLY about? We couple JS9, a fun to use, web-based image display environment, with archival satellite data to allow students to perform astronomical analysis remotely using their browser. Energy spectra, light curves, periodic phenomena, and much more can be explored, using data from thousands of deep sky objects, spanning the gamut of observed energies, from infra-red emission to gamma rays. Since this system is platform independent, it is especially useful in the classroom, as well as in distance learning environments.
*Sponsored by Donna Young

PST1C02: 2:15-3 p.m. NASA and National Science Olympiad Universe of Learning Astronomy Program

Poster – Donna L. Young, NASA/NSO/CXC 3484 Cottage Meadow Way Laughlin, NV 89029-0192

There are opportunities to become involved with the NASA UoL and NSO STEM Literacy Network. NSO, a well-established and successful program for 35 years, is a national nonprofit organization dedicated to improving the quality of K12 science education, increasing interest in science for all students, creating a STEM literate workforce, and providing recognition for outstanding achievement by students and educators. These goals are achieved by participating in events at invitational, regional, state and national tournaments, and incorporating Science Olympiad events into classroom curricula. Events address NGSS scientific practices, crosscutting concepts and core disciplinary ideas from every scientific discipline, including physics and astronomy. Participation at the post-secondary level by Science Olympiad alumni have resulted in opportunities for hosting an invitational, writing an invitational, regional or state event test, becoming an event supervisor, or contributing questions to the national test bank or mentoring teams preparing for competition in the space science events.

PST1C03: 1:30-2:15 p.m. LIGO Analysis in a Few Lines of MATLAB Code

Poster – Duncan L. Carlsmith, University of Wisconsin-Madison 1150 University Ave Madison, WI 53711

Analysis of open data from exciting big science experiments can engage physics students in courses incorporating computation. This poster illustrates how gravitational wave data from LIGO may be analyzed with a few lines of MATLAB code, reproducing results that led to a recent Nobel prize. The code is used in a tutorial exercise for first year undergraduates.

PST1C04: 2:15-3 p.m. Pulsar Search Collaboratory – Building a Research Community

Poster – Sue Ann Heatherly, Green Bank Observatory PO Box 2 Green Bank, WV 24944-0002

Harsha Blumer, Natalia Lewandowska, Kathryn Williamson, Cabot Zabriske, West Virginia University

The Pulsar Search Collaboratory (PSC), now in its 12th year, engages high school students, undergraduate students, K-12 teachers, and professional astronomers in a shared research enterprise -- to discover pulsars and radio transients and to understand their properties. The PSC is unique in that all of our "audiences" participate together in one community of practice. In this poster we will describe how the PSC works and discuss our findings; the new discoveries made by community members, as well as our educational research results.

PST1C05: 1:30-2:15 p.m. Modeling the Disk of the Milky Way Galaxy

Poster– Sarah E. Gonzalez, New College of Florida 5800 Bay Shore Rd, Box 239 Sarasota, FL 34243;

Ava Doyle, Columbia University

Chris Huang, Heidi Jo Newberg, Rensselaer Polytechnic Institute

The purpose of this project is to map stars within the disk of the Milky Way galaxy. We accomplish this goal through methods of statistical photometric parallax. Potential substructure has been identified and linked to galactic wiggles, the Hercules Aquila Cloud, and the Hercules Halo Stream.

PST1C06: 2:15-3 p.m. Globe at Night

Poster – Robert T. Sparks, NOAO 950 N Cherry Ave Tucson, AZ 85710

Constance E. Walker, NOAO

Globe at Night is international in nature, inviting citizen-scientists around the world to measure and submit night sky brightness observations in their locale. It is designed to raise public awareness of the disappearing starry night sky caused by light pollution. During ten days per month of moonless evenings, citizen-scientists worldwide record the night sky brightness in a "star hunt" for the faintest star visible. They then submit their choice of star map online or with a smart phone along with their date, time and location to help create a light pollution map worldwide. On-the-fly mapping can be used to see contributed observations immediately. Postcards, activity guides and report pages are available in multiple languages. STEM activities for young children (Dark Skies Rangers) and problem-based learning activities for older students (Quality Lighting Teaching Kit) are integrated with the program.
https://www.globeatnight.org/

PST1C07: 1:30 -2:15 p.m. NANOGrav Outreach through Homework Questions

Poster – Carl Schmiedekamp, Penn State University, Abington 1600 Woodland Rd. Abington, PA 19001

As part of the NANOGrav collaboration's outreach activities, we have developed a set of homework questions that have the goal of increasing interest in the astrophysics related to gravitational waves and pulsars. NANOGrav is the North American Nanohertz Observatory for Gravitational Waves, a National Science Foundation Physics Frontiers Center. The questions are on common introductory topics such as density, rotational motion, and centripetal force but use pulsars and gravitational waves as the subjects of the situations described. The questions are targeted to introductory, algebra-based physics classes and are applicable for college as well as high school classes. The questions will be provided in text format via the NANOGrav website and with solutions on the Living Physics Portal and in WebAssign.

Physics Education Research

PST1D01: 1:30-2:15 p.m. Building Partnerships Between Learning Assistants and Faculty by Leveraging Authentic LA Expertise*

Poster – Jamia Whitehorn, Chicago State University 9501 S. King Drive Chicago, IL 60628

Ember Smith, Chicago State University

Mel Sabella, Andrea Van Duzor, Chicago State University

The Learning Assistant (LA) Model involves undergraduate students as peer support in STEM classrooms. In one component of the LA Model, faculty meet with their LAs and have the opportunity to discuss content, think about student understanding, develop instructional materials, and much more. These sessions are opportunities to engage LAs in collaborative partnerships where LAs are authentic members of an instructional team. In this poster we talk about the affordances of collaborative partnerships, discuss instructional power shifts from instructor to LA, and present resources to support LA-faculty teams in moving toward collaboration.
* Supported by the National Science Foundation (DUE#1524829), Illinois Space Grant Consortium, and the Department of Education.

PST1D02: 2:15-3 p.m. Building on Student Resources for Understanding Mechanical Wave Propagation: Examples from Classroom Video

Poster – Lauren C. Bauman, Quest University 3200 University Blvd. Squamish, BC V8B 0N8 Canada

Lisa M. Goodhew, University of Washington

Amy D. Robertson, Seattle Pacific University

Paula R.L. Heron, University of Washington

Rachel E. Scherr, University of Washington Bothell

Resource theory depicts resources as dynamic, context-dependent "pieces of knowledge" and learning as building from students' resources. In line with resource theory, we developed research-based instructional materials meant to elicit and build on common conceptual resources for mechanical wave propagation. In this talk, we will investigate the following questions: What does building-on students' resources look like? What contextual and interactional features support students in this process? To answer these questions, we will look at an example from classroom video, where students are building on and working with their conceptual resources for understanding mechanical wave propagation.

PST1D03: 1:30-2:15 p.m. Apparatus for Demonstration of Acoustic Bubble Levitation in Water

Poster – Mikaela E. Furman, United States Naval Academy Physics Department, United States Naval Academy, 572 C Holloway Road Annapolis, MD 21402;

Murray S. Korman, United States Naval Academy

An apparatus has been built at the USNA to demonstrate that with a sufficiently large amplitude sound wave it is possible to levitate an air bubble in water. The levitation cell is a 15 cm cubic acrylic tank (3.2 mm wall thickness) filled to 9 cm. A standing wave with a pressure node at the surface, bottom and near the middle is generated by four end-capped 17 KHz cylindrical shell transducers secured on the underside of the tank. The transducer resonant frequency is matched to the standing wave resonance in the open tank. A 17 KHz monopole resonant bubble has a radius of 0.19 mm. If the bubble radius > 0.19 mm (where the bubble resonate frequency < 17 kHz of the sound), then the bubble will levitate slightly above the pressure node in the middle of the tank. The oscillator, amplifier, and impedance matching circuits are vital electronic components.

PST1D04: 2:15-3 p.m. Classroom Demonstration of Reflective Ultrasonic Tomography Imaging in Water

Poster Sarah Kwon, United States Naval Academy U.S. Naval Academy, Physics Department, 572 C Holloway Rd. Annapolis, MD 21402

An apparatus has been built at the USNA to demonstrate acoustic imaging. Reflective ultrasonic tomography imaging was chosen because the medical community, using photo-acoustic tomography imaging, utilizes a similar back-projection imaging algorithm. The experiment involves suspending an ultrasonic transducer unit of resonant frequency 2.5 MHz in an aquarium filled with water. The transducer (sender-receiver) generates a short Gaussian shaped pulse characterized by a 20% amplitude reduction two cycles from the peak. The circular plane array transducer diameter is 1 cm. Its wavelength in water is 0.6 mm (using c=1480 m/s). The half-power down angle is 20 degrees. The target, located 10 cm from the source, consists of three long vertical stainless steel rods (0.5 mm diam, separated by 2 mm). Received echoes vs. time (data sets) are measured at 2 degree rotation increments of the target (from 0 to 360 degrees) for back-projecting the 2-D image reflectance of the target.

PST1D05: 1:30-2:15 p.m. Increasing Growth Mindset with a Brief, Interactive, Classroom-based Intervention*

Poster – Stephanie J. Sedberry, University of North Carolina at Greensboro 321 Petty Building, PO Box 26170 Greensboro, NC 27410-9445

Ian D. Beatty, William J. Gerace, Maha A Elobeid, University of North Carolina at Greensboro

Jason E. Strickhouser ,Florida State University

A convincing body of research indicates that psychosocial constructs such as self-efficacy, growth mindset, and perceived academic control predict and affect student performance, persistence, and success in STEM. Interventions designed to increase these factors have proven particularly effective for women and underrepresented minorities. As a part of an NSF-funded project, we have developed and honed a 30-minute interactive, classroom-based intervention aimed at improving students' STEM self-efficacy. Through a combination of short video presentations, live discussions, and short writing prompts, the intervention teaches students about the scientific basis of "growth mindset," stresses the importance of "productive struggle" for getting smarter, and suggests some concrete strategies students can try to take control of their learning and turn struggles into successes. A quasi-experimental study at three universities (n = 853) showed that the intervention significantly increases students' growth mindset, although impacts on self-efficacy and course grades were not statistically significant.

*This material is based upon work supported by the US National Science Foundation under Grant No. DUE-1612053.

PST1D06: 2:15-3 p.m. A Rubric for Assessing Thinking Skills in Free-Response Exam Problems

Poster – Beth Thacker, Texas Tech University Physics Dept., MS 41051 Lubbock, TX 79409-1051;

Fatema Al Salmani, Texas Tech University

We designed a rubric to assess free-response exam problems in order to compare thinking skills evidenced in exams in classes taught by different pedagogies. The rubric was designed based on Bloom's taxonomy. The rubric was then used to code exam problems. We analyzed exams from different sections of the algebra-based physics course taught the same semester by the same instructor with different pedagogies. One section was inquiry-based and the other was taught traditionally. We discuss the instrument, present results and present plans for future research. The inquiry-based students demonstrated all of the thinking skills coded more often than the traditional students.

PST1D08: 2:15-3 p.m. Integration in Physics without Calculus. Integration for the Layman

Poster – David Wright, University of Central Florida 4111 Libra Drive, Physical Science Building, Room 430 Orlando, FL 32816

Christos Velissaris, Al-Rawi Ahlam, Zhongzhou Chen, University of Central Florida

Integration in STEM disciplines presents a formidable task for novice students which according to our findings is due to students considering integrals as mere antiderivatives. We developed a pedagogy where solutions inhomogeneous physics problems are approximated as finite sums, eventually becoming limits of an infinite series of infinitesimally small terms (Riemann sum). In a series of worksheets inhomogeneous problems are presented to students who are being asked to derive approximate solutions as sum of partial results obtained from dividing the original problem into a number of smaller, approximately homogeneous, ones. As we increase the number of divisions, the accuracy of the solution increases and the integral is naturally emerging as a Riemann sum. No calculus is required for completion of the worksheets and the work is essentially algebra based. Recently we implemented the pedagogy on the web to facilitate disbursement and data collection in large classes.

Physics Department University of Central Florida Department Chair: Dr. Eduardo Mucciolo Dr. Zhongzhou Chen Dr. Ahlam Al-Rawi Dr. Christos Velissaris

PST1D09: 1:30-2:15 p.m. A Comparison of Flipped Versus Traditional Teaching of College Physics*

Poster – Donald Walter, South Carolina State University, 300 College St. Orangeburg, SC 29115

Eugene Kennedy, Louisiana State University

Jennifer Cash, Nikunja Swain, South Carolina State University

We previously implemented the flipped approach to teaching calculus-based physics (University Physics) at South Carolina State University, a HBCU located in Orangeburg, SC. In the fall of 2019 we piloted a similar approach with algebra based physics. An instructor is teaching two sections of the same course. One is presented in the traditional lecture format with some in-class problem solving as the "control" group. The other is taught by the flipped method. Earlier we created over 250 short videos on mathematical and physics topics. Students in the flipped section are required to view these videos and other resources prior to lecture and take an online quiz before class. The flipped class receives only a short review of the topics and spends the rest of the period working on problems interactively. We present our preliminary results comparing the two methods.

*We acknowledge NSF HRD support through grant 1912085.

PST1D10: 2:15-3 p.m. Investigating and Improving Student Understanding of Dirac Notation By Using Analogical Reasoning In the Context of A Three-Dimensional Vector Space

Poster – Chandralekha D. Singh, University of Pittsburgh 3941 Ohara St Pittsburgh, PA 15260

Emily Marshman, University of Pittsburgh

We discuss an investigation of student difficulties with Dirac notation in the context of a three-dimensional vector space and the development, validation and evaluation of a Quantum Interactive Learning Tutorial (QuILT) to improve student understanding of these concepts. We find that many upper-level undergraduate students in quan-

tum mechanics courses have difficulties with Dirac notation even in the context of a three-dimensional vector space. The QuILT uses analogical reasoning and builds on students' prior knowledge of three-dimensional vectors in the familiar context of introductory mechanics to help students build a coherent understanding of Dirac notation in three dimensions before transitioning to the quantum mechanical context. We summarize the development of the QuILT and findings from its evaluations. We thank the National Science Foundation for support.

PST1D11: 1:30-2:15 p.m. Validation and Administration of a Conceptual Survey on the Formalism and Postulates of Quantum Mechanics

Poster – Chandralekha D. Singh University of Pittsburgh 3941 Ohara St Pittsburgh, PA 15260 United States

Emily Marshman, University of Pittsburgh

We developed and validated a conceptual survey that focuses on the formalism and postulates of quantum mechanics covered in upper-level undergraduate quantum mechanics courses. We describe the validation and administration of the survey, which has been administered to over 400 upper-level undergraduate and graduate students from six institutions. The QMFPS is valid and reliable for use as a low-stakes test to measure the effectiveness of instruction in an undergraduate quantum mechanics course that covers relevant content. The survey can also be used by instructors to identify students' understanding of the formalism and postulates of quantum mechanics at the beginning and end of a graduate quantum mechanics course since graduate students are expected to have taken an undergraduate quantum mechanics course that covers the content included in the survey. We found that undergraduate students who engaged with research-validated learning tools performed better than students who did not on the QMFPS after the first semester of a junior/senior level quantum mechanics course. In addition, the performance of graduate students on QMFPS after instruction in the first semester of a core graduate-level quantum mechanics course was significantly better than the performance of undergraduate students at the end of the first semester of an undergraduate quantum mechanics course. We thank the National Science Foundation for support.

PST1D12: 2:15-3 p.m. Investigating and Addressing Student Difficulties with the Corrections to the Energies of the Hydrogen Atom for the Strong and Weak Field Zeeman Effects

Poster – Chandralekha D. Singh, University of Pittsburgh 3941 Ohara St Pittsburgh, PA 15260

Christof Keebaugh, Emily Marshman, University of Pittsburgh

Understanding when and how to make limiting case approximations and why they are valid in a particular situation is a hallmark of expertise in physics. Using limiting cases can simplify the problem-solving process significantly and they often provide a means to check that the results obtained are reasonable. We discuss an investigation of student difficulties with the corrections to the energy spectrum of the hydrogen atom for the limiting cases of the strong and weak field Zeeman effects using degenerate perturbation theory. This investigation was carried out in advanced quantum mechanics courses by administering written free-response and multiple-choice questions and conducting individual interviews with students. Here we first discuss the common student difficulties related to these concepts. We then 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 the concepts necessary for finding the corrections to the energy spectrum of the hydrogen atom for the strong field and weak field Zeeman effects. The development of the QuILT and its evaluation in the undergraduate and graduate level courses are presented. We thank the National Science Foundation for support.

PST1D13: 1:30-2:15 p.m. Investigating and Improving Student Understanding of the Basics for a System of Non-Interacting Identical Particles

Poster – Chandralekha D. Singh, University of Pittsburgh 3941 Ohara St Pittsburgh, PA 15260

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 the concepts necessary for determining the many-particle Hamiltonian and stationary state wavefunctions for a system of non-interacting identical particles. We discuss the development of the identical particles QuILT and its evaluation in undergraduate and graduate courses that focused on these issues.

PST1D14: 2:15-3 p.m. Active Learning in Physics: Strategies for the Community College Classroom

Poster – Petia Yanchulova Merica-Jones, University of California, San Diego PO Box 12701 La Jolla, CA 92037

Philip Blanco, Grossmont College

Irena Stojimirovi, San Diego Mesa College

We applied two active learning strategies - Think, Pair, Share (TPS) and Muddiest Point Feedback (MPF) - to Introductory Mechanics courses at San Diego Mesa College and Grossmont College in 2019 as part of a student-centered course redesign. We reflect on the strategies' implementation and outcomes to understand the teaching and learning dynamics of the course. The key learning goal is for students to analyze physical situations by applying physics laws with confidence. In particular, students are asked to discern which conservation laws apply to a certain physical situation. We gather evidence of learning by relatively standard methods of quizzes, finals exams, and lab reports. We implement the ABCD card collaboration activity for instant feedback and to spark peer-to-peer instruction in the TPS strategy. We obtain prompt and authentic feedback by asking students to hand in index cards containing their MPF - a low-stakes activity giving students the permission to disclose their challenges in understanding a topic, and receive acknowledgment and tailored instruction in the following lecture. These activities foster an inclusive environment as all students are asked to participate. These approaches to a modular course transformation were prompted by the need to increase the success and retention rates in these courses, which typically are below 65%.

PST1D15: 1:30-2:15 p.m. The Coming Revolution in Physics and Engineering Education – Computational Calculus

Poster – William Flannery, Berkeley Science Books 2920 2nd St N Saint Petersburg, FL 33704

The laws governing physical processes are written as differential equations. Wiki reveals what I call the universities' little secret: - "Only the simplest differential equations are solvable by explicit formulas; however, some properties of solutions of a given differential equation may be determined without finding their exact form. If a closed-form expression for the solution is not available, the solution may be numerically approximated using computers." The simplest way to numerically approximate a solution to a differential equation is Euler's method. It is based on one formula, distance equals velocity times time. Euler's method can be taught to high school science students with no prior exposure to calculus in a single one-hour lecture. The poster explores how Euler's method can be used to solve problems in central force motion, electric circuit analysis, and 2D rigid body dynamics.

'The Coming Revolution in Physics Education', W. Flannery, The Physics Teacher, Oct. 2019 'Mathematical Modeling and Computational Calculus I', W. Flannery, http://berkeleyscience.com/MMCCI.htm 'The University's Little Secret - Most Differential Equations are Unsolvable', W. Flannery, https://www.academia.edu/38928183/The_Universitys_Little_Secret_-_Most_Differential_Equations_Are_Unsolvable The poster - http://berkeleyscience.com/Poster1.pdf

PST1D16: 2:15-3 p.m. The Coming Revolution in Physics Education – The Finite Difference Method

Poster – William Flannery, Berkeley Science Books 2920 2nd St N Saint Petersburg, FL 33704

The finite difference method (FDM) is Euler's method adapted to compute solutions to partial differential equations. The FDM converts by rote a partial differential equation into a computational equation that can be used to compute numerical solutions to the equation. The FDM is simple, intuitively clear, and easily taught. The laws of physics governing heat transfer, material stress and strain, fluid dynamics, and electrodynamics, are written as partial differential equations. Like ordinary differential equations, partial equations are difficult and usually impossible to solve analytically. As a result I believe these branches of physics, with the exception of electrodynamics, are forgotten at many universities, they are completely missing from the (nearby to me) University of South Florida physics undergraduate curriculum. The poster

covers the application of the finite difference method to analyzing partial differential equation models of physical processes, including the physical laws, the model derivation, applying the FDM, and results.

'The Coming Revolution in Physics Education', W. Flannery, The Physics Teacher, Oct. 2019 'Mathematical Modeling and Computational Calculus II', W. Flannery, http://berkeleyscience.com/MMCCII.htm 'The University's Little Secret - Most Differential Equations are Unsolvable', W. Flannery, https://www.academia.edu/38928183/The_Universitys_Little_Secret_-_Most_Differential_Equations_Are_Unsolvable The poster - http://berkeleyscience.com/Poster2.pdf

PST1D17: 1:30-2:15 p.m. Exploring the E-CLASS Using Item Response Theory

Poster – Anne Wang, Department of Aerospace Engineering, Texas A&M University 276 Claywell Drive San Antonio, TX 78209-3344

Marcos D Caballero, Rachel Henderson, Department of Physics & Astronomy, Michigan State University

Traditional physics laboratory courses at Michigan State University (MSU) were transformed into the Design, Analysis, Tools, and Apprenticeship Lab (DATA Lab) two-course sequence as a response to the national call for a focus on practices and skills within the physics laboratory context. In order to measure how well students' views align with expert-like views of experimental physics, the Colorado Learning Attitudes and Science Survey for Experimental Physics (E-CLASS) was developed. Analysis using Item Response Theory (IRT), a psychometric paradigm for constructing, validating, and analyzing surveys, will be presented to comment on how the E-CLASS items contribute to the assessment. With respect to the set of learning goals from the MSU DATA Lab courses, results show that the majority of the items on the E-CLASS are reliable for each of the learning goals.

PST1D18: 2:15-3 p.m. A Four-Pillar Approach to Teach (Radioactive) Decay

Poster – Martina E. Bachlechner, Pierpont Community & Technical College, 1201 Locust Avenue, Fairmont, WV 26554

To engage students in a two-year college in learning various aspects of half-life and decay, a four-pillar approach was developed: For ideal decay, (i) differently wide strips of paper are cut repeatedly in half and taped to the wall with the bottom aligned and (ii) spreadsheet software is utilized to "remove exactly one sixth or exactly one third of currently present dice" and graph the number remaining versus time. To incorporate the randomness of the radioactive decay process, (iii) a high number of dice is rolled virtually and those with a specific number of eyes are "removed." Spreadsheet software is used to calculate the remaining number of dice, to graph the remaining number versus time, and add a trendline. The learning process is rounded off with the (iv) PhET Radioactive Dating Game that interactively visualizes the randomness of the decay process and relates it to the previously studied graphs.

PST1D19: 1:30-2:15 p.m. The Physics of Second Chances

Poster – Ethan A. Deneault, University of Tampa 401 W Kennedy Blvd., Tampa, FL 33606-1450

When one learns to ride a bicycle, the oft-repeated mantra is "get up and try again". In physics, especially at the undergraduate level, the mantra is much different: "do well on this test to succeed." In this latter paradigm, the student's understanding can only be demonstrated by a singular event. Mastery of a skill, however, comes from repetition: failure and "getting back on the bike." In this poster, we present a pedagogical method which stresses repetition, in which the students' struggles and failures are recognized and realigned into opportunities for growth and better understanding of the material.

PST1D20: 2:15-3 p.m. Assessing a New Pedagogy for Introductory Physics Using Institutional Data

Poster– Christopher Fischer, University of Kansas 1082 Malott Hall, 1251 Wescoe Hall Drive Lawrence, KS 66045

Jennifer Delgado University of Kansas

Sarah Rush, University of Kansas

We collaborated with our university's office of institutional research to assess pedagogical changes in our calculus-based introductory physics courses using different sets of student data. We found that switching to a competency-based grading system in these classes reduced the drop/fail/withdrawal rates and course-associated grade penalties of under-represented minority, first generation, and female students. We separately performed a longitudinal study to identify how changing the curriculum of these physics courses affected student performance in downstream engineering courses. We found that increasing the calculus content in introductory physics correlated with higher grades earned in subsequent engineering courses, and that these downstream benefits were largest for students with lower math abilities. Taken together, these results demonstrate how instructors can use educational data sets to make improvements in their courses that specifically target improving the performance and retention of traditionally underserved populations.

Analysis of aggregate student grades in downstream engineering courses was performed in collaboration with the University of Kansas STEM Analytics Program, which is supported by the American Association of Universities Undergraduate STEM Education Initiative funded by the Northrop Grumman Foundation.

PST1D21: 1:30-2:15 p.m. Student and Faculty Perspectives of Retention in Physics Graduate Programs

Poster – Kelli Shar, The University of Tampa 6727 South Lois Avenue Tampa, FL 33616

Lindsay Owens Rochester Institute of Technology

Benjamin M Zwickl Rochester Institute of Technology

Casey W Miller Rochester Institute of Technology

Why do physics graduate students leave their programs? Seventeen faculty from four different institutions and 54 graduate students from 23 institutions were asked this question. Faculty discussed poor work ethic and struggles with coursework and qualifying exams as the primary reasons that graduate students leave their programs. Graduate students cited departmental culture and mentoring not meeting their expectations as well as opportunities in industry as common reasons for withdrawing from Physics Ph.D. programs. Based on this discrepancy between perspectives we recommend that faculty and students actively communicate about the underlying issues of why graduate students leave. Such discussions can aid programs in creating solutions to address issues and improve retention rates.

DA Introducing Computation in Physics Classes

Time: 3–4:10 p.m. **Sponsor: Committee on Physics in Two-Year Colleges** **Date: Monday, Jan. 20**
Location: Grand Sierra C **Presider:** *Dwain Desbien*

DA01: 3-3:10 p.m. Integrated Computational Modeling Curricular Resources for Physics First

Contributed – Rebecca E. Vieyra, University of Maryland 225 C St. SE Washington, DC 20003

Colleen Megowan Romanowicz, American Modeling Teachers Association

Melissa Girmscheid

Jess Dykes

This presentation will use concept maps to present a visual overview of how a group of 30+ physics teachers have integrated computational modeling into the first five units of Modeling Instruction for Physics First. It will include an overview of the integrated conceptual knowledge as it is embedded into unit objectives, as well as the flow of computational knowledge-building as it relates to a progression through qualitative energy, constant velocity, uniform acceleration, and balanced and unbalanced forces.

DA02: 3:10-3:20 p.m. A Computational Approach to University Physics

Contributed – Michael Butros, Victor Valley College, 18422 Bear Valley Road Victorville, CA 92395

The university physics sequence at Victor Valley College (VVC) is integrating computational techniques in the curriculum. These computational techniques are in terms of using open source software (SCILAB) and requiring the completion of PICUP assignments. This presentation will introduce the methodologies used to teach the university physics sequence and how computation is incorporated within them.

DA03: 3:20-3:30 p.m. Assessing the Value of Video-Game-like Coding Activities for Introductory Physics*

Contributed – Chris Orban, 191 W Woodruff Ave Columbus, OH 43210

The STEMcoding project has developed a number of "Physics of Video Games" that are fusion of PhET-like web interactives and traditional coding activities. A crucial question is whether these activities do anything more than build student's familiarity with computer science. I briefly overview efforts to assess growth in conceptual physics knowledge from completing these activities. Our hypothesis is that these activities naturally encourage students to look more critically at the behavior of a physics-rich digital game than they would if the code behind an interactive were hidden. Student data from the Ohio State Marion campus will be presented, which is a two-year regional campus serving the larger Columbus campus.

*The STEMcoding project received support from the 2017 AIP Meggers Award.

DA04: 3:30-3:40 p.m. Anim: A Language-Agnostic, Accessible 2D and 3D Animation Tool

Contributed – Walter Freeman, Syracuse University 215 Physics Building Syracuse, NY 13244

The ability to visualize simulation results is a crucial benefit to integrating computation. Students gain a deeper appreciation of phenomenology by watching a physical model come alive on the screen than by only looking at equations on paper. However, most animation tools are far from ideal. They often have clumsy syntax that is difficult to remember, require a significant computer-science burden of knowledge from the students, and are specific to a particular programming language or environment. To fill the need for an accessible, flexible animation tool, I have written an opensource tool that acts as a command-line filter, ingesting text and creating 2D/3D animations using an OpenGL backend. This allows students to generate attractive animations using only the pipe feature of the shell and the print command in their favorite programming language. Anim is flexible, language-agnostic, and allows students to focus their efforts on physics rather than syntax.

DA05: 3:40-3:50 p.m. Visualization of the Electric Field of a Charge Undergoing Arbitrary Motion in Three Dimensions

Contributed – Duncan L. Carlsmith, University of Wisconsin-Madison 1150 University Ave Madison, WI 53711 US

The classical theory of electromagnetic radiation is generally left to advanced undergraduate or graduate courses, leaving beginning undergraduates with a conceptual disconnect between their studies of electromagnetic theory, relativity, and optical and other electromagnetic wave phenomena, both classical and quantum. The idea of propagating kinks in electric field lines provides an intuitive explanation for the generation of a radiation component in the field of a charge instantaneously accelerated. Exact expressions for the full field for other motions are quite limited, and complicated. Visualization of the electric field of an accelerated charge undergoing an accelerated motion in three dimensions, computed from exact but implicit analytic expressions with a MATLAB code, is demonstrated and applied to a variety of standard example processes including synchrotron radiation and bremsstrahlung. The code itself has been used as a capstone tutorial in computational techniques for 1st year students.

DA06: 3:50-4 p.m. Assessment of Computational Worksheets Implementation in a Quantum Mechanics Course

Contributed – Scot A.C. Gould, Claremont McKenna, Pitzer, Scripps W.M. Keck Science Center, 925 N. Mills Ave. Claremont, CA 91711-5916

An undergraduate upper division quantum mechanics course was taught using a computer algebraic and numeric system, Maple™. Virtually all course content and solutions to example problems were disseminated through Maple worksheets. Students where encouraged, but not required, to use Maple. Homework assignments included traditional hand solved problems as well as problems that required the aid of a high-level computer package. Two of the exams were traditional, two computational. Each student's capability to use Maple to solve the problems and present the output in a readable worksheet was assessed by the instructor at the end of the semester. More than one-third of the students could perform and properly present all multi-variable calculus, linear algebra, and Dirac notation algebra calculations and derivations in a single Maple worksheet. Students nearly universally felt the computational helped them better understand the physical principles and to make the material more accessible and interesting.

DA07: 4-4:10 p.m. The Coming Revolution in Physics and Engineering Education – Computational Calculus

Contributed – William Flannery, Berkeley Science Books 2920 2nd St N Saint Petersburg, FL 33704

Modern math and physics began in the 17th century when Isaac Newton discovered the law of gravity and the laws of motion, and derived the equation for the acceleration of a falling object in a gravitational field. The same formula is now derived in high school physics classes. This is a differential equation, i.e. an equation for a rate of change, and Newton developed analytic calculus to solve differential equations. However this equation is analytically unsolvable. Computers have revolutionized physics and engineering because they make it easy to compute approximate solutions to differential equations, even unsolvable ones. The basic method of computational calculus is known as Euler's method. Euler's method is simple, intuitively clear, and easy to learn: it can be taught to high school science students in a single one-hour lecture. We present Euler's method and show how to compute trajectories for Newton's apple, orbits, and the Apollo mission.

http://berkeleyscience.com/MMCCI.htm

DB Get the Facts Out: Changing the Conversation Around Physics Teacher Recruitment

Time: 3–5 p.m. **Sponsor: Committee on Teacher Preparation** **Co-Sponsor: Committee on Research in Physics Education**
Date: Monday, Jan. 20 **Location: Grand Sierra F** **Presider:** *Drew Isola*

DB01: 3-3:30 p.m. Research Design of the Get the Facts Out Project

Invited – Wendy K. Adams, Colorado School of Mines, 1700 Illinois Street, Golden, CO 80401

Savannah Logan, Colorado School of Mines

Richard L Pearson III, Embry Riddle Aeronautical University

The Get the Facts Out (GFO) project is a joint effort between four national societies and the Colorado School of Mines to change the conversation around grade 7-12 physics, chemistry, and math teaching careers. We have developed a toolkit of recruitment materials which are designed to be customizable and adaptable to the local situation. To develop these materials and better understand best practices around recruiting math and science teachers, GFO has a rigorous research arm. Our research includes the study of both student, faculty, and the general public's perceptions of the teaching profession including development of instruments to measure these. We also have embarked on a study to identify emotionally engaging ways to share facts about the profession. Finally, to measure the effectiveness of the project, we have an aggressive research design that includes annual collection of qualitative data from eighteen departments and quantitative data from another 57 departments.

DB02: 3:30-4 p.m. GFO Copywrite: Development of Materials for Recruiting STEM Teachers*

Invited – Savannah L. Logan, Colorado School of Mines, 2329 S Eldridge St., Golden, CO 80228

Wendy K. Adams, Colorado School of Mines

There is a serious shortage of secondary science and math teachers across the United States. Part of this shortage can be attributed to a lack of research-based recruitment materials. To this end, we have developed written and visual materials for recruiting future teachers as part of the Get the Facts Out (GFO) project. We began by working with a marketing expert to develop tag lines, sentences, and other written material based on our research on perceptions of the teaching profession. We then tested and refined these materials through faculty and student focus groups at several demographically and geographically diverse U.S. universities. Most recently, we collected large-scale data via a national online survey. Our findings provide insights into optimal recruitment strategies, and we will share some of our unique findings based on location, demographics, and target audience.

*This project is supported by NSF DUE-1821710.

DB03: 4-4:30 p.m. Statistical Analyses of the PTaP.HE, a Faculty Perceptions Instrument

Invited – Brian A. Pyper, APS/ BYU-Idaho BYUI Physics 118 Romney Building Rexburg, ID 83460-0520

Savannah Logan, Richard L Pearson III, 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 views of teaching as a career—we have developed a new instrument that measures university faculty's perceptions of teaching as a profession. Here we will share the outcomes of a factor analysis of data collected from approximately 800 faculty, our recommended scoring strategy, and preliminary results. We will also discuss the potential impact of faculty perceptions of the teaching profession on our future science and math teacher workforce. This work is part of the Get the Facts Out project which is supported by NSF DUE-1821710.

DB04: 4:30-5 p.m. A Theory of Change for Getting the Facts Out*

Invited David May, American Physical Society, 1 Physics Ellipse College Park, MD 20740

Monica Plisch, American Physical Society

GFO's Theory of Change guides how partner societies will conduct national messaging campaigns to the broader STEM community while directly supporting more customized, in-depth campaigns on individual campuses, led by "local champions" from among each institution's STEM faculty. These local campaigns (including the recruitment of local champions) are supported by (1) direct member engagement by societies, (2) GFO's extensive resources for conducting such campaigns, and (3) expert "change agents" hired by the project to facilitate workshops and online communities. These local and national campaigns are intended to engender more realistic perceptions of the teaching profession in students and in the faculty and others who influence their career choices. These changed perceptions are expected to lead to an increase in the number of students who enroll in STEM teaching certification programs. Specific examples of how this theory has informed the project will be shown.

*This work is supported by NSF DUE-1821710.

DC Introductory Physics II

Time: 3–3:50 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Grand Sierra G** **Presider:** *TBA*

DC01: 3-3:10 p.m. What a Psychologist, an Engineer, and a Physicist Learned about Engineering Students

Contributed – Jennifer Blue Miami University 217 Kreger Hall Oxford, OH 45056 United States

Amy Summerville, Brian Kirkmeyer, Miami University

We have been working on an interdisciplinary project supported by a National Science Foundation grant (award 1530627). The goal of this work was to learn about, and support, first-year engineering students as they take their introductory required courses – such as calculus-based physics. We looked at mindset, self-efficacy, social belonging, and regret, paying particular attention to differences between students in traditionally excluded groups and their peers.

DC02: 3:10-3:20 p.m. Bringing Active Engagement and Peer Instruction to Online Learners

Contributed – KC Walsh, Oregon State University, 301 Weniger Hall Corvallis, OR 97331-8507

Following tremendous success reforming the class structure of the traditional face-to-face Introductory Physics sequence, Oregon State University has embarked on re-envisioning their online physics courses. Distance learners now participate in real-time collaborative problem solving and critical thinking through our Virtual Classroom. Live video feeds from the Lightboard Studio allow instructors to interact with students and content in ways never been done before. Real-time polling and the ability to quickly form breakout rooms for groups of students allows for Think-pair-share exercises. AsyncSync sessions run by LAs and SI leaders facilitates real-time group formation over a flexible number of hours to accommodate busy schedules online learners typically have. Students work both individually and collaboratively on their weekly inquiry-based lab experiments. Students have access to unprecedented real-time support from TAs in the Virtual WormHole helpdesk. I'll present on this innovative approach to distance learning and show how we are getting PER approved curriculum into our online classes.

DC03: 3:20-3:30 p.m. Incorporating Non-Western Contributions Into the Intro Physics Curriculum

Contributed – Cory W. Christenson, Washington & Jefferson College 60 S Lincoln St Washington, PA 15301

Brianna Billingsley, Washington & Jefferson College

If you look through any physics textbook you will encounter canonical names such as Newton and Galileo. While their contributions are indeed significant, presenting the history of physics solely in terms of these western scholars hides a much deeper and complex history that is not often taught. Here we will discuss how to incorporate contributions from Chinese and Arab civilizations. These concepts can be introduced to students through labs, homeworks, and discussion questions. A broader and more culturally diverse scientific history can engage student interest, teach them about how science actually happens, help them to appreciate the value of diversity.

DC04: 3:30-3:40 p.m. New Course on the Physics of Theater Light Design

Contributed – Donald Andrew Smith, Guilford College 5800 W. Friendly Ave. Greensboro, NC 27410

I will present a new course for non-majors on the Physics of Theater Light Design. It was team-taught with a colleague from the Theater Arts department and cross-listed to count for either a science or an arts general education requirement. The course was implemented as a three-week immersive course in August 2019. Each morning students completed laboratory exercises about circuits, mirrors, lenses, light, and color. In the afternoon, we met in the theater, where the students learned how to choose and place instruments to create scenes on stage. In the last week, we shifted into a production schedule, and our class designed the lights for a performance class's musical. Thirteen students completed the course: 11 for a science credit and two for an arts credit. I will present the activities we used to teach both the physics and the technical craft of stage lighting, and how we linked the two.

DC05: 3:40-3:50 p.m. Using Computation to Teach Circuits in an Introductory Physics Class

Contributed – Kathy Shan, University of Toledo 2801 W Bancroft St. Toledo, OH 43606

I discuss a case study of the use of a computational activity to be used for teaching circuits to students in an interactively taught (partially flipped) small honors section of the introductory, calculus-based physics course for science and engineering majors at an open enrollment public university. Due to a lack of experience with coding on the part of the students and the instructor, the activity was developed for use with a spreadsheet program. Student understanding was evaluated by comparing performance on midterm and final exam questions to students in previous semesters.

DD History of NASA

Time: 3–5 p.m. **Sponsor: Committee on History and Philosophy in Physics** **Date: Monday, Jan. 20**
Location: Grand Sierra H **Presider:** *Joanna Behrman*

DD01: 3-3:30 p.m. Space from the Ground Up

Invited – Kenneth Lipartito, Florida International University Department of History Miami, FL 33199-0002

Most images of spaceflight stress the flight and living and working in space. Few give attention to the work that goes on before liftoff, to the ground operations that take place at the Kennedy Space Center. This talk will explore the operational side of the technology of space flight. It questions the highly rational view of management structures and the designed centered logic of systems engineering, and argues for the importance of importance of hands on learning and the highly innovative and even experimental nature of operational work. The Challenger and Columbia accidents and the failure of the space shuttle to live up to its promise reflect the subordination of operations and the overly abstract systems engineering and management structures of the space program.

DD02: 3:30-4 p.m. NASA Space Grant – 30 Years of Aerospace Workforce Development, the Oregon Experience

Invited – Jack Higginbotham, Oregon State University 92 Kerr Administration Bldg Corvallis, OR 97331

The NASA Space Grant program was created by Congress in 1987, "… to help maintain America's preeminence in aerospace, science and technology. Through the establishment of state-based consortia … institutions provide leadership and support for program objectives in their state and nationally by interacting with other universities, by broadening joint activities with NASA and aerospace-related industries, and by providing public service functions, such as support to elementary and secondary schools and to the public." From the Oregon/NASA Space Grant experience, there many ways student treks towards aerospace careers are influenced and inspired by decadal public investment in NASA education efforts. The key to such success in Oregon is nurturing a path of successive opportunities building from the point of a student's inspiration, to engagement, then education and finally STEM employment. These strings of opportunities will be presented with an eye to the emerging importance physics plays in the STEM pathway.

DD03: 4-4:30 p.m. Sex in Space: The History of NASA's Women Astronauts

Invited – Amy Foster, University of Central Florida 12796 Aquarius Agora Drive Trevor Colbourn Hall, Ste 319 Orlando, FL 32816-1350

The Soviet Union launched Valentina Tereshkova, the first woman in space, in June 1963. The United States did not succeed in launching its first woman into space, Sally Ride, until June 1983. What circumstances explain the significant lag in the U.S. space program's decision to launch its first female astronaut? How do politics, culture, and technology influence this decision to not launch a woman until well after the Soviet Union accomplished the same feat? While these are complicated questions, this talk proposes to provide some answers to the why and how women flew in space.

DD04: 4:30-5 p.m. Integrating Women into the Astronaut Corps

Invited – Joanna Behrman, Johns Hopkins University 3400 N Charles Street Baltimore, MD 21218

The Soviet Union launched Valentina Tereshkova, the first woman in space, in June 1963. The United States did not succeed in launching its first woman into space, Sally Ride, until June 1983. What circumstances explain the significant lag in the U.S. space program's decision to launch its first female astronaut? How do politics, culture, and technology influence this decision to not launch a woman until well after the Soviet Union accomplished the same feat? While these are complicated questions, this talk proposes to provide some answers to the why and how women flew in space.

DE How to Start Your Undergraduate Program with Contemporary Physics

Time: 3–5 p.m. **Sponsor: Committee on Contemporary Physics** **Co-Sponsor: Committee on Physics in Undergraduate Education**
Date: Monday, Jan. 20 **Location: Grand Sierra I** **Presider:** *Charles Holbrow*

DE01: 3-3:30 p.m. Atoms and Waves: Starting Physics Education with a Big Question

Invited – Beth Parks, Colgate University 13 Oak Drive Hamilton, NY 13346-1338

The course "Atoms and Waves" was created to introduce first-semester students to the excitement of contemporary physics, and, at the same time, to allow incoming students to complete at least one semester of calculus before starting mechanics. While we normally think of modern physics as requiring significant mathematical sophistication, careful consideration of topics yields a syllabus that allows students to explore an exciting question in physics--does matter consist of particles or waves?--and simultaneously introduces them to foundational ideas in physics. Teaching topics such as photon energy, interference, and atomic spectra allows introductory-level students to better understand (and even participate in) current research, allowing them to more quickly integrate into the physics department. The textbook [1] and laboratories we've developed provide enough breadth to allow instructors to choose the topics that they find most compelling, in order to inspire students to study physics.
[1] Modern Introductory Physics, 2nd edition, C.H. Holbrow et al., Springer 2010.

DE02: 3:30-4 p.m. A Decade of Teaching Contemporary Physics First at Pomona

Invited – Thomas Moore, Pomona College, Pomona Physics / 610 N College Ave., Claremont, CA 91711

Since 2009, Pomona College's introductory physics course for potential majors (Physics 70) has started with special relativity, quantum mechanics, and statistical physics. (We offer half-courses in mechanics and in electricity and magnetism in the spring semester for students who need them.) Shortly after that transition, the number of physics and astronomy majors jumped up sharply and has remained significantly higher since. This talk will explore why we chose to make this shift, how we designed the course, how we have evaluated its success, how we have continued to modify the course to respond to changes in the background and demographic profile of our students, and some of the surprises we encountered along the way.

DE03: 4-4:30 p.m. Beginning with Modern Physics – How It Is Working at a Regional Comprehensive University

Invited – Michael T. Carini, Western Kentucky University 1906 College Heights Blvd Bowling Green, KY 42101-3576

Scott Bonham, Richard Gelderman, Douglas Harper, Ting-Hui Lee, Western Kentucky University

In the fall semester of 2007, the Physics and Astronomy Department at Western Kentucky University changed its physics curriculum such that students would begin with a course covering introductory modern physics, rather than classical mechanics. This change was patterned after a similar change reported to be successful in improving student success at Colgate University. In this presentation, I will report on the evolution of this course over that past 12 years and our perceptions of the effectiveness of this change to student learning and success.

DE04: 4:30-5 p.m. Labs to Teach Quantum Physics to First-Year Students

Invited – Enrique Galvez, Colgate University 13 Oak Drive Hamilton, NY 13346

We discuss our efforts to offer labs to complement teaching quantum physics in the first semester of the physics curriculum. Our offerings include kinetic theory, Brownian motion, quantization and quantum interference.

DF Physics Specific Pedagogy Courses

Time: 3–4:40 p.m. **Sponsor: Committee on Teacher Preparation** **Co-Sponsor: Committee on Physics in High Schools**
Date: Monday, Jan. 20 **Location: Bonaire 1-2** **Presider:** *John Stewart*

DF01: 3-3:30 p.m. Improving Physics Instruction with the Undergraduate Physics Pedagogy Course at the University of Central Florida

Invited – Jacquelyn Chini, University of Central Florida 4111 Libra Dr Orlando, FL 32816;

The Physics Department at the University of Central Florida has offered a three-credit undergraduate physics pedagogy course once per year since spring 2015. We have tried to develop the course to support the range of reasons students enroll in it: science education majors looking for physics-specific teaching practices, physics and engineering majors considering careers in teaching, Learning Assistants continuing in our pedagogy course sequence, and physics majors in need of an additional physics elective. We have incorporated a range of service-learning projects with the dual purpose of giving our students authentic teaching experiences and supporting physics instruction in central Florida; we even earned departmental support to revise our introductory laboratory sequence through a "self-centered" service-learning project! This talk will describe strategies for sustaining enrollment, selecting course content and topics, and developing and managing service-learning projects as well as lessons learned through the first five years of running "Teaching Introductory Physics".

DF02: 3:30-4 p.m. Iterative Tuning of the Scope of a Physics Pedagogy Course*

Invited – Hunter G. Close, Texas State University 601 University Dr. San Marcos, TX 78666

What should the mission and topical scope of a physics-specific pedagogy course be? Texas State University has a Learning Assistant Program in physics only, but this program serves LAs with various STEM majors in their physics LA work. Thus, our LA-required "Pedagogy I" course aims to introduce LAs to a critical look at STEM learning, with moderate emphasis on physics. With Texas State as a PhysTEC Comprehensive Site (2015-2018), we created a follow-up upper-division physics course ("Pedagogy II") to delve deeper into physics education research and instructional issues, emphasizing cognitive psychological perspectives. The course counts toward any physics degree and aims to be useful and interesting for future teachers, but not only for them. What, therefore, should we teach? I will describe our iterations of course scope, including feedback from new student teachers, and our projected revisions.
*This work is supported by NSF DUE 1557405.

DF03: 4-4:10 p.m. Projects and Student Centered Activities Featured in Capstone Teacher Prep Course

Contributed– Richard Gelderman, Western Kentucky University 1906 College Heights Blvd Bowling Green, KY 42101-1077

The "Physics for Teachers" course at Western Kentucky University is a capstone, senior-level course with a pre-requisite of a year of introductory physics. The focus, therefore, is on "pedagogical content knowledge" of both knowing the physics and how to help students best learn the physics. This is accomplished without lecture, instead adopting a student-centered approach based on the Modeling Physics and/or Investigative Science Learning Environment approaches. The pre-service teachers in this class are provided with a discrepant event, interactive demonstration, or case study to start each each topical unit. Then they are tasked with developing concluding practicum assessments to conclude the unit. For instance, the projectile motion section might be introduced with a video featuring the NFL's fastest player shows him throw a pass and apparently run and catch his own pass; with the challenge to identify evidence which supports or disproves the claim. After developing understanding through sequenced assignments, the students create novel hands-on challenges with a tangible right answer that can be mastered through various creative problem-solving approaches to the challenge.

DF04: 4:10-4:20 p.m. Women as Physics Makers

Contributed – Jill A. Marshall, The University of Texas, 1 University Station, D5700, Austin, TX, TX 78712

For several years, the Physics by Inquiry course (McDermott and the University of Washington PEG) at the University of Texas, Austin, has included a Maker component. Students are tasked with making (designing and building) something that they would like to share or own that somehow involves electric circuits or optics. These are topics covered in the course, in alignment with preparation for teaching high school in Texas, where both are included in the student learning standards. In this study, I explore the effect of including this maker project in the curriculum on women students. Women in the class have created artifacts (e.g., a doll with an embedded sound card that plays a mother's heartbeat to a newborn) that reviewers have said could easily be adapted for marketing, as well as objects of deep personal meaning and usefulness. Some have credited the Maker project with changing their goals as teachers.

DF05: 4:20-4:30 p.m. Interference Experiment with Two Coherent Acoustic Sources

Contributed – Xiaoyu Niu, Institute of Acoustics, Chinese Academy of Sciences No.21 North 4th Ring Road Haidian District, Beijing 100190 China

Wei Wang, Nanjing University

Chenguang Li, Peking University

Ce Bian Ocean, Dazhi Gao Ocean University of China

As for the "Interference Experiment," we design and conduct a specific experiment by means of the sound wave to demonstrate the interference of wave. However, if we depend on the general Double-slit Interference theory, as the most University Physics textbooks required, the experimental result will hold approximately 16% inaccuracy. Thus, we designed the second experiment which is based on amelioration of analysis. The result shows the error was controlled within 4%, which may indicate that the amelioration on analysis could arise the accuracy of the experiment. Thus, we designed the second experiment which based on amelioration of analysis. The result shows the error was controlled within 4%, which may indicate that the amelioration on analysis could arise the accuracy of the experiment. Moreover, it may be helpful for teachers and students to comprehend the essence of the interference phenomenon.

DF06: 4:30-4:40 p.m. Newton's Second Something or Other

Contributed – P James Norris, Idaho State University 5706 Moses St ., Chubbuck, ID 83202

Newton's Second Law, "The change in an object's momentum is equal to the net force acting on the object.", cannot serve as a law because it does not allow one to make falsifiable predictions regarding the motion of an object under the influence of a non-zero net force. The ceteris paribus version of the statement commonly offered as Newton's Second Law, "(If the object's mass is constant, then) the net force on a body equals the body's mass times its acceleration.", is, in fact, our fundamental mechanism for quantifying an object's mass. Thus, Newton's second law is not a law.

DG PER: Assessment, Grading and Feedback

Time: 3–4:40 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Bonaire 3-4** **Presider:** *TBA*

DG01: 3-3:10 p.m. A Rubric for Assessing Thinking Skills in Free-Response Exam Problems

Contributed – Beth Thacker, Texas Tech University Physics Dept., MS41051 Lubbock, TX 79409-1051

Fatema Al Salmani ,Texas Tech University

We designed a rubric to assess free-response exam problems in order to compare thinking skills evidenced in exams in classes taught by different pedagogies. The rubric was designed based on Bloom's taxonomy. The rubric was then used to code exam problems. We analyzed exams from different sections of the algebra-based physics course taught the same semester by the same instructor with different pedagogies. One section was inquiry-based and the other was taught traditionally. We discuss the instrument, present results, and present plans for future research. The inquiry-based students demonstrated all of the thinking skills coded more often than the traditional students.

DG02: 3:10-3:20 p.m. Student Understanding and Applications of Infinity in Physics and Mathematics

Contributed – Daniel B. Marsh, Missouri Southern State University 3950 E Newman Rd Joplin, MO 64801

Cade M Hensley, Rabindra R Bajracharya, Missouri Southern State University

The concept of infinity is applied widely in various contexts in physics, particularly while implementing the limits of large quantities, such as distance, time, and mass. We are investigating how students' deal with this concept when they solve problems in mathematics and physics. We report results from individual semi-structured interviews with physics students, where they are required to use the concept of infinity to solve the problems. We found that students have several difficulties with the implementation and interpretation of the concept of infinity. These difficulties are due to either insufficient understanding of the underlying mathematical concept, differences in how it is interpreted and implemented in mathematics and physics, or inappropriate implementation to physics. We also found that student difficulties stem from the fact that in mathematics infinity is used as an abstract upper bound, whereas in physics it is used to quantify scales of physical quantities.

DG03: 3:20-3:30 p.m. Toward a More Nuanced Approach for Scoring Responses to RBAIs*

Contributed – Trevor I. Smith, Rowan University 201 Mullica Hill Rd. Glassboro, NJ 08028-1701

Nasrine Bendjilali, Rowan University

Research-based assessment instruments (RBAIs) are powerful tools for measuring learning in physics classes. Common RBAIs have been administered to thousands of students, providing a baseline for instructors and researchers to evaluate the achievements of specific student populations. The common method for analyzing RBAI data is to categorize each response dichotomously as either correct or incorrect, which ignores the fact that incorrect choices often align with common student ideas that have been identified by previous research and may contain elements of the correct response. We have previously shown that quantitative methods (e.g., item response theory) may be used to rank incorrect responses as being more or less closely aligned with the correct response. We present our first attempts to translate these rankings into a method for scoring responses to RBAIs in a more nuanced way that accounts for the productive ideas represented in students' incorrect responses.

*Supported by NSF award DUE-1836470

DG04: 3:30-3:40 p.m. Lessons from Students' "Letters" in Introductory Physics Courses

Contributed – Ramesh Adhikari, Jacksonville University 2800 University Blvd N Jacksonville, FL 32211

Terry Ellis, Jacksonville University

Students come to introductory physics classes with various degree of preparation and preconceptions about learning physics. That may lead to various degree of concerns and expectations regarding the course as they start their semester. In order to study the evolution of students' expectation and concerns over the semester, we administered a survey in the form of writing letters to self at the beginning and at the midterm, and a letter to incoming students at the end of the semester. Students share their expectations, learning goals, concerns, and plan of action at the beginning of the semester. Then they reflect upon and update these items at the midterm based

on their experience. Finally, they reflect upon and provide suggestions to the incoming students at the end of the semester. We will also present if students' anxiety or expectation level had any effect on their overall performance in the class.

DG05: 3:40-3:50 p.m. Studying Students' Understanding of Vectors in College Physics 1

Contributed – Sarah Elizabeth Muller, University of Central Florida 3200 N Alafaya Trail apt 4410, Orlando, FL 32826

Archana Dubey PhD, University of Central Florida

It was observed over several years of teaching college physics 1 that many students struggle with the concept of vectors and thus all associated math. The lack of basic understanding of vectors leads to students not doing as well as they could, not just in College Physics 1, but in College Physics 2. To try to stress vectors more in physics 1, the Test of Understanding Vectors (TUV) was given to a studio mode college physics 1 class as a pre- and post-test. The TUV was developed in 2014 [1] and is a reliable diagnostic test. This test involves some cross and dot product questions which were excluded from the analysis of the results as the students represented were not taught these concepts.

[1] Barniol, P. and Zavala, G. (2014). Test of Understanding of Vectors: A Reliable Multiple-Choice Vector Concept Test. Physical Review Special Topics- Physics Education Research, 10, 010121.

DG06: 3:50-4 p.m. Feedback and Learning: Take Two, Lessons from the Pocket Guitar

Contributed – Adebanjo Oriade, University of Delaware, Department of Physics and Astronomy, Newark, DE 19716

Student centered active learning depends on use of feedback. In this presentation we explore different dimensions of feedback – kind and utility. The first lesson is a way to improve office hour attendance. The second lesson relates to improving instructor use of feedback, and empathy for learning. The lessons come from observing the effects, on learning and instruction, of tuning an assessment from a primarily summative exercise to one, partly formative in nature. The course is a physics course, primarily, for students in majors other than the sciences. Weekly quizzes are primarily summative but when, after grading, students were allowed to reclaim points, it became a partly formative assessment. Students earned points back by visiting with a member of the instructional team to explain something they missed, why/how it happened, and how it can be fixed. Learning to play guitar, the pocket guitar became a metaphor for the effects diverse kinds of feedback have on learning.

DG07: 4-4:10 p.m. Results of Concept Inventories at a Small Engineering-Focused University

Contributed – Luke Corwin, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701

Michael Dowding, Robert Corey, Xinhua Bai, South Dakota School of Mines and Technology

We present the results of the Force Concept Inventory (FCI) and the Conceptual Survey in Electricity and Magnetism (CSEM) in introductory calculus-based physics courses at the South Dakota School of Mines & Technology, which is a small engineering-focused university that requires all students to take at least one semester of introductory physics. Specifically, we evaluate which concepts we are teaching well and which we are not; whether active learning techniques, such as Think-Pair-Share, improve student learning; correlations between grades and concept inventory scores; and how student attendance of recitation and labs is correlated with learning outcomes. We conclude with our plans for how to use these results to improve our teaching methods and techniques.

DG08: 4:10-4:20 p.m. Exploring the E-CLASS Using Item Response Theory

Contributed – Anne Wang, Department of Aerospace Engineering, Texas A&M University 276 Claywell Drive San Antonio, TX 78209-3344

Marcos D. Caballero, Rachel Henderson, Department of Physics & Astronomy, Michigan State University

Traditional physics laboratory courses at Michigan State University (MSU) were transformed into the Design, Analysis, Tools, and Apprenticeship Lab (DATA Lab) two-course sequence as a response to the national call for a focus on practices and skills within the physics laboratory context. In order to measure how well students' views align with expert-like views of experimental physics, the Colorado Learning Attitudes and Science Survey for Experimental Physics (E-CLASS) was developed. Analysis using Item Response Theory (IRT), a psychometric paradigm for constructing, validating, and analyzing surveys, will be presented to comment on how the E-CLASS items contribute to the assessment. With respect to the set of learning goals from the MSU DATA Lab courses, results show that the majority of the items on the E-CLASS are reliable for each of the learning goals.

DG09: 4:20-4:30 p.m. Development of an Instrument Designed to Measure Student Reasoning*

Contributed – Brianna Santangelo, North Dakota State University 1340 Administration Ave Fargo, ND 58105

Mila Kryjevskaia, Alexey Leontyev North Dakota State University

One of the goals of physics instruction is to help students develop reasoning skills in the context of physics. Since conceptual understanding is required to reason productively, it is challenging to design an assessment tool that solely focuses on student reasoning. To address this challenge, we have been developing sequences of screening-target questions: screening questions probe conceptual understanding, while target questions require students to apply this understanding in situations that present reasoning challenges. The level of consistency between responses to screening and target questions is used to make inferences about students' reasoning skills. We will discuss pre- and post-test performance on these sequences of screening-target questions and the inferences that can be drawn about students' development of reasoning skills in the context of physics.

*This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431940, DUE-1431541, DUE-1431857, DUE-1432052, DUE-1432765, DUE-1821390, DUE-1821123, DUE-1821400, DUE-1821511, DUE-1821561

DG10: 4:30-4:40 p.m. Understanding Parameters Affecting the Accuracy of Machine Learning Algorithms

Contributed – John C. Stewart, West Virginia University 135 Willey St. Morgantown, WV 26506

Seth DeVore, Jie Yang West Virginia University

Machine learning algorithms represent an exciting new class of quantitative methods to understand physics classes and students. Recent work has applied these algorithms to understand physics major retention to degree and the risk factors influencing success in introductory physics. This talk will explore some of the requirements of successfully applying these algorithms including required sample sizes, optimal test/training dataset sizes, and review various methods of characterizing the quality of the models produced. We will also explore the issues of unbalanced independent and dependent variables and the requirements for the accurate use of categorical variables.

DK Resistance & Resilience: How we show up for ourselves when we are the only___ in the room

Time: 3:30–5 p.m. Sponsor: Committee on Research in Physics Education Co-Sponsor: Committee on Graduate Education in Physics Date: Monday, Jan. 20 Location: Bonaire 5-6 Presider: *Jennifer A. Sandoval*

For years white women and people of color have been told the best way to respond to the stress of managing institutions not created for them is self-care. While some forms of self-care can be important, it is not enough for finding ways to engage our organizations in ways that feel authentic and honest. This session focuses on cultivating a practice of resilience, on constructing communities of care, and finding ways to enact resistance to practices that are used to disempower and often silence us in our organizational structures.

DH Lessons Learned from Integrating Computation into Undergraduate Physics Courses

Time: 3–4:40 p.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on Educational Technologies**
Date: Monday, Jan. 20 **Location: Antigua 1-2** **Presider:** *Joseph Kozminski*

DH01: 3-3:30 p.m. Program-level Scaffolding of Computation in the Physics Major

Invited – Jason E. Ybarra, Bridgewater College 402 E College St, Department of Physics Bridgewater, Virginia 22812

Deva O'Neil, Bridgewater College

Over the last few years we have redesigned our major curriculum to provide students with a solid foundation in programming and the ability to transfer these skills to multiple programming languages. Our department has adopted the objective of including computer programming in the majority of our courses. In the past 2 years, 11 of our 13 upper-level levels have required students to complete computational assignments. The success of this program depends on scaffolding throughout the curriculum, with students taking 4 courses that introduce computation in their first two years before they reach upper-level physics. We include examples of course level assignments typical for each year and demonstrate how our curriculum structure and faculty involvement in PICUP support students' success.

DH02: 3:30-4 p.m. The Computational Perspective: How Computational Training Builds Better Physics Students

Invited – Walter Freeman, Syracuse University, 215 Physics Building, Syracuse University Syracuse, NY 13244

The notion that computational physics has value in the physics classroom has become widely accepted. But why? If computation only helps students learn the same old things more efficiently, then integrating computation doesn't stand out from any of the myriad ways that we can improve student learning. But computational physics training does more than that: it allows us to provide students a richer, more fundamental perspective on nature. Computation and visualization are powerful companions to pencil-and-paper mathematics in understanding nature. Most interesting systems are not analytically tractable, and numerical simulation and visualization allow students to focus on fundamental principles rather than mathematical details. Thus I will argue that the computationally-trained student is a different and more complete sort of physicist: one with a deep understanding focused on fundamental interactions and rich phenomenology, and one with a more complete toolkit to extract physical insight from both empirical data and first principles.

DH03: 4-4:10 p.m. Lessons Learned Implementing Computation Across the Curriculum at IUPUI

Contributed – Andrew D. Gavrin, IUPUI 402 N. Blackford St., Department of Physics, LD154 Indianapolis, IN 46202

Gautam Vemuri, Yogesh N. Joglekar, IUPUI

We are entering the third year of a project to implement computational methods in all undergraduate physics classes at IUPUI. Our goal is ambitious: for approximately 25% of all assignments to be computational by 2023. This talk will describe our department's change process, and share lessons learned from the individual assignment scale to the overall curricular level. Issues including vertical integration of the curriculum, choice of computational platform, and assessment will be addressed.

DH04: 4:10-4:20 p.m. Exploration of Potential Energy with an Extended Euler-Cromer Method

Contributed – W. Brian Lane, Jacksonville University 2800 University Boulevard North, Jacksonville, FL 32211

Many introductory mechanics courses (particularly those based on Matter and Interactions) are built on Newton's second law and conservation of energy as primary explanatory principles. However, computational activities that implement the Euler-Cromer Method tend to place more attention and significance on forces than on energy, with Newton's second law determining an object's motion and conservation of energy confirming the results' accuracy. By adding the relationship between force and potential energy to the standard Euler-Cromer implementation, I present an open-ended computational activity that places potential energy on equal footing with force as the function that determines the object's motion. Such an addition enables students to create and study their own potential energy function. Using VPython's 3D animation environment, I also demonstrate how we can help students visualize various potential energy functions in multiple dimensions.

DI Training Newcomers to Lab Instruction

Time: 4–5 p.m. **Sponsor: Committee on Laboratories** **Co-Sponsor: Committee on Physics in Two-Year Colleges**
Date: Monday, Jan. 20 **Location: Bonaire 7** **Presider:** *Merita Haxhia*

Physics labs are changing from a very traditional and proscriptive "cookbook" style to more open-ended experiences with greater focus on student-led design, modeling and communication. The purpose of this session is to discuss best practices and challenges in training instructors new to laboratory coursework. Speakers will present their experiences in training instructors for transformed labs, and in training graduate students, for whom labs are usually their first experience with teaching.

DI01: 4-5 p.m. Training TAs to Become Successful Lab Assistants and Future Educators

Panel – Merita Haxhia, Washington University in St. Louis One Brooking Dr Saint Louis, MO 63130-4899

Jennifer A. Delgado, Kansas University

Kasey Wagoner, Princeton University

Less traditional labs require less traditional instruction from laboratory instructors. For most universities, labs are taught by graduate teaching assistants (TAs). They need to know the state of the art of teaching, believe in it, and know how to make it work. It requires both training and supervision. We have found that the key to overcoming these hurdles is employing the same approaches that PER has shown to be effective in the classroom: cultivating motivation in TAs and using active-learning approaches to teach them. In addition, multi-contact approach to TA instruction and supervision involving contact with both the Department leadership and the Instructional leadership has been found to help them be successful in guiding their students through laboratory experiences. We report preliminary findings on using interviews, question games, debates and practice labs to train TAs to use a more Socratic method of teaching in their labs.

DI02: 4-5 p.m. Certification of Instructors in Laboratory Programs

Contributed – Travis Barker, United States Military Academy, 3310 E CONTINENTAL RD West Point, NY 10996*

Cathleen Barker, James Bowen, Peter Chapman, United States Military Academy

Laboratory programs are the first introduction students receive to application of the lecture material in a practical sense. As such, it has the potential to anchor their appreciation for physics to the tangible world they live in or destroy their interest. Sadly, for some students this loss of interest can stem from their performance in the lab. The laboratory program at the United States Military Academy at West Point (USMA) identified a statistical disparity between the grades that students earn from varying instructors based on instructor individual interpretations. This yields two inductive assumptions to address the challenge of inspiring curiosity: perceived student performance can frustrate interest in the application of material and similar levels of performance across multiple instructors should yield similar grades. This talk will discuss USMA's lab teacher training program in an effort to reduce disparity between grades through instructor mentorship, certification, and uniform assessment metrics.

*Sponsored by LTC(P) Peter Chapmen

DI03: 4-5 p.m. Creating an Instructors' Guide to Onboard TAs in the Laboratory

Contributed – Lauren Dana, 44 Massachusetts Ave. Cambridge, MA 02139-4307

Kay Lowden, Massachusetts Institute of Technology

I will present on the recent experience of onboarding graduate TA's in MIT's Physics advanced Laboratory ("junior Lab"). Graduate TA's support undergrads in 14 experiments every semester, often with no experience in the apparati themselves. Therefore, two years ago we created a "cheat sheet" for each experiment outlining its safety concerns, common student issues, and learning moments for the students. This will cover the pedagogy we used in creating such a reference, challenges we faced in making sure it is useful, and the effect of providing it as a resource.

DI04: 4-5 p.m. Training Learning Assistants for the Calculus and Algebra based Physics Laboratory-Lessons Learned

Contributed – Michael T. Carini, Western Kentucky University 1906 College Heights Blvd Bowling Green, KY 42101-3576

Scott Bonham, Richard Gelderman, Douglas Harper, Western Kentucky University

For the past several years, the Physics and Astronomy Department at Western Kentucky University has utilized undergraduate learning assistants (LA) in its undergraduate calculus and algebra based Physics labs. I will discuss in this presentation how we select and train these LAs and what we have learned after several years of utilizing LAs in our physics laboratories. "Physics labs are changing from a very traditional and proscriptive "cookbook" style to more open-ended experiences with greater focus on student-led design, modeling and communication. The purpose of this session is to discuss best practices and challenges in training instructors new to laboratory coursework. Speakers will present their experiences in training instructors for transformed labs, and in training graduate students, for whom labs are usually their first experience with teaching."

DJ Professional Development at HSIs

Time: 4–5 p.m. Sponsor: Committee on Women in Physics Date: Monday, Jan. 20 Location: Hibiscus Presider: *Juan Burciaga*

DJ01: 4-5 p.m. HSI STEM Hub Seeks to Improve Undergraduate STEM Education

Panel – Jorge Iniguez, Pasadena City College, 1570 E. Colorado Blvd. Pasadena, CA 91106*

Hispanic-Serving Institutions (HSIs) comprise 1/7 of post-secondary institutions and educate over 2/3 of Hispanic college students, yet HSIs have not benefited from government funding for STEM research and education in proportion with their enrollments. The goals of this session are to provide an overview of the new NSF HSI Initiative and the NSF STEM Resource Hub that is tasked with supporting HSIs, especially those without prior NSF support, in grantsmanship and capacity building. Workshop activities will have high relevance for faculty members at any institution that has little to no prior NSF grant support.
*Sponsored by Juan Burciaga

DJ02: 4-5 p.m. Data Analysis Research Experience to Improve Students' Quantitative Reasoning Skills

Panel – Esther Wilder, Lehman College/City University of New York 250 Bedford Park Boulevard, West Bronx, NY 14068-1589*

Eduardo Vianna, LaGuardia Community College

Dahlia Remler, Baruch College

Quantitative reasoning, the contextualized use of numbers and data in ways that involve critical thinking, is an essential competency for college students, particularly for those pursuing STEM careers. We describe an initiative under way at CUNY to train faculty in best practices for quantitative reasoning instruction and to implement a data analysis research experience in the classroom. Our preliminary findings reveal that many CUNY students struggle with fundamental quantitative skills. Our initiative is designed to respond to these skills deficits by having faculty engage students in meaningful data analysis whereby they: (1) identify a research question; (2) undertake data collection; (3) compile and analyze the data using spreadsheet software; (4) interpret the data; and (5) present their findings orally or in writing. Results from a pilot study show that our intervention is associated with gains in both students' interest in data analysis as well as their understanding of fundamental quantitative skills.
*Sponsored by Juan Burciaga

DL Student Topical Discussion and Social

Time: 3–4:30 p.m. Sponsor: Committee on Research in Physics Education Co-Sponsor: Committee on Graduate Education in Physics
Date: Monday, Jan. 20 Location: TBA 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!

EA Outreach Programs Connecting College and K-12

Time: 6:30–8:20 p.m. Sponsor: Committee on Physics in Pre-High School Education Date: Monday, Jan. 20
Location: Grand Sierra F Presider: *Shawn Reeves*

EA01: 6:30-7 p.m. Cultivating K12 Engagement in Physics Aboard the Physics Bus

Invited – Erik A. Herman, Physics Factory, PO Box 651, Ithaca, NY 14851

Bruce Bayly, Chris Discenza, Bruce Bayly, John Perkins, Physics Factory

The Physics Bus is a mobile exhibition of physics phenomena directly engaged through the senses. Showcased to K12 audiences, our exhibits--fashioned from bailing wire and duct tape--include a microwave ionized gas disco party, a four foot tall tornado of fog, a TV whose beam wiggles to the sound of an electronic toy guitar, and a high current rail accelerator that crackles with sparks. The informal environment of playful exploration is designed to convey two messages, that physics is chock full of things yet to be discovered and that the joy of discovery is deserved by everyone. The project benefits from the involvement of undergraduates in the designing, prototyping, and facilitation of the showcase. Students inject fresh ideas and positive energy into the K12 experience while gaining important skills doing meaningful work. This semester we will be piloting a course at Cornell University based on this model.

EA02: 7-7:30 p.m. Forever '05: Continuing the K12-Higher Ed Mainely Physics Connection

Invited – David E. Sturm, University of Maine, 5709 Bennett, Orono, ME 04469

Fifteen years beyond the World Year of Physics 2005, the University of Maine Department of Physics and Astronomy strives to continue outreach in usual and unusual ways (with limited budgets). The goal remains to invite K12 students everywhere to engage in learning about physics. Frugal use of grants and donations, existing laboratory and demonstration equipment, and clever construction of contraptions from castoffs provide a source of apparatus. Through finding events amenable to phys-

ics demonstration to fill 'gaps', large audiences are reached. By engaging with STEM teacher associations, we broaden school contacts for on-the-road and in-school demonstrations. With student volunteers and partners around our college, visiting groups regularly arrive that gladly will partake of an hour of physics. With local media, still more students can be reached. From anecdotal evidence and surveys, we see how this melds together to make the Mainely Physics Road Show successful.

EA03: 7:30-7:40 p.m. A New Partnership-based Model for High School Physics Outreach

Contributed – Michael B. Bennett, University of Colorado Boulder 440 UCB Boulder, CO 80309

Rosemary Wulf, Englewood High School

Noah D. Finkelstein, University of Colorado Boulder

Over its decade-plus lifespan, the University of Colorado Boulder-based Partnerships for Informal Science Education in the Community (PISEC) outreach program has worked with thousands of local primary-school students in efforts to facilitate pathways to STEM through mutually-beneficial engagement between students and CU Boulder mentors. In recent years, PISEC has sought to complement its primary-school work through the pursuit of new partnership-based outreach with local high schools. PISEC's high school offerings continue the program's tradition of providing opportunities for students to build STEM skills through guided exploration of open-ended projects alongside peer mentors from CU Boulder, and has seen tremendous success and growth even in the few semesters of its early operation. We will here outline the history of PISEC's high school efforts, discuss the design and implementation of programming, and detail first research efforts, including assessment of benefits to both the local high school community and university student mentors.

EA04: 7:40-7:50 p.m. Journey into a 6th Grade Classroom with Pre-Service Elementary Teachers

Contributed – Beth Marchant, Indiana University South Bend, 25756 Little Fox Trl South Bend, IN 46628

Elementary education majors in Physical Science for Elementary Teachers at Indiana University South Bend (IUSB) worked with a group of 6th graders in a 90-minute math and science block class held at Navarre Middle School, which has been deemed by the state a "Failing" school for the past six years. The 6th graders first worked on science fair projects with the IUSB student mentors. Later in the semester, the IUSB students led science labs on light and photosynthesis with the same group of students. This effort was inspired by a Campus Community Grant through IUSB and involved professors from the Departments of Physics & Astronomy and Mathematical Sciences.

EA05: 7:50-8 p.m. The Professor Sko Science Show Makes You Want to Know!

Contributed – Brenda Skoczelas, Lake-Sumter State College, 9501 U.S. Hwy 441 Leesburg, FL 34788

What's the one thing everyone wants to know after an amazing magic act? How they did it, of course! Our outreach program couches physics as "magic" in a stage performance to stimulate curiosity and wonder. The difference is after the show, the students are shown how everything was done and why it works! The Professor Sko Science Show is an upbeat and entertaining stage performance for grades 6-12 that dazzles with a bed of nails, defies mortality with the "Bowling Ball of Doom," and wows with the "Dancing Inferno!" Supported by a cast of lovable characters, The Sko Show underscores how fun physics is, fostering the students' desire to learn. Through Lake-Sumter State College's PreFLITE program, Professor Sko goes into local schools performing teaser demonstrations. These serve to attract underrepresented populations onto the college campus for the stage show, engaging them in STEM and encouraging them to become STEM teachers.

EA06: 8-8:10 p.m. K-12 Outreach to Promote STEM Awareness

Contributed – Shahida Dar, Mohawk Valley Community College 1101 Sherman Dr Utica, NY 13501

Outreach programs designed for K-12 students are extremely important to promote awareness about STEM (Science, Technology, Engineering, and Mathematics). They could also be helpful in preventing the leaks in STEM pipeline. In this paper, I will talk about few of such outreach programs that have been running at my institution.

EA07: 8:10-8:20 p.m. Measurements of 137Cs In and Around the Daiichi Power Plant 1:A Case Study in Secondary School-University Cooperation

Contributed – Malene Nielsen, Zahles Gymnasium Nørre Voldgade 5-7 Copenhagen, 2100*

Ian G Bearden Niels Bohr Institute Ungdomslaboratoriet

In September 2019, we had the great good fortune to be allowed to visit the Daiichi Nuclear Power Plant in Okuma, Fukushima prefecture, Japan with a group of final year students from Zahles Gymnasium. During the previous academic year, members of this class visited the Niels Bohr Institute's "Ungdomslaboratory" (YouthLab) to construct, test, and characterize inexpensive gamma-ray spectrometers. In our September visit to Daiichi, these spectrometers were used to measure gamma spectra in and nearby the site of the nuclear accident which occurred in the aftermath of the Tohuku earthquake and tsunami. Here, we will discuss the how the project came about, how the project was run, and some of the keys to its success.

*Sponsored by I.G. Bearden

EB Integrating Outreach into the Student Experience

Time: 6:30–8:30 p.m. Sponsor: Committee on Science Education for the Public Co-Sponsor: Committee on Physics in Undergraduate Education Date: Monday, Jan. 20 Location: Bonaire 7-8 Presider: *Brian Pyper*

EB01: 6:30-7 p.m. Learning from Engaging: University-Community Partnerships as a Model for Student Development

Invited – Noah Finkelstein, University of Colorado Boulder 2000 Colorado Ave Boulder, CO 80309

Michael Bennett, University of Colorado Boulder

We present the model of the Partnership for Informal Science Education in the Community (PISEC), a program designed to leverage and enhance the capacities of university students, children, and the institutions seeking to support their development. Building on the several-decade standing Fifth Dimension model of after-school programming as a mechanism to support university student learning alongside the development youth in foundational literacy skills, PISEC focusses on pathways to engage universities and communities in mutual support of each other through STEM education. We discuss theoretical foundations for the program, demonstrate positive outcomes for community-based participants, and share practical insight into the enactment of PISEC's long-standing efforts. In particular, we discuss the structure's intentional focus on positively impacting university students' frameworks for physics through community building, partnership development, and preparation for public engagement; simultaneously we also find university students develop skills in physics, teaching, and science communication.

EB02: 7-7:30 p.m. Building Physics Identity Through Teaching in Informal Physics Environments

Invited – Katie Hinko, Michigan State University, 919 E. Shaw East Lansing, MI 48824-2320

Brean Prefontaine, Michigan State University

Claudia Fracchiolla, University College Dublin

How does involvement in informal physics experiences affect university students' physics identities? In this presentation, we take a research-based approach to look at how participation in public engagement events and programs can provide significant experiences for undergraduate and graduate students as they navigate their other roles and responsibilities as students. We look at data from three different informal physics programs (afterschool program, demo show, music/physics) that can each be considered a Community of Practice. We describe the structural components and cultural practices of each program that act as a mechanism for allowing students

to become more centrally involved in the informal physics activities of the groups. Some key factors to increasing students' membership include having 1) meaningful interactions between other members of the group, 2) the ability to develop skills in presenting physics content, 3) opportunities to take on leadership roles. We conclude with some ideas on how to leverage these findings to support students at your institution.

EB03: 7:30-8 p.m. Student-centered Physics Outreach at Texas A&M

Invited – Tatiana Erukhimova, Texas A&M University. Department of Physics and Astronomy 4242 TAMU College Station, TX 77843-4242

Can physics outreach become not only a service provided by an academic department to the public but also a unique learning opportunity for students? This talk will discuss successful physics outreach programs at Texas A&M which put students at the center of all outreach activities and make outreach an important part of their educational experience. As one example, teams of undergraduate students mentored by graduate students work throughout the school year on the design and fabrication of new physics demonstrations, and then show their demonstrations at the annual Physics & Engineering Festival attended by thousands of visitors. As another example, students bring physics experiments to First Fridays in downtown and football games. In RealPhysicsLive project, students create entertaining videos for middle and high school audience, which highlight physics concepts through demonstrations and experiments. We will share the ideas how to build such programs and keep students engaged.

EB04: 8-8:10 p.m. Physics Majors Motivated When Supporting K-12 and Public Outreach Efforts

Contributed – Richard Gelderman, Western Kentucky University 1906 College Heights Blvd Bowling Green, KY 42101-1077

Jason Boyles, Michael Carini, Western Kentucky University

Western Kentucky University's Physics & Astronomy hosts multiple annual large events featuring science outreach for the public and/or K-12 audiences. The success of these outreach events involves substantial costs, but we find the benefits clearly dominate our equation. After decades of experience, it is clear that the most significant benefits to our department are the positive experiences for our undergraduate physics majors that help support these large events provide. Working the outreach events are important chances to reinforce the effectiveness of learning opportunities built around engaging hands-on/minds-on learning activities. Additionally, preparatory meetings with the student volunteers give us a chance to reinforce valuable skills that otherwise are hard to fit into a physics major's program of study -- such as teamwork, leadership, and communication. It was less obvious to us when we realized that our majors find these to be engaging and motivating interruptions to their regular schedule. Exit interviews with graduating students make it clear that the role our students play is internalized as a meaningful and positive example of practice as a physics professional, as much as being part of a research project or academic achievement.

EB05: 8:10-8:20 p.m. The Impact of Service Learning on Students in an Introductory Astronomy Course

Contributed – Tracy Hodge, Berea College CPO 2007 Physics Berea, KY 40404

Service-learning is a teaching strategy that integrates meaningful community service with course learning goals. We have modified the laboratory component of the introductory astronomy course for non-majors to include a significant service-learning requirement. Students work in teams to design an outreach activity that will introduce fundamental concepts of observational astronomy to K-12 students and their families. Here we report on the effects of participation in the project on students attitudes and self-efficacy towards science among two cohorts of students (N=38) who participated in the redesigned course. Student were administered the Introductory Astronomy Diagnostic Survey and Survey of Attitudes Towards Astronomy both pre- and post-experience. Students were also required to submit a reflective essay on how the experience impacted their attitudes about science and its accessibility to non-scientists. Preliminary results demonstrate a modest increase in self-reported interest in astronomy and ability to understand astronomy concepts.

EB06: 8:30-8:30 p.m. Family Physics Night at TLU - A

Contributed – Toni Sauncy, Texas Lutheran University 1000 West Court Street Seguin, TX 78155

Calvin Berggren, Josh Fuchs, Texas Lutheran University

The Texas Lutheran University (TLU) Family Physics Night event attracts around 400 visitors to our small campus each fall. Over the past seven years, the TLU Physics Department faculty and TLU Society of Physics Students Chapter, along with nearly every student enrolled in physics courses, have worked together to present a robust evening of physics to the regional community. TLU is located in Seguin, a small (population 27,000) south central Texas town surrounded by many rural school districts. Family Physics Night draws K-12 students from the region, along with their families, for an evening of experiential learning that begins with a public lecture, followed by three hours of hands-on, themed activities. All classes in the department participate with class projects that are developed, constructed and presented by students with faculty guidance. Family Physics Night has become a valuable recruiting tool and an essential component as we strive to engage and retain our physics majors.

EC Four Current Space Missions Making History

Time: 6:30–8:30 p.m. Sponsor: Committee on Space Science and Astronomy Co-Sponsor: Committee on History and Philosophy in Physics Date: Monday, Jan. 20 Location: Grand Sierra G Presider: *Toby Dittrich*

EC01: 6:30-7 p.m. Gaia Satellite: Visualizing a Billion Stars for Science and Education

Invited – Jackie Faherty, American Museum of Natural History, W 79th St New York, NY 10024

On April 25, 2018, the European space agency (ESA) released the second catalog of the Gaia mission. Contained in these data are nearly 1.4 billion parallaxes and proper motions, over 7 million radial velocities, photometric data in Gaia's three bands (G, R, and B), variability information, and effective temperatures for a subset of objects. The Gaia results provide a unique opportunity for astronomers, data visualizers, and educators. Stellar positions and velocities enable us to map the Milky Way and examine the dynamics of stellar streams, co-moving companions, hypervelocity stars, nearby moving groups, and solar system encounters. From a visualization perspective, real time rendering of Gaia data is a challenge. In this presentation, I will show the results of our visualization efforts with the Gaia catalog at the American Museum of Natural History. The visuals generated for this talk isolate scientifically rich data and stories, which can lead to scientific discovery and will illuminate Gaia data for students, teachers, and the general public.

EC02: 7-7:30 p.m. Asteroid Sample Return Mission Hayabusa2

Invited – Makoto Yoshikawa, JAXA 3-1-1, Yoshinodai, Chuo-ku Sagamihara, Kanagawa 252-5210 Japan

Hayabusa2 is the second sample return mission from asteroids following Hayabusa. The target asteroid is Ryugu, which is a C-type near Earth asteroid. Hayabusa2 was launched on Dec. 3, 2014, and it arrived at Ryugu on June 27, 2018. At first, we observed Ryugu by the remote sensing instruments on board. Then Hayabusa2 released two small rovers (MINERVA-II-1) in September 2018 and one lander (MASCOT) in October 2018. The 1st touchdown operations to get the surface material was done on Feb. 22, 2019. The impactor operation to create a small crater on the surface of Ryugu was executed on April 5, 2019. And the 2nd touchdown to near the artificial crater was carried out on July 11, 2019 to get the sub-surface material. Hayabusa2 will leave Ryugu at the end of 2019 and return to the Earth at the end of 2020.

EC03: 7:30-8 p.m. NASA's OSIRIS-REx Asteroid Sample Return Mission

Invited – Humberto Campins, University of Central Florida/NASA's OSIRIS-REx, 2205 Chantilly Terrace, Oviedo, FL 32765*

NASA's OSIRIS-REx sample return mission is currently at asteroid Bennu and will deliver a pristine sample back to our planet in 2023. Bennu is a potentially hazardous

asteroid and also a likely target for space mining. Scientifically, objects like Bennu are of great interest as they may have brought pre-biotic organic molecules and water to Earth. Most of the predicted characteristics for Bennu, including size, shape and composition, match the findings very well. However, there have also been exciting surprises. The surface is covered with more and larger boulders than expected, and the spacecraft has discovered particles being ejected from Bennu by an unknown process. In other words, Bennu is an active asteroid!

*Sponsored by Toby Dittrich

EC04: 8-8:30 p.m. The James Webb Space Telescope Mission

Invited – Matthew Greenhouse, NASA 1800 Greenbelt Ave Greenbelt, MD 20771

The James Web Space Telescope is the successor to the Hubble Space Telescope. It is the largest space telescope ever constructed that will extend humanities' high definition view of the universe into the infrared spectrum to reveal early epochs of the universe that the Hubble cannot see. The Webb's science instrument payload includes four sensor systems that provide imagery, coronagraphy, and spectroscopy over the near- and mid-infrared spectrum. The JWST is being developed by NASA, in partnership with the European and Canadian Space Agencies, with science observations proposed by the international astronomical community in a manner similar to the Hubble. The final stages of pre-flight testing is underway in all areas of the program.

ED Student-driven Inquiry

Time: 6:30–7:30 p.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on Physics in High Schools**
Date: Monday, Jan. 20 **Location: Grand Sierra H** **Presider:** *Nancy Beverly*

ED01: 6:30-7 p.m. Student-driven Inquiry in Introductory Physics for Life Science

Invited – Nancy Beverly, Mercy College, Dobbs Ferry, NY 10522

How can students be guided to be their own drivers of inquiry in the direction of instructional intent? How can they be helped to formulate their own explorable questions, especially about the physics of phenomena of interest to them? In our introductory course for life science, students start to build a life-long habit of looking deeper into living processes, to uncover the underlying physical mechanisms. Students initially identify a larger, personally motivating life/health phenomenon or scenario of interest to them. They then focus their inquiry along different physical concept strands as the courses progress, framing their own questions to investigate underlying physical mechanisms related to those concepts. Refining to quantitative inquiry, they obtain and analyze their own data, using models to make inferences or conclusions. Framing in terms of comparison eases making quantitative analysis meaningful. The inquiry process is assessed in weekly "mini-project" homework assignments leading to a semester-long project.

ED02: 7-7:10 p.m. Analyzing Students' Ability to Make and Report Accurate Measurements

Contributed – Duane L. Deardorff, The University of North Carolina at Chapel Hill CB 3255 Chapel Hill, NC 27599-3255

When asked to make measurements in an introductory physics lab, students often struggle to use simple devices effectively in order to accurately measure and report their findings. They also confuse the concepts of measurement errors and uncertainty. With nearly two decades of experience administering laboratory exam questions in our intro physics courses at UNC-CH, we have thousands of practicums that give us insights into the strengths and weaknesses students have demonstrated when their grade depends on making and reporting accurate measurements.

ED03: 7:10-7:20 p.m. Student Perceptions of Laboratory Classroom Performances and Experimental Physics Practice*

Contributed – Dimitri R. Dounas-Frazer, Western Washington University, 516 High Street - MS 9164 Bellingham, WA 98225

Kimme Johnson, Western Washington University

Soojin Park, Western Washington University

Heather J. Lewandowski, University of Colorado Boulder

Laboratory courses plausibly play a role in shaping students' ideas about what experimentation entails. Here, we report results from interviews with students in an undergraduate laboratory course. Drawing on Ford's (2015) conceptions of scientific performance and practice, we explored the circumstances under which students perceived particular classroom performances to be features of experimental physics practice. Interviews focused on student perceptions of 18 performances, including analyzing data, troubleshooting apparatus, maintaining a notebook, and making team decisions. During interviews, students referenced their own and others' experiences working on projects as evidence to support nuanced ideas about experimentation. Many students identified certain performances (e.g., data analysis) as inherent to experimentation while also acknowledging the existence of a plurality of valid experimental approaches depending on research goals, resource availability, and group expertise. Our findings suggest that noticing performative similarities and differences among projects may be causally linked to students' beliefs about experimental physics practice.

*This material is based on work supported by the NSF under Grant Nos. DUE-1726045, DUE-1323101, PHY-1734006, and PHY-1208930. This work was also funded by the Washington NASA Space Grant Consortium under NASA Grant No. NNX14AR60A.

ED04: 7:20-7:30 p.m. Initial Development and Playtesting of Physics-Based Tabletop Roleplaying Game

Contributed – Jack Daniel Terrell, Jacksonville University 2800 University Blvd N Jacksonville, FL 32211

Sarah Patrick, W. Brian Lane, Jacksonville University

Gamification is becoming an increasingly popular and research-driven practice in education. Meanwhile, tabletop roleplaying games (such as Dungeons & Dragons or Pathfinder) are resurging in popularity. Building on these trends, we are developing Adventures in Notharia, an educational physics-based tabletop roleplaying game, which can supplement classroom learning and provide fun activities for physics clubs and conferences. Early playtest results indicate that students find this game to be engaging and effective at reinforcing their learning when they apply key physics concepts in resolving game encounters. We plan on showcasing a demo of this game during the Winter Meeting, time TBD; please contact the presenters for details.

EE Teacher Training/Enhancement

Time: 6:30–7:50 p.m. **Sponsor: AAPT** **Date: Monday, Jan. 20** **Location: Grand Sierra I** **Presider:** *TBA*

EE01: 6:30-7 p.m. Follow the Heartbeat – Physics of the Cardiovascular System

Invited – Nancy L. Donaldson, Rockhurst University, 1100 Rockhurst Rd. Kansas City, MO 64110-2561

The Physics of the Cardiovascular System Module is an NSF-funded, vetted, curricular resource on the Living Physics Portal – an online, community-sourced platform for physics for the life sciences faculty. Using hands-on active learning curriculum, this module guides students through an investigation of the mechanics of the cardiovascular system and the pressure differences that guide blood flow in health and disease. The target learning audience is students pursuing graduate school/careers in medicine or healthcare. Module activities address Pre-Health Competency E3 (Demonstrate knowledge of basic physical principles and their applications to the understanding of living systems) and Foundational Concept 4B (Importance of fluids for the circulation of blood, gas movement, and gas exchange) and are directed toward an application of physics to medicine. This Living Physics Portal curriculum includes complete instructor resources including pedagogy, materials, all solutions to qualitative and quantitative assessment questions, building instructions, and suggestions for use in different educational environments.

EE02: 7-7:10 p.m. Development of Physics Mentorship Program for Sound Waveform Analysis

Contributed – Sujin Moon, Korea National University of Education, Chungcheongbuk-do Cheongwon-gun Gangnae-myeon Korea National Univ. of Education. Cheongju, Chungbuk 28173 Republic of Korea,

Jungbok Kim, Korea National University of Education

Sound is a concept that is very closely related to our lives and has been steadily emphasized in the Korean curriculum. Many studies, however, show that students, even teachers, are not familiar with the basic concepts of sound waves. Also, the development of educational materials on wave concept is insignificant. The purpose of this study is to develop a physics mentorship program for sound wave analysis for middle school science gifted students. The students learned basic knowledge of sound waves and learned how to use oscilloscopes to observe the sound waveforms around them. Then, the obtained waveform was decomposed into frequency components through Fourier transform, and the educational contents were constructed to learn about the sound wave based on the analysis of what frequency the sound is composed of. It is expected that this educational material will help students intuitively establish the correct concept of sound waves.

EE03: 7:10-7:20 p.m. Equipping Teachers to Engage Underrepresented Students in STEM

Contributed – Debbie A. French, Wake Forest University PO Box 7266 Winston-Salem, NC 27109

Sean Hauze, San Diego State University

Richard M. French, Purdue University

Doug Hunt, Southern Wells High School

Tom Singer, Sinclair Community College

Providing engaging and sustained STEM learning opportunities are two research-based strategies that supports underrepresented students in STEM. Building upon the previous successes of the STEM Guitar Grants, two objectives of the current grant are to increase the number of teachers of underrepresented K-16 students trained in STEM education and increase students' STEM knowledge, skills, and attitudes. Results include increases in teachers' confidence in teaching STEM, increases in students' STEM content knowledge, tenacity, and attitudes towards STEM. Students also reported increasing confidence with skills such as critical thinking, problem solving, communication, and collaboration—skills that are applicable to students' post-secondary endeavors.

EE04: 7:20-7:30 p.m. Strategies to Develop Confident and Flexible Physics Faculty

Contributed – Cathleen Barker, 3310 E. CONTINENTAL ROAD West Point, NY 10996*

Travis Barker, Peter Chapman, United States Military Academy

Undergraduate physics is often a required, challenging course for students. As such, physics faculty require leader and teaching development prior to instructing students so they can better assist students in overcoming mental hurdles. This presentation will discuss three areas the United States Military Academy's Department of Physics and Nuclear Engineering have targeted to create a successful new faculty training: team cohesion, mastery of course materials, and training on physics education research and pedagogy. Additionally, the presentation will discuss techniques for continued development of new faculty throughout their first year of instruction; these faculty development workshops boost new faculty's understanding and implementation of active learning tools. Through a discussion of quantitative and qualitative feedback, this talk will highlight the benefits of a strong new faculty training program that ensures all new faculty, regardless of educational background, are adaptive and flexible to student inputs in the classroom.

*Sponsored by LTC Peter Chapman

EE05: 7:30-7:40 p.m. Physics Teacher Qualifications: Examining Influence on Minorities

Contributed – Philomena N. Agu, Jordan High School 5807 Candlecreek Drive, Richmond, TX 77469

Several studies used possession of undergraduate degree and certification in teaching subject to measure teacher effectiveness. Usually, unqualified teachers lack the credential and assumed out-of-field label. The teachers lack abilities to teach for critical thinking and to engage students' interest in the subject. Moreover, their self-efficacy is low. In Texas, prospective physics teachers could obtain certification by taking an exam with rigorous subject content or the general science with less rigor, 20 percent physics contents. However, the teachers preferred general science. A survey of 510 physics teachers revealed that while 70.2 percent hold certification in general science., less than 13 percent certified in physics or physical science. Similarly, only 33.0 percent possess an undergraduate degree major in a physical science field. Overall, the teachers seem unqualified, and concentration of out-of-field teachers is more in high-poverty schools where most minorities attend. The implication is continuous under-representation of minorities in physics.

EE06: 7:40-7:50 p.m. The Effect of the Evaluator's Level of Scientific Knowledge on the Creativity Evaluation of Scientific Outputs

Contributed – Arla Go, Korea National University of Education 411e, Natural Science building, 250, Taeseongtabyeon-ro, Gangnae-myeon, Heungdeok-gu Cheongju-si, Korea 28173 Republic of Korea

Jungbok Kim, Korea National University of Education

In evaluating creativity, evaluator effects have been continually studied and found to affect evaluation results. And It is necessary to find out whether the level of knowledge that significantly influences the expression of creativity affects the results of creativity evaluation as an evaluator effect. Therefore, this study aimed to examine how the evaluator's level of scientific knowledge affects the creativity evaluation of scientific outputs. The subjects of this study were 160 elementary school teachers and physics science teachers and non-physics science teachers. The evaluators evaluated the creativity of the works of science exhibition in the field of physics, with nine criteria on a five-point scale using the Creative Output Analysis Matrix (CPAM). The results of the creativity evaluation by teacher group were statistically analyzed and the results were found to influence creativity evaluation according to the level of scientific knowledge.

EF Physics in Environmental Science

Time: 6:30–8:30 p.m. Sponsor: Committee on Physics in Undergraduate Education Co-Sponsor: Committee on Science Education for the Public Date: Monday, Jan. 20 Location: Bonaire 1-2 Presider: *TBA*

EF01: 6:30-7 p.m. Physics in the Coastal Sciences: Public and Non-profit Sector Applications

Invited – Soupy Dalyander, The Water Institute of the Gulf 2021 Lakeshore Drive, Suite 310 New Orleans, LA 70122*

Physics is an ideal foundation for oceanography, which is often only offered as a graduate-level major. This presentation will discuss a range of coastal science studies from the public (U.S. Geological Survey and Army Corps of Engineers) and non-profit sectors (Water Institute of the Gulf), where the focus is on applied research and real-world use. A diverse suite of applications will be highlighted, including modeling menhaden impact on estuarine water quality; predicting the fate of "tarballs" that can cause beach pollution after oil spills; and improving restoration of barrier islands to preserve habitat and protect coastal communities.

*Invited by Anne Cox

EF02: 7-7:30 p.m. The Physics of Wind Engineering: A Workshop for STEM Teachers

Invited – Remy Dou, Florida International University 11200 SW 8TH ST Miami, FL 33155

The Wind Engineering for STEM Teachers (WEST) professional development workshop brings secondary school teachers from the southeastern region of the United States to Florida International University (FIU) to study hurricane science and the physics of wind engineering. FIU implemented the WEST workshop in 2018 as part of the education outreach arm of the Wall of Wind (WOW)—a high-tech research facility capable of reproducing Category 5 hurricane wind speeds. The WOW is part of the Natural Hazards Engineering Research Infrastructure supported by the National Science Foundation. Each year we select two teachers to participate in a six-week research experience where they perform research alongside engineering faculty working at the WOW. These teachers also design, develop, and facilitate a four-day workshop for other teachers from around the country. WEST aims to develop teachers' content knowledge and pedagogical content knowledge. This presentation provides an overview of the research experience and the workshop.

EF03: 7:30-8 p.m. The Sea Level Rise Puzzle

Invited –Thomas Wahl, University of Central Florida 12800 Pegasus Drive, Suite 211 Orlando, FL 32816-2450

Sea level rise has been the main oceanographic driver for changes in coastal flood risk in the 20th and 21st centuries, leading to more and higher extreme events which can have dramatic societal impacts. Such extreme events always represent the superposition of different sea level components, comprising an underlying base water level (i.e. the mean sea level), astronomical tides, as well as storm surges and waves forced by low-pressure systems and strong winds. Many of these components exhibit different trends and variability in different locations around the world, and they also interact with each other. Understanding how and where the different components change and their non-linear relationships is crucial in order to develop efficient coastal adaptation strategies. In this presentation the different drivers for changes in sea level as well as different components contributing to extreme events, and their spatio-temporal variations and interactions will be discussed.

EF04: 8-8:30 p.m. Orbits and Ice Ages: The History of Climate

Invited – Daniel Britt, University of Central Florida, Dept. of Physics 4111 Libra Dr. PSB 430 Orlando, FL 32816

Climate change has become a major political issue, but few understand how climate has changed in the past and the forces that drive climate. Most people don't know that 50 million years ago there were breadfruit trees and crocodiles on the shores of the Arctic Ocean, or that 18,000 years ago there was a mile-thick glacier on Manhattan and a continuous belt of winter sea ice extending south to Cape Hatteras. Our current climate system is a complex interplay between the Earth's orbit around the Sun, our atmosphere, and plate tectonics. The History of Climate provides context of our current climate debate and fundamental insight how the climate works.

EG Increasing African American Bachelor's Degrees in Physics and Astronomy: Results and Recommendations from the National TEAM-UP Study

Time: 6:30–8 p.m. Sponsor: Committee on Diversity in Physics Co-Sponsor: Physics in Undergraduate Education Date: Monday, Jan. 20 Location: Bonaire 3-4 Presider: *TBA*

In response to the recent drop in the number of physics degrees earned by African American students, the AIP formed the Task Force to Elevate the representation of African Americans in Undergraduate Physics and astronomy (TEAM-UP). TEAM-UP's goals included understanding, specifically from the viewpoint of African American undergraduates, what their experiences are within the physics and astronomy culture and what factors lead them to persevere; learning from physics departments that have experienced some measure of success in attracting and retaining African American students in these fields; understanding how the overall landscape of physics and astronomy culture and climate contributes to the persistence (or not) of African American students; and uncovering what impedes or promotes the culture change necessary for persistence. In December of 2019 TEAM-UP released its report, this session features an introductory talk and a panel to discuss and digest the report's findings.

Speakers:

Arlene Modeste Knowles, American Institute of Physics

Bo Hammer, American Institute of Physics

EH Student Harassment and Intimidation of Faculty

Time: 7:30–8:30 p.m. **Sponsor: Committee on Professional Concerns** **Co-Sponsor: Committee on Women in Physics**
Date: Monday, Jan. 20 **Location: Antigua 1-2** **Presider:** *Beverly Cannon*

The current political and social climate has allowed destructive criticism and critiques to swell among the school population. Therefore, we are seeking brief descriptions of personal events and the strategies adopted by the colleges and school districts that provide a recovery path for the instructor. If you have not been a target for negative comments or evaluations, perhaps you can share the procedure your institution has for someone that is being targeted.

EI Critical Methodologies and Intersectionality Frameworks in Research

Time: 7:30–9 p.m. **Sponsor: Committee on Research in Physics Education** **Co-Sponsor: Committee on Diversity in Physics**
Date: Monday, Jan. 20 **Location: Antigua 3-4** **Presider:** *Geraldine Cochran*

EI01: 7:30-8 p.m. Intersectional Consciousness, Black Feminism(s), and Critical Race Theories for the Collaborative Physics Educator

Invited – Mildred Boveda, Mary Lou Fulton Teachers College, PO BOX 871811 Tempe, AZ 85287-1811

Informed by intersectionality as conceptualized by Black feminist theorists, this presentation emphasizes the unique contributions Black feminism(s) and Critical Race Theory offer the academy. Situated in special education and teacher education research, the presenter will discuss how she developed the intersectional consciousness construct to facilitate collaboration with colleagues outside of special education, such as physics educator. Intersectionality provides a lens for examining how systemic oppression enacted on those with multiple minoritized and marginalized identities—e.g., ableism, ageism, classism, colonialism, heterosexism, imperialism, nationalism, patriarchy, religious bigotry, white supremacy—interconnect in nuanced and complex ways. These intersecting and systemic challenges exist within the P-12 and higher education contexts. Centering the scholarship of people of color is critical for diversifying the epistemologies considered viable in physics education. This presentation will review methods for engaging in dialogue about intersectionality and critical race theory, and discuss tools for developing the equity-oriented mindsets of physics educators.

EI02: 8-8:30 p.m. Critical Frameworks and Methods Using Critical Authethnography as an Example

Invited – Myrtle Jones, Rochester Institute of Technology, 1330 Fifth Avenue, New York, NY 10026-3912*

Autoethnography allows a member of a cultural group to account for their experience systematically. (Ellis, Adams, Bochner 2011) Because it is a member of the cultural group accounting for their own experience, it is often very liberating for the autoethnographer and provides a more authentic depiction of the culture. In auto-ethnography, those within the culture are inclusive researchers, decentering power structures. Autoethnographers use a variety of different data to generate the narrative such as memoirs, photographs, diaries, recordings, and other audio-visual material, and it may also include interviews or writing of other who can corroborate the data or conclusion. So, it is similar to narrative research in this vein as well. This talk will also review ways in which autoethnography has been used in STEM Education research.

*Sponsored by Dr. Geraldine Cochran

EI03: 8:30-9 p.m. Which Truths Shall We Speak To Power? How Research Choices Affect Efforts to Reduce Educational Inequities

Invited – Julie R. Posselt, University of Southern California, 3470 Trousdale Parkway Waite Phillips Hall, Los Angeles, CA 90089

Critical methodologies and other studies of power in educational settings name problematic practices and inherited assumptions among teachers, faculty, and/or educational administrators. However, those same people may become key players in reducing inequities and improving education. Whether practitioners engage seriously with our findings and reevaluate their assumptions and practices, may hinge upon 1) our own theoretical choices as scholars and 2) our ability to communicate results and implications in meaningful language. In this talk, taken from the Quaker call to "speak truth to power," I propose that theoretical perspectives from relational sociology are fruitful for this type of work due to their dynamic conceptualizations of power. Relational sociology depicts power in and responsive to connections, transactions, and relationships, rather than painting power as a substance or property inherent in individual people and their behaviors. I will illustrate the consequences of our theoretical choices by interpreting the same set of ethnographic field notes from constructivist, critical, and relational perspectives on power; then, I will present ethical implications for researchers and practical implications for engaging with educators as learners.

PST2 Poster Session 2

Time: 8:30–10 p.m. Sponsor: AAPT Date: Monday, Jan. 20 Location: Grand Sierra AB

Those with odd-numbered posters will present from 8:30–9:15 p.m. Those with even-numbered posters present from 9:15–10 p.m.

PST2A01: 8:30-9:15 p.m. The Science of Sound: An Interdepartmental Research Collaboration

Poster – Corinne E. Brevik, Dickinson State University 291 Campus Drive Dickinson, ND 58601

Jeremy Wohletz, Dickinson State University

In the spring of 2018, Dickinson State University's physics and music faculty partnered to create a semester-long research project focused on the "Science of Sound" for the College Physics II class. The physics curriculum was re-arranged so that students learned about waves and music at the beginning of the semester. They then had the rest of the semester to design and implement their research project. The entire class identified the questions they wished to answer, and then pairs of students chose individual instruments, including the piano, clarinet, and human voice, on which to focus. With the help of music majors and the music faculty, the physics students were able to collect sound data in a variety of settings that they later analyzed. This experience reinforced the fundamental concepts of experimental design, greatly strengthened the students' knowledge of sound and waves, and created a great deal of enthusiasm for all involved.

PST2A02: 9:15-10 p.m. Effects of Physics Identity and Academic Integration on Retention

Poster – Zeynep Topdemir, Georgia State University One Park Place Atlanta, GA 30303

Brian D. Thoms, Joshua Von Korff, Amin Bayat Barooni, Georgia State University

Only 43% of undergraduate students who start in the physical sciences are graduating with the same degree.(1) Also, physics identity has been found as a predictor of career choices of students. To understand the factors that help students to graduate in the physics program, we have prepared a survey measuring students' physics identity and their academic integration to the physics department. The survey is given to physics majors at different stages of the undergraduate program. The differences between the students in the early and late stages of the program are compared. The effects of physics identity and academic integration on retention will be discussed.

1. https://nsf.gov/nsb/sei/edTool/data/college-10.html

PST2A03: 8:30-9:15 p.m. Student Understanding and Applications of Infinity in Physics and Mathematics

Poster – Daniel B. Marsh, Missouri Southern State University 3950 E Newman Rd Joplin, MO 64801

Cade M. Hensley, Rabindra R. Bajracharya, Missouri Southern State University

The concept of infinity is applied widely in various contexts in physics, particularly while implementing the limits of large quantities, such as distance, time, and mass. We are investigating how students' deal with this concept when they solve problems in mathematics and physics. We report results from individual semi-structured interviews with physics students, where they are required to use the concept of infinity to solve the problems. We found that students have several difficulties with the implementation and interpretation of the concept of infinity. These difficulties are due to either insufficient understanding of the underlying mathematical concept, differences in how it is interpreted and implemented in mathematics and physics, or inappropriate implementation to physics. We also found that student difficulties stem from the fact that in mathematics infinity is used as an abstract upper bound, whereas in physics it is used to quantify scales of physical quantities.

PST2A04: 9:15-10 p.m. Nonlinear Scattering of Crossed Ultrasonic Beams from Turbulent Constricted Flow

Poster – Leah E. Burge, United States Naval Academy U.S. Naval Academy, Physics Department, 572 C Holloway Rd. Annapolis, MD 21402

Murray S. Korman, United States Naval Academy

This experiment explores the correlation between a blockage size in axially symmetric flow and the resulting Doppler shift, spectral broadening, and intensity values of the scattered 4.1 MHz sum frequency using incident crossed beams (2.0 and 2.1 MHz). This experiment simulates the location of Deep Vein Thrombosis and will prospectively improve technology to detect DVT. The experimental pipe-flow set-up (submerged in an aquarium) artificially resembles a vein, using various orifice plates to simulate blockage (blood clots). Sum frequency scattering measurements (outside the pipe) indicate turbulent flow. Doppler shift is proportional to the mean flow speed of the turbulent eddies, spectral broadening is proportional to the root mean squared turbulent velocity, and intensity is proportional to spatial concentration of turbulent eddies measured from the Gaussian shaped power spectrum. The results indicate a decrease in the Doppler shift and an increase in spectral broadening and the peak of the Gaussian shaped spectrum.

PST2A05: 8:30-9:15 p.m. Developing a Codebook for Student Self-Feedback

Poster – Matthew A. Dew, Texas A&M University 4313 Oaklawn Street Bryan, TX 77801

Paul Irving, Paul Hamerski, Daryl McPadden, Michigan State University

At Michigan State University, students may choose between a standard lecture-based physics course or a flipped classroom for their introductory calculus-based physics sequence. In Electricity and Magnetism Projects and Practices in Physics (EMP^3), the second semester flipped physics class, students are given formative feedback by their instructors on their performance every week with the aim of assessing and developing scientific practices. A third of the way into the semester, students are required to assess their performance in three categories and write feedback for themselves. For this self-feedback, students are prompted to discuss something they did well, something they want to improve, and strategies to improve that aspect of their performance. The three categories are group collaboration, individual understanding, and process skills. In this study, we investigate how well student responses fit these three categories and highlight self-feedback themes present in students' feedback that are focused on alternative categories.

PST2A06: 9:15-10 p.m. Physicists' Views about Disability and Physics Careers

Poster – Daniel Oleynik, University of Central Florida 12039 Reb Ibis Lane Orlando, Fl 32817

Erin Scanlon, Jacquelyn Chini, University of Central Florida

According to the NSF Women, Minorities, and People with Disabilities Report, people with disabilities are underrepresented in the science and engineering workforce. Specifically, in 2016, people with disabilities represented 19.5% of all postsecondary science and engineering students and only 10% of employed scientists and engineers. This, in large part, is due to attitudes in the physics community, and physicists' implicit beliefs about the capabilities of people with disabilities. On the other hand, the literature also indicates that supportive beliefs about the capabilities of people with disabilities can create a supportive environment and help to increase the representation of people with disabilities in science and engineering. Thus, building on prior research in the geosciences community, we developed surveys to investigate the relationship between physicists' beliefs about disability and potential physics careers, we piloted a survey at two APS section meetings and present themes of physicists' views about physics career viability across disability type.

PST2A07: 8:30-9:15 p.m. Investigating Albedo with ACES

Poster – Freja Liebach Guttesen, ULAB, University of Copenhagen Fogedmarken 8, 5. tv. København N, København 2200 Denmark

Ian Bearden, Rebekka Frøystad ULAB, University of Copenhagen

We have created a dynamical small scale model of a planetary system to demonstrate the detection of exoplanets. The experiment consists of an orrery with a light bulb at the center, representing a star, and two Arduino controlled orbiting planets. By monitoring the amount of light from the center star as planets pass by, students can

apply Keppler's laws to deduce the size of the planets and their distances from the center. The setup can further be used to investigate the albedo of the planets as one detects a rise in intensity when they pass the back of the star. This induces discussions concerning the Moon, detection of Earth-like exoplanets, and how the albedo of the Earth is affected by climate change. Throughout the experiment, students will not only be strengthened in their mathematical skills and physical understanding, but also gain insight into advanced research in a palpable way.

PST2A08: 9:15-10 p.m. Investigating the Effects of Short-Term Mindfulness Sessions on Student Learning

Poster – Cade M. Hensley, Missouri Southern State University 3950 E Newman Rd Joplin, MO 64801

Danielle M. Plutino, Daniel Marsh, Rabindra R. Bajracharya, Missouri Southern State University

The effects of mindfulness on an individual's mind-body have been studied in multiple disciplines including psychology and medicine. Many K-12 schools have already started to implement mindfulness practices in their curricula to foster teaching and learning practices. We are investigating the effects of short-term mindfulness sessions on students' learning processes in physics including reading, responding to conceptual questions, and problem solving. In each experiment, the participants were randomly assigned to either the treatment or the control group. The treatment group completed a five-minute long mindfulness session, during which they were instructed to observe their breathing objectively. After the mindfulness sessions, both the groups read either powerpoint slides, the solution to a problem, or sections from their textbook. The students then answered conceptual questions or solved problems. We present the results from the study to answer whether or not short-term mindfulness sessions have any impact on students' learning processes in physics.

PST2A10: 9:15-10 p.m. Why Use Normalized Gain and How To Use It

Poster – Vincent Coletta Loyola Marymount U. 1 LMU Drive Los Angeles, CA 90045-1373

Normalized gain has long been applied to pre and post testing on concept inventories and used as a measure of learning in introductory physics classes. We show how normalized gain has been used to improve learning in those classes. We also show that one must be careful in making comparisons of normalized gains when those comparisons involve significantly different student populations. One must take into account some independent measure of those populations. We describe how one can do this. Failure to do so is an example of omitted variable bias.

PST2A11: 9:15-10 p.m. Gender Dynamics and Sense-making within a SCALE-UP Classroom: Patterns in Introductory Electricity and Magnetism

Poster – Mark Akubo, Florida State University 900 W Tennessee St Tallahassee, FL 32304

This is a qualitative case study on gender dynamics and sense-making in a student-centered active learning environment for undergraduate physics classroom. The context is an Introductory Electricity and Magnetism course in a large research university in Southeastern U.S. I documented patterns in gender dynamics, exploring how such patterns may influence student sense-making in small groups. Gender dynamics include the relationships and interactions that take place within and across gender groups. I adopted the conceptualization of gender as performance (e.g., Traxler et al., 2016) as a way to frame gender dynamics in two heterogeneous groups of students. In sense-making, students share their perspectives, argue about stuff, push back on each other's ideas, take opportunities to generate, use and extend scientific knowledge in order to understand the natural world. Preliminary findings suggest that cohesive and inclusive gender dynamics foster equitable participation in sense-making while non-cohesive and exclusionary gender dynamics inhibited equitable participation.

PST2A12: 9 :15-10 p.m. Opinions About Working in a Group: Positive and Nuanced

Poster – Miranda Straub, Winona State University, 315 W Mill St., Winona, MN 55987

I will present on the results of a survey sent to post-secondary physics instructors in Minnesota regarding their beliefs about group work. Group work here was set in the context of working on homework outside of class or obligation. The survey respondents were overwhelmingly positive (88%) about the benefits of working in a group but most (79%) had reservations about how the group work should be done. The most cited drawback was an unequal distribution of work. I concluded that the implications of this portion of the survey in the larger context of problem-solving was the instructors believe it is necessary for students to talk about their ideas as part of successful problem-solving.

PST2A13: 8:30-9:15 p.m. Update on the STEM Connections Program at Lewis University*

Poster – Joseph F. Kozminski, Lewis University Physics Department 1 University Pkwy Romeoville, IL 60446-2200

Jason J. Keleher, Lewis University Chemistry Department

The STEM Connections Program builds scientific community early on through a first year cohort program for students majoring in programs offered by the Chemistry and Physics Departments at Lewis University. Students with financial need in the first three cohorts were also awarded renewable scholarships through an NSF S-STEM grant for their participation in the program. As students progress through their college careers, STEM Connections offers research, professional development, and other opportunities for students. This poster will review the program goals, present program data, and discuss challenges and successes over the last 4.5 years.

*The STEM Connections program is supported in part by NSF S-STEM Award #1458353.

PST2A14: 9:15-10 p.m. Understanding the Perception Radar Plots of the PTaP & PTaP.HE

Poster – Richard L. Pearson III, Embry-Riddle Aeronautical University 1 Aerospace Blvd Daytona Beach, FL 32114

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

As the PTaP and PTaP.HE continue to be broadly utilized to analyze what undergraduate students and university faculty perceive about secondary teaching, a quick and effective visual tool is needed to easily compare results. The radar plots produced from each survey allow for easy comparative viewing of multidimensional contrast: for example, year-to-year, institution-to-institution, discipline-to-discipline, and demographics. The poster is meant to introduce, explain, and direct others on how to build, use, and construct their own plots to visually articulate perception changes within their area of influence. This work is supported by NSF DUE-1821710.

PST2A15: 8:30-9:15 p.m. Guiding Physics Students Towards Writing Strong Explanations: An Intervention

Poster – Alfredo X. Sanchez, California Polytechnic State University, San Luis Obispo 1 Grand Ave San Luis Obispo, CA 93407-0404*

Matt Moelter California Polytechnic State University, San Luis Obispo

Students in physics courses often find it difficult to explain their answers to a question or problem in a detailed, logical manner. We carried out an intervention in some sections of our introductory electromagnetism course to guide students towards writing better explanations. In the intervention, small groups of students worked on a series of questions requiring an explanation; then, they were given sample explanations that they were asked to rank based on their quality, using criteria they determined on their own. We find that students are consistently able to distinguish a "strong" explanation from a "weak" one, and that they come up with similar criteria for their analysis. To test the effectiveness of the intervention, we present a comparison of exam question scores across sections where the intervention was or was not carried out, using a grading rubric that accounts for explanation quality.

*Sponsored by Stamatis Vokos (Cal Poly)

PST2A16: 9:15-10 p.m. Considering Different Representations of Research-based Activities

Poster – Amin Bayat Barooni, Georgia State University One Park Place, Room 431 Atlanta, GA 30302-3999

Joshua Von Korff, Brian D. Thoms, Zeynep Topdemir, Georgia State University

Jacquelyn Chini, University of Central Florida

In our research 66 research-based activities from 11 academic activities were coded for student actions and K-means cluster analysis was applied. We found three different clusters that we called Thinking Like a Scientist, Learning Concepts, and Building Models. These three clusters not only address different design goals, but also use different kind and amounts of representations to help students to learn. Examples of different representations include, mathematical, discussions, diagrams, multiple choices, pie charts and so on.

PST2A17: 8:30-9:15 p.m. Characterizing Goal Orientations Held by Hispanic Women Physics Students

Poster – Brian Zamarripa Roman, University of Central Florida 4000 Central Florida Blvd. Orlando, FL 32816

Jacquelyn J. Chini University of Central Florida

According to IPEDS data, the number of Hispanic women attaining physics degrees yearly and the number of institutions awarding those degrees tripled between 2011 and 2017. However, Hispanic women only made up 2% of physics degrees awarded in 2017 while making up 10% of the student population. Since the perspectives of Hispanic women remain underrepresented yet more of them are attaining traditional markers of success, it is important for the physics community to understand Hispanic women's conceptualizations of success to better support their integration in the community. In this qualitative study we characterize the goal orientations of Hispanic women studying physics at public four-year universities by analyzing participant responses during semi-structured interviews about success. The responses were coded with a priori codes of goal orientations based on Motivational Systems Theory. We present the most common goal orientations, and recommend educators align their practices to support a variety of goals.

Labs/Apparatus

PST2B01: 8:30-9:15 p.m. Engaging Students in the Learning Process: Active Learning Labs for Scientists and Engineers

Poster – Irene Guerinot, Maryville College 502 E. Lamar Alexander Pkwy Maryville, TN 37804

Jordan Woodward, Sarah Woodward, Maryville College

The goals of introductory physics laboratories have been evolving over the past 70 years. To design effective instruction and excellent laboratory programs, we need to listen to the students and find ways to learn and understand how they process physics concepts. We will discuss a new suite of laboratory exercises and class demonstrations designed by two undergraduate engineering students in collaboration with their physics professor. The new labs will be benefiting our engineering, math, biochemistry, and teacher licensure students. We will also discuss the challenges and successes we encountered during this effort.

PST2B02: 9:15-10 p.m. A PSoC Coincidence Counting Unit for Single Photon Investigations

Poster – Mark F. Masters, Purdue University Fort Wayne, Department of Physics 2101 Coliseum Blvd E Fort Wayne, IN 46805-1499

Justin Smethers, Purdue University Fort Wayne, Department of Physics

We present results of more single photon investigations using our low cost ($50) Cypress PSoC based Coincidence Counting Unit.

PST2B05: 8:30-9:15 p.m. A Low Cost Muon Telescope

Poster – Erik M. Belhage, Niels Bohr Institute, Thorsgade 91A Copenhagen, Copenhagen 2200 Denmark*

Freja Guttesen, Ian G. Bearden, Niels Bohr Institute

Using two disk shaped Geiger Müller counters a simple muon detector can be constructed, giving students and teachers an opportunity to further their investigation into particle physics and radioactivity beyond the scope of traditional measurements concerning half-life and half-value thickness of radioactive sources. Adding a third counter, the efficiency of the detectors easily can be estimated by setting them up in line, and the probability of recording background counts on all three detectors simultaneously can be estimated from setting them up spatially apart measuring coincidences. The poster will be split threefold. The setup's characteristics including efficiency estimations, digital solutions for data collection for use in secondary and tertiary physics education and finally the measurements.

*Sponsored by Ian G. Bearden

PST2B06: 9:15-10 p.m. Investigating Energy Loss in a Simple Pendulum

Poster – Sytil K. Murphy, Shepherd University PO Box 5000 Shepherdstown, WV 25443-5000

The simple pendulum is one of the standard systems in physics used to analyze conservation of mechanical energy. However, in order for energy conservation to be seen, assumptions have to be made and steps taken to validate these assumptions. For example, the pendulum is often made with a small metal ball for the bob and energy transfer over a single oscillation is measured in order to minimize energy loss due to air resistance and other forms of friction. Video analysis provides a means of observing the total energy of a pendulum as a function of time, allowing students to investigate energy loss from the system in order to better see the circumstances in which energy can be considered conserved. Particularly striking is a comparison of the behavior of a pendulum with a metal ball for the bob to one with a Styrofoam bob.

PST2B07: 8:30-9:15 p.m. Improving Precision for TeachSpin's Faraday Rotation DC Activities

Poster – Patricia E. Allen, Appalachian State University PO Box 57 Sugar Grove, NC 28679

TeachSpin's Faraday Rotation manual includes two DC and four AC activities to find the Verdet constant for a glass rod. While the AC activities lead to consistent and precise values for the Verdet constant, the two DC activities can result in imprecise Verdet constants markedly different from AC values and each other. The small angle approximation for Malus' Law can be used, together with relation for the rotation angle = VBL (V is the Verdet constant, B is the applied magnetic field, and L is the length of the material), to derive the relative intensity for any angle of the polarizer. This relationship will be presented, along with how it can be applied to two special cases: extinction (when intensity is a minimum) and half-maximum (intensity is halved). Results for SF-57 will be included, along with a comparison to the DC activities described in the TeachSpin manual. While many may be familiar with the small angle approach, others may benefit from this addition to the TeachSpin suite of Faraday Rotation activities.

PST2B08: 9:15-10 p.m. Simple Measurements of the Speed of Light

Poster Mark E. Rupright, Birmingham-Southern College 900 Arkadelphia Rd., Box 549022 Birmingham, AL 35254

I outline two simple undergraduate laboratory activities for measuring the speed of light. The first measures the wavelength of microwaves of known frequency. The second measures the speed of a high frequency modulated laser directly by changing distance between transmitter and receiver. Both methods exploit intentional systematic errors to ensure high-precision distance measurements and analysis. These activities introduce students to the benefits and potential pitfalls of fundamental data analysis techniques.

PST2B09: 8:30-9:15 p.m. Line of Sight Communication

Poster – Dakota Turk, Mohawk Valley Community College 1101 Sherman Dr. Utica, NY 13501

Roman Shikula, Adam Clemons, Steven Arbogast, Mohawk Valley Community College

This project utilizes two raspberry pis, LEDs and a camera module to send a string of text from one raspberry pi to the other across an open distance. This works by using the LEDs controlled by the raspberry pi as placeholders in a binary array; a light on represent a 1 in the list; a light off represents a 0. Using the camera module attached to the second raspberry pi, we can take a picture of the set up of LEDs and determine what binary character is being represented at that moment. Using a simple

console based program we can have the LEDs send multiple characters until the end of a string, all while the other detects and interprets the LED-binary array.

PST2B10: 9:15-10 p.m. The NBI-ULAB Table Top PET Scanner

Poster – Ian Bearden, Niels Bohr Institute Ungdomslaboratoriet Blegdamsvej 17 Copenhagen, 2100

In addition to being valuable medical imaging devices, Positron Emission Tomography (PET) Scanners provide a direct demonstration of what is almost certainly the most widely known physics equation in the history of human endeavours. While almost everyone knows the equation, E=mc**2, many don't fully understand its implications. In order to help pupils and students attain this understanding, we have developed a "toy" PET Scanner consisting of two BiGS gamma spectrometers, and a simple DAQ. Students "image" a 22Na source and discover that the 2 gammas produced in the annihilation process always have the same energy and that they are always emitted "back-to-back". Depending on the students' prior knowledge, this can lead to a discussion of how actual PET scanners work, why coincidence measurements are useful, or even how one could use the device to estimate the e+-e- collision relative velocity distribution.

PST2B11: 8:30-9:15 p.m. Student Evaluations of Cookbook versus Guided Inquiry Laboratory Activities

Poster – Brian D. Thoms, Georgia State University 25 Park Place NE Atlanta, GA 30303

Sumith Doluweera, Georgia State University

Laboratory exercises for an introductory algebra-based physics sequence were redesigned from "cookbook" style to guided inquiry. Student opinions regarding aspects of the labs were collected through Likert-scale and open-answer questions before and after the redesign. The redesign led to increased agreement by students to statements that labs helped them to learn physics and were interesting. Students also significantly increased their evaluations of helpfulness, preparation, and knowledge of the lab instructors (graduate student teaching assistants). Student comments, grades, and conceptual survey results will also be reported.

PST2B12: 9:15-10 p.m. Training TAs to Teach Non-traditional Labs

Poster – Jennifer Delgado, Malott Hall 1251 Wescoe Hall Dr Lawrence, KS 66045

Less traditional labs require less traditional instruction from laboratory instructors. For most large universities, labs are taught by graduate teaching assistants (TAs), who often do not have a lot of pedagogical training. For two years at KU we have tried a new format for training our TAs. We report preliminary findings on using interviews, question games, debates and practice labs to train TAs to use a more Socratic method of teaching in their labs.

PST2B13: 8:30-9:15 p.m. Measurement Errors, Random and Systematic, Illustrated to Students

Poster – Jingbo Ye, Department of Physics, Southern Methodist University 3215 Daniel Ave. Dallas, TX 75205-0100

Almost always in the first lab of entry-level physics measurement errors or uncertainties are discussed. Standard instruments, often rulers or scales, are used to illustrate random errors, sometimes systematic errors. I will present a newly designed lab in which both the random and systematic errors are made sizable and clearly illustrated to students, through a basic length measurement with specially made rulers and lab procedures. Guidance in data taking and analysis is provided to students so that they will have a good understanding about the process of estimating either type of the errors, through the numbers that they obtain in their own measurements. A discussion of random error propagation is also included in the lab, and the concept of instrument calibration is brought to the students' attention to fight systematic errors.

PST2B14: 9:15-10 p.m. Experimentally Mapping Sound Wave Intensity vs. Distance

Poster – Nicholas A. Johnson, Troy University 600 University Avenue Troy, AL 36082*

Victoria Colvin, Soumitra Ganguly, Sebastian Lee, Suraj Thapa Magar, Troy University

The sound intensity is measured as a function of distance from a single loudspeaker. An open speaker is placed on a table, and then a detector is moved away from the speaker along the axis perpendicular to the plane containing the speaker. The sound waves emitted from the speaker are subject to reflections from the boundaries (e.g. walls) of the room. By using a motion detector in conjunction with the sound detector, we collected data for a plot of sound intensity level (in dB) versus distance (in m). The intensity level varies linearly with the logarithm of the distance from the speaker, but some local maxima and minima are also observed, in good agreement with theoretical predictions when accounting for interference from reflections. This was an undergraduate student research project.

*Sponsored by James Sanders

PST2B15: 8:30-9:15 p.m. Classroom Research with Noyce Scholars Is Rewarding and Improves Learning

Poster – Jeffrey J. Williams, Bridgewater State University 87 Church St. North Adams, MA 01247

Bridgewater State University (BSU) has had Noyce funding for the last six years and has supported four physics majors. Physics majors with Noyce funding are also hired to serve as Learning Assistants in our Introductory Calculus Based Physics courses. One of those students was very interested in working toward improving the laboratory work of the students in the class. Over the last two years we have experimented with two different methods to improve the student lab reports. We compared the effectiveness of pre-laboratory data activities versus scaffolded laboratory procedures. This poster will report on the results of that work. Supported by BSU ATP summer research program and support for Noyce scholars from NSF Noyce grant DUE-1339779.

PST2B16: 9:15-10 p.m. Pedagogical Materials to Cure Misconceptions Connecting Special and General Relativity

Poster – Ron Pepino, Florida Southern College Physics Lakeland, FL 33801

Risley Mabile, Florida Southern College

Many professional physicists do not fully understand the implications of the Einstein equivalence principle of general relativity. Consequently, they are unaware of the fact that special relativity is fully capable of handling accelerated reference frames. We present results from our nationwide survey that confirm this is the case. We discuss the possible origins of this misconception and then suggest new materials for educators to use while introducing both special and general relativity. These materials can help prevent the propagation of this misunderstanding to the next generation of physicists.

Pre-college/Informal and Outreach

PST2C01: 8:30-9:15 p.m. The Devil's Staircase: Latest Progress and Future Plans

Poster – Timothy McCaskey, Columbia College Chicago Science and Mathematics Department, 600 S. Michigan Ave Chicago, IL 60605-1996

Luis Nasser, Columbia College Chicago

This poster will discuss further progress on our musical project where the compositional forms are inspired by phenomena in math and physics such as fractals and cellular automata. We discuss our continued communication and outreach efforts, plans for the final product, ways this work has inspired new scholarly results, inclusion of our ideas in projects assigned to students, and other future ambitions.

PST2C02: 9:15-10 p.m. Measurements of 137Cs in and Around the Daiichi Power Plant 2: Results

Poster – Ian G. Bearden, Niels Bohr Institute Ungdomslaboratoriet Blegdamsvej 17 Copenhagen, 2100 Denmark

Helene Kaas, Malene Nielsen Zahles Gymnasium

In September 2019, we had the great good fortune to be allowed to visit the Daiichi Nuclear Power Plant in Okuma, Fukushima prefecture, Japan with a group of final year students from Zahles Gymnasium. During the previous academic year, members of this class visited the Niels Bohr Institute's "Ungdomslaboratory" (YouthLab) to

construct, test, and characterize inexpensive gamma-ray spectrometers. In our September visit to Daiichi, these spectrometers were used to measure gamma spectra in and nearby the site of the nuclear accident which occurred in the aftermath of the Tohuku earthquake and tsunami. This poster will summarise the characteristics of the detectors, and the results of measurements in the vicinity of the Daiichi reactors.

PST2C03: 8:30-9:15 p.m. Establishing Physics Identity through Informal Physics Experiences with Outreach

Poster – Callie A. Rethman, Texas A&M University 1040 Crested Point Drive College Station, TX 77845

Tatiana L. Erukhimova, Texas A&M University

Jonathan D. Perry, University of Texas

Beyond the formal curriculum of a physics degree, students majoring or minoring in the field may choose to enhance their education through participation in informal experiences such as physics outreach. While participation in outreach gives students opportunities to engage with the public and communicate physics, the role of these experiences in establishing a student's identity within physics is not well understood. This work investigates how engaging in outreach programs affects a physics student's identity as a physicist, a member of their home department, and in the STEM field as a whole. For the initial iteration of this study, current and former participants from outreach programs at Texas A&M University will be surveyed. This survey will specifically investigate the impact of outreach programs on a student's integration, identity, soft skills, and experiential learning.

PST2C05: 8:30-9:15 p.m. Journey into a 6th Grade Classroom with Pre-Service Elementary Teachers*

Poster – Beth Marchant, Indiana University South Bend 25756 Little Fox Trl South Bend, IN 46628

Elementary education majors in Physical Science for Elementary Teachers at Indiana University South Bend (IUSB) worked with a group of 6th graders in a 90-minute math and science block class held at Navarre Middle School, which has been deemed by the state a "Failing" school for the past 6 years. The 6th graders first worked on science fair projects with the IUSB student mentors. Later in the semester, the IUSB students led science labs on light and photosynthesis with the same group of students. This effort was inspired by a Campus Community Grant through IUSB and involved professors from the Departments of Physics & Astronomy and Mathematical Sciences.

*Note: this poster is a more in-depth version of the presentation by the same title.

PST2C06: 9:15-10 p.m. Utilizing National Science Olympiad Alumni Undergraduates for NSO STEM Outreach

Poster – Donna L. Young, NASA/NSO/CXC, 3484 Cottage Meadow Way Laughlin, NV 89029-0192

National Science Olympiad (NSO) is a national non-profit organization dedicated to increasing interest in science for all students, creating a STEM-literate workforce, and providing recognition for outstanding achievement by both students and teachers. These goals are achieved by participating in regional, state and/or national tournaments. Each year more than 230,000 middle school and high school students begin competition by preparing for 23-25 unique events that include all scientific disciplines, construction and engineering. Many participants enter engineering and science professions as a result of their involvement with NSO events. Thousands of NSO alumni, many who have metaled at the state and national levels, continue their Science Olympiad experience by becoming involved in mentoring teams, supervising invitationals, writing tests for invitational, regional, state and national competitions, and presenting at coaches' clinics. NSO alumni want to provide others the same experience they enjoyed so encourage the SO alumni at your institution to participate!

PST2C07: 8:30-9:15 p.m. The Teen Astronomy Cafe Program

Poster – Robert T. Sparks, NOAO 950 N Cherry Ave Tucson, AZ 85710

Constance E. Walker

Stephen M. Pompea

The Teen Astronomy Café program to excites the interest of talented youth in STEM. One Saturday a month during the academic year, high school students interact with expert astronomers who work with big data. Students learn about killer asteroids, exoplanets, lives and deaths of stars, variable stars, black holes, the structure of the universe, gravitational lensing, dark matter, colliding galaxies, and more. Each cafés begins with a short presentation by an astronomer, a computer-based lab activity and a discussion during lunch. Students explore the astronomer's research using tools such as Python and Jupityr notebooks to examine astronomical data. The diverse team includes the program director, grad students, an undergrad student and high school students. The input of high school students is valuable to make the experience relevant to their peers. The experience offers them training in planning, leadership, and communication skills and encourages their personal interests in STEM.

PST2C08: 9:15-10 p.m. Einstein Schools

Poster – Robert T. Sparks, NOAO 950 N Cherry Ave Tucson, AZ 85710

Stephen M. Pompea, NOAO

The Einstein Schools program was founded by the International Astronomical Union (IAU) as part of the celebration of its 100th anniversary. Albert Einstein's Theory of General Relativity passed its first test during a solar eclipse in 1919, the famous Eddington Experiment, the same year the IAU was founded. The Einstein Schools Program helps students at schools around the explore the fore of gravity through such topics as black holes, gravitational waves, orbits and the dark matter. The Einstein Schools program encourages schools to collaborate as they explore their chosen topics. Einstein schools are provided an archive of high quality internet based resources on various topics related to General Relativity and the opportunity to apply for time on robotic telescopes to observe objects of interest. The program is free to schools around the world.

https://www.einsteinschools.org/

PST2C09: 9:15-10 p.m. Utilizing Undergraduate Students to Staff Family Science Days

Poster – Corinne E. Brevik Dickinson State University 291 Campus Drive Dickinson, ND 58601

Cynthia Burgess Dickinson State University

Each fall, Dickinson State University offers a series of monthly Family Science Days that are free and open to the public. These Saturday-afternoon events include both a planetarium show and a series of thematically linked hands-on activities. While each month's activities are planned by a faculty member in the Department of Natural Sciences, the staffing for all the activities is composed solely of college students. These students come from a large variety of majors – science, nursing, elementary education, business, and more. Typically, they sign up to help with these events either because it is required for their current college science course or because it will earn them extra credit. This arrangement benefits the youth who attend by exposing them to college students who are excited about science, and it benefits the college students by providing them with experience explaining scientific concepts at a level that the kids can understand.

PST2C10: 9:15-10 p.m. Introducing Students to the Wonders of the Universe Through Outreach

Poster – Noura Ibrahim, Embry-Riddle Aeronautical University 3700 Willow Creek Road #9023 - H Prescott, AZ 86301*

While the education system covers many important and crucial scientific topics, it does not always cover the most interesting and exciting ones. The more exciting scientific topics can be seen as too advanced for students, and as a result, students can go through 12 years of school without ever hearing about those topics. Through outreach, however, we can introduce students to the most fascinating parts of physics and astronomy just to pique their interest. This basic introduction leaves interested students wanting more. They can then go on to research the topics that appealed to them and in some cases, they might decide to pursue physics or astronomy professionally, which is the ultimate goal.

*Sponsored by Dr. Brad Conrad

PST2C11: 8:30-9:15 p.m. Teaching Physics inside of a Florida State Prison

Poster – Dave Austin, University of Central Florida 4000 Central Florida Blvd Orlando, FL 32816

Nicholas Cox University of Central Florida

Stephanie Jarmark, Justin Reyes, Michael Chini, University of Central Florida

Studies have shown that access to postsecondary education while incarcerated reduces recidivism. With the help of four professors and four graduate students at the University of Central Florida, a "Physics and Everyday Thinking" course was organized and taught at the Florida Reception Center, a mixed security men's prison in Orlando, Florida. There were three main objectives for students participating in the course. The first was to develop an understanding of physics ideas about magnetism and energy that can be used to explain everyday phenomena. The second was to an understanding of how knowledge is developed within the scientific community and the nature of that knowledge itself. The third was to learn to evaluate and draw conclusions from observations. Here we present an overview of the course content, bureaucratic difficulties in administering the course, and personal experiences of teaching in the program.

FA Astronomy Education Research

Time: 8:30–9:10 a.m. **Sponsor: Committee on Space Science and Astronomy** **Date: Tuesday, Jan. 21** **Location: Grand Sierra F**

Presider: *Ken Brandt*

FA01: 8:30-8:40 a.m. A Modern Version of the Eddington Experiment

Contributed – Robert T. Sparks, NOAO, 950 N Cherry Ave., Tucson, AZ 85710

Juan Seguel Cerro, Tololo Inter-American Observatory

Stephen M. Pompea, NOAO

The first experimental evidence supporting Einstein's Theory of General Relativity was obtained in 1919 during a total solar eclipse. Two teams of astronomers led by British Astronomer Arthur Eddington measured the deflection of starlight near the Sun during a total solar eclipse, an effect predicted by general relativity. During the 2019 total solar eclipse, a team from the National Optical Astronomy Observatory and Cerro Tololo Inter-American Observatory led a group of students from the University of La Serena in an attempt to recreate these historic observations. Students used a modern Celestron 11 telescope and high-speed ZWO CMOS camera to capture data during totality and measure the small deflection of stars near the Sum. We are working on preparations to get more groups involved in observing this effect during the 2020 eclipse in Chile and are looking forward to bringing this project to the U.S. for the 2024 eclipse.

FA02: 8:40-8:50 a.m. Developing Space Science Educational Materials to Supplement College Instruction

Contributed – Ramon E. Lopez, University of Texas at Arlington Department of Physics Arlington, TX 76019

Brad Ambrose, Grand Valley State University

Ximena Cid, California State University, Dominguez Hills

Darsa Donelan, Gustavus Adolphus College

Caroline Hall, American Association of Physics Teachers

This presentation will provide an update on the AAPT partnership with the NASA Space Science Education Consortium (NSSEC). Since 2015, a team under the auspices of AAPT has been developing instructional materials for use in post-secondary education using space science as the theme. The team has developed research-based activities (structured lecture-tutorials, peer-instruction styled concept questions, etc.) for use in introductory physics and astronomy, teacher preservice education, as well as upper division physics courses. Some of these materials are suitable for use in High School settings, though they have not yet been utilized in these settings. We will provide a review of our progress, as well as discuss how interested parties can collaborate with our team and the NSSEC in general.

FA03: 8:50-9 a.m. Astrophysics and Astronomy Curriculum Enrichment Through LLNL and CFHT

Contributed – Tessie U.L. Ford, Waipahu High School - Hawaii Department of Education 94-1211 Farrington Hwy Waipahu, HI 96797

The purpose of this presentation is to share my experiences at the Lawrence Livermore National Laboratory's Teacher Research Academy (LLNL's TRA) and Canada-France-Hawaii Telescope's (CFHT) Maunakea Scholars Program. LLNL's TRA provides opportunities for teachers to work with scientists in biotechnology, climate change, and astrophysics. As an astrophysics teacher intern, I worked with LLNL's astrophysicists to help further resolve the Fe XVII emission problem and created a spectra for the lower transition energy levels of chromium. This experience allowed me to gain enough knowledge to become a Maunakea Scholars advisor. The program allows high school students to write project proposals to CFHT astronomers to receive telescope time for their own projects. These opportunities helped me to enrich my physics and astronomy curricula by teaching and engaging the students with modern scientific advancements. This work was performed under the auspices of the Department of Energy by LLNL under Contract No. DE-AC52-07NA27344.

FA04: 9-9:10 a.m. Considerations When Renovating SIUE's Outreach Sky Lab

Contributed – Thomas Foster, Southern Illinois University Edwardsville 6 Hairpin Dr Edwardsville, IL 62026-1654

During the summer of 2019, Southern Illinois University Edwardsville undertook renovating our existing outreach site. Originally built in 1985 from donations made by Dr. William Shaw, the concrete pad with telescopes piers had seen it all and worse. When it was decided that the site needed a major overhaul, members of the University community came together to decide the priority list and budget for the renovations. This talk will discuss those decisions and the outcome of the new Shaw Sky Lab. We hope what we decided to do will help in your outreach decisions.

FB Effective Practices in Educational Technology

Time: 8:30–9:30 a.m. **Sponsor: Committee on Educational Technologies** **Date: Tuesday, Jan. 21** **Location: Grand Sierra G**

Presider: *Shahida Dar*

FB01: 8:30-8:40 a.m. Using Homework Platform OneUp with Gamification Features for Physics*

Contributed – Xiuping Tao, Winston-Salem State University 601 Martin Luther King Jr. Dr Winston-Salem, NC 27110

Darina Dicheva, Keith Irwin, Christo Dichev, Elva Jones. Winston-Salem State University

Gamification – the use of game design elements in non-game contexts – increasingly attracts the interest of educators due to its promise to foster motivation and behavioral changes in learning. However, the support available to instructors who want to apply gamification to their courses is still very limited. To address this problem, we implemented a course gamification platform, OneUp Learning, that is aimed at facilitating the process of gamifying academic courses and enabling tailoring of the gamification features to meet the vision of the course instructor. We will present experiences using the platform for general physics at Winston-Salem State University. We will show comparison of using it with and without the gamification features and also will provide information about how to become an instructor user of the platform.

*This project is supported in part by NSF Award # 1623236.

FB02: 8:40-8:50 a.m. Changing Attributes of Students in a Project-based STEM Media Course

Contributed – Kathleen Ann Falconer, Universität zu Köln 27 East Girard Blvd. Buffalo, NY 14217

Florian Genz, André Bresges, Universität zu Köln

While the personal and professional attributes of successful students in physics have been studied, the same can't be said for physics students who create physics content media for use in the classroom. We will discuss the changes in the personal and professional attributes of students in a STEM course for the creation and use of media in the school classroom. The students' reflective writings and pre/post online surveys were analyzed using grounded theory. In a preliminary analysis, the students' view of self-management and self-motivation, especially in regards to peer/group learning seems to be more accepting through their experiences in the course. There is mixed evidence for change in the students' worldview for the creation of media for classrooms. Their view of the usage and utility of media seems to be changeable as well. The analysis of additional data to saturation of categories is ongoing and we will report upon the results.

FB03: 8:50-9 a.m. Teaching of Relevance in Algebra-based Physics Classroom

Contributed – Gen Long, Saint John's University 8000 Utopia Pkwy Jamaica, NY 11439

In this presentation, we report an ongoing exploration of the teaching of College Physics to non-major students including Biology, Toxicology and Biomedical, etc. In our mostly traditional classroom setting, we try to educate the students about the relevance of physics to their own majors, which wasn't emphasized in previous teaching practices. We provide specific examples of physics applications in their disciplines through in class teaching and discussions, as well as post class assignments. We're also working on to find out whether or not this helps students learn more actively, through self-assessment, and assessment done on the learning outcomes. Pre and post assessments on physics and math prerequisite were also conducted.

FB04: 9-9:10 a.m. Engaged Quality Instruction through Professional Development

Contributed – Nancy Ruzycki, University of Florida 100 Rhines Hall Gainesville, FL 32611

Engaged Quality Instruction through Professional Development (EQuIPD) is a Department of Education funded, Teacher Quality Program to train teachers in Inquiry, System Thinking, and Technology to support student core content model building. This program trains teachers in 10 Florida School Districts in use of technology for data collection and analysis (sensors and probes), simulation and modeling (computational) along with pedagogy (inquiry, modeling cycles) to support student development of core content models grades K-9. This professional development model is especially useful to support teacher and student development of core content models in physics. This talk illustrates how teachers have used this PD approach to build out model inquiry lessons for Force & Motion and Energy Transfer in elementary grades using sensors and probes to collect and analyze data and simulations (including Scratch programming & CoSpaces AR) to predict behavior and refine models.

FB05: 9:10-9:20 a.m. Technology and Materiality in Physics Instruction at Historic Wellesley College

Contributed – Joanna Behrman, Johns Hopkins University 3023 Saint Paul Street Apt 3 Baltimore, MD 21218

From its founding, Wellesley College was a center for the instruction of women in physics, and by the mid-20th century, the college could claim an outsize role in launching women into physics-related occupations. A key part of Wellesley's success stemmed from the importance the physics professors placed on teaching students familiarity and confidence with a wide range of technologies and tools. Over time, the types of technologies taught changed with the changing range of occupations open to women. Mechanical facility improved the students' career prospects, but also, as one professor wrote, "to sharpen the pencil sharpens the eyes." Teaching students to attend to the materiality and function of technologies also taught them to notice their function and skill with their other senses. From microscopes and lathes to radios and automobiles, Wellesley physics students "sharpened" various kinds of tools over the years, and in conjunction sharpened their mind as well.

FB06: 9:20-9:30 a.m. The Software and Hardware Used to Create Video Lectures

Contributed – Timothy A. Duman, University of Indianapolis 6916 Barberry Ct. Plainfield, IN 46168

At a small liberal arts university, the number of physics majors is usually less than 10 students in a year. To increase the number of student taking the upper-level courses, we offer most of these courses every other year. To reduce the conflict with student schedules, we don't have a set time for these courses during registration. We try and find a time that will fit into all the students and faculty schedules after registration. Inevitability we have a situation where students cannot meet at the same time and place. The development of single concept video lectures, recorded class lectures and problem solving video lectures that are post to YouTube and linked to a LMS was started so that students would have access to the same information that would be presented in a face-to-face class. The presentation will discuss the software and hardware used to create these resources.

FB08: 9:40-9:50 a.m. Dynamically Generated Plots in LON-CAPA Online Assignments

Contributed – Todd K. Timberlake, Berry College 2277 Martha Berry Hwy NW Mount Berry, GA 30149-5004

The online homework system known as LearningOnline Network with Computer-Assisted Personalized Approach (LON-CAPA) offers several advantages for both easing the burden of grading and fostering productive student collaboration. One useful feature of LON-CAPA is that it can display plots of author-defined functions or data sets with parameter values generated randomly for each student. Assignments that include these plots can be used to assess student understanding of how to interpret and extract information from technical plots. I will give a brief overview of LON-CAPA and then present examples, drawn from physics and astronomy, of meaningful assignments that incorporate dynamically generated plots.

FB09: 9:50-10 a.m. Games, Spreadsheets, and Quantum Wave Function Collapse

Contributed – Shira K. Eliaser, Rochelle Zell Jewish High School 1095 Lake Cook Rd Deerfield, IL 60015

Teach quantum wave functions to high school students by tying into their math knowledge of probability and games! This activity pairs a student-run coin flip game with real-time graphing in Excel or Google spreadsheets. As students to track the progress of their game in rounds played and results possible, the histogram onscreen illustrates the wave function collapse from a Gaussian bell of all probable outcomes to a single outcome restricted by past results. This activity presents a way to teach quantum mechanics without calculus as well as developing students' spreadsheet and programming skills.

FC Middle School Modeling

Time: 8:30–9:30 a.m. **Sponsor: Committee on Physics in Pre-High School Education** **Date: Tuesday, Jan. 21**
Location: Grand Sierra H **Presider:** *Colleen Megowan-Romanowicz,*

Modeling Instruction is not just for high school physics. Join us for an interactive session that will explore what modeling looks like in the middle school classroom.

FD PER Using Institutional Data Sources and Big Data Research Methods

Time: 8:30–10:10 a.m. **Sponsor: Committee on Research in Physics Education** **Date: Tuesday, Jan. 21**
Location: Grand Sierra I **Presider:** *Jackie Chini*

FD01: 8:30-9 a.m. The Learning Machines Lab: Analyzing Big Data with Innovative Methods

Invited – Rachel Henderson, Michigan State University, 567 Wilson Rd East Lansing, MI 48824

Nicholas T. Young, Alyssa Waterson, Marcos D. Caballero, Michigan State University

Historically, Physics Education Research (PER) have collected and analyzed quantitative data sources using traditional statistical and modeling techniques. As educational research advances, quantitative data sets have become more robust and complex. Here, we will discuss the quantitative research being done in the Learning Machines Lab--a collaboration between Michigan State University (MSU) and the University of Oslo (UiO)--where graduate students, post-docs, and undergraduate

researchers, are conducting cutting-edge research on large data sets. These projects include using innovative big data research methods including machine learning techniques to explore solutions to complex educational research questions. In this talk, the various projects will be highlighted including the variety of data sources, the innovative research methods, and the central outcomes of these studies.

FD02: 9-9:30 a.m. Estimating Graduation Rates using Bayesian Updates to a Markov Model

Invited – Shahab Boumi, University of Central Florida 4000 Central Florida Blvd Orlando, FL 32816

Adan Vela, Jackie Chini, University of Central Florida

Accurate estimates of student graduation and retention rates are critical when assessing and evaluating high education institutions. Traditionally, a rolling six years graduation rate (SYGR), computed from data, is standard for higher education, while utilization of absorbing Markov chains is also common among researchers. Both approaches, however, may not serve as accurate metrics when the sample sizes are small, especially when focusing on sub-populations. Moreover, neither approach captures the sensitivity of data to curriculum and institutional changes over time. In this study, we show mimicking hierarchical modeling techniques can be used to overcome these challenges by identifying how sub-populations or time-periods deviate from means. Accordingly, we use a hierarchical framework and apply Bayesian statistics to update transition probabilities between academic levels in a Markov model. We compare SYGR vs. Hierarchical methods performance in estimating graduation rates using undergraduate students records in University of Central Florida.

FD03: 9:30-10 a.m. Using Machine Learning to Understand the Retention of STEM Students

Invited – John Stewart, West Virginia University 135 Willey St. Morgantown, WV 26506

Retention of STEM students is a critical national problem. Introductory physics classes play a key role in the retention of these students. This talk will first explore retention through survival analysis to show the critical role of time in understanding retention. Machine learning algorithms including logistic regression, decision trees, and random forests are then applied to understand the variables important in predicting retention through the first year of college. This analysis identifies being a successful student in high school and arriving on campus "calculus-ready" as critical predictors of success. The student's progression through the network of introductory science and mathematics courses is then explored. Machine learning algorithms are applied to understand a student's risk factors as they matriculate from Calculus 1 and Chemistry 1 through Physics 1 and Physics 2. This will show students who matriculate through the network along different paths have different risk factors and chances of success.

FE Academic Advising and Retention of Physics Majors

Time: 8:30–9:30 a.m. **Sponsor: Committee on Physics in Undergraduate Education** **Co-Sponsor: Committee on Professional Concerns**
Date: Tuesday, Jan. 21 **Location: Antigua 3-4** **Presiders:** *Tengiz Bibilashvili, Toni Sauncy, Crystal Bailey*

FE01: 8:30-9:30 a.m. How Research Experiences Relate to Physics Identity, Retention, and Integration

Contributed – Zeynep Topdemir, Georgia State University One Park Place Atlanta, GA 30303

Brian D. Thoms, Joshua Von Korff, Amin Bayat Barooni, Georgia State University

Research experiences are opportunities for students to gain essential skills that are needed in their careers. Also, research experiences are beneficial to shape students' physics identities and which in turn may increase retention rates in undergraduate physics programs. Twenty students at different stages of an undergraduate program were interviewed in order to understand how research experiences are related to students' integration to the department, their physics identity development, and retention in the program.

FE02: 8:30-9:30 a.m. Attitudinal and Motivational Factors in Graduate Physics Students

Contributed – Christopher D. Porter, The Ohio State University 191 W. Woodruff Ave Columbus, OH 43210

Andrew F. Heckler, Sara Mueller, Amber Simmons, Srividya Suresh, The Ohio State University

According to the American Physical Society, only 55% of physics graduate students who begin a PhD program are retained through the program to complete that degree. In an effort to improve retention, student experience, and diversity in graduate physics courses and programs, we are conducting a longitudinal study that examines cognitive and motivational factors through surveys, interviews, and focus groups. Currently, six physics departments across the Midwest are participating in this study, and more are in the works. This talk will focus primarily on the results of graduate student surveys, which include minor modifications of validated scales on belonging, cost, physics identity, and several other factors. Differences between institutions will also be discussed. This study is at a middle point, such that most data will be cross-sectional. A more longitudinal picture will become possible after more years of data collection.

FF Recruitment and Retention of Female Students in Physics

Time: 8:30–10:30 a.m. **Sponsor: Committee on Women in Physics** **Co-Sponsor: Committee on Research in Physics Education**
Date: Tuesday, Jan. 21 **Location: Bonaire 5-6** **Presider:** *Alexandru Maries*

FF01: 8:30-9 a.m. STEP UP: A Social Movement in Physics to Promote Women's Participation and Cultural Change*

Invited – Zahra Hazari, Florida International University 11200 SW 8th St. Miami, FL 33199

Geoff Potvin, Raina Khatri, Laird Kramer, Robynne Lock, Texas A&M University Commerce

In a history of physics that spans centuries, it is only in the last 50 years that larger numbers of women have been able to meaningfully participate and contribute to the field. While we have made strides towards greater equity and inclusivity as a community, changing a culture that has been reinforced over centuries requires much more of a collective effort. Together, physics educators can create a new future for physics by inspiring students who have traditionally been marginalized in physics, such as women, and exemplify the critical role of educators in cultural change. As such, STEP UP is a social movement by and for physics educators, supported by physics education researchers and two of the largest societies of physicists in the world (APS and AAPT). This talk will discuss the development of the movement and how physics educators can lead the way in changing the future of physics.

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

FF02: 9-9:30 a.m. Locating Where Women of Color Thrive in Physics

Invited – Angela Johnson, St. Mary's College of Maryland 47645 College Dr, St Marys City, MD 20686 Saint Marys City, MD 20686-3001

"I feel like I'm pretty good at physics. I can't really think of anything I don't like.... I feel like I've been pretty supported in this department." This is what we hope all students will say; the fact that it comes from a black woman in her last year in a physics major should not be a big deal. But, unfortunately, it is. Physics is a compelling area of study, and a powerful tool to solve pressing human problems. And yet few women, and vanishingly few women of color, major in physics. Fixing this would benefit both the women who could thrive in physics and the quality of physics being done. In this session I will cover surprising patterns about the institutions where women of color study physics. I have already studied two inclusive institutions, and will share what they are doing right.

FF03: 9:30-10 a.m. Active Learning in an Inequitable Learning Environment Can Increase the Gender Performance Gap: The Negative Impact of Stereotype Threat and Interventions to Help Mitigate It*

Invited – Alexandru Maries, 345 Clifton Court, Cincinnati, OH 45220

Chandralekha Singh, University of Pittsburgh

Evidence-based active engagement (EBAE) instructional strategies are being used with increasing frequency. However, they may not help all student demographics equally if the learning environment is not equitable because stereotype threats can be higher for women and other underrepresented groups in a collaborative situation and students from these groups may not have the opportunity to contribute meaningfully to the group work if equity is not kept at the center of the learning environment. Here we summarize the findings of two research studies related to these issues that have important implications for physics teaching. In the first study we find that in calculus-based introductory physics 2, the gender gap on the Conceptual Survey of Electricity and Magnetism increased in EBAE courses, but remained relatively constant in traditional Lecture Based (LB) courses. In particular, EBAE instruction provided disproportionate benefit to male students and increased the gender gap even though all students performed better on average in EBAE courses compared to LB courses. A subsequent investigation suggests that stereotype threat may be larger for female students who agree with a gender stereotype about physics learning, and can have an added detrimental effect on their physics learning compared to the other female students who disagree with the stereotype. The findings suggest that in order to improve learning of all students, it is important for physics instructors to create equitable physics learning environments in which all students feel valued and respected and internalize that intelligence is malleable and can grow with hard work because such environments can encourage productive struggle with challenging physics problems without anxiety. Examples of promising interventions to reduce the gender gap along with data supporting their effectiveness will also be discussed.

*Work supported by NSF

FF04: 10-10:30 a.m. Attrition of Women from High School Physics to Faculty Employment

Invited – Anne Marie Porter, American Institute of Physics One Physics Ellipse College Park, MD 20740

The Statistical Research Center at the American Institute of Physics (AIP) regularly conducts nationwide surveys on the representation of women in degrees earned, graduate school enrollment, and faculty employment. Although women's representation has increased over time, the proportion of female physics students is below that of other STEM disciplines. In 2018, women earned only 22% of physics bachelor's degrees and 20% of physics doctoral degrees. We conducted a "pipeline" analysis to identify points of attrition for women in physics between high school physics enrollment and faculty employment in academic departments. We found no attrition for women between receiving a physics bachelor's degree, receiving a physics doctorate, and being employed in faculty positions. However, the percentage of women decreased between high school physics enrollment and receiving a physics bachelor's degree. Future research should explore potential explanations for the attrition of women during high school and undergraduate education.

FG Introductory Physics for the Life Sciences (IPLS)

Time: 8:30–10:30 a.m. **Sponsor: Committee on Physics in Undergraduate Education**
Date: Tuesday, Jan. 21 **Location: Bonaire 1-2** **Presider:** *Juan Burciaga*

FG01: 8:30-9 a.m. From the Classroom to the Living Physics Portal

Invited – Juan Burciaga, Colorado College 14 E. Cache La Poudre Colorado Springs, CO 80903-3243

The transition from preparing an educational supplement for the classroom to submitting the material to the Living Physics Portal can be daunting. The presentation will focus on two educational supplements that were developed for the IPLS classroom but then expanded, developed and submitted to the Portal for community sharing. The process of educational scholarship that transformed a class supplement into an educational supplement that can be shared, the submission to the portal, and the use of feedback from the reviewers and community will be discussed.

FG02: 9-9:30 a.m. Reforming Introductory Physics for the Life Sciences at an Urban Research University

Invited – Peter M. Hoffmann, Wayne State University, 666 W Hancock St., Department of Physics, Detroit, MI 48201

Matthew Gonderinger, Edward Kramkowski, Wayne State University

Wayne State University (WSU) is an urban research university with many first-generation students. Lacking prior exposure, many students see physics courses as of low relevance to their careers. The previous use of a physics curriculum with poor alignment to the life sciences acerbated this problem. Through an NSF-IUSE grant "Student Success through Evidence-based pedagogies" (SSTEP), of which the presenter is a Co-PI, a team in the department of physics overhauled the physics sequence for

life science students in 2015. The goal was fourfold: To increase relevance, to consistently introduce active learning strategies in lectures, discussion and labs, to improve student success and retention, and to create student interest in biomedical physics. I will report on the rationale, process, challenges, outcomes and future of this reform project, and how it fits into the context of institutional reform around student-centered teaching and broad use of evidence-based teaching methods.
Funded by NSF-IUSE "Student Success through Evidence-based pedagogies" (SSTEP).

FG04: 9:30-10:30 a.m. Why You Should Use Normalized Gain and How To Use

Poster – Vincent Coletta, Loyola Marymount U., 1 LMU Drive, Los Angeles, CA 90045-1373

Normalized gain has long been applied to pre and post testing on concept inventories and used as a measure of learning in introductory physics classes. We show how normalized gain has been used to improve learning in those classes. We also show that one must be careful in making comparisons of normalized gains when those comparisons involve significantly different student populations. One must take into account some independent measure of those populations. We describe how one can do this. Failure to do so is an example of omitted variable bias.

FG05: 9:30-10:30 a.m. Beautiful Natural Phenomena

Poster – Mohamed Salem Ellid, Libyan Academy 3053 Cardillino Way Kissimmee, FL 34741

Several beautiful wiggling patterns (similar to a goalkeeper net) were projected on the sand underwater, most of the figures look lhexagonal in shape. The color inside the hexagonal was gray (like a shadow), while the border of the hexagonal was very shine like we have a source of light present at the border of the patterns. The depth of the water at the shore was about 120 cm. It took me a few minutes trying to find a physical explanations to this fascinating phenomena. Finally I a came up with an idea that, the reason behind the shadows color inside these shapes was due to partial absorption of the light rays incident on the flat part of the water (in fact water is transparent to visible wavelengths, it strongly absorbs both ultraviolet light below 300nm and infrared wavelengths over 1300nm). I think the reason behind the very bright borders is due to the behavior of the water waves , which acts as a convergence lens flatten from one side . Since the rays from the Sun are parallel and it happens that the position of the sand was near the focal point of this lens, so the Sun rays will be focused on the border of these patterns and it looks very shining, while inside of these patterns looks dimmer. This explanation was supported using a very simple optical formula.

FG06: 9:30-10:30 a.m. Change of Students' Attitudes in a Redesigned Lecture

Poster – Guillaume Schiltz, ETH Zurich (Swiss Federal Institute of Technology) D-PHYS, LFKP, HPZ G 36 Zurich, CH 8093 Switzerland

Students with non-physics majors often lack a motivational incentive in studying physics and they struggle in viewing physics as a valuable subject for their own discipline. To overcome these motivational issues, we have completely redesigned a compulsory calculus-based first year introductory physics lecture which is offered to students in biology together with students in pharmaceutical sciences. By making physics more accessible, we hope that students also change their attitudes and beliefs of learning physics. To that end, we are relying on CLASS, the "Colorado Learning Attitudes about Science Survey" that we administered as a pre- and as a posttest. In this poster, we discuss the question to what extent the redesigned physics lecture induces changes in the students' attitudes of learning physics and how well we succeed in making the students think like a physicist.

Awards Session

Location: Grand Sierra Ballroom E **Sponsor:** AAPT **Time:** 10:30 a.m.–12 p.m. **Date:** Tuesday, Jan. 21 **Presider:** Mel Sabella

David Sokoloff

Orested Medal presented to David Sokoloff

If Opportunity Doesn't Knock, Build a Door – My Path to Active Dissemination of Active Learning

I've had the good fortune to be able to influence the way physics is taught around the world. The influence of a number of very special colleagues, the synergy of events and a bit of chutzpah have all contributed. I will comment on these factors, and also describe what I believe are the essential features of active dissemination of research-validated active learning strategies.

Richard W. Peterson

Melba Newell Phillips Medal presented to Richard Peterson

Changed . . . by a high and humbling calling

The intent here is to reflect a bit on the many changes of our lives as we teach physics. Inspired by the sometimes tumultuous and amazing career of Melba Newell Phillips, we are reminded of the formative and lasting role the teaching of physics may play in bringing meaning to our lives. It is appropriate that the rich diversity of the AAPT family should more often lead to a sharing of the human impacts of physics and teaching within our lives and careers. In that context I will share a bit of my own teaching story, the excitement of creative experimental apparatus, and of being nurtured within an engaging community of those who delight in mentoring students and skillfully teaching physics.

Raman Prinja

2020 AIP Science Writing Award

Raman Prinja won the 2019 AIP Science Communication Award in the Writing for Children category for his *Planetarium*, published by Bonnier Books in the U.K. and Big Picture Press in the U.S. He is a professor of astrophysics and head of department at University College London, and his research has focused on the evolution and properties of the most massive stars in the galaxy and their progression into supernovae. Prinja has been awarded the Pol and Christiane Swings research prize as well as UCL faculty and department teaching awards. When he's not teaching and researching, Prinja is an active public speaker and regularly presents lectures to a wide audience range. He has made it his personal goal to bring the subject of astronomy to more diverse audiences, including children, and has written over 20 successful outreach-level science books.

Prinja will have a book signing immediately following the session.

AAPT Presidential Transfer

Mel Sabella
Chicago State Univ.
2019 President

Chandralekha Singh
University of Pittsburgh
2020 President

GA Interactive Lecture Demonstrations: A Research-Validated Strategy to Improve Learning in Lecture

Sponsor: Committee on Research in Physics Education Co-Sponsor: Committee on Educational Technologies

Time: 12:30–1:50 p.m. Date: Tuesday, Jan. 21 Location: Grand Sierra F Presider: *David Sokoloff*

GA01: 12:30-1 p.m. Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers and Video Analysis

Invited – David Sokoloff, University of Oregon, 1371 E 13th Ave, Department of Physics, Eugene, OR 97403-1274

Ronald K. Thornton, 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).

GA02: 1-1:30 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Tufts University, 12 Temple St Medford, MA 02155

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. (1), (2) 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: 6, 340 (1997). 2. David R. Sokoloff, "Active Learning of Introductory Light and Optics," Phys. Teach. 54: 1, 18 (2016).

GA03: 1:30-1:40 p.m. Effective Teaching and O-AMAS Model

Contributed – Yudong Li, School of Physics, Nankai University Weijin road 94#, Nankai District Tianjin, Tianjin 300071 P. R. China

Qian Sun School of Physics, Nankai University

Yongfa Kong School of Physics, Nankai University

In order to make our classroom teaching more effective, we design the course of College Physics for undergraduates with O-AMAS (Objective-Activation, Multi-learning, Assessment and Summary) model based on outcomes/objectives principle. At the beginning of the class, demonstration experiments or interesting problems are sent out to excite students' engagement in the class. During the class, we keep the activation by using multiplex learning modes, including direct learning, co-operative learning, and independent learning. In order to monitor the learning outcomes, we use APPs to make process and summative evaluations. At last, we use games or activities to summarize the class content. The O-AMAS mold help us to maintain students' learning interest and attention during the class time.

GA04: 1:40-1:50 p.m. Make Optics Course Education More Effective by DEAR Cycle

Contributed – Qian Sun, School of Physics, Nankai University Weijin road 94#, Nankai District Tianjin, Tianjin 300071 P. R. China

Yudong Li, Zongqiang Chen, Jing Chen, Yongfa Kong, School of Physics, Nankai University

As an important course for undergraduates with a major in Physics, Optics provides sophomores great chance to connect theory and experiments. Generally, in the teaching process of Optics, lecturers pay high attention to the demonstration experiments. We developed a new teaching strategy, in short DEAR cycle?--including demonstration, exploration, argument and research. Demonstration experiments, especially the ones based on daily necessaries & groceries, are used to active students learning interest. We assign exploration questions originated from the course context to the students as group works each week. And the students present and argue their exploration results. Selected outstanding students have chance to apply innovation project. With the help of DEAR cycle, students are excited from acceptor of knowledge to potential creator of new ideas.

GB Virtual Reality, Augmented Reality, Drones, and Other Emerging Technologies in Higher Ed.

Sponsor: Committee on Educational Technologies

Time: 12:30–1:30 p.m. Date: Tuesday, Jan. 21 Location: Grand Sierra G Presider: *Andre Bresges*

GB01: 12:30-1 p.m. How Fluid Dynamics May Save the Planet, and Virtual Reality Helps Us to Teach How*

Invited – Andre Bresges, University of Cologne Gronewaldstrasse 2 Cologne, 50931 Germany

When Greta Turnberg sailed into New York aboard a yacht, she demonstrated that intercontinental travel is possible without fossile fuel. Hydrofoils lifted the hull out of the water to reduce drag, while computers controlled the airflow on the sails for stability and performance. Electrical energy was provided by Hydrogenerators. Hence, this journey also proves the importance of Fluid Dynamics for the post-fossile era. Fluid Dynamics helps to generate energy from wind or water; it determines the influence of climate change on oceanic currents and hurricanes; its knowledge is also necessary to predict and prevent floodings. Despite that, it plays a neglected role in physics curricula worldwide; partly because concepts are really hard to grasp without the support of computer simulations. Today, Computational Fluid Dynamics (CFD) readily exists on Tablets, Smartphones and Game Consoles. We display several teaching and learning paths using educational technology combined with hands-on experiments, and display our Virtual Reality Environment - Virtual Rhine Riverbed - that uses a game-based, bionic teaching approach.

*Virtual Rhine Riverbed is supported by federal and state grants as part of the Qualitaetsoffensive Lehrerbildung, funded by the German Ministery of Education and Research (BMBF).

GB02: 1-1:30 p.m. All Real or More!? Augmented Reality in Physics Lessons

Invited – Johannes Lhotzky, Johannes Gutenberg-Universität Staudingerweg 7 Mainz, Rheinland-Pfalz 55118

Klaus Wendt, Johannes Gutenberg-Universität

Our "Augmented Reality" (AR) application captures coded place holders in real world through the camera of a tablet or a smartphone, which are converted in the program code into experimental equipment. As primary topic the appealing field of optics was chosen. Here, experiments are often not carried out hands-on by students due to financial, organizational or safety aspects. Implying the AR place holders, devices such as light sources, lasers, mirrors, lenses, beam splitters, prisms, and much more can be accessed "through the tablet" as if actually at hand. All objects and phenomena are simulated regarding their entire set of physical attributes and can be combined arbitrarily. In this way numerous different experiments are rendered possible – from simply verifying the law of reflection up to constructing complex interferometric units. The application is obtained from the AppStore – the required different place holders can simply be printed and copied in the class set.

GC PER: Student Content Understanding, Problem-Solving and Reasoning

Sponsor: AAPT **Time: 12:30–2:20 p.m.** **Date: Tuesday, Jan. 21** **Location: Grand Sierra H** **Presider:** *TBA*

GC01: 12:30-12:40 p.m. Developing a Strategy to Address Physics Students' Mathematical Difficulties*

Contributed – David E. Meltzer, Arizona State University College of Integrative Sciences and Arts Mesa, AZ 85212

Dakota H. King, Arizona State University

We report preliminary plans to address mathematical difficulties revealed in our four-year investigation of students in introductory physics courses. We have administered over 5000 written diagnostic tests in algebra- and calculus-based physics courses, and carried out many individual problem-solving interviews. We have previously reported that difficulties with basic mathematical operations are widespread, and that performance on problems using symbols for constants is consistently and significantly worse than on problems using numbers. In collaboration with Ohio State University, we are working to develop and test an online instructional tool that will provide opportunities for regular, targeted practice to address these difficulties. We have refined our diagnostic tool to explore the distinction between specific operational difficulties on the one hand, and difficulties arising from context complexity on the other. We will report our most recent findings and describe how they inform our initial instructional strategies.

*Supported in part by NSF DUE #1504986 and #1914712

GC02: 12:40-12:50 p.m. Physics Students' Mathematical Difficulties with Operations and Algebra*

Contributed – Dakota H. King, Arizona State University 1519 East Hale Street Mesa, AZ 85203

David E. Meltzer, Arizona State University

As part of an investigation into students' mathematical difficulties, over 5000 written diagnostics have been administered to both algebra- and calculus-based introductory physics courses at Arizona State University over the past four years. We continue to observe that many of these students have significant difficulties with basic symbolic algebra problems ("symbolic" refers to the nature of the constant coefficients). Such problems require mathematical skill that is essential to solving many problems encountered in introductory physics. New to our most recent versions of the diagnostic are questions that test students' operational skills necessary for solving multi-step algebra problems; for example, fraction multiplication and division. In addition, our newest version of the diagnostic has been administered at another large state university. We will report an overview of our most-recent findings with comparisons to the other university, and provide data on our detailed analysis of the algebra and operation problems.

*Supported in part by NSF DUE #1504986 and #1914712

GC03: 12:50-1 p.m. Practice with Dysfunctional Avatar-student Groups in a Mixed-reality Classroom Simulator

Contributed – Constance M. Doty, University of Central Florida, Department of Physics 4111 Libra Drive Orlando, FL 32816

Ashley A. Geraets, Tong Wan, Erin K. H. Saitta, Jacquelyn J. Chini, University of Central Florida, Department of Physics

Undergraduate active-learning STEM recitation and laboratory courses often adopt curricula that encourage or require students to work in small groups. However, not all student groups function as intended by the curricula or course designer and group management is a complex pedagogical skill. In this study, STEM graduate teaching assistants (GTAs) participated in four practice teaching sessions in a mixed-reality classroom simulator. During one of the practice teaching sessions, GTAs practiced group management skills with the goal of ensuring each avatar-student was contributing their ideas and disagreements were being addressed by the avatar-student group. The simulated classroom featured two avatar-student groups with varied student difficulties and group management related challenges. The GTAs interacted with the two groups for two seven-minute sessions, with a break for reflection and feedback. Here, we discuss the strategies a few GTAs used to support the avatar-student groups before and after receiving feedback from facilitators.

GC04: 1-1:10 p.m. Building on Student Resources for Understanding Mechanical Wave Propagation: Examples from Classroom Video

Contributed – Lauren C. Bauman, Quest University 3200 University Blvd. Squamish, BC V8B 0N8 Canada

Lisa M. Goodhew, Paula R. Heron, University of Washington

Amy D. Robertson, Seattle Pacific University.

Rachel E. Scherr, University of Washington Bothell

Resource theory depicts resources as dynamic, context-dependent "pieces of knowledge" and learning as building from students' resources. In line with resource theory, we developed research-based instructional materials meant to elicit and build on common conceptual resources for mechanical wave propagation. In this talk, we will investigate the following questions: What does building on students' resources look like? What contextual and interactional features support students in this process? To answer these questions, we will look at an example from classroom video, where students are building on and working with their conceptual resources for understanding mechanical wave propagation.

GC05: 1:10-1:20 p.m. Investigating Student Reasoning in Theory Evidence Coordination*

Contributed – Krista E. Wood, University of Cincinnati 9955 Plainfield Rd. Cincinnati, OH 45236

Kathleen M. Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Scientific thinking involves making connections between claims, evidence, and reasoning. Often students struggle making valid claims, supporting claims with evidence, and explaining their reasoning. In a preliminary study, we investigated the reasoning processes students engaged in when given both a hypothetical physics-based and non-physics based task. In our data analysis, we specifically looked for how students developed self-generated theories, any differences in how claims were made based on the context of the physics versus non-physics task, and to what extent students were able to support their claim with evidence. We will present the results on how students evaluate evidence, what reasoning flaws occurred when connecting claims with evidence, and provide a finer grain analysis of the student reasoning process.

*Partially supported by NSF DUE 1431908

GC06: 1:20-1:30 p.m. Modelling via Experiment

Contributed – Ian Bearden, Blegdamsvej 17 Copenhagen

Labs are often thought of as an opportunity for students to reinforce the knowledge they are expected to have learned in lectures. While there is little evidence that this actually happens, there are a number of other educational opportunities provided by experimental activities. Among these is the opportunity to use student developed apparatus for simple experimental tests to probe their understanding of the physics they are trying to test. In particular, such discussions quickly unmask student difficulties modelling simple physical systems. This talk will focus on one activity focused on students' testing the dependence of a pendulum's period on various testable factors.

GC07: 1:30-1:40 p.m. Opinions of Working in a Group: Positive and Nuanced

Contributed – Miranda Straub, Winona State University 315 W. Mill St Winona, MN 55987

I will present on the results of a survey sent to post-secondary physics instructors in Minnesota regarding their beliefs about group work. Group work here was set in the context of working on homework outside of class or obligation. The survey respondents were overwhelmingly positive (88%) about the benefits of working in a

group but most (79%) had reservations about how the group work should be done. The most cited drawback was an unequal distribution of work. I concluded that the implications of this portion of the survey in the larger context of problem-solving was the instructors believe it is necessary for students to talk about their ideas as part of successful problem-solving.

GC08: 1:40-1:50 p.m. Impact of Multiple Practices in a Mixed-reality Teaching Simulator

Contributed – Ashley A. Geraets, University of Central Florida 9538 Brimton Drive Orlando, FL 32817-2736

Constance M. Doty, Tong Wan, Jacquelyn J. Chini, Erin K. H. Saitta, University of Central Florida

STEM graduate teaching assistants (GTAs) are often assigned to lead laboratory, discussion, or recitation sections as part of their teaching assignments. Often, these GTAs receive little formal training regarding teaching before they interact with their students. In this study, STEM GTAs participated in a mixed-reality teaching simulator which provided them an opportunity to practice evidence-based pedagogical skills including cold-calling and error framing in a low-risk environment. As part of their professional development, GTAs teaching in the Spring 2019 and Fall 2019 semesters rehearsed cold calling and error framing in the simulator; four GTAs practiced these skills in both semesters. We conducted classroom observations following the practice in the simulator in both semesters. Here we will discuss the impact of multiple practice of the teaching skills cold-calling and error framing during the simulator session and subsequent in-class observations.

GC09: 1:50-2 p.m. Evaluating Impact of Teaching in a Mixed-reality Classroom Simulator on GTAs' Teaching Practices

Contributed – Tong Wan, University of Central Florida 4111 Libra Drive Orlando, FL 32816

Constance M. Doty, Ashley A. Geraets, Erin K. H. Saitta, Jacquelyn J. Chini, University of Central Florida

Studies show that graduate teaching assistants (GTAs) who participate in the same training program can vary substantially in the extent to which they implement essential pedagogical practices; this variation suggests more effective GTA training is needed. In this study, we evaluate the impact of rehearsing teaching skills in a classroom simulator on GTAs' classroom practices. GTAs in an introductory physics course rehearsed particular pedagogical skills with avatar-students in a mixed-reality simulator four times during a semester (about once every three weeks). In the first three activities, GTAs rehearsed specific skills: cold calling with error framing, questioning, and group management techniques. For the fourth activity, GTAs chose one of the previous skills to rehearse again. We conducted classroom observations to track changes in teaching practices of 12 GTAs. We report the extent to which GTAs implemented these skills in their classrooms and how their teaching practices evolve over the semester.

GC10: 2-2:10 p.m. STEP UP: Careers in Physics Lesson*

Contributed – Raina M. Khatri, Florida International University 11200 SW 8th St Miami, FL 33174

Zahra Hazari, Geoff Potvin, Laird Kramer, Florida International University

Robynne Lock, Texas A&M University - Commerce

As part of the STEP UP project, two lessons have been developed to help teachers to encourage the pursuit of physics in college. One lesson, focusing on Careers in Physics, builds a counternarrative in the classroom by dismantling commonly held stereotypes of what physics is and who physicists are, which then opens new possibilities for pursuing physics as a career. Students are asked to consider their own values and what they want in a career and, based on this reflection, are exposed to profiles of physics graduates working in sometimes unexpected careers (including writers, film producers, skateboarders, actuaries and more). Developed through close and long-term collaboration between high school physics teachers and education researchers, the Careers in Physics lesson has been taught in classrooms in different contexts around the country. In this talk I will provide an overview of the l esson, research supporting the efficacy, and success stories from teachers.

*This work is supported by the National Science Foundation under Grant No. 1720810, 1720869, 1720917, and 1721021.

GC11: 2:10-2:20 p.m. Students' Learning in a Physics Course on Research Skills Using Perusall

Contributed – Mohammad T. AlFiky, The American University in Cairo School of Sciences and Engineering, Physics Department New Cairo, P.O.Box 74, 11835 Egypt

Many students tend to read the textbook like a novel, if at all. I am sharing my positive experience with using Perusall, an online platform for active reading, collaborative learning and stimulating discussions, in a physics course on Research Skills. Research Skills is 1-credit newly developed course which is taken by all physics major students with senior standing at the American University in Cairo. It covers topics such as Rayleigh algorithm, Pi theorem, and symmetry and invariants. This tool does not only engage the students and allow the instructor to locate their points of confusion, but also it uncovers subtle points of misunderstanding which are revealed only by their comments.

GD Teaching and Engaging Students at HSI's

Sponsor: Committee on Women in Physics **Co-Sponsor: Committee on Diversity in Physics** **Time: 12:30–1:50 p.m.**
Date: Tuesday, Jan. 21 **Location: Grand Sierra I** **Presider:** *Juan Burciaga*

GD01: 12:30-1 p.m. Integrating Research, Mentoring, and Industry Collaborations to Improve STEM Recruitment & Retention*

Invited – Nichole Spencer, 1202 W. Thomas Road, Physical Sciences Building-C Chandler, AZ 85224-2750;u

This project at Phoenix College will advance the aims of the Hispanic-Serving Institutions Program (HSI Program) by incorporating multi-disciplinary Course-Based Undergraduate Research Experiences (CUREs) into STEM curricula in colleges throughout the district. The specific goals of this project are to 1) promote increased interest in STEM disciplines, especially among students from groups that are underrepresented in STEM; 2) increase recruitment and retention of students in introductory STEM courses; 3) increase the number of students from two-year HSIs who transfer into STEM degree programs at four-year institutions; and 4) establish cross-sector partnerships with industry to improve workforce readiness and promote interest in STEM careers among two-year HSI students.

*Sponsored by Juan Burciaga.

GD02: 1-1:30 p.m. Modeling Instruction: A Transformative Was to Experience STEM Content

Invited – Idaykis Rodriguez, Florida International University 11200 SW 8th Street, STEM Transformation Institute, VH 160 Miami, FL 33199

Modeling Instruction in University Physics is an evidence-based, active learning, student-centered, curricula that transforms the way students experience STEM content. Focused around doing science, students engage in cooperative group learning, whole-class discussion, and develop theoretical models of physical phenomena with little to no lecture time. This talk will focus on explaining how to create an introductory physics experience that is culturally sensitive and inclusive of students that are traditionally under-represented minorities in STEM and transforming students conceptions of physics. At Florida International University, a majority Hispanic Serving Institution, we have been practicing Modeling Instruction for the last 15 years, where in the last 5 years, Modeling Instruction is scaled to large 100 person classes. The success of Modeling Instruction is reflected in a 14% difference in student conceptual understanding as measured by the standardized diagnostics when compared to lecture courses, a 6.73 times greater odds of success, and an equally likely survival rate for Modeling Instruction students that become physics majors to succeed in their upper level program when compared to lecture students. The general success of this course has led us to rethink and redesign STEM experiences for students that are tailored to their educational and individual needs.

GD03: 1:30-1:40 p.m. First-generation and Continuing-generation Women in Introductory Physics

Contributed – Roger A. Freedman, University of California, Santa Barbara Dept. of Physics Santa Barbara, CA 93106-9530

Vanessa Woods, Dept. of Psychological and Brain Sciences, University of California, Santa Barbara

We are investigating the relationships among pedagogical practices, attitudes, and performance in large, introductory, algebra-based and calculus-based physics courses at a large R1 university that is an HSI. We surveyed students in these courses on attitudes, physics confidence, self-efficacy, and use of active learning techniques, and correlated their answers with class performance and FCI data. In accordance with previous studies, in our sample men reported higher confidence and efficacy than did women. However, first-generation women reported lower confidence, efficacy, and performance measures than continuing-generation women. This suggests that to identify which students in introductory physics courses may need added support to be successful, it is wise to look at intersections of identity (e. g. first-generation women).

GD04: 1:40-1:50 p.m. The Effect of Community Building in a 2YC Introductory Physics Course

Contributed – Jennifer Snyder, San Diego Mesa College, 7250 Mesa College Drive, San Diego, CA 92111-4998

As part of a certificate program in College STEM Teaching in HSI's, an analysis of achievement gaps was performed for an Introductory Algebra-based Physics course. Comparisons of success rates for different demographics of students were analyzed for significant differences. Whereas success rates did not show any significant findings, a deeper look at the unsuccessful students did. A portion of the students classified as "unsuccessful" withdrew from the course before the third exam. Other students remained in the course but ultimately received D's or F's due to coursework challenges. These "persisters" were more likely to be Latina students or those with Veteran status. This finding led to the creation of an intervention to provide small group work and community building in the course. The results will be discussed with further implications for teaching in HSI 2YC's.

GE Physics Majors: High School to Doctorate

Sponsor: AAPT **Time: 12:30–1 p.m.** **Date: Tuesday, Jan. 21** **Location: Bonaire 5-6** **Presider:** *TBA*

GE01: 12:30-12:40 p.m. Non Metric Relativistic Gravitation at the Graduate and Undergraduate level

Contributed – James W. Douglass, Florida Institute of Theoretical Physics PO Box 3372 Melbourne, FL 32902-3372

The general theory of relativity is the accepted theory of relativistic gravitation. It is formulated using metric mathematical methods and combines space and time into one mathematical entity. While elegant, this way of describing gravitational mechanics makes physical insight difficult and relegates the subject to advanced graduate levels. Non metric relativistic gravitation^1 on the other hand is based on the physical processes that modify space and time. It extends the physical insights and postulates of special relativity showing how time and space are effected by gravitational acceleration as well as uniform motion. It therefore provides a level of physical understanding which is intuitive and interesting to the student of gravitation and relativity at the graduate and undergraduate levels. The mathematical methods are those of special relativity and Lagrangian mechanics. As noted by Richard Feynman, the ability to describe a subject in multiple ways may be what makes a subject "simple".
1) Details of this theory may be found at: https://arxiv.org/abs/1508.05810

GE02: 12:40-12:50 p.m. Acronyms to Help Formula (Physics) Recollection, and Encourage Further Study Thereof!

Contributed – Shannon A. Schunicht, 1505 Sranbury Dr. Orlando, FL 32818-5894

The study of Physics is intimidating to anyone due to the multitudes of formulas required for recollection come test time. A pragmatic discoveries were made for formula recollection to compensate for the residual memory deficits after being in a 3 week coma (19 days). The most valuable was each vowel: mathematical operation, i.e. a:@ =>multiplication, o:over =>division, i:minus =>subtraction, u:plus =>addition, and e:equals. Most constants and variables are indeed consonants, e.g. c=speed of light, & z=altitude ADDITIONAL LETTERS may be inserted to enhance a letter combination's intelligibility, but need be CONSONANTS only! Examples include an acronym for The Quadratic Equation, i.e. exCePT i buiLD rabbiTS 4 caTS oN 2 HaTS. After all, everyone remembers Dr. Seuss (Theodor Seuss Geisel).? The possibilities with Western languages are remarkable, whereas Eastern Characters have yet to be explored. Regardless, its potential remains Limitless as Delta X=>0

GE03: 12:50-1 p.m. Limitations and Modifications in Newton's Laws of Motion

Contributed – Amritpal Singh Nafria, Lovely Professional University #303, Street No.-10, Prem Basti Sangrur, Punjab 148001 India

Newton's laws of motion are three physical laws that laid the foundation for classical mechanics. They describe the relationship between a body and the forces acting upon it, and its motion in response to those forces. Newton's first law according to Principia states that everybody perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon. The second law states that the alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed. In other words, force is directly proportional to rate of change in momentum (F=ma). And the third law states that to every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts. This paper shows force can be calculated in numeric by using force-meter, when it is applied on wall/stationary objects. Further, it explains a quantity may have two different formula's, if the quantity acts under different conditions, i.e. 'F=ma' is not a universal equation, as the role of gravity is missing in the given convention. The modified equation of force should be F=mga' or 'F=wa' when force is applied under gravity. Whereas equation becomes 'F=ma' when force is applied in the absence of gravity. Furthermore, modified third law explains that both action and reaction act simultaneously till stick together and are always opposite but equal when both bodies stay stationary; whereas if both bodies cause movement in the same direction, action and reaction gets unequal till stick together. The direction shows action applies more force or reaction, whereas velocity shows how large force is applied by one body onto another.

GF Upper Division Undergraduate

Sponsor: AAPT **Time: 12:30–1:10 p.m.** **Date: Tuesday, Jan. 21** **Location: Bonaire 1-2** **Presider:** *TBA*

GF01: 12:30-12:40 p.m. Guitar Experiment Assisting for Comprehension on String Vibration Function

Contributed – Xiaoyu Niu Institute of Acoustics, Chinese Academy of Sciences No.21 North 4th Ring Road, Haidian District Beijing, Beijing 100190 China

Haomeng Zhou, Ocean University of China

Ce Bian Ocean, University of China

Chenguang Li ,Peking University

Wei Wang, Nanjing University

A powerful way to introduce students to study and technique is through subjects in which they might find the interest and strengthen their comprehension of certain physical concepts. As for the course-method of mathematical physics (this course is also named mathematical physical function), some students state that they have a less detailed and impressive knowledge of it, for this course is too abstract to grasp. Therefore, it is very significant to help introductory physics students comprehend the method of mathematical physics. Instead, in this paper, we design practical and straightforward experiments with a guitar to assist for the comprehension of mathemati-

cal physical functions, especially on string vibration function. Once having a complete perception of string vibration function, students would be likely to grasp the powerful and standard method of modal analysis, which is bound to their future study and research.

GF02: 12:40-12:50 p.m. Computation of Macroscopic Magnetic Field in a Uniformly Magnetized Object

Contributed – Vladimir I. Tsifrinovich, NYU Tandon School of Engineering 6 MetroTech Center Brooklyn, NY 11201

In the advance course of electricity and magnetism one of the important topics is computation of the magnetic field in a uniformly magnetized object. I suggest that the most instructive and accessible for a student way for such computation is to map the electric field problems onto the corresponding magnetic field problems. Namely, I suggest to prove that the Maxwell equation for the auxiliary magnetic field (the H-field) in a magnetized object is similar to the equation for the electric field E in an electrically polarized object. After that one can easily derive the expression for the H-field in terms of magnetization M based on the corresponding expressions for the E-field in terms of polarization P. Finally, one determines the magnetic field B. I argue that this approach ensures the simplest way for the computation of magnetic field in a uniformly magnetized object. Also it provides an additional insight on the relation between the electricity and magnetism.

GF03: 12:50-12:40 p.m. Effective Undergraduate Programs: Scaffolding, Careers, and Resources

Contributed – Brad R. Conrad, Society of Physics Students, 1 Physics Ellipse College Park, MD 20740

As faculty aim to build thriving undergraduate programs, developing course sequences and content that both serve and recruit undergraduates for a broad array of career outcomes is vital for a successful department. Course sequences and material can be made to include tools that serve students aiming for both graduate school and careers immediately after graduation. This session aims to tie educational outcomes within course sequences to career objectives through specific examples and tools. By empowering a broad range of students to manage their career goals and objectives, departments can both self-evaluate and promote an inclusive environment for a diverse student population. The findings, results, and suggestions from a wide variety of source will be touched on and special attention will be given to comprehensive course development that compliments current education objectives and the SPS careers toolbox.

GF04: 1-1:10 p.m. REU Site in Physics at Howard University: Experiment in Diversity*

Contributed – Prabhakar Misra, Howard University Department of Physics & Astronomy, 2355 6th St., NW Washington, DC 20059

Silvina Gatica, Quinton L Williams, Howard University

The REU Site in Physics at Howard University has provided a 10-week summer research experience in computational, theoretical and experimental nanoscale condensed matter physics, optics and laser spectroscopy, to a targeted and diverse undergraduate student population from institutions with limited STEM research resources. The REU cohorts of physics majors were truly diverse. During the period 2014-19, 38 participants benefited from the REU Physics Program at Howard University, which included 13 females, 13 African Americans, and 5 other minority students. The Howard Physics REU introduced participants to exciting research tools and methods; the students acquired skills in specific methodology, while developing a keen awareness of the applications of physics to a broad range of science careers. The REU site has served as a catalyst for talented students who may be undecided about pursuing a career in physics, providing them with skills needed to explore a range of career options.

*Financial support from the National Science Foundation (Award#s PHY-1358727 and PHY-1659224) is gratefully acknowledged.

GG Theory Meets Practice

Sponsor: Committee on Physics in High Schools **Time: 12:30–1:30 p.m.** **Date: Tuesday, Jan. 21**
Location: Bonaire 3-4 **Presider:** *Jon Anderson*

The intent of this panel discussion is to examine several introductory physics topics from two different perspectives: that of physics education researchers and that of in-service high school physics teachers. The panel will consist of individuals that bring expertise in each area and the discussion will focus on how theory and practice overlap and where differences may lie when examining these topics. Additionally, there will be time for questions from attendees and discussion with the panelists.

GH Reaching Learners Where They Are: Bringing Science to Hospitals, Prisons and Podcasts

Sponsor: Committee on Science Education for the Public **Time: 12:30–2:30 p.m.** **Date: Tuesday, Jan. 21**
Location: Antigua 3-4 **Presider:** *Jacquelyn J. Chini*

GH01: 12:30-2:30 p.m. Building Brighter Futures: The Importance of Higher Education in Prison

Invited – Keri Watson, University of Central Florida, 12400 Aquarius Agora Orlando, FL 32816-8040

Mass incarceration is among the most crucial issues of our time. Since 1978, the U.S. prison population has increased 408%, and Florida has the nation's third largest prison system, with 100,000 people behind bars. Evidence shows that education increases the likelihood of post-release employment by 58% and reduces recidivism by 40%, yet until recently, Florida's correctional institutions did not offer college courses. To address this issue, the Florida Prison Education Project was formed by faculty from across the University of Central Florida in 2017. The Florida Prison Education Project offers high-quality continuing education courses to people incarcerated in Central Florida, studies the effects of higher education in prison programs, and integrates the study of social justice into the University of Central Florida curriculum. Since its founding, the Florida Prison Education Project has offered eleven classes to 147 men at the Central Florida Reception Center, a mixed security men's prison in Orlando, FL.

GH02: 12:30-2:30 p.m. Implementing a Conceptual Physics Course through the Florida Prison Education Project

Invited – Michael Chini, University of Central Florida, 4111 Libra Drive, Physical Sciences Bldg 430 Orlando, FL 32816

The Florida Prison Education Project is an initiative that seeks to offer a high-quality undergraduate education to incarcerated people in Central Florida. In Fall 2019, we administered a conceptual physics course to 15 students enrolled at the Central Florida Reception Center, a mixed security men's prison in Orlando. The course, which was team-taught by a group of four faculty members and four graduate students from the Department of Physics and College of Optics and Photonics at the University of Central Florida, was based on the "Next GEN Physical Science and Everyday Thinking" curriculum. Course topics included magnetism and energy interactions, with an overall focus on scientific model building and scientific argumentation. In this talk, I will discuss the implementation of the course, with a focus on the organizational hurdles associated with working with a large team of volunteer instructors and delivering an interactive physics course in a prison setting.

GH03: 12:30-2:30 p.m. Science Education in Pediatric Hospital Settings

Invited – Megan Nickels, University of Central Florida, 1883 Gatewood Dr Deltona, FL 32738-4209

Norman Jeune Nemours Children's Hospital

In this presentation we will discuss strategies for teaching science to K-12 children with complex medical issues in hospital settings. We introduce the idea of precision education to describe research-backed educational activities specific to a child's respective disease or condition needs such as neurocognitive deficit, physiological positioning, and socio-emotional health. The teaching strategies and activities we share are focused on robotics and immersive virtual reality with the aim of helping medically complex children gain a leg up as critical problem solvers, flexible thinkers, and irrepressible learners.

GH04: 12:30-2:30 p.m. Walkabout the Galaxy: The Accidentally Educational Astronomy Podcast

Invited – Joshua Colwell University of Central Florida. 4111, Libra Dr ORLANDO, Florida 32816 United States

There are many excellent podcasts and programs dealing with astronomy and space exploration. We created Walkabout the Galaxy not with the primary motivation of being an educational show, but rather an entertaining show. Just as NPR's "Car Talk" was not a show aimed at home auto mechanics, the style of Walkabout is designed to be entertaining and funny to appeal to a broad audience who may not identify as interested in astronomy. By incorporating elements such as humorous sponsors, trivia questions, discussions of stereotypical nerd culture, and kidding and banter between the three hosts, we target a broader audience than might tune into a purely educational show. We then slyly insert segments providing discussions of the latest news and discoveries in astronomy. Discussions are aimed at the non-expert, and we assume no prior knowledge. We invite guests from outside the field to provide additional variety.

GH05: 12:30-2:30 p.m. Walkabout the Galaxy: The Accidentally Educational Astronomy Podcast

Invited – Adrienne Done, University of Central Florida, 4111 Libra Dr ORLANDO, FL 32816

There are many excellent podcasts and programs dealing with astronomy and space exploration. We created Walkabout the Galaxy not with the primary motivation of being an educational show, but rather an entertaining show. Just as NPR's "Car Talk" was not a show aimed at home auto mechanics, the style of Walkabout is designed to be entertaining and funny to appeal to a broad audience who may not identify as interested in astronomy. By incorporating elements such as humorous sponsors, trivia questions, discussions of stereotypical nerd culture, and kidding and banter between the three hosts, we target a broader audience than might tune into a purely educational show. We then slyly insert segments providing discussions of the latest news and discoveries in astronomy. Discussions are aimed at the non-expert, and we assume no prior knowledge. We invite guests from outside the field to provide additional variety.

GH06: 12:30-2:30 p.m. Walkabout the Galaxy: The Accidentally Educational Astronomy Podcast

Invited – Jacquelyn Chini, University of Central Florida, 4111 Libra Dr ORLANDO, FL 32816

There are many excellent podcasts and programs dealing with astronomy and space exploration. We created Walkabout the Galaxy not with the primary motivation of being an educational show, but rather an entertaining show. Just as NPR's "Car Talk" was not a show aimed at home auto mechanics, the style of Walkabout is designed to be entertaining and funny to appeal to a broad audience who may not identify as interested in astronomy. By incorporating elements such as humorous sponsors, trivia questions, discussions of stereotypical nerd culture, and kidding and banter between the three hosts, we target a broader audience than might tune into a purely educational show. We then slyly insert segments providing discussions of the latest news and discoveries in astronomy. Discussions are aimed at the non-expert, and we assume no prior knowledge. We invite guests from outside the field to provide additional variety.

GI Professional Skills for Students

Sponsor: Committee on Research in Physics Education **Co-Sponsor: Committee on Graduate Education in Physics**
Time: 12:30–2:30 p.m. **Date: Tuesday, Jan. 21** **Location: Curacao 3-4** **Presider:** *Lisa Goodhew*

This interactive panel focuses on developing professional skills for graduate students and other early-stage researchers. This session will feature a discussion of how to give critical, ethical, and constructive reviews of journal or conference proceedings articles. 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!

HA Post-deadline

Sponsor: AAPT **Time: 2:30–4:10 p.m.** **Date: Tuesday, Jan. 21** **Location: Bonaire 3-4** **Presider:** *TBA*

HA01: 2:30-2:40 p.m. A Comparison of Sound Quality Between PLA 3D Printing Ukulele and Single Board Wooden Ukulele

Contributed – Peng Qian, Institute of Acoustics, Chinese Academy of Sciences, No.21 North 4th Ring Road, Haidian, Beijing 100190 China

Shanru Lin, Liangzhi Ma, Junjie Ma, Ocean University of China

Xiaoyu Niu Institute of Acoustics, Chinese Academy of Sciences

Based on the 3D printing techniques, we compare the acoustic quality between the 3D printing Ukulele and the wooden Ukulele. Consequently, the A-weight sound level of PLA 3D printing Ukulele is less than that of traditional wooden with the same size, indicating that a wooden resonant box is better at sound radiation than PLA 3D printing Ukulele does. What's more, in the frequency domain, the fundamental frequency is higher than that of PLA 3D printing Ukulele. In addition, in order to explain the difference between PLA 3D printing Ukulele and wooden Ukulele, we simulate the vibrating state of two kinds of Ukulele with COMSOL. As a result, radiation acoustic impedance calculated by COMSOL could illustrate the difference. Hence, it's significant for musical instruments concerning the influence of material science.

HA02: 2:40-2:50 p.m. Active Learning Techniques Improve Everyone's Conceptual Understanding, But Especially Women

Contributed – Adria C. Updike, Roger Williams University 53 Foxhill Ave Bristol, RI 02809

The effects of active learning techniques were studied using the FCI and student grades over the course of several semesters at Roger Williams University, a relatively small (<5,000 undergraduates) liberal-arts university. Introductory physics classes (both algebra- and calculus-based) were taught, some in a lecture classroom, and some in an active learning classroom with combined lecture/labs, with the same material and sometimes the same professors. When FCI scores and grades were assessed, we found that, on average, students in the active learning classrooms consistently had higher FCI gains and grades than their peers in lecture classrooms. When broken down by gender, we found that male students had a mild gain in conceptual understanding and grades as a result of the active learning classroom, but female students had a very large gain in conceptual understanding and grades as a result of the active learning environment.

HA03: 2:50-3 p.m. Development of Programming-Based Physics Teaching Materials in Teacher Education

Contributed – Jun Haeng Lee, Seoul National University Building 13, Room 415, 1 Gwanak-ro Gwanak-gu, Seoul 08826

Youngrae Ji, Korea Institute for Curriculum and Evaluation

Seung Chul Chae, Seoul National University

We investigated the educational effects of developing physics teaching materials based on Python and Jupyter Notebook in pre-service teacher education. We collected 19 programming-based physics teaching materials developed by pre-service teachers who attend computational physics class in the department of physics education, Seoul National University, South Korea, as well as interviewed six pre-service teachers individually. The teaching materials were quantitatively evaluated by professionals (physics education researchers or physics teachers), and the transcriptions were analyzed qualitatively. We report that developing process of physics teaching material based on Python and Jupyter Notebook improve the teaching expertise of pre-service teachers and reduce difficulties in physics learning.

HA04: 3-3:10 p.m. Improving Student Success in First Physics Course

Contributed – Tuwaner Lamar, Ph.D. Morehouse College 830 Westview Drive SW Atlanta, GA 30314*

Can success in the first physics course taken be predicted by placement into first Math course taken, at or above Calculus I? Foundational concepts and analytical skills for success in physics courses are covered in Calculus I. So, could it be that students who are successful in their Calculus I course have a greater chance of succeeding in their first Physics course? In this research, we take an in depth look at the relationship between initial Math placement at Calculus I or higher and success in the first Physics course at both Morehouse College and the US Air Force Academy (USAFA). Then we implement interventions at USAFA, in both Calculus I and introductory Physics, to improve chances of student success.

*Sponsored by Lt. Col. Jessica Dwyer, Ph.D.

HA05: 3:10-3:20 p.m. Logistics of Presenting the November 11, 2019 Transit of Mercury to 6th Graders

Contributed – Frank D. Lock, Georgia State University PhysTEC c/o 4424 Sardis Rd. Gainesville, GA 30506

On November 11, 2019 the presenter arranged for approximately four hundred 6th grade students at a Gainesville, Georgia, middle school to observe the transit of Mercury. As pre-transit preparation the presenter made solar system science presentations to groups of sixth graders. This contributed talk will present the logistics involved in arranging for the Mercury transit outreach, as well portions of the pre-transit presentations.

HA06: 3:20-3:40 p.m. Reducing Disciplinary Barriers to Learning

Contributed – Aseem Talukdar, Madisonville Community College 2000 College Drive Madisonville, KY 42431

Mike Shifflett, John Lowbridge, Madisonville Community College

Kentucky Community and Technical College System (KCTCS) general education competencies emphasize that students should be able to make connections among different disciplines of science. In addition, students are also expected to demonstrate an awareness of the individual's relationship to the biological and physical environment. We will report on our attempt to address these goals by connecting astronomy, chemistry, and physics, through a few common fundamental concepts, introducing the implications and applications of the knowledge in all three realms in each of the classes.

HA07: 3:40-3:50 p.m. Using Model Analysis to Investigate Students' Understanding of Waves

Contributed – Nan Zhang, Department of Physics, Fudan University Room C405, Physics Building,No.2005, Songhu Road, Yangpu District, Shanghai Shanghai, Yangpu District 200438 China

Shihong Ma, Department of Physics, Fudan University

We use model analysis to investigate students' understanding of mechanical waves by administering the modified Mechanical Waves Conceptual Survey, divided into five clusters, to 205 students in a Chinese university from first year and second year. From the result we found that in Cluster 1,2,4, most students hold a consistent "correct" model. In Cluster 3(reflection) and Cluster 5(standing waves in tube), the first-year students have a mixed model state, after one-year instruction, the students model state shifts to the model 1 region which means students mostly hold a correct model. But it does not mean the second-year student models are the same as the expert one. The concentration factors of questions in cluster 3 and 5, which tells about how the student responses are distributed, are mostly in a medium level, as well as the scores. It means more than 30% students tend to favor an incorrect model.

HA08: 3:50-4 p.m. Labs based on AP Physics 1 and 2 Questions

Contributed – Marsha M. Hobbs, Jackson Preparatory School 3100 Lakeland Dr Flowood, MS 39232-8834

Dee Dee Messer, WM. MASON HIGH SCHOOL

Although the AP Physics 1 and 2 exams do not have a required collection of laboratories, students are expected to have a strong understanding of physics labs and data analysis. In this talk we will give specific examples of labs that can be incorporated into the courses that reflect past AP questions or closely fit the curriculum framework. Laboratory topics will include gravitational accelerations, forces circuits, waves and optics.

PST3 Poster Session 3

Sponsor: AAPT Time: 2:30–4 p.m.
Date: Tuesday, Jan. 21 Location: Grand Sierra Foyer

Those with odd-numbered posters will present from 2:30–3:15 p.m. Those with even-numbered posters present from 3:15–4 p.m.

PST3A01: 2:30-3:15 p.m. Exploring Nuclear Reactions through Hands-on Fusion and Fission Modeling

Poster – David A. Osmond, University of North Georgia 3820 Mundy Mill Road Oakwood, GA 30566

Donna Governor, University of North Georgia

Hands on demonstrations involving nuclear reactions are uncommon in high school and early undergraduate physics courses. However, learning some common components of these reactions is relatively simple when students are provided a hands-on approach. In this poster I will present two relatively simple demonstrations that allow students to discover the relationships of nucleus size and progressing to fission or fusion events. Components of star size and mass are also demonstrated to allow students to think about the rate of stellar fusion. This lab activity is inexpensive and safe enough to be done in an elementary classroom, but the ideas are complex enough to be applicable in an undergraduate setting.

PST3A02: 3:15-4 p.m. Personalized, Adaptive, and Interactive Approach in Teaching Introductory Physics Courses

Poster – Priya Jamkhedkar, Portland State University 21380 Horton CT West Linn, OR 97068

Misty Hamideh, Toai Nguyen, Chuck Faber, Ralf Widenhorn, Portland State University

We summarize the development of personalized, adaptive and interactive courses for algebra-based General Physics and calculus-based courses taught at Portland State University. Teaching introductory physics courses to large classes with students having diverse skills in math, problem-solving, conceptual reasoning, and learning styles is challenging. The need to provide support in terms of math remediation, improvement in problem-solving, understanding of concepts to students who work at different

paces led us to look for a platform providing these features. The poster summarizes the design of such a course using "CogBooks" as an adaptive platform with many support features including concept-checks, simulations, problems with intermediate steps, and drawing tools. In-class activities promote active and engaged learning to achieve a positive impact on the students' educational experience. We conclude the poster with early results and insights for the future improvements to these courses. Prof. Ralf Widenhorn is the sponsoring member. Three more authors need to be added: 1. Amy Lorber - Portland State University 2. Joseph Scotto - Portland State University 3. Theodore Stenmark - Portland State University

PST3A03: 2:30-3:15 p.m. How PLTL & Demographics Affect the Development of an Expert-Like Schema in Introductory Physics

Poster – Siera Stoen, Washington University St Louis 1968 Wissant Ln Saint Loius, MO 63146

Robust evidence shows that Peer-led Team Learning (PLTL) improves the academic success of college students in introductory Science, Technology, Engineering, and Mathematics (STEM) courses. However, it is unclear what is actually causing the benefit of increased academic success. The present study explores whether or not one of the benefits of PLTL is in the development of an expert-like schema for undergraduates enrolled in Introductory Physics at a selective private university. After using a similarity rating task to measure a student's schema, I used analyses of variance to test whether PLTL participants outperformed non-participants, thus demonstrating a more expert-like schema. Furthermore, I looked at whether the PLTL effects varied across race, gender, and preparedness of students.

PST3A04: 3:15-4 p.m. The Need of a Physical Perspective in this Rocky World: Transitioning to Environmental Science

Poster – Katrina Henry, Virginia Wesleyan University 5817 Wesleyan Drive Virginia Beach, VA 23322-3138

Zachary Hubbard, Virginia Wesleyan University

The authors who are at different stages in their career (one pre-tenure professor and one undergraduate student) transitioned from a path in physics to environmental science at different points in their education. They share the perspective of being environmental scientists with a background in the fundamental science of physics. As environmental science advances and the problems faced become more complex, there arises a need for the next generation of environmental scientists to have the strong quantitative, problem solving, and reasoning skills that come from a cross disciplinary scientific education. Students, and even practicing scientists, in other STEM fields may not consider themselves qualified to transition to environmental science. We have found the transition from physicist to environmental scientist to be remarkably frictionless because environmental science takes the fundamental laws of the universe and applies them in a way that explain the interactions of the various systems comprising our planet.

PST3A05: 2:30-3:15 p.m. The Optimal Group Size for Small Introductory Physics Classrooms

Poster – JaQuan M Bullock, Queens University of Charlotte 1900 Selwyn Ave Charlotte, NC 28207

Marco Scipioni, Soroush D. Khosravi, Queens University of Charlotte

Learning can be hard in an introductory physics classroom. Students often lack the experience to master concepts and to use them for solving physics problems. Conceptual understanding is a critical skill, but educators' ultimate goal should be creating a learning environment that enhances students' problem-solving ability. Research shows that group cooperative learning is an effective way to reach this goal. The main objective of this research was to identify the optimal group size in small introductory physics classrooms for the life sciences. Students were divided into groups of two and three and were given Force Concept Inventory (FCI) as well as context-rich problem-solving tests, which were taken individually. The test results indicate that, while groups of two improved their conceptual understanding, groups of three had a more significant improvement in their problem-solving skills.

PST3A06: 3:15-4 p.m. Visit to Coelba's Electricity Museum: Learning in an Informal Academic Environment

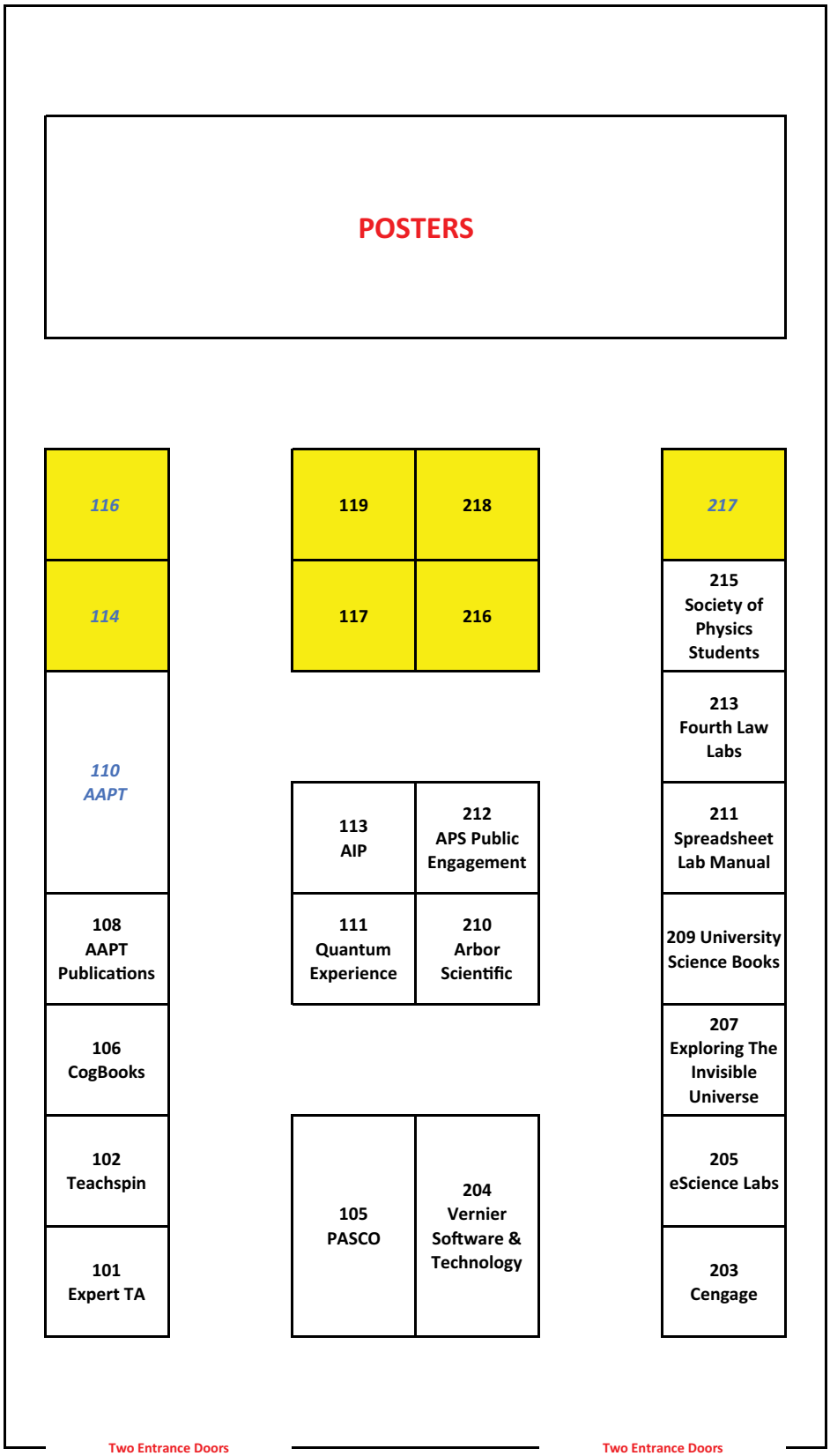
Poster – Dielson Pereira Hohenfeld, IFBA Rua Dra. Lígia Dantas S Lauro Freitas, Brazil/Bahia 42706-180 Brazil

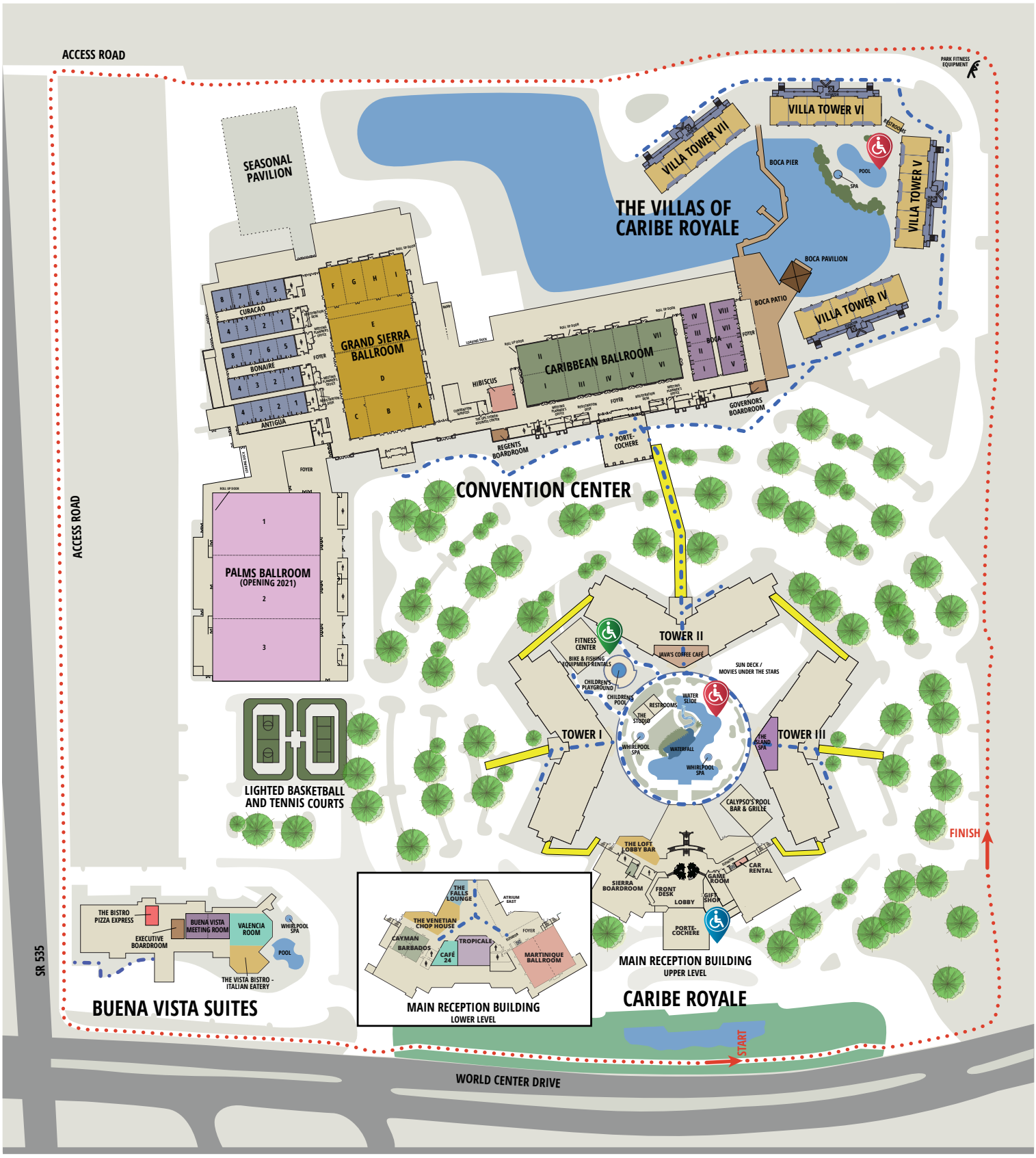
FELIPE Cordeiro César Rodrigues, IFBA

Non-formal academic environments are an alternative to bring students closer to the teachings of the exact sciences. Believing in the potential of these environments, a visit to Coelba's Museum of Electricity with students of the State School Mário Augusto Teixeira de Freitas was undertaken. With the objective of having the students interact with the experiments and discuss and visualize phenomena of physics outside of the classroom, an investigative script was prepared to take full advantage of the visit. Returning to the classroom, a quantitative questionnaire was given to the students in order to verify whether classes in informal environments have potential for learning physics.

AAPT 2020 WINTER MEETING
January 18-21 Orlando, FL
PHYSICS EDUCATION®

Exhibit Hall
Grand Sierra Ballroom D





CARIBE ROYALE
ORLANDO

COVERED WALKWAYS

RUNNING/WALKING TRAIL (1.5 miles)

INDICATED ACCESSIBLE ROUTES

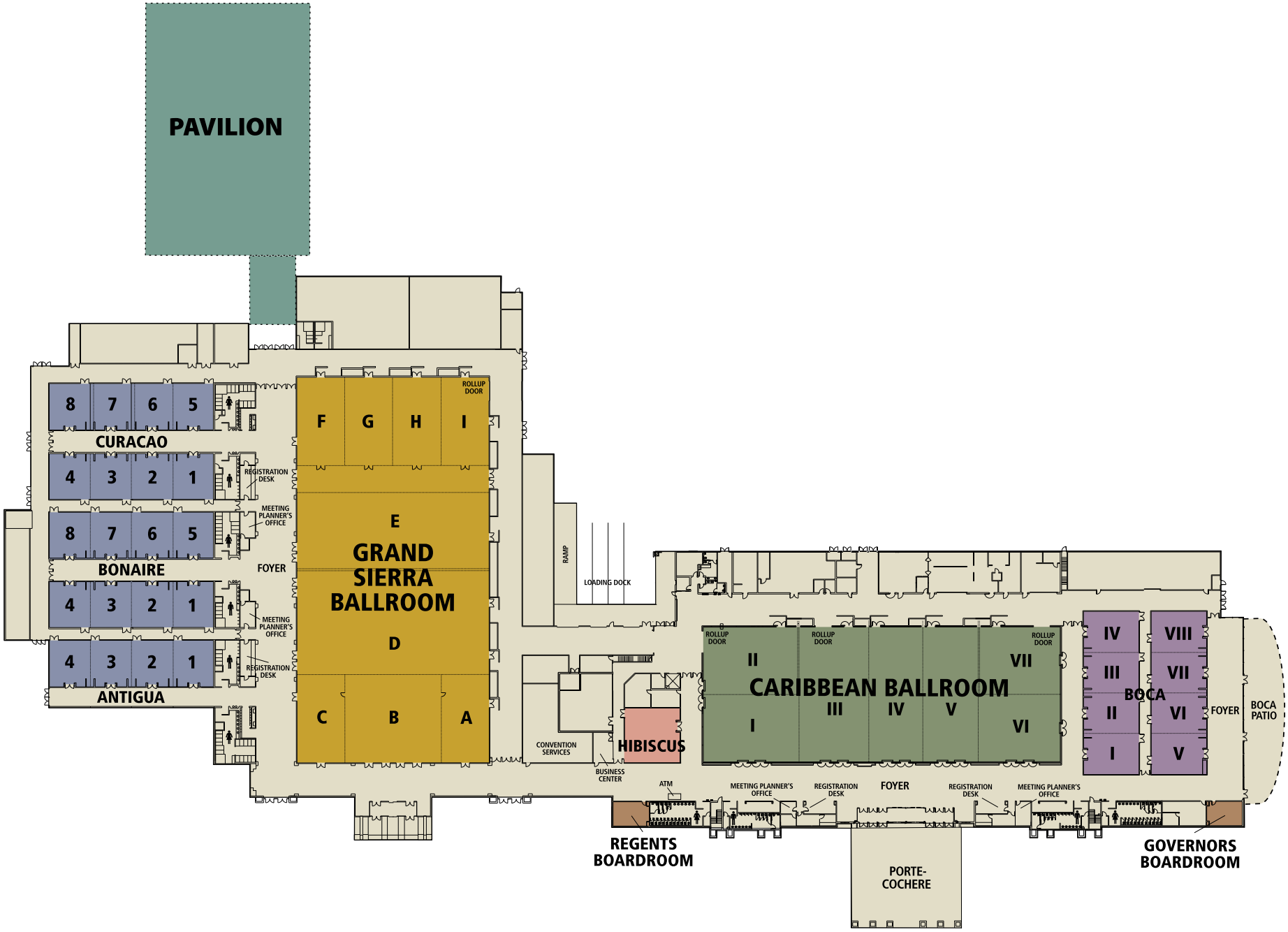
COMPLIMENTARY VALET PARKING (available at the reception building for any guests with disabilities)

POOL LIFT (available upon request)

ACCESSIBLE LIFT IN FITNESS CENTER

TDD (available upon request)

BRAILLE MENUS AND OTHER ADA DEVICES (available upon request)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CARIBE ROYALE
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Hotel Description

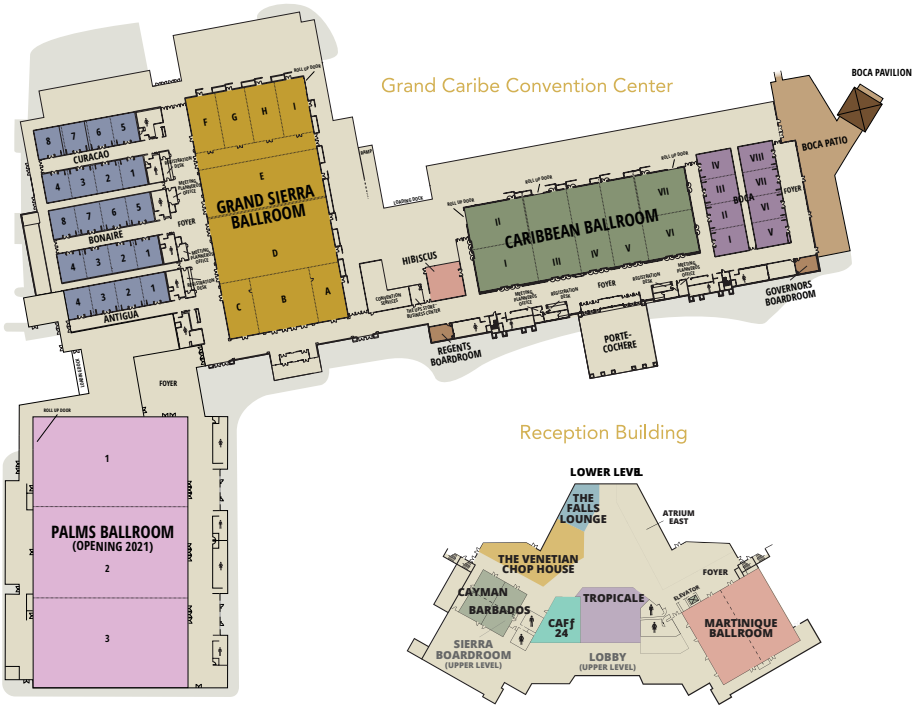
Located in the Lake Buena Vista area, just minutes from all of Orlando's attractions and conveniently located to Orlando International airport, the Caribe Royale is a full service hotel and convention center that offers 1,215 one-bedroom suites and 120 two-bedroom, two-bath villas with full kitchens plus, 150,000 (220,000 in 2021) sq. ft. of flexible, state-of-the-art meeting facilities all on one level.

Property Highlights

- 1215 one-bedroom Suites
- 120 fully renovated 2 - bedroom 2 - bathroom villas
- 4 restaurants, including the 4 Diamond Venetian Chop House
- 24 hour room service
- 3 lounges and bars
- Coffee Bar
- 2 level 3,500 sq. ft. gym
- Jogging trail/bicycle rentals
- Yoga studio/ spin classes/Basketball and tennis courts
- The Island Spa

Grand Caribe Convention Center

- 50,000 sq. ft. Palms Ballroom – Coming in 2021
- 40,000 sq. ft. Grand Sierra Ballroom
- 26,000 sq. ft. Caribbean Ballroom
- 6,400 sq. ft. Martinique Ballroom
- 36 Individual breakout rooms
- 26,000 sq. ft. seasonal pavilion
- 120 Villas that can accommodate a breakout for 14 people



Rollins College Map

Meeting Participants Index