2017 AAPT Winter Meeting

Atlanta, GA
February 18-21

AAPT
PHYSICS EDUCATION

What's New with Expert TA?

Stop by our booth to learn more.
Marquis Ballroom Booth 106

Free-Body Diagrams

We have invested significant resources in developing our Free-Body Diagram package that finally gets vector drawing in a homework system how it should be.

AP Physics

We offer an abundance of multi-step questions which give students practice solving problems symbolically. Students get access to hints and receive detailed, and specific feedback when they make errors.

Expert TA Blog

We are excited to introduce the Expert TA blog, and would like you to be an integral part of our journey. We would love to hear what you have to say about educational topics that are important to us all.

www.theexpertta.com (918) 949-4190 main@theexpertta.com

Atlanta, GA
February 18–21, 2017

Atlanta Marriott Marquis

AAPT American Association of Physics Teachers

American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740
301-209-3311
www.aapt.org

Welcome from 2017 AAPT Winter Meeting Program Chair

Welcome to Atlanta! The Atlanta Marriott Marquis, which is located in Peachtree Center, is near many of the popular places to visit in Atlanta. Most of the workshops will be held at the Georgia Institute of Technology. The sessions, tutorials and workshops cover all interests and levels from the novice to the experienced teacher. The biology and physics workshop will be held at Spelman College. Transportation will be provided to all workshops.

The plenary talks include astronomy, space programs, particle physics and the physics of music. Transportation will also be available to the two weekend plenary talks at Georgia Tech. and the Solar Astronomy events Saturday afternoon. Be sure to check out the special events at the Fernbank Science Center (about 8.5 km from the Marriott) over the weekend.

It will be an exciting and invigorating four days! Have fun and enjoy that famous Southern Hospitality!

Gordon Ramsey, Program Chair

Thank You to AAPT Sustaining Members

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

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Special Thanks

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

Michael Schatz, School of Physics, Georgia Institute of Technology, for organizing the workshops

Lila M. Adair, Piedmont College

Don Franklin, Hampton, GA

Paper sorters:

Anne Huntress, South Lewis Central School
Lila Adair, Piedmont College
Andrew Boudreaux, Western Washington University
Amy Robertson, Seattle Pacific University
Brianna Santangelo, The College of New Jersey
Ben Jenkins, University of West Georgia

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Robert C. Hilborn (guest)
AAPT Associate Executive Officer

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 **#aaptwm17**. 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 Sacramento. We look forward to connecting with you!

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

Contacts:

Meeting Registration Desk: 301-209-3340
AAPT Programs & Conferences Dept: 301-209-3340; programs@aapt.org
Tiffany Hayes, Director, Programs & Conferences
Cerena Cantrell, Associate Director, Programs & Conferences
Janet Lane, Programs Administrator

The wireless information is:
Network: **Marriott_Conference**
Password: **AAPT2017**

American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845
301-209-3340, fax: 301-209-0845
programs@aapt.org, www.aapt.org

First time at an AAPT meeting?

Welcome to the 2017 AAPT Winter Meeting in Atlanta! Everyone at AAPT hopes you fulfill all the goals you have for attending this meeting. To help you plan your meeting activities, the following information and suggestions have been developed.

- Being at your first National Meeting can be a lonely experience if you don't know anyone. AAPT members are friendly people, so do not hesitate to introduce yourself to others in sessions and in the hallways. It is fun and rewarding to establish a network of other physics teachers with whom you can talk and share experiences. This is especially true during lunch and dinner.
- Area Committee meetings are not only for members of the committee, but also for friends of the committee. You are welcome to attend any Area Committee meeting. You should be able to find one or two committees that match your interests. Their meeting times are listed in the meeting at a glance. Area Committee meetings are often relatively small and are a great place to meet other people with interests similar to yours.
- Be sure to attend the First Timers' Gathering from **7–8 a.m. Sunday in Marquis - M301**. (Registration is required.) It is a wonderful way to learn more about the meeting and about AAPT.
- Awards and other plenary sessions have distinguished speakers and are especially recommended. Invited speakers are experts in their fields and will have half an hour or more to discuss their subjects in some depth. Posters will be up all day and presenters will be available during the times indicated in the schedule. Contributed papers summarize work the presenters have been doing. You are encouraged to talk to presenters at the poster sessions or after the contributed paper sessions to gain more information about topics of interest to you. Informal discussion among those interested in the announced topic typically will follow a panel presentation, and Topical Discussions are entirely devoted to such discussions.
- Be sure to make time to visit the exhibits in the Exhibit Hall. This is a great place to learn what textbooks and equipment are available in physics education.

Download Your Mobile App Now!

Download Steps:

1. **Download the app by going to https://crowd.cc/s/x8p6, or search the "Apple" or "Google Play" stores for AAPT, American Association of Physics Teachers, WM17, 2017 AAPT Winter Meeting.**
2. **Open the app and tap on 2017 AAPT Winter Meeting (WM17).**
3. **For online access, go to https://crowd.cc/wm17**

CrowdCompass by Cvent

Bus Schedule for AAPT Workshops

T02, T03, T04 will be held at the Marriott Marquis.

Saturday, February 18

Buses departing Marriott Marquis to Georgia Tech

- 7:15 a.m.
- 7:25 a.m.
- 12:20 p.m.
- 12:45 p.m.
- 4:30 p.m.
- 4:45 p.m.

Buses will run every 25 minutes between 1 p.m. and 4 p.m. from the Marriott Marquis to Georgia Tech for those interested in attending the Solar Astronomy Events and plenaries at Georgia Tech.

Buses departing Georgia Tech, returning to Marriott Marquis

- 12:15 p.m.
- 1:00 p.m.
- 5:15 p.m.
- 5:30 p.m.
- 6:45 p.m.
- 7:00 p.m.

Sunday, February 19

Buses departing Marriott Marquis to Georgia Tech

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

Buses departing Georgia Tech, returning to Marriott Marquis

- 12:15 p.m.
- 12:30 p.m.

A van will take participants to Workshop W15 at Spelman College on Saturday:

- Pick-up at Marriott: 9:00 a.m.
- Departure from Spelman (Science Center): 4:30 p.m.

Buses will depart the Marriott on the International Level at the Cortland Street exit.

Buses will pick up at Georgia Tech near the CULC building.

Atlanta Marriott Marquis
265 Peachtree Center Avenue
Atlanta, GA 30303

Georgia Institute of Technology
Clough Undergraduate Learning Commons
266 4th St. NW
Atlanta, GA 30313

Spelman College
350 Spelman Way S.W.
Atlanta, GA 30314

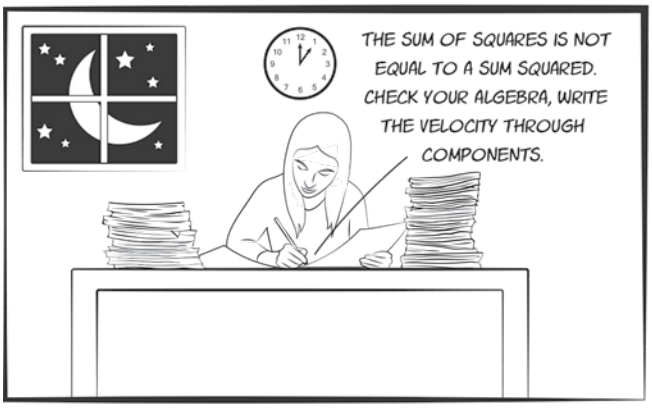
Early Career Professionals Speed Networking Event

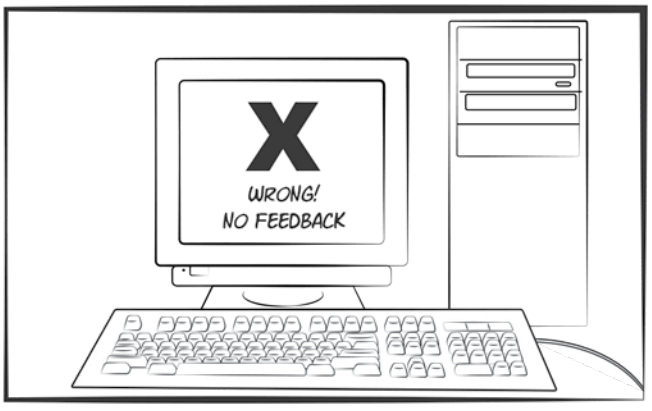
Career development and networking can be time consuming, so AAPT is spearheading a fun and exciting way to get connected to a large number of early career and seasoned physics professionals in a short amount of time. Speed-networking provides the opportunity to discuss career goals and challenges with a new contact for five minutes, exchange information, and then move on to the next person. By the end of the event each participant will have meaningful interactions with over half a dozen colleagues and the opportunity to meet many more. If you think you made a good contact, follow up with the person and schedule a time to meet for coffee. It's that simple! By the end of the first day of the conference you would have already made several personal connections with other attendees. If you have business cards, don't forget to bring them.

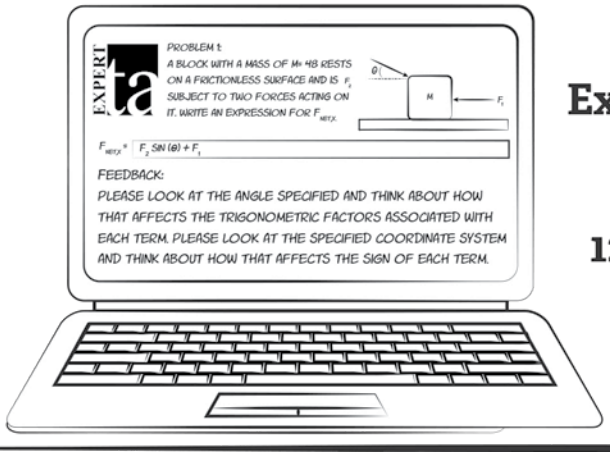
Sunday, February 19, 12:30–2 p.m.
L401-L403

EXPERT ta

Education...Evolved.





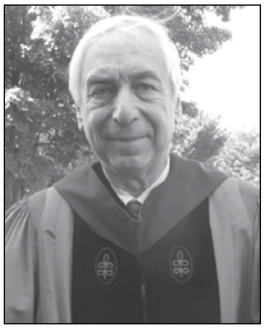


Expert TA Commercial Workshop

Sunday, February 19th

12:30-1:30 p.m. Lunch provided.

Room M101



Jay M. Pasachoff
Williams College
Williamstown, MA

Observing the Great American Eclipse of August 21, 2017

Sunday, February 19

7:30–8:30 p.m.

Marquis Ballroom B

2017 Richtmyer Memorial Lecture Award

Jay Pasachoff is Field Memorial Professor of Astronomy and Director of the Hopkins Observatory at Williams College, Williamstown, MA. A veteran of 64 solar eclipses, he is Chair of the International Astronomical Union's Working Group on Solar Eclipses and a member of the American Astronomical Society's Solar Eclipse Task Force. His recent research includes studies of the dynamics of the solar corona studied from the ground at eclipses and from spacecraft, and the temperature and structure of the corona over the solar-activity cycle from images and spectra. He also studies the atmosphere of Pluto through observation of stellar occultations. His recent eclipse and other solar research is and has been supported by the NSF and the Committee for Research and Exploration of the National Geographic Society; his Pluto research has recently been supported by NASA.

Pasachoff received the 2003 Education Prize of the American Astronomical Society and the 2012 Janssen Prize of the Société Astronomique de France.

After the Bronx High School of Science, he studied at Harvard, receiving his bachelor's degree in 1963, his master's degree in 1965, and his doctorate in 1969. He worked at the Harvard College Observatory and Caltech before going to Williams College in 1972.

Pasachoff is a Fellow of the American Physical Society, the International Planetarium Society, the American Association for the Advancement of Science, Committee for Skeptical Inquiry, and the Royal Astronomical Society, and he has held a Getty Fellowship. He is a member of the American Astronomical Society and is past chair of its Historical Astronomy Division. He has lectured widely, including a stint as a Sigma Xi Distinguished Lecturer. He is also Director of the Hopkins Observatory and past (in rotation, most recently 2014–2015) Chair of the Astronomy Department at Williams.

In addition, he has been active in educational and curriculum matters. He is U.S. National Liaison to, and was President (2003–2006), of the Commission on Education and Development of the International Astronomical Union, has twice been Chair of the Astronomy Division of the American Association for the Advancement of Science, and has been on the astronomy committees of the American Astronomical Society (and its representative 2004–2017 to the AAAS), the American Physical Society, and the American Association of Physics Teachers.

Named for Floyd K. Richtmyer, distinguished physicist, teacher, and administrator and one of the founders of AAPT, the Richtmyer Memorial Lecture Award recognizes those who have made outstanding contributions to physics and their communication to physics educators. The award was established in 1941.

Jan Tobochnik
Dow Distinguished Professor in the Natural Sciences
Kalamazoo College
Kalamazoo, MI

The Changing Face of Physics and the Students Who Take Physics

Tuesday, February 21

10:30 a.m.–12:00 p.m.

Marquis Ballroom B

2017 Oersted Medal

Jan Tobochnik graduated summa cum laude from Amherst College in 1975 with a major in physics. He then went to Cornell University where in 1980 he obtained a PhD in physics. Tobochnik joined the faculty at Kalamazoo College in 1985 where he currently holds the position of Dow Distinguished Professor in the Natural Sciences.

Within the physics community, Tobochnik is well known for his series of texts written with Harvey Gould that cover computer simulation methods at the introductory level and statistical and thermal physics at the intermediate level. In the early 1990s he was a practitioner of active learning methods, long before it became fashionable, and was busy developing software to assist student learning. Tobochnik's fluency in computational methods especially in the service of advanced thermal and statistical physics research has informed dozens of publications in refereed journals, columns in *Computers in Physics*, and a second textbook with Harvey Gould, *Statistical and Thermal Physics With Computer Applications*, the first book being *An Introduction to Computer Simulation Methods: Applications to Physical Systems* with co-authors Harvey Gould and Wolfgang Christian which is now in its third edition. He has also provided important professional services including co-editing the first ever theme issue of the *American Journal of Physics* (*AJP*), co-creating the Gordon Conference on Physics Research and Education series and co-chairing its first conference, co-editing the Computer Simulations section of *Computers in Physics*, and above all else, he had a successful 10-year stint (2001-2011) as the Editor of the *American Journal of Physics*. Tobochnik has served on several AAPT committees, more recently, he has been a member of the AJP Resource Letter Advisory Board. He was also a Divisional Associate Editor of *Physical Review Letters* (2001-2006). Tobochnik has received numerous awards, including the AAPT Homer L. Dodge Distinguished Service Citation, Fellow of AAPT, and Fellow of the American Physical Society.

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.

Welcome First-Timers

AND EARLY CAREER PROFESSIONALS

WE HAVE A DAY OF ACTIVITIES PLANNED FOR YOU ON **SUNDAY, FEBRUARY 19:**

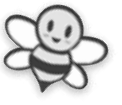
First, meet newbies and check out what resources AAPT has to support you during the **First-Timers' Gathering** from 7:00 – 8:00 AM. Registration required.

Then, our early career professionals can meet with experienced faculty and teachers at the **Early Career Speed Networking Even**t from 12:30 – 2:00 PM.

Finally, join us for the **Early Career and First Timers' Social** from 6:00 – 7:30 PM at the White Oak Kitchen & Cocktails. Take this opportunity to get social with other attendees and have some fun!

Download our meetings app for more about these events and for event locations.

NOT SURE WHO'S NEW? IDENTIFY OTHER "NEWBEES" WITH BEES ON THEIR BADGES. PICK UP YOUR BEE STICKER AT AAPT BOOTH 212.



Homer L. Dodge Citations for Distinguished Service to AAPT

Tuesday, February 21 • 10:30 a.m.–12 p.m. • Marquis Ballroom B

Ernest R. Behringer

Ernest R. Behringer

Ernest R. Behringer earned his BS in physics at the University of California at Santa Barbara, and his MS and PhD in physics at Cornell University. He is currently at Eastern Michigan University. Behringer has served as president of the Michigan Section of the AAPT, as the chair of the AAPT Area Committee on Physics in Undergraduate Education, on the AAPT Governance Committee, and as a reviewer and an Advisory Board member for the *American Journal of Physics*. He has also served as a board member of the AAPT-affiliated Advanced Laboratory Physics Association (ALPhA), as well as on the organizing committees of the 2012 and 2015 topical ("BFY") conferences. He currently serves as the chair of the AAPT Undergraduate Curriculum Task Force.

Richard Gelderman

Richard Gelderman

Richard Gelderman earned his BS in physics at Virginia Polytechnic Institute & State University, and MA and PhD in Astronomy at University of Virginia. Gelderman currently holds the position of Professor of Physics and Astronomy at Western Kentucky University where he is also the director of the Hardin Planetarium. Gelderman has been instrumental in increasing the vitality, scope, and effectiveness of the Space Science and Astronomy Committee. Gelderman has also contributed to many other committees and activities in his many years of service to AAPT. In particular, he has served on the Membership and Benefits Committee, the Nominating Committee, and is currently the chair for the Science Education for the Public Committee as well as a member of both the Programs and Meetings Committee.

Sharon Kirby

Sharon Kirby

Sharon Kirby earned her BA in chemistry at Western Carolina University, a Master's in secondary science education at the University of West Georgia, and a Specialist Degree in Curriculum and Instruction at Piedmont College. Kirby most recently was an instructor in the Department of Physics at the University of West Georgia. Kirby has a distinguished record of teaching and learning at the high school level and more recently at the university level with courses for education majors. A Physics Teacher Resource Agent (PTRA) since 2000, she has assisted in leading many PTRA workshops for teachers in the University of Georgia system. She has presented workshops and papers about the PTRA professional development at many state, regional, and national meetings, including national AAPT meetings.

Kenneth S. Krane

Kenneth S. Krane

Kenneth S. Krane earned his BS in physics at the University of Arizona, and his MS and PhD in physics at Purdue University. Krane is currently Emeritus Professor of Physics at Oregon State University. Krane has served AAPT for many years and in many ways. He has been a member of the *American Journal of Physics* (AJP) Editorial Board as well as an AJP Associate Editor, a member of the Committee on Physics in Graduate Education (1994-1997), a member of the Nominating Committee (2006), and a Principal Investigator, Director, and founder of the AAPT New Faculty Workshop from 1995-2006. He is also the 2004 recipient of the Robert A. Millikan Medal, a 2014 AAPT Fellow, and a co-leader of the Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP) project, providing guidelines and recommendations to physics departments that led to more than doubling of the number of bachelor's degrees awarded in physics over the past 15 years.

Ann M. Robinson

Ann M. Robinson

Ann M. Robinson earned her BS in biology at Appalachian State University, a MA in science education at Atlanta University, and completed the Education Specialist program at University of West Georgia. She is currently a part-time instructor in the Physics Department at the University of West Georgia. Robinson has a distinguished record of teaching and learning at the high school level and more recently at the university level with courses for education majors. A Physics Teacher Resource Agent (PTRA) since 1999, she has been an instructor for many PTRA summer workshops for science teachers in several different states, but especially, at the University of West Georgia. She has helped to write proposals to fund PTRA professional development and has presented papers about PTRA professional development at many state, regional, and national meetings, including national AAPT meetings. Robinson has served the association as a member of the Southern Atlantic Coast Section and as the Vice Chair of the Committee on Physics in Pre-High School Education.

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

#AAPTWM17

JOIN US FOR A TWEET-UP
SATURDAY, FEBRUARY 18TH
FROM 6:00-7:00 PM IN M103

Gather with attendees and discuss how social media impacts your classroom, what you're going to be tweeting at the meeting, and more! Treats will be provided.

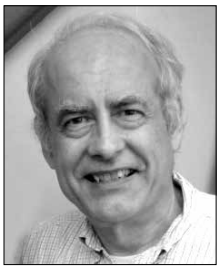
Stephen Ramsden
Atlanta, GA

Solar Astronomy

by Stephen Ramsden

Saturday, February 18 • 5:00–5:30 p.m. • Georgia Institute of Technology, Ferst Center for the Arts

Stephen Ramsden is a Navy Veteran and retired Air Traffic Controller in Atlanta, GA. He uses the latest in narrowband solar telescopes to bring solar activity in the Sun's photosphere and chromosphere to the eyes of students so that it may spark or reinforce an interest in the sciences. He personally administers the program to over 60,000 students and adults at over 70 events annually. His affiliates in 23 countries around the world use equipment and glasses donated through his program to perform solar astronomy outreach to over 350,000 students per year in their local communities.



Michael Ruiz
University of North Carolina at Asheville

Physics of Music

by Michael Ruiz

Saturday, February 18 • 5:30–6:30 p.m. • Georgia Institute of Technology, Ferst Center for the Arts

Michael J. Ruiz is Professor of Physics at the University of North Carolina at Asheville with a doctorate in theoretical physics from the University of Maryland. He has spent many years designing demonstrations and interactive online software for the general student in sound and light. His innovative approaches have been featured on CNN and published in *The Physics Teacher* and *Physics Education*. Ruiz is also a pianist and composer who has written three piano concertos performed by the Winston-Salem Symphony. His approaches to learning bridge the gap between the sciences and the arts. Prof. Ruiz is the first faculty member at his university to receive all three of his institution's major teaching awards.

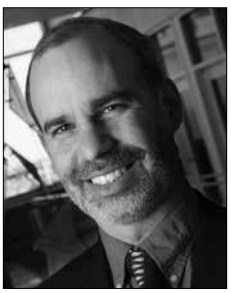
Moogega Stricker
Jet Propulsion Lab.
Cal Tech

Mars 2020 Mission Overview and the Importance of Planetary Protection

by Moogega Stricker

Monday, February 20 • 9:30–10:30 a.m. • Marquis Ballroom B

Moogega Stricker received her BS in physics from Hampton University in 2006. She successively enrolled in Drexel University where she received her Master's and PhD in Mechanical Engineering with a concentration in thermal fluid sciences in 2009. She has worked at the Jet Propulsion Laboratory's Planetary Protection Group for seven years. She has been involved in the Mars Science Laboratory Mission, and is currently supporting the InSight Mission as a Planetary Protection Engineer and the Mars 2020 project as the Planetary Protection co-lead. Her current projects also include developing plasma sterilization methodologies and additional sterilization capabilities for future mission use.



Ken Bloom
University of Nebraska Lincoln

Discovering the Quantum Universe at the Large Hadron Collider

by Ken Bloom

Monday, February 20 • 2:00–3:00 p.m. • Marquis Ballroom B

Ken Bloom is a Professor of Physics and Astronomy at the University of Nebraska-Lincoln (UNL) and a Visiting Scientist in the Scientific Computing Division at the Fermi National Accelerator Laboratory (Fermilab). He grew up in South Orange, NJ, where he met his first physics teacher in fourth grade and then was the captain of the Columbia High School Physics Team. He holds an AB in physics from The University of Chicago (1992), and an MS (1995) and PhD (1997) in physics from Cornell University. After postdoctoral appointments at The Johns Hopkins University and the University of Michigan, he joined the UNL in 2004, where he was promoted to Associate Professor in 2009 and then to Professor in 2016. At UNL, he is the chief advisor for undergraduate physics majors. He is a previous recipient of an NSF Early Career Development Award, and is a Fellow of the American Physical Society. Bloom's research expertise is in experimental particle physics and its computational challenges. He has worked previously on the CDF experiment at Fermilab in 1989-92 and 1997-2004, the CLEO experiment at Cornell in 1992-97, and the D0 experiment at Fermilab from 2004 until now.

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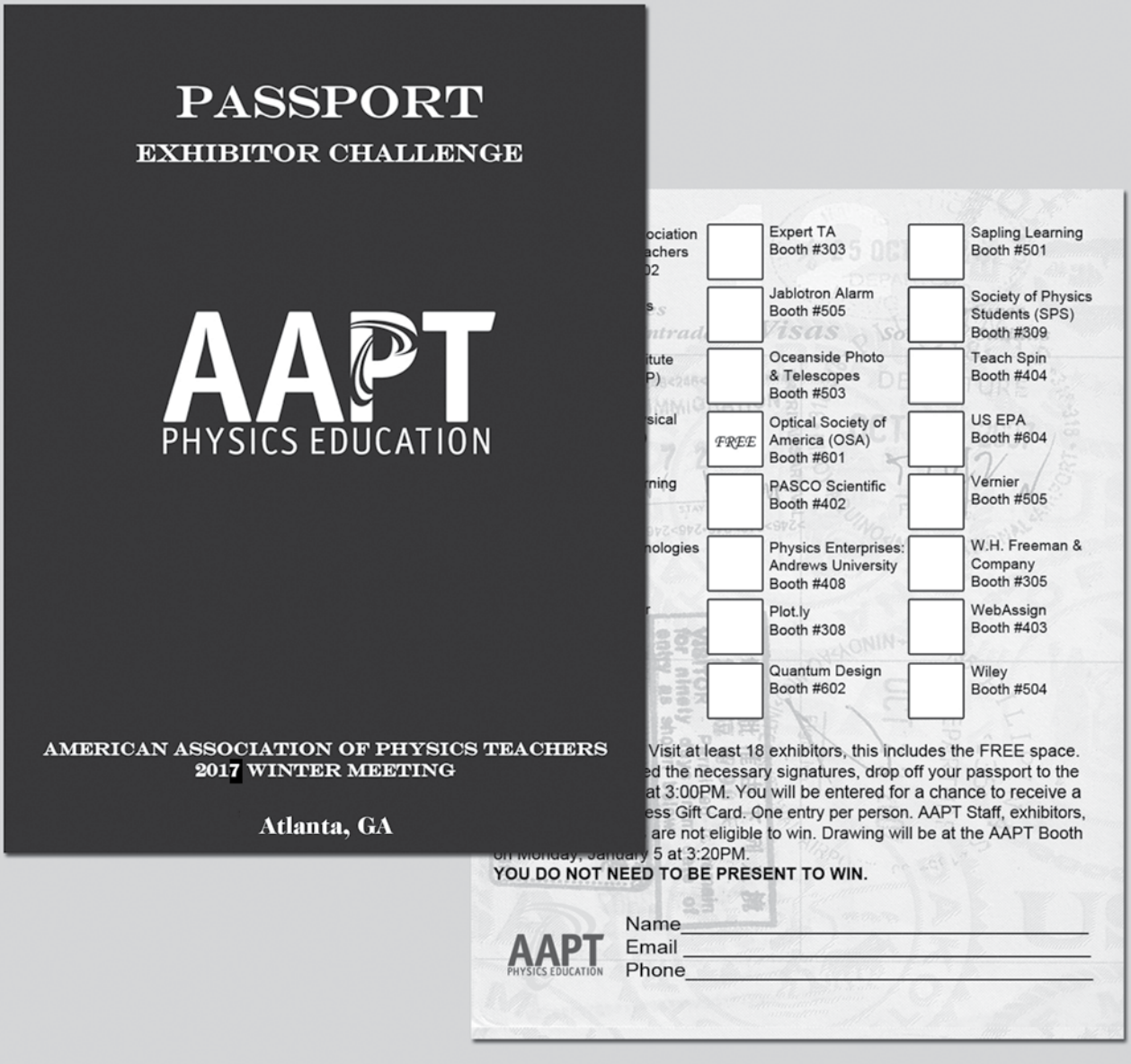

PICK UP YOUR PASSPORT TODAY!

Free Commercial Workshops

CW01: Expert TA: Free Body Diagrams in Online Homework and the Value of Solving Problems the Right Way

Location: M101
Date: Sunday, Feb. 19
Time: 12:30–1:30 p.m.
Sponsor: Expert TA

Leader: Jeremy Morton

While online homework makes grading more manageable, many instructors feel that it is a compromised version of hand-written homework. Yes, students should solve for final numeric results, but most instructors agree that they should also deal with key symbolic relationships, and draw Free Body Diagrams when necessary. Emphasizing the problem solving process and including symbolic expressions has always been central to Expert TA's online homework system, and is backed by case studies showing measurable increases in student outcomes. We have a fool-proof interface that allows students to easily enter symbolic answers, a robust math engine that recognizes all mathematical equivalents, and a data-mining approach that allows students to receive feedback specific to their mistakes. And now we are happy to announce the upcoming release of a robust Vector and Free Body Diagram drawing package, which will not only automatically grade the student diagrams, but will do so with partial credit and feedback specific to mistakes within the drawings. This will allow students to participate in guided practice while completing a step that is critical to solving many physics problems. Please join us for lunch, and learn more about how Expert TA helps students practice solving problems the right way.

CW02: Lab4Physics: How to Engage Students in the Physics Classroom

Location: M104
Date: Sunday, Feb. 19
Time: 12:30–1:30 p.m.
Sponsor: LAB4U

Leader: Komai Dadlani

How do you keep your students motivated and engaged? How do you impart long-lasting knowledge? Educators ourselves, the Lab4U team has identified three common features of effective learning in the physics classroom. First, students learn physics most efficiently when they actively pose questions to themselves and receive repeated feedback through experimentation. Second, students internalize key concepts when they can connect course material to real life examples of the relevant physical phenomena. Finally, students are inspired to master challenging coursework when they realize that they have the potential to be great scientists too—that science is not the product of individual genius but rather of concerted effort and deliberate inquiry. In this session, we are going to demonstrate how the tools developed by Lab4U can help you to foster these three features in your classroom. Using Lab4Physics, your students will become the protagonist in their own scientific adventure, conjuring up and testing their own hypotheses as they uncover the physical laws of nature for themselves. Can you imagine how will your students react if you present the oscillation topic in a completely different way? How about trying with an exercise such as this one: imagine you are the owner of an amusement park and are planning on building a new pirate ship to replace the old one, which is broken. Came to this workshop to learn more about innovation in physics.

CW03: Data Collection on Mobile Devices with Vernier

Location: M101
Date: Monday, Feb. 20
Time: 11:30 a.m.–12:30 p.m.
Sponsor: Vernier Software & Technology

Leaders: Fran Poodry, John Gastineau, David Vernier

Join us for a hands-on experience using new physics equipment from Vernier. Bring your own mobile device or use one of ours..

CW04: Data Collection on Mobile Devices with Vernier

Location: M101
Date: Monday, Feb. 20
Time: 12:30–1:30 p.m.
Sponsor: Vernier Software & Technology

Leaders: Fran Poodry, John Gastineau, David Vernier

Join us for a hands-on experience using new physics equipment from Vernier. Bring your own mobile device or use one of ours..

CW05: PASCO scientific: Smart Cart Workshop

Location: M102
Date: Sunday, Feb. 19
Time: 3:30–4:30 p.m.
Sponsor: PASCO scientific

Leader: Brett Sackett

The Wireless Smart Cart is the ultimate tool for teaching physics from PASCO, the world leader in physics apparatus and instrumentation. The Smart Cart is a Bluetooth®-enabled, low-friction dynamics cart with onboard sensors that measure force, position, velocity, acceleration, and rotational speed. Get hands-on with the Smart Cart and Capstone software to see all the possibilities of teaching with this amazing instructional tool. Augment Smart Cart's capabilities with 3D-printed accessories. Attendees could win a Smart Cart and Capstone software!

CW06: PASCO scientific: Smart Cart Workshop

Location: M102
Date: Sunday, Feb. 19
Time: 2–3 p.m.
Sponsor: PASCO scientific

Leader: Brett Sackett

The Wireless Smart Cart is the ultimate tool for teaching physics from PASCO, the world leader in physics apparatus and instrumentation. The Smart Cart is a Bluetooth®-enabled, low-friction dynamics cart with onboard sensors that measure force, position, velocity, acceleration, and rotational speed. Get hands-on with the Smart Cart and Capstone software to see all the possibilities of teaching with this amazing instructional tool. Augment Smart Cart's capabilities with 3D-printed accessories. Attendees could win a Smart Cart and Capstone software!

CW07: PASCO scientific: Essential Physics, the Ultimate e-Book for Physics

Location: M102
Date: Sunday, Feb. 19
Time: 12:30–1:30 p.m.
Sponsor: PASCO scientific

Leaders: Tom Hsu

Meet Essential Physics author Dr. Tom Hsu and see how this interactive physics e-Book is the ultimate complement to your instruction. With the Essential Physics e-Book, students will have all the tools they need in one location, with a common user interface. Essential Physics combines quality physics textbook content with over 100 physics simulations, interactive equations, videos, random quiz-builder, and the Infinite Test Bank with built-in assessment. Runs on standard browsers on Mac®, Windows®, Android™, iPad®, and Chromebook™.

AAPT Exhibitors:

Exhibit Hall CD: (*Hours:* Sat. 8-10 p.m., Sun. 10-5, Mon. 10-4)

AAPT Journals

Booth #210
One Physics Ellipse
College Park, MD 20740
301-209-3311
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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 3B Scientific

Booth #305
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678-405-5612
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American Association of Physics Teachers

Booth #212
One Physics Ellipse
College Park, MD 20740
301-209-3311
www.aapt.org

Welcome to Atlanta! Join us at the AAPT booth and spin the wheel for your chance to win awesome prizes. This year, try out our new interactive demos based on lesson plans created from *The Physics Teacher!* We will also have a large selection of educational resources available to meet the needs of everyone from students to faculty. Show us you've tweeted using the hashtag #AAPTWM17 or liked us on Facebook to be entered into a free raffle, and don't forget to pick up your raffle ticket for the Great Book Giveaway!

AAPT Photo Booth

Booth #105

SATURDAY NIGHT ONLY – Take complimentary, unlimited photos of you and your friends at the Welcoming Reception in the exhibit hall! Experience the VIP treatment with AAPT's red carpet and velvet rope Hollywood style "photo booth." Use the interactive props provided or bring some of your own. Plus, share your photos digitally on the spot and make all of your colleagues at home jealous.

American Institute of Physics

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College Park, MD 20740
301-209-3100
www.aip.org

AIP has been sending *Physics Today* magazine to AAPT members for more than 60 years. Come by the booth to learn about other AIP benefits to which you're entitled, including career resources like employment statistics, Society of Physics Students and an online job board.

American Physical Society

Booth #503
One Physics Ellipse
College Park, MD 20740
301-209-3206
www.aps.org

The American Physical Society's Public Outreach Department aims to bring the excitement of physics to all. Stop by to grab our new retro poster series, your copy of Spectra's Quantum leap or hear more about www.physicscentral.com. We will also be demoing our new comic book app as well as SpectraSnapp for android.

Arbor Scientific

Booth #206
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 for students in elementary grades through college. Stop by our Booth and try the most fascinating, dynamic, hands-on methods that demonstrate key concepts and principles of physics and chemistry. We find the cool stuff!.

CAEN Technologies

Booth #401
1140 Bay Street - Suite 2C
Staten Island, NY 10305
718-981-0401
www.caentechnologies.com

The EASYPET is the new Educational tool in the CAEN Catalog and it strengthens CAEN to provide advanced instrumentation for Modern Physics teaching. Developed together with University of Aveiro, the EASYPET is a compact Arduino based PET station, thanks to which it is possible to learn the principle of operation of Positron Emission Tomography and the secrets behind this technique. The product includes a dedicated MATLAB Control & Analysis SW, allowing for a simple acquisition and lab notes preparation.

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Suite 200
Raleigh, NC 27606
919-829-8181
www.webassign.net

WebAssign has been delivering powerful online instructional solutions since 1997. A vital partner in physics education, WebAssign provides extensive content, instant assessment, and superior support. Educators appreciate our additional question collections, customizable labs, and free resources. Stop by booth 207 to learn more about WebAssign's new analytics tool, Class Insights..

Disney Youth Programs

Booth #504
P.O. Box 10111
Lake Buena Vista, FL 32830
www.disney.com

Youth Education Series: Disney Youth Education Series offers educational field trip programs and academic journeys year-round. Participants find enrichment, inspiration, and pure fun as they see how principles they're learning in the classroom are making exciting things happen around the Disney Parks.

Expert TA

Booth #106
624 South Boston Avenue
Suite 220
Tulsa, OK 74119
877-572-0734
www.theexpertta.com

Expert TA is a dynamic online homework system focused solely on introductory Physics. Expert TA's library has the most symbolic and multi-step questions on the market designed to provide the best possible feedback to students. Through ongoing data mining of incorrect submissions, Expert TA develops meaningful feedback and partial-credit scoring. Our textbook independent library works with algebra and calculus-based courses. Expert TA has a strong focus on academic integrity. We randomize numbers and phrases, provide question pools, and limit the availability of online solutions. Instructors rely on Expert TA to deliver accurate assessment and to reinforce the problem-solving process. Visit Booth 106 for a demonstration.

Lab4U, Inc

Booth #204
673 Brannan St.
Unit 116
San Francisco, CA 94107
415-3737451
www.lab4u.co

At Lab4U we are democratizing science education by developing technologies that transform tablets and smartphones into scientific instruments, giving every student the opportunity to have a lab in their pocket. The Lab4Physics App developed by Lab4U leverages built-in sensors found in smartphones and tablets to transform mobile devices into a powerful science lab with multiple instruments that can be used flexibly by teachers and students. In this physics lab, students can find tools (like an accelerometer, a sonometer or a speedometer) that can help them measure gravity or acceleration in real time. These tools can be used in unlimited ways, allowing students to investigate, measure and analyze inside and outside the classroom.

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904-849-1101
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Science First® specializes in the design, manufacturing, marketing and distribution of high-quality, hands-on science products. Scientific equipment and experiments from PHYWE and Daedalon® are especially designed and built to meet the teaching requirements of the higher education market. Our product program covers 100% of the experimental courses of the Bachelor of Science in Physics curriculum.

Society of Physics Students

Booths #501
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).

Spectrum Techniques, LLC

Booth #307
106 Union Valley Road
Oak Ridge, TN 37830
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Spectrum Techniques, the leading supplier of nuclear GM counting equipment, Exempt Quantity radioisotopes, and nuclear spectrometers is now showcasing a wifi-enabled radiation counter with standard ethernet and USB.

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13979 SW Millikan Way
Beaverton, OR 97005
888-837-6437
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Wiley is a global provider of content and content-enabled workflow solutions in areas of scientific, technical, medical, and scholarly research; professional development; and education.

Workshops – Saturday, February 18

Transportation between the Marriott Marquis and the Georgia Institute of Technology will be provided. Some Tutorials (T02, T03, T04) will be held at the hotel. W15 will be held at Spelman. Workshops are in **Clough Undergraduate Learning Commons (CULC) building.**

T01: Using a Planetarium for Teaching and Outreach

Sponsor: Committee on Space Science and Astronomy
Time: 8–11 a.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: CULC Atrium

Phil Grosce, 619 Orange St., Macon, GA 31201; hps4075@bellsouth.net

Planetariums in both formal and informal educational institutions have been used to teach and inspire students and the general public about the physical nature of the universe. Planetariums have the unique ability to illustrate astronomy and physics concepts that are difficult, if not impossible in the classroom. Participants in this workshop will discover though live presentations and hands-on operation better teaching methods through the use of planetariums. This workshop will use the August 21, 2017 Great American Solar Eclipse as the focus subject. A few of the goals of the workshop are: • To provide a participatory and practical professional development opportunity focusing on presentations about this 2017 Total Solar Eclipse. • To share information about available resources and products for this Eclipse. • To demonstrate the multi-disciplinary nature of planetariums. For instance, in addition to the physics and geometry of this eclipse, observations of changes in animal behavior during an eclipse can lead to better understanding of "light-dark" behavior in animals.

W01: Dark Matter and Neutrinos

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Modern Physics
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: CULC 123

Peggy Norris, Sanford Underground Research Facility, 630 E. Summit St., Lead, SD 57754; PNorris@sanfordlab.org

The Sanford Underground Research Facility in Lead, SD is hosting some of the world's most sensitive experiments designed to understand some of the mysteries of the universe. We have developed a curriculum unit for middle and high school physical science classes based on learning about dark matter and neutrinos. 'What's the 'Matter' with the Big Bang" is appropriate for both formal and informal education settings, aligned to the NGSS standards, and is available free of charge.

W02: Everything You Wanted to Know About Using Smartphones in Your Classroom: 10+ Engaging Labs to Teach Mechanics, Sound, Light, E&M, and Modern Physics

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Apparatus
Time: 8 a.m.–12 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: CULC 362

Rebecca Vieyra, One Physics Ellipse, College Park, MD 20740; rvieyra@aapt.org

Martin Monteiro, Chrystian Vieyra, Arturo Marti

Attend this workshop to participate in hands-on, engaging inquiry labs suitable for introductory physics courses in high school and college. Use your own Android or iOS smartphone or tablet—or borrow one from us—to perform both classic and novel lab experiments using free apps in the areas of (1) mechanics, (2) sound, (3) light, (4) electricity and magnetism, and (5) modern physics. In this workshop, we will show some of the capabilities of mobile devices and do experiments recently proposed in the literature, especially from *The Physics Teacher's* "iPhysicsLab" column. The population of mobile device users around the world is growing exponentially, yet their primary use is still communication. Strikingly, smartphones incorporate an increasing number of sensors, including accelerometers, gyroscopes, magnetometers, and pressure, light, and proximity sensors, among others (GPS, hygrometers, UV detectors, thermometers, heart-rate monitors, and even blood oxygenation levels). You will walk away from this workshop experience with 10+ lesson ideas and sets of accompanying student teaching materials. In advance of the workshop, registrants will be provided with an optional tutorial and webinar gathering to learn about the basics of using your mobile device's internal sensors with freely available apps.

W03: Making Physics Videos with iPads

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Saturday
Member Price: $65 **Non-Member Price:** $90
Location: CULC 372

Dan MacIsaac, 27 E Girard Blvd.; danmacisaac@mac.com

André Bresges, Florian Genz, David Abbott, Kathleen Falconer, Brad Gearhart, Joey Heimburger, and Andrew Roberts

Participants will learn how to make short physics video vignettes for learning purposes using modern tablets with low-cost applets. Participants will view examples, learn and practice how to plan, storyboard, shoot, simply animate, edit, caption, and voiceover videos using tablets. Constructive critiques and guidance will be provided, as well as advice on how to incorporate student video projects into physics classes. We encourage you to come to the workshop prepared with a physics topic of interest to you, and a tablet. Draft videos and storyboards are also welcome—the more you do in advance the more you can take away from the session. A limited number of loaner iPad tablets will be made available to participants without a device. This project is supported by the NSF, SUNY Buffalo State and the University of Cologne.

W04: Maximize Student Interest and Learning

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–12 p.m. Saturday
Member Price: $135 **Non-Member Price:** $160
Location: CULC 373

Matt Bobrowsky, Delaware State University,1200 N. DuPont Highway, Dover, DE 19904; mbobrowsky@desu.edu

We now know ways to teach that are much more effective than traditional methods. In this workshop, we will draw from a body of physics education research, which has greatly expanded during the past few decades, to really experience what effective teaching looks like. Take the best parts of progressive inquiry, problem-based learning, project-based learning, collaborative learning, responsive teaching, phenomenon-based learning, role playing, Socratic questioning, just-in-time teaching, and more, and get your students motivated and learning! Teach broader concepts and useful thinking and performance skills (as with NGSS) rather than asking students to simply memorize facts and formulas. In this workshop, you will employ research-based practices that are very effective with diverse learners and that promote science and engineering practices.

W06: Classroom Activities that Support the Conceptual Understanding of Magnetism and Quantum Mechanics

Sponsor: Committee on International Physics Education
Time: 8 a.m.–12 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: CULC 375

Daniel Laumann, Wilhelm-Klemm-Str., 10 48149 Münster, Germany; Daniel.laumann@uni-muenster.de

Stefan Heusler

Teaching magnetism and quantum states at school level is a demanding task, especially without educational materials that are visually appealing and provide a modern and scientifically accurate insight. In this workshop, we present different hands-on approaches for the treatment of dia-, para- and ferromagnetism in schools. The approaches combine professional interactive multimedia content and novel experimental activities based on strong neodymium magnets. Currently, teaching magnetism in school is almost always related to ferro- and electromagnetism. Therefore, the terms magnetism and ferromagnetism are often used synonymously in educational settings. Yet, since only three elements of the periodic table are related to ferromagnetism and the vast majority of elements are dia- or paramagnetic, it is confusing to separate the world in magnetic and non-magnetic substances: Including dia- and paramagnetism, almost ALL elements respond to a magnetic field. Especially dia- and paramagnetism impart fascinating and unexpected magnetic phenomena of everyday materials like water, aluminum or common salt. Additionally, dia- and paramagnetism reveal an excellent possibility to include quantum mechanics as the origin of all types of magnetism in classroom activities. The workshop offers possible ways to impart quantum states within high school education.

W07: Atlanta Master Teachers and Their Best Practices

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Professional Concerns
Time: 8 a.m.–12 p.m. Saturday
Member Price: $110 **Non-Member Price:** $155
Location: CULC 125

David Rosengrant; drosengr@kennesaw.edu

Jason Goodman, Jordan Tidrick, Lyric Portwood, Phil Heier, Sarah Eales; Cohort II: Amanda Amos, Berkil Alexander, Bradley Davis, Cheree Vaughn, Justin Harvey, Micah Porter, Philip Matthews, Rachel Washburn, Rebecca Howell, Shelley Howerton, Trevor Register, Warren Collier; Cohort II: Doug Pekkanen, Eden Hunt, Jacquelyn Brennan, Kristen Powell, Tracey Beyer, Naoman Malik, Lindsay Giglio, Yolanda Payton, Philip Money, Beth White

This workshop will be run by a series of master physics teachers who are all part of a Robert Noyce Scholarship Program through Kennesaw State University. These teachers come together to bring a unique background combining foundations from industry with extensive pedagogical experience. They serve a wide range of students in the Atlanta area and suburbs and are bringing their best teaching practices to this workshop. Topics will include but are not limited to: graphical methods of problem solving, designing and implementing video games in the classroom, teaching holistically from scenarios as opposed to separate content areas, diagnosing and addressing students' preconceived notions, and how to truly assess what it is you are teaching. The workshop will include not only how to implement these strategies but also will allow time to build and create artifacts which you can take home to your own classroom.

W13: Research-based Alternatives to Problem Solving in General Physics

Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–5 p.m. Saturday
Member Price: $85 **Non-Member Price:** $110
Location: CULC 127

Kathy Harper, Department of Engineering Education, The Ohio State University, 244 Hitchcock Hall, 2070 Neil Ave., Columbus, OH 43210; harper.217@osu.edu

David P. Maloney, Thomas M. Foster

Accumulating research on problem solving in physics clearly indicates that traditional, end-of-chapter exercises in physics texts are not useful and may actually hinder students' learning of important physics concepts. The research also raises questions about the efficacy of such tasks for helping students develop "problem solving skills." In light of these results the question is: What alternative tasks can we use to help students develop problem solving skills and a conceptual understanding? This workshop will review the research and then provide examples of several alternative tasks and their use. Participants will also get practice writing alternative problems in a variety of formats for use in their own classrooms.

W14: Developing Inquiry Labs for AP Physics

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Saturday
Member Price: $105 **Non-Member Price:** $130
Location: CULC 346

Shelly Strand, 9 Prairiewood Dr., S Fargo, ND 58103; shelhusk@gmail.com

Dolores Gende, Becca Howell

Participants will be able to work through several inquiry-based labs for AP Physics 1, AP Physics 2 and AP Physics C (Mechanics and Electricity & Magnetism).

W15: Trans-Disciplinary Project-based Instruction in Biology and Physics at Spelman College

Sponsor: AAPT
Time: 10 a.m.–4 p.m. Saturday
Member Price: $25 **Non-Member Price:** $35
Location: Spelman College

Natarajan Ravi, Spellman; thayes@aapt.org

The Physics and Biology Departments at Spelman College have worked together to reform physics instruction to biology, health sciences, and environmental science majors. We have introduced project-based modules linked across introductory biology and physics courses, as well as advanced biology courses. In this workshop, we will present our implementation strategies and introduce two of our projects pertaining to fluids and circuits. Concepts of fluids are introduced in the context of the circulatory system. In the biology course, students use complex arrangements of tubes to simulate various medical conditions and qualitatively study effects on pressure differences. In the physics course, students examine possible "designs" of a circulatory system, with the lab work focused on using one-tube systems to study the factors that influence flow rate for a particular pressure difference. Circuit concepts are introduced in the context of students developing a circuit model of the neuronal action potential. In the biology course, students learn the actual phenomenon via analogies and a software simulation where they can test the effects of circuit parameters. In the physics course, they design the circuit model, learn about circuit theory and components, and build and test the various designs. Participants will work through activities from these courses that show how physical models can be used to present an interdisci-

plinary approach to learning science. The morning session will focus on the fluids project and the afternoon session will focus on the circuitry project. The wrap-up will include a discussion of the extension of these projects to advanced biology courses. This workshop will include lunch and transportation for the Atlanta Marriott Marquis Hotel.

W18: Fun and Engaging Labs

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: CULC 362

Wendy Adams, University of Northern Colorado, Greeley, CO 80639; wendy.adams@unco.edu

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.

W19: Fun, Engaging and Effective Labs and Demos in Electricity and Magnetism and Optics

Sponsor: Committee Educational Technologies
Co-sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Saturday
Member Price: $75 **Non-Member Price:** $100
Location: CULC 372

David Sokoloff, 1274 University of Oregon; sokoloff@uoregon.edu

Ronald Thornton, Priscilla Laws

RealTime Physics and Interactive Lecture Demonstrations have been available for over 15 years—so what's new? Participants in this workshop will have hands-on experience with some of the activities in RTP and ILD using clickers, video analysis and computer-based tools to teach electricity, magnetism and optics. These active learning approaches for lectures, labs, and recitations (tutorials) are fun, engaging and validated by physics education research (PER). Research results demonstrating the effectiveness of these curricula will be presented. The following will be distributed: Modules from the Third Edition of RTP, the ILD book, and the Physics with Video Analysis book and CD.

W21: Learn to Create Interactive Physics Simulations for Computers, Tablet Devices, and Smart Phones in Just 4 Hours

Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Saturday
Member Price: $70 **Non-Member Price:** $95
Location: CULC 373

Andrew Duffy, Department of Physics, Boston Univ., 590 Commonwealth Ave., Boston, MA 02215; aduffy@bu.edu

Wolfgang Bauer

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

W22: Project-based Learning for Introductory Physics for Life Science

Sponsor: Committee on Physics in Undergraduate Education
Time: 1–5 p.m. Saturday
Member Price: $135 **Non-Member Price:** $160
Location: CULC 123

Nancy Beverly, Mercy College, 555 Broadway, Dobbs Ferry, NY 10522; NBeverly@mercy.edu

Project-based learning is particularly valuable for life or health science students as it gives them the experience of recognizing and applying physics in biological scenarios of most interest to them. It can be the vehicle by which the student can pose meaningful inquiry about the physical mechanisms underlying biological or biomedical processes, and make conceptual and mathematical models with articulated limitations for living scenarios. They can analyze data from their self-designed experiments or from literature searches, and with modeling can calculate results for which biological inference can be made. In this workshop you will go through the process of deciding the appropriate learning outcomes, project guidelines, and associated assessment strategies for your particular student population and format, as well as explore many examples of IPLS student projects.

W23: Teaching Introductory Astronomy Using Quantitative Reasoning Activities

Sponsor: Committee on Space Science and Astronomy
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price:** $85
Location: CULC 125

Stephanie Slater, CAPER Center for Astronomy & Physics Education Research, 604 S 26th St., Laramie, WY 82070; stephanie@caperteam.com

Windsor Morgan

In this half-day, participatory workshop specially designed for college introductory astronomy faculty and high school teachers, participants will learn how to use active learning tutorials to develop and enhance students' quantitative reasoning skills. It has long been recognized that many astronomy students are terrified of courses requiring them to perform what they perceive as being tedious arithmetical calculations. At the same time, few materials exist across the broader astronomy education community to help students overcome their reluctance to engage in mathematical thinking and enjoy success at doing astronomy. Created by teaching-experts affiliated with the CAPER Center for Astronomy & Physics Education Research Team, these active learning tutorials are purposefully designed to support students' in learning challenging astronomy concepts by introducing short and highly structured quantitative reasoning intervals where students collaboratively wrestle with how to think of astronomy in novel settings. Astronomy education research consistently demonstrates that students significantly increase their understanding of astronomy through the use of collaborative learning materials and that teachers find them easy to implement. Classroom-ready materials will be provided to all participants.

W24: Demos for Outreach

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Science Education for the Public
Time: 1–5 p.m. Saturday
Member Price: $60 **Non-Member Price: $85**
Location: CULC 481

David Sturm, 5709 Bennett Hall, Department of Physics & Astronomy, University of Maine, Orono, ME 04469-5709; David_Sturm@umit.maine.edu

Jerry Hester (and others to-be-determined)

How do you organize apparatus for Physics on the Road? Structured like PIRA Lecture Demonstration workshops, we invite folks who do, have done, and/or want to do physics outreach to join us for a workshop that focuses on demonstrations for the road. We'll look at a top 50 list. For each, we'll cover design and construction, purchasing, and using existing demonstrations found in many departments. Workshop leaders will discuss organizing using the PIRA DCS. And of course, we'll network, share, and develop plenty of new ideas for cool road show gear.

Sunday, February 19 Workshops

T02: Electrostatics Tutorial

Sponsor: Committee on Physics in High Schools
Time: 9–11 a.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: M101 (Marriott)

Robert Morse, 5530 Nevada Ave., NW Washington, DC 20015; ramorse@rcn.com

With inexpensive equipment, students can carry out activities to build a conceptual understanding of electrostatic phenomena. In this short tutorial we will build the equipment and learn to carry out experiments patterned after those from William Gilbert to Alessandro Volta, including charge detection, electric field patterns and electrostatic induction.

T04: Preparing for the 2017 Solar Eclipse

Sponsor: Committee on Space Science and Astronomy
Time: 9 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price: $95**
Location: L504 (Marriott)

Toby Dittrich, 3301 G St., Vancouver, WA 98663; tdittric@pcc.edu

Jay Pasachoff

The "Great American Eclipse" is coming up on August 21, 2017. This workshop will give you information and research possibilities to increase the readiness of you and your students to get the most out of this very unusual eclipse. Experiments include a repeat of the Eddington Experiment with dramatically improved accuracy, and experimental observations of the corona. Historical, viewing options, photographic techniques, and eclipse safety will be discussed. Co-presenters Toby Dittrich (Portland Community College, Oregon) and Jay Pasachoff (Williams College) will discuss experiments, and other presenters will discuss the variety of topics listed above.

W26: Reaching, Teaching, and Keeping Underrepresented Groups in Physics

Sponsor: Committee on Diversity in Physics
Time: 8 a.m.–12 p.m. Sunday
Member Price: $65 **Non-Member Price: $90**
Location: CULC 123

Juan Burciaga, Department of Physis & Astronomy, Bowdoin College, 8800 College Station, Brunswick, ME 04011; jburciag@bowdoin.edu

The purpose of the workshop is to increase the effectiveness of teachers (K-12) and college faculty in constructing inclusive learning environments in their classrooms and beyond. Workshop participants, using guided discussions and collaborative exercises will explore pedagogical philosophies, outreach paradigms, and assessment strategies that can be adapted to individual uses. Participants will also investigate the factors that can help (or hinder) widespread, permanent change. Though focused particularly on under-represented groups, the workshop is actually geared to making the learning of physics more effective for all students. The pedagogical exercises are built on physics at the senior high school and introductory college level, but teachers in the K-20 educational enterprise may find the workshop useful.

W27: Introduction to Arduino – An Underwater Robot Operated Vehicle

Sponsor: Committee on Physics in Two-Year Colleges
Time: 8 a.m.–12 p.m. Sunday
Member Price: $185 **Non-Member Price: $210**
Location: CULC 362

Greg Mulder, Dept. of Physical Sciences, Linn-Benton Community College, 6500 Pacific Blvd. SW, Albany, OR 97321; mulderg@linnbenton.edu

Pat Keefe

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.

W28: Integrating Computation into Undergraduate Physics*

Sponsor: Committee Physics in Undergraduate Education
Co-Sponsor: Committee on Educational Technologies
Time: 8 a.m.–12 p.m. Sunday
Member Price: $20 **Non-Member Price: $45**
Location: CULC 373

Larry Engelhardt, PO Box 100547, Florence, SC 29506; lengelhardt@fmarion.edu

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

In this workshop we will discuss the importance of integrating computation into the physics curriculum and will guide participants in discussing and planning how they would integrate computation into their courses. The PICUP partnership has developed materials for a variety of physics courses in a variety of platforms including Python/VPython, C/C++, Fortran, MATLAB/Octave, Java, and Mathematica. Participants will receive information on the computational materials that have been developed, will discuss ways to tailor the materials to their own classes, and will learn about opportunities that are available to receive additional support through the PICUP partnership. PLEASE BRING A LAPTOP COMPUTER WITH THE PLATFORM OF YOUR CHOICE INSTALLED.

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

W29: Low-Cost, At-Home Labs for School-based or Online Courses

Sponsor: Committee on Laboratories
Time: 8 a.m.–12 p.m. Sunday
Member Price: $85 **Non-Member Price: $110**
Location: CULC C372

Alex Burr, 695 Stone Canyon Drive, Las Cruces, NM 88011; aburr@aol.com

A physics course without experiments is not a physics course. However many instructors teaching in high schools, colleges, and online courses feel pressured in terms of money, time, and room to neglect this aspect of physics instruction. This workshop will address these problems. The participants will actually do real experiments which do not have to use expensive, sophisticated equipment. The experiment instructions are simple written notes that do not need class time to explain. The experiments can be done at home or some other place so a laboratory room is not needed. The experiments can be done at several levels so they are appropriate for several types of general physics courses. The experiments can illustrate advanced experimental concepts if you wish but all will show that if you ask questions of nature, she will answer. Topics mentioned include mechanics, electricity, and optics. They will be done individually and in groups. Participants should bring Apple or Android smart phones or tablets if they have them. Participants will leave with inexpensive apparatus, detailed notes, and a renewed commitment to physics as an experimental science.

W30: Projects in Physics Beyond Rockets and Rollercoasters

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–12 p.m. Sunday
Member Price: $70 **Non-Member Price: $95**
Location: CULC 375

Amber Henry, 2730 E Dahlia Dr.; MrsAmberHenry@gmail.com
Cori Araza

Students learn more when they put the physics they have learned in the classroom to use in hands-on projects. The long-time favorites of physics classrooms have been pop bottle rockets, mousetrap cars, and roller coasters. While these projects have been staples as more and more middle school teachers utilize these activities they have lost their impact in the high school classroom. This workshop will show you how to expand your projects to include such things as a school garden, 3D printed clocks, maker projects and even how to put the reins in the students hands. Participants will see how these projects can be applied, design and build small projects and work to design some innovative lessons they can apply in their classrooms. Projects will range from those can be implemented in a single day to those that can span a semester.

W31: Submitting Competitive Proposals to the NSF IUSE Program

Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Sunday
Member Price: $60 **Non-Member Price: $85**
Location: CULC 123

Kevin M. Lee, 4201 Wilson Blvd., Arlington, VA 22230; KELEE@nsf.gov

This workshop will provide an overview of the National Science Foundation's Improving Undergraduate STEM Education Program. We will cover all aspects of its history including the programs that preceded it, their goals, and their evolution over time. A complete description of the present IUSE program and the distinguishing characteristics of grants in today's physics and astronomy portfolio will be given. We will then explore the process of proposal review and the benefits of reviewing. The characteristics of a good proposal will be analyzed from looking at several project summaries as well as a full proposal. A guest speaker will detail the strategies that led to their submission of a funded IUSE proposal. All topics will be explored through classroom techniques developed for modern interactive teaching. Participants will leave with numerous resources and guidance essential for submitting their own IUSE proposal. Note that participants will be asked to prepare for the workshop beforehand. This preparation will include reading the currently active IUSE solicitation, reading an IUSE proposal, and writing a review of the proposal in preparation for participating in a mock NSF panel exercise. Registrants should be proactive in contacting the workshop organizer to obtain the needed materials.

Monday, February 20

T03: Tools for Undergraduates Conducting Outreach

Sponsor: AAPT/SPS
Time: 3:30–5 p.m. Monday
Member Price: $0 **Non-Member Price: $0**
Location: M101 (Marriott)

Brad Conrad, One Physics Ellipse, College Park, MD 20740; bconrad@aip.org

In this tutorial, students will be introduced to the best practices for outreach activities to a wide variety of audiences. Methods will focus on communication with groups of children and the general public. Activities will be demonstrated and discussed and will focus on interactive examples and a physics demonstration kit developed by the Society of Physics Students. The overall goal is to encourage student groups to conduct outreach at schools and give the presenters the tools and knowledge to do so effectively.

SHARED BOOK LIST

Princeton University Press

1. Goldberg, *The Standard Model in a Nutshell*
2. Langacker, *Can the Laws of Physics Be Unified*
3. Maoz, *Astrophysics in a Nutshell* (2nd Edition)
4. Nahin, *In Praise of Simple Physics*
5. Newman, *Mathematical Methods for Geophysics & Space Physics*
6. Penrose, *Fashion, Faith, & Fantasy in the New Physics of the Universe*
7. Robinson, *Data Analysis for Scientists & Engineers*
8. Tyson, *Welcome to the Universe*
9. Zee, *Group Theory in a Nutshell for Physicists*

Books will be raffled off on Monday at 3:30 p.m. in the Exhibit Hall. Get your ticket at the AAPT booth!

enhancing the understanding and appreciation of physics through teaching

AAPT makes me a better teacher, but it's more complicated than that. AAPT provides a forum not only for improvement but for questioning our practice. Attending an AAPT meeting inspired two other teachers and myself to start EnergyTeachers.org. I go back to AAPT every year for new inspiration.

— Shawn Reeves, EnergyTeachers.org

National Meetings

- Held bi-annually, winter and summer
- Talks by internationally known physicists and educators
- Research and teaching presentations
- Professional development sessions
- Workshops for Continuing Education Units (CEU)
- Apparatus Competition

Workshops & Conferences

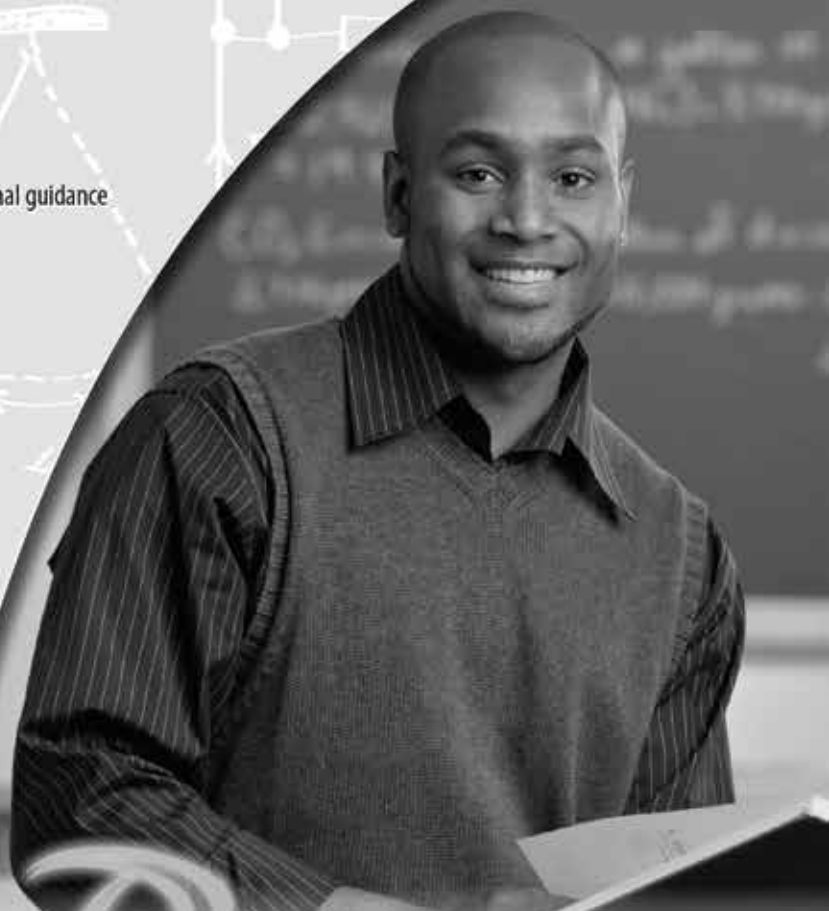
- Physics Department Chairs Conference
- Workshops for New and Experienced Physics & Astronomy Faculty: twice yearly training for physics and astronomy faculty

Online Resources

- AAPT eNNOUNCER
- eMentoring: connects high school physics educators who desire additional guidance
- ComPADRE: digital physics and astronomy collections
- Career Center: online resume postings, ads, inquiries and interviews
- Physics Review Special Topics
- Physical Sciences Resource Center: teaching materials and ideas
- Topical listservs

Awards & Honors

- Oersted Medal
- Millikan Medal
- Klopsteg Memorial Award
- Richtmyer Memorial Award
- Melba Newell Phillips Medal
- Homer L. Dodge Citations for Distinguished Service to AAPT
- Paul W. Zitzewitz Award for Excellence in Pre-College Physics Teaching
- David Halliday and Robert Resnick Award for Excellence in Undergraduate Physics Teaching
- John David Jackson Award for Excellence in Graduate Physics Education



AAPT American Association of Physics Teachers

aapt.org

Plenary Session

Location: Georgia Institute of Technology, Ferst Center for the Arts
Date: Saturday, February 18
Time: 5–5:30 p.m and 5:30–6:30 p.m.

Presider: Don Franklin

Stephen W. Ramsden

Solar Astronomy, by *Stephen Ramsden,* Atlanta, GA

Stephen W. Ramsden is the founder and Director of the world's largest Solar Astronomy and Spectroscopy hands-on STEM program, The Charlie Bates Solar Astronomy Project (www.solarastronomy.org). This global nonprofit is named in memoriam to a fellow veteran. Mr. Ramsden's talk will discuss the critical need for Physics and Math instruction and introduction to elementary and middle school students around the globe and his own experience in putting together this massive program with no help from Universities or Government entities. It is an exploration of a completely grassroots organization dedicated to ending radicalization and extremism by early intervention with science.

Enjoy Special Solar Astronomy Events

with Stephen Ramsden from 12 to 4 p.m. Saturday at Georgia Tech

Stephen Ramsden will be live presenting the Sun in multiple wavelengths through his solar telescope/spectrograph array. Come check out chromospheric and photospheric features from all across the visible light spectrum like you've never seen them before! Free solar viewing glasses and diffraction gratings for everyone! This will be a great example of how your facility can setup a public solar viewing program for the Great American Eclipse of 2017 and beyond. Weather permitting.

Equipment to be available includes spectographs, diffraction modules, several telescopes, and solar guiding modules.

Michael Ruiz

The Physics of Music, by *Michael Ruiz,* University of North Carolina, Ashville

This event will take place at Georgia Institute of Technology. Transportation provided from the Marriott. We will first use a musical ear-training exercise in conjunction with Lissajous figures to establish the simplest ratios for the frequencies of the major scale. We will call this scale the musician's scale. Then we will proceed to use strings and pipes to arrive at the harmonic series, which we will call the physicist's scale. We will show how the I, V, and IV harmonies pervasive in Western music emerge naturally from our analyses. We will give examples in classical music and jazz, including live piano performance.

Attention High School Teachers!

Come to the HS Teachers' Lounge (room L505) to engage in hands-on activities, pick up lesson plans, review new Digi Kits, and network with colleagues!

Sunday: 11:30 a.m.–12:30 p.m. and 2–3 p.m.
Monday: 11:00 a.m.–12:30 p.m. and 3-4 p.m.
Tuesday: 9–10:30 a.m.

Session SPS: SPS Undergraduate Research and Outreach Posters

Location: Marquis Salon C-D
Sponsor: AAPT/SPS
Date: Saturday, February 18
Time: 8–10 p.m.

Presider: Brad Conrad

SPS01: 8-10 p.m. A Classical Demonstration of Avoided Crossing with Springs

Poster – Daniel Steinwachs, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30149; Daniel.Steinwachs@vikings.berry.edu

Andrew Lockhart, Shawn A. Hilbert, Berry College

Avoided crossings are a phenomenon typically associated with quantum mechanics. Here we experimentally demonstrate the formation of an avoided crossing in a completely classical system—two coupled harmonic oscillators. We show that this avoided crossing can be created by a variation of mass as well as a variation of spring constant. We also look at effects on the strength of the avoided crossing in both cases by varying the coupling spring. This classical visualization of avoided crossing could make a great demonstration in quantum mechanics or classical mechanics a fine addition to an advanced lab course.

SPS02: 8-10 p.m. An Acoustic Analog to Avoided Crossing of Energy Levels

Poster – Alexandria Skinner, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30149; Alexandria.Skinner@vikings.berry.edu

William Newman, Shawn A. Hilbert, Berry College

Avoided crossings are traditionally associated with quantum mechanical systems but they have been known to occur in classical systems. The emergence of an avoided crossing in traditionally classical systems has been observed in coupled systems. In our experiment, we explore the emergence of an avoided crossing in a coupled acoustic system. The acoustic system mimics the quantum system of an infinite square well split into two regions, one of fixed length and another of variable length, and separated by a delta potential well. The acoustic system was constructed with two PVC tube sections, one of fixed length and another of variable length. The tubes are separated by an aluminum diaphragm with a variable reflectivity controlling the coupling between the sections. By comparing the energy eigenvalues of the quantum system and the resonant frequencies of the acoustic system, we demonstrate that the quantum and acoustic systems exhibit similar avoided crossing behaviors.

SPS03: 8-10 p.m. Band Structure from Atomic Orbital Analogs

Poster – Parker Roberts, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30149; Parker.Roberts@vikings.berry.edu

Alexandria Skinner, Shawn A. Hilbert, Scott V. Carr, Berry College

According to quantum mechanics, electrons in an atom are confined to a particular set of discrete energy levels, which are consistent for identical atoms. Coupling of two atoms, such as in the formation of a crystalline solid, results in a splitting of these levels. As more atoms are coupled, the energy levels continue to split. With enough atoms coupled, the number of levels become large enough and the level spacing small enough that the allowed states essentially form a continuum, or band. Because the electronic wave functions in atoms have harmonic oscillator solutions, classical oscillators directly mirror atomic energy levels. A single oscillator has a discrete set of resonant frequencies, while coupling between oscillators will induce resonance splitting. In this presentation we will discuss the validity of this analogy from a theoretical perspective and demonstrate experimentally the construction of resonance bands from coupled mechanical oscillators.

SPS04: 8-10 p.m. Band Structure in Coupled Oscillators

Poster – Tadan Cobb, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30161; Tadan.Cobb@vikings.berry.edu

Daniel Steinwachs, Scott V. Carr, Shawn A. Hilbert, Berry College

Band structure and level splitting are concepts typically dealt with in quantum mechanics. This project explores these quantum phenomena using a classical system of masses connected to springs. A single oscillator produces a single resonant frequency. Each mass added to the system causes an additional resonant frequency to appear. When a large number of masses are introduced, a large number of corresponding resonances begin to overlap. These resonances form a band of allowed frequencies. Frequencies not in this band are forbidden, meaning the system cannot oscillate at these resonances. These bands are useful for predicting a range of allowable frequencies that a system can produce from additional level splitting. We will also analyze how changing the system's physical parameters affects the band structure. This analog is cost effective and can be used for lab demonstration in undergraduate labs.

SPS05: 8-10 p.m. Continuous and Episodic Relativistic Outflows in Advection-Dominated Accretion Flows

Poster – William T. Newman, Berry College, 2277 Martha Berry Hwy, Mount Berry, GA 30149; william.newman@vikings.berry.edu

Troung Le, Elizabeth Edge, Berry College

Previously, Le et al. (2004, 2005, 2007) demonstrated that particle acceleration in the vicinity of a shock in an advection-dominated accretion disk can extract enough energy to power a relativistic jet from a supermassive black hole. However, to maintain a steady jet, a stable shock location is required. Employing the Chevalier & Imamura linearization method and the Nakayama instability boundary conditions, Le et al. (2016) showed that a region of the energy and angular momentum parameter space in which disk/shocks with outflows can be either stable or unstable. In unstable regions, the velocity profiles that exhibit pre-shock deceleration and acceleration are unstable to the zeroth mode with zero frequency of oscillation, but are stable for the fundamental and the overtones. Continuing, we use the parameterized space for when the zeroth mode transitions between stable and unstable to explain observations of continuous and episodic jets in M87 and Sgr A*, respectively.

SPS06: 8-10 p.m. Cosmic Ray Study: Effect of Detector Area on Shower Rates

Poster – Kamryn B. Abraskin, Glenbrook North High School, 2300 Shermer Road, Northbrook, IL 60062; avalsamis@glenbrook225.org*

Brian Burke, Kendall Crispin, Anthony Valsamis, Glenbrook North High School

Cosmic rays are immensely high-energy particles originating mainly from outside our solar system. Although they have been studied since the early 20th century, much remains unknown about their origin, properties, and behavior. These primary cosmic rays produce secondary particle showers through interaction with Earth's upper atmosphere. Using QuarkNet cosmic ray detectors, an investigation was conducted to measure the amount of cosmic ray events per hour as a function of detector area; both indoors and outdoors. Three counters placed in a triangular array were tested within a one-story building and inside of a greenhouse with a thin plastic roof. The data collected suggests that roofing material affects the measured shower rates.

*Sponsor: Anthony Valsamis, Glenbrook North High School.

SPS07: 8-10 p.m. Development of Gamma Camera Model to Teach Nuclear Medicine

Poster – Adam L. Sova, Rockhurst University, 1100 Rockhurst Rd., Kansas City, MO 64110; SovaA@hawks.rockhurst.edu

Nancy L. Donaldson, Rockhurst University

As an undergraduate Medical Physics Major, the field of nuclear medicine for both imaging and therapy will be central to my studies and future career as a medical physicist. Working with my mentor, my research is focused in the following areas: 1) construction of a hands-on Gamma Camera apparatus that uses optical principles to model the detection of gamma ray photons in the formation of an image (Lowe, Spiro, 2015); 2) development of an active learning curriculum to teach the basics of nuclear medicine to Physics of Medicine students; and, 3) extending modeled principles to current developments in nuclear medicine.

SPS08: 8-10 p.m. Progress Report on Exciting Non-Harmonic Resonances

Poster – Andrew Lockhart, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30161; Andrew.Lockhart@vikings.berry.edu

Erin Bassett, Shawn A. Hilbert, Berry College

In a single tube, multiple resonances form, each of them being a harmonic of the fundamental resonance. When exciting the fundamental, each of the harmonics are also excited. In this project we explore a way to excite non-harmonic resonances while exciting the fundamental resonance. To do this, we use a system that has a pair of resonances that are close together (with a frequency different of a few hundred Hertz) where the higher-frequency resonance is not a harmonic of the lower-frequency resonance. This is done by utilizing the level splitting from a pair of coupled tube sections. By driving the system with a mixture of two frequencies: the fundamental frequency and the frequency difference between the frequency pair, we attempt to excite the higher frequency resonance. Applying this to a laser system could provide another method for laser tuning.

SPS09: 8-10 p.m. Qualitative Analysis of the Conversion to SCALE-UP: Listening to Students

Poster – Nikita Moore, Miami University, Department of Physics, 500 E Spring St., Oxford, OH 45056; bluejm@miamioh.edu*

Jennifer Blue Miami. University Department of Physics

The Department of Physics at Miami University moved to a new building in the fall of 2014. We seized this opportunity and designed ourselves large, flat classrooms. This means we can teach both our algebra-based and calculus-based introductory courses in the SCALE-UP (Student-Centered Active Learning Environment with Upside-Down Pedagogies) model. We are now in year three of SCALE-UP, and continuing our evaluation. We have given an informal midterm survey during the middle of the fall semesters, where students give qualitative feedback on the course, including what they see as strengths of the course and suggestions for improvement. We will present results of these surveys.

*Sponsor: Jennifer Blue

SPS10: 8-10 p.m. Slow Sound Via Dispersion in a Closed Tube

Poster – Rachel E. Bibbey, Berry College, 2277 Martha Berry Highway NW, Mount Berry, GA 30161; Rachel.Bibbey@vikings.berry.edu

Eric R. Vanderwolf, Shawn A. Hilbert, Berry College

This project mimics slow light using sound. The experiment uses sound waves inside a PVC tube with aluminum end caps. A frequency sweep in the tube demonstrates a phase shift over each resonance in the tube. These phase shifts are indicative of dispersion effects. The dispersion curve over these resonances match in slope the dispersion curve for light in atomic resonances with electromagnetically induced transparency. The sound system has the advantage that amplitude increases over a resonance; therefore, no transparency trick is required. The slope of the dispersion curve is used to estimate the group velocity of a Gaussian pulse inside the tube. The actual velocity is determined by sending a pulse through the tube and measuring the travel time in the tube. Our system produced speeds down to 26 m/s. We also analyze the effect of tuning the frequency around the resonance and varying wall reflectivities.

SPS11: 8-10 p.m. Untangling the Coefficients of the Lorentz-Violating Standard-Model Extension

Poster – Kenneth A. Amandolia, Berry College, 2277 Martha Berry Highway, Mount Berry, GA 30149; Austin.Amandolia@vikings.berry.edu*

Charles D. Lane, Berry College

The Lorentz-Violating Standard-Model Extension provides a list of coefficients to describe each of the known Lorentz violation factors. While there are many coefficients where the value they contribute to this Lorentz violation is clear, there are other cases where instead a linear combination of these coefficients describes these effects. The goal of this project is to unpack these equations, so that the individual sensitivity to each of these coefficients can be found.

*Sponsor: Charles D. Lane

SPS12: 8-10 p.m. Using Physics to Explore the Psychology of Small Mammal Behavior

Poster – Ashton M. Levry, Mercer University, 1501 Mercer University Dr., Macon, GA 31207; ashtonlevry@gmail.com

Ciara Alvis, Ciara Alvis, Catherine Potin, Jeff Pullen, Katharine Northcutt, Jarred Jenkins, Chamaree de Silva, Mercer University

As part of the research component of a year-long freshman integrative science program at Mercer University, we used kinematics to gain insight on Optimal Escape Theory, which states that animals moderate their flight responses according to the level of risk represented by a potential predator. We examined how this theory applies to squirrels on our campus by exploring how three different human approach speeds affect squirrels' flight accelerations. Our procedure involves approaching squirrels at each speed and recording their flight with a high-speed video camera. Video analysis was then performed using Logger Pro software to calculate the acceleration of each squirrel. In addition, we measured the Flight Initiation Distance; the distance between the human and the squirrel when the squirrel flees. In this study, we combine physics, biology, statistics, and the psychology of small mammal behavior to explore the integrative aspect of science as a whole.

SPS14: 8-10 p.m. Testing and Modeling a Physical Galton Board

Poster – Brandon Inscoe, High Point University, Department of Physics, High Point, NC 27268; binscoe@highpoint.edu

In this project we created a physical model of a Galton board where the ball's path is determined by physical collisions with each peg and by actual physical parameters of the ball, pegs, and board. To test the model, we built a Galton board and compared results with the computational model. The model produced similar distributions of drift time and final bin position. However, the statistical variation in the model completely depended on random variation in the initial position of the ball, and the statistical variation in the experiment depended on the apparent variation of physical parameters of the ball and board (because its initial position was nearly constant). The computational model is similar enough to the actual board that the model can be used to investigate how the statistical distribution of the ball depends on various parameters. The Galton board is an instrument that involves statistics and many fundamental and classical physics concepts such as collisions, angular momentum, Newton's second law of motion and conservation of energy. Thus, the board has educational value and can also be used as an analogy for DC current in a wire.

SPS15: 8-10 p.m. The Impact of Studio Mode on Conceptual Understanding and Physics Identity Development

Poster – Zackary L. Hutchens, High Point University, 118 Pleasant Drive, Thomasvile, NC 27360-8816; zhutchen@highpoint.edu

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

Studio physics is an innovative pedagogy that uses interactive-engagement to teach introductory calculus-based physics. Over a span of four semesters at Texas A&M University-Commerce, data was collected in both traditional and studio physics courses using the BEMA and FMCE concept inventories and the CUPID physics identity survey. The results demonstrate that studio mode is a highly effective method of teaching calculus-based physics, with 24.06 and 19.64 percent higher mean normalized gain for PHYS 2425 and PHYS 2426 respectively. The results of CUPID show that studio mode generates some improvement in physics identities for first-semester physics, but show no significant change in second-semester physics.

SPS16: 8-10 p.m. Homemade Diode for Physics and Engineering Labs*

Poster – Travis M. King, 491 Oak Grove Road, Temple, GA 30179; Tking13@my.westga.edu

L. Ajith DeSilva, J. E. Hasbun, R. Kulasiri, Kennesaw State University

We constructed a simple diode from commercially available compound semiconductors, namely n-TiO 2 and p-CuI. The diode is a semiconductor p-n junction, the most basic device of all electronics. The entire diode can be made within 10 minutes without any sophisticated instruments. The current-voltage characteristics showed a similar behavior to a regular Si diode. We use a non-linear fitting procedure to analyze the experimental results. The fitting non-linear model used is based on the work of Danielson and Depoy [1] with slightly fewer parameters. Diode characteristics and rectification properties are discussed and compared with a regular Si diode. [1]"Accurate Method for Forward and Reverse Bias Curve Fitting of TPV I-V Data," L. R. Danielson and D. M. Depoy, (2006, http://www.osti.gov/scitech/servlets/purl/882557).

*Financial support from UWG SEEP and SRAP programs are acknowledged.

SPS17: 8-10 p.m. Measurement of Radial Buoyant Force in a Rotating Fluid

Poster – Amiras S. Simeonides, High Point University, 4733 Eastwin Dr., Winston-Salem, NC 27104; sasimeonides@gmail.com

We constructed an apparatus that uses pressure sensors to measure the pressure difference between two sides of a container of water that is in uniform circular motion. We then demonstrate how to use this pressure difference to explain the radial buoyant force on a fishing bobber suspended in the water. Finally, we compare these calculations to the theoretical buoyant force obtained by analyzing a video of the apparatus in motion. air or in N2, etc.) on device performance were also studied. We have demonstrated that the heterojunction devices with a combination of wide gap and narrow gap semiconductor nanostructures can function for photovoltaic applications. The key challenges are to minimize the trap states and optimize the interface of nanostructures.

TOP01: The Fulbright Experience

Location: M106
Sponsor: AAPT
Date: Sunday, February 19
Time: 9–10:30 a.m.

Presider: Perry Tompkins

Computer Based Instrumentation: A Fulbright Scholar's Experience in Ecuador

The Fulbright Scholar program, funded through the US department of State, sends US scholars abroad to teach and do research with colleagues in over 125 countries worldwide. These scholars are usually college and university faculty or professionals such as lawyers or artists. This program is exceptionally well suited for physics professors, due to the international collaboration inherent in the field, along with a world-wide desire for STEM education. This tutorial describes the presenter's experiences as a Fulbright scholar during 2007 in Cuenca, Ecuador, including how he was able to teach computer-based instrumentation at multiple venues within the country. At the end of the presentation, there will be time for questions and discussion from the audience.

Session AA: Teaching Scientific Practices in High School and College Labs

Location: International 4
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in High Schools
Date: Sunday, February 19
Time: 10–11:50 a.m.

Presider: Bob Weber

AA01: 10-10:30 a.m. Teaching Physics Instead of Teaching About Physics

Invited – Andrew Jackson, Harrisonburg City Public Schools, 1001 Garbers Church Road, Harrisonburg, VA 22801; ajackson@harrisonburg.k12.va.us

The Next Generation Science Standards have three explicit dimensions: Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. This presentation is about approaches that address teaching physics more than teaching about physics. The difference between teaching physics and teaching about physics is based on how the dimensions of crosscutting concepts and disciplinary core ideas are integrated with the science and engineering practices. The three dimensions are columns supporting our physics instruction. Attempting to support instruction for any time with only one column weakens the learning. The dimensions need to be viewed as inseparable, and together, provide the strength found in good pedagogy. Attendees will examine and question traditional lab and lecture. They will explore how to expand and alter approaches to be in philosophical alignment with NGSS and the NRC framework where the practices of scientists and engineers are put into use as students gain understanding of physics content.

AA02: 10:30-10:40 a.m. Evaluating and Improving Laboratory Notebook Practices

Contributed – Joseph F. Kozminski, Lewis University, Department of Physics, Romeoville, IL 60446; kozminjo@lewisu.edu

Keeping a laboratory notebook is an important skill for undergraduates to develop whether they plan to go to graduate school, industry, research, or any other area where keeping organized, detailed records is important. Often students are presented with a set of guidelines and possibly some examples of notebook entries and are expected to develop good notebook practices on their own. However, constructive feedback and mentoring are important in helping students develop this skill. This presentation will give preliminary results of an evaluation of student laboratory notebook practices and some pedagogical methods to help students better develop this skill.

AA03: 10:40-10:50 a.m. Assessing Scientific Abilities in the High School Classroom

Contributed – Kelly O´Shea, Little Red School House & Elisabeth Irwin High School, 40 Charlton St., New York, NY 10014; kellyoshea@gmail.com

Over the past year, I have focused on how I can give students feedback about their developing scientific abilities without relying on lab reports. I have started developing assessments (both written and practical) to try to address abilities like designing observational experiments, taking and analyzing data, and creating and interpreting graphs. I shared some of that work in a blog post (https://kellyoshea.wordpress.com/2016/03/31/assessing-scientific-abilities/), and I will use this talk to share updates, student work, and my new ideas for teaching and assessing these abilities in my high school physics and chemistry classes.

AA04: 10:50-11 a.m. Students' Engagement in Argumentation While Working on Physics Tutorials

Contributed – Ozden Sengul, Georgia State University, 112 Courtland St NE 21101B, Atlanta, GA 30303; osengul1@student.gsu.edu

Renee S. Schwartz, Joshua Von Korff, Georgia State University

Argumentation as a core epistemic practice of science involves scientific reasoning and proficiency through advancing, critiquing, and justifying claims. Physics Education Research has developed numerous methods and scaffolds to promote students' engagement in scientific argumentation. Through a case study approach, we examined how research-based materials—Open Source Tutorials in Physics Sense-Making—can facilitate students' use of argumentation in small groups as well as their conceptual understanding. We analyzed transcriptions of students' group discussions based on modified Toulmin's Argumentation Layout. We will discuss the results of two episodes from the study to report what features of tutorials helped students engage in argumentation and make sense of physics concepts.

AA05: 11-11:10 a.m. Effect of Scientific Reasoning Curriculum for Different Prior COV Ability

Contributed – Krista E. Wood, University of Cincinnati, 9555 Plainfield Rd., Cincinnati, OH 45236; Krista.Wood@uc.edu

Kathleen Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Scientific reasoning (SR) skills are important for constructing knowledge based on experimental data. A curriculum needs to specifically target SR skills to promote students' SR development. While control of variables (COV) skills are foundational to scientific reasoning, little research has studied the effect of an SR-targeted curriculum on students' COV skill development. In a two-year college physics lab during the first implementation of an SR-targeted curriculum, we divided our students into Low, Mid, and High prior COV ability based on pre-test COV questions. Using pre- and post-test scores, we determined the effect of the SR-targeted curriculum on student development of COV skills at various complexity levels. We found notable differences in student development of COV skills depending on their prior ability and the COV skill complexity. In this talk, we will discuss these differences and the implications.

AA06: 11:10-11:20 a.m. Identifying Common Difficulties in Causal Reasoning*

Contributed – Lindsay Owens, The University of Cincinnati, 3843 Mantell Ave., Cincinnati, OH 45236; owensly@mail.uc.edu

Kathy Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Students use causal reasoning in their everyday lives to generate hypotheses as to why an event occurred, or to create predictions about future events based on personal experience and/or data. Yet, students in introductory physics labs quickly demonstrated difficulties in causal reasoning when interacting with story-based scenarios and data. Qualitative think-aloud interviews were conducted with a variety of both algebra-based and calculus-based students; students verbally reasoned through causal scenarios which featured causal mechanisms, covariation data, or both. Students were categorized into low, medium, or high reasoning subgroups using additional questions given as part of a pre-test in the laboratory class. Common difficulties were noted among the group of students with low-causal reasoning skills, while a different set of reasoning difficulties were noted among the group of students with medium-causal reasoning abilities. These difficulties in causal reasoning will be discussed within the talk.

*This work is supported in part by NSF IUSE DUE 1431908.

AA07: 11:20-11:50 a.m. Science Practices in the AP® Physics Laboratory

Invited – Robert A. Morse, Emeritus, St. Albans School, 5530 Nevada Ave., Washington, DC 20015-1784; ramorse@rcn.com

The new AP® Science curricula define specific Learning Objectives that combine content in terms of Essential Knowledge with seven specific Science Practices common to all sciences. These learning objectives guide teachers' work in the classroom and the laboratory, and are the basis for AP® examinations. The new curricula emphasize learning through laboratory inquiry and data analysis as a basis for students to develop conceptual and mathematical models of system behavior, reflected in a syllabus requirement that 25% of student time be spent in inquiry-based laboratory work. The AP® Physics 1 and 2 Lab manual (2015) includes 16 example investigations described in terms of Essential Knowledge and Science Practices. In this talk I will discuss the Science Practices, give examples of their use in laboratory investigations in the AP Physics 1 & 2 courses, and briefly compare them with the eight practices of the NGSS Framework (2012).

Session AB: Understanding the Apparatus

Location: International 5
Sponsor: Committee on Apparatus
Date: Sunday, February 19
Time: 10 a.m.–12 p.m.

Presider: Yongkang Le

AB01: 10-10:30 a.m. Teaching Apparatus for Advanced Biomedical Physics Labs

Invited – Mary Lowe, Loyola University Maryland, Physics Department, 4501 N. Charles St., Baltimore, MD 21210; mlowe@loyola.edu

Alex Spiro, Loyola University Maryland

For several years, we have been developing teaching apparatus pertinent to medical applications for use in intermediate and advanced undergraduate physics labs. To understand the physics of a medical device, model apparatus need to be constructed that functions on a human scale so students can explore it with their own hands. The developers of the teaching apparatus must make decisions based on cost, the availability of parts, safety, and the most important aspects to teach. In this talk, I will describe considerations in designing some of the apparatus for our biomedical physics curricula, including gamma camera imaging, ultrasound imaging, and fiber optics for light delivery. In order for students to understand the limitations of the model apparatus, similarities and differences between the teaching apparatus and the real device used in the field must be clarified through instructional materials.

AB02: 10:30-11 a.m. Learning Physics by Understanding the Instruments

Invited – Jingbo Ye, 3215 Daniel Ave. Rm 102, Dallas, TX 75205-0100; yejb@smu.edu

Physics is advanced based on measurements (with instrumentation) and it in turn invents instruments that are not only for physics but also used in many other fields. It is especially important in the training of a student in physics to understand the apparatus, the tools he or she will use to conduct measurements. In this talk I will use a few examples and even two demos, time permits, to illustrate the importance of instrumentation in discoveries as well as in a teaching lab, and then offer my own experience in getting students to read manuals and to understand not only how to operate the instruments, but the principles the measurements are based upon, this helps the students to interpret the numbers and judge the validity of the measurements, a crucial step in learning from teaching labs and then physics.

AB03: 11-11:30 a.m. Experimental Teaching by PPBL: Using the Michelson Interferometer as an Example

Invited – Jinhuan Li, School of Physics, Northeast Normal University, No.5268,Renmin Street, Changchun, Jilin 130024 China; lijh248@nenu.edu.cn

Xiaojun Wang, Georgia Southern University

In past few years, we have reconstructed our lab training program and classroom teaching into the PPBL (Physics Problem Based Learning)-model to engage the students to be more active in learning. In this talk, the lab Michelson Interferometer will be used as an example to demonstrate how the teaching activities are carried in the PPBL-model. Michelson interferometer is one of the most popular optical interferometric systems used in optical metrology. Wavelengths, tiny displacement, thermal extension of a sample, and even the gravitational wave (Advanced LIGO) can be measured with the Michelson interferometer. Under traditional lab course arrangement, students found it difficult to understand the lab well and to operate the apparatus effectively. In the PPBL-model, students pay much more attention to the apparatus under the guidance of heuristic questions, such as when is the compensating plate necessary, what will be results if the reflection of the beam-splitter is not 50%. Our experience shows that the PPBL-model provides students not only a more solid training of lab skills, but also improvement in problem solving and critical reasoning.

AB04: 11:30-11:40 a.m. Electronics Labs and Apparatus Limitations

Contributed – Satinder S. Sidhu, Washington College (Emeritus), 103 Sutton Way, Chestertown, MD 21620-1197; ssidhu2@washcoll.edu

Labs associated with an electronics course are an ideal venue for imparting lessons about equipment characteristics that can prove frustrating to the unwary user. Although formal error analysis is not usually associated with these labs, they can serve as real eye-openers about the discrepancies between the ideal world of theoretical models and the real one of measurements made with the simplest of bench apparatus. Lessons learned here—taught early and often—will stay with the budding experimentalist as well as the casual user as they move on to dealing with more complex equipment and systems. Examples of some short introductory experiments will be presented to illustrate these ideas.

AB05: 11:40-11:50 a.m. Taming the Cavendish Balance

Contributed – Peter A. Bennett, Arizona State University, Box 871504, Tempe, AZ 85287-1504; peter.bennett@asu.edu

The Cavendish Balance is a beautiful experiment that is often done in college lab courses for physics majors. This experiment uses a torsion balance to measure the force of gravity between kG spheres a few cm apart to determine a value for "big G", the gravitational force constant. The concept is relatively simple, but the presence of noise or background effects presents a significant challenge for an accurate measurement. We describe our solutions to mitigate several sources of "noise" including: vibrations, temperature, wind, and capacitance. Using a Tel-Atomic apparatus, with modest adjustments, we are able to reduce or control such effects, to yield a value for G that is good to a few percent.

AB06: 11:50 a.m.-12 p.m. Beach Ball Physics

Contributed – Michael R. Gallis, Penn State Schuylkill, 200 University Dr., Schuylkill Haven, PA 17972; mrg3@psu.edu

Ryan M. Vidal, Penn State Schuylkill

When discussing how to throw a wicked curve ball, "Bend it Like Beckham" or just those falling objects that don't keep up, beach balls provide a convenient mechanism to explore the non-ideal features that can arise in projectile motion. A beach ball's motion can be understood in terms of weight, drag, buoyancy and the Magnus effect. This presentation shows some ways the motion of a beach ball in introductory mechanics labs, both as a departure from ideal free fall behavior and as a detailed exploration of friction and drag. Several short demonstration videos of beach balls in flight will also be shown. An interactive 3D simulation of beach ball trajectories which illustrates the roles of the various forces in the ball's projectile motion will also be demonstrated. This presentation makes use of the Tracker video analysis program and the Easy JavaScript Simulations package, both from Open Source Physics (www.opensourcephysics.org).

Session AC: The Physics of the NSF IUSE Program

Location: International 6
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, February 19
Time: 10 a.m.–12 p.m.

Presider: Kevin Lee

AC01: 10-10:30 a.m. Phys21: Preparing Physics Students for 21st Century Careers*

Invited – Paula Heron, University of Washington, 3910 15th Ave. NE, Department of Physics, Seattle, WA 98195-1560; pheron@uw.edu

With support from the NSF IUSE program, the AAPT and APS formed a Joint Task Force on Undergraduate Physics Programs (JTUPP). The task force reviewed employment data, surveys of employers, and reports generated by other disciplines. We also met with with physicists in selected industries to get their views on the strengths and weaknesses of physics graduates, commissioned a series of interviews with recent physics graduates employed in the private sector, and identified exemplary programs that ensure that all of their students are well prepared to pursue a wide range of career paths. The resulting report "PHYS21: Preparing Physics Students for 21st Century Careers" describes the skills and knowledge that undergraduate physics degree holders should possess to be well prepared for a diverse set of careers and makes recommendations intended to help departments and professional associations support student career preparation.

*Supported in part by the NSF IUSE grants DUE #1540574 and DUE #1540570.

AC02: 10:30-11 a.m. Collaborative Research: Examining the Development of Student Reasoning Skills*

Invited – Mila Kryjevskaia, North Dakota State University, Department of Physics, PO Box 6050, Fargo, ND 58108-6050;; mila.kryjevskaia@ndsu.edu

Andrew Boudreaux, Western Washington University

Paula R. L. Heron, University of Washington

Beth Lindsey, Penn State Greater Allegheny

MacKenzie R. Stetzer, University of Maine

The development of reasoning is arguably the most important outcome of college physics instruction. In spite of sustained research interest, little is known about how students construct reasoning chains when responding to qualitative physics questions. We are therefore developing assessment methods to disentangle conceptual understanding from the reasoning abilities needed to productively apply that understanding. Such methods would have practical as well as theoretical value. They could lead to creation of instruments for systematically tracking the development of student reasoning throughout physics instruction, and could also inform existing and emerging theories of cognition (e.g., dual process theories). We will share lessons learned during the first two years of this multi-institutional collaborative project, discuss our current findings, and outline future directions.

* This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431857, 1431940, 1432052, 1431541, and 1432765.

AC03: 11-11:30 a.m. Research Validated Distance Learning Labs for Introductory Physics Using IOLab

Invited – David R. Sokoloff, University of Oregon and Portland State University, 1430 E 43rd Ave., Eugene, OR 97405; sokoloff@uoregon.edu

Erik Bodegom, Portland State University

Erik Jensen, Chemeketa Community College

The IOLab is a versatile, relatively inexpensive data acquisition device developed by Mats Selen and his colleagues at University of Illinois.[1,2] It is self-contained in a cart that can roll on its own wheels, while an optical encoder measures motion quantities. It also contains sensors to measure a variety of other physical quantities like force, temperature, light intensity, sound intensity and current and voltage. With a current cost of around $100, students can purchase their own individual device (like a clicker), and can—in theory—use it to do hands-on laboratory, pre-lecture (flipped classroom) and homework activities at home. We report on the preliminary results of a project to develop distance-learning (DL) laboratories using the IOLab. We have developed RealTime Physics[3,4]-like mechanics labs based on the IOLab, tested them in supervised laboratory environments at PSU and Chemeketa, and just finished the first DL test of the labs at Chemeketa (Summer, 2016). We will present preliminary research on student learning and epistemological issues using the FMCE [5] and ECLASS.[6]

(1) See http://www.iolab.science/ (2) Funded under U.S. National Science Foundation grant DUE – 1505086, July 1, 2015-June 30, 2017. (3) 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. (4) David R. Sokoloff, Ronald K. Thornton and Priscilla W. Laws, RealTime Physics: Active Learning Laboratories, Module 1: Mechanics, 3rd Edition (Hoboken, NJ, John Wiley and Sons, 2011). (5) Ronald K. Thornton and David R. Sokoloff, "Assessing student learning of Newton's laws: The Force and Motion Conceptual Evaluation and the Evaluation of Active Learning Laboratory and Lecture Curricula", Am. J. Phys.: 66, 338-352 (1998) (6) See http://www.colorado.edu/sei/departments/phys-advlab-eclass.htm

AC04: 11:30 a.m.-12 p.m. Connecting Math and Physics Across the Upper-division

Invited – Eleanor C. Sayre, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; Esayre@gmail.com

The Mathematization project studies how upper-division physics students use mathematics across multiple courses and in several modalities. Our research takes place primarily in Classical Mechanics, Electromagnetic Fields, and Quantum Mechanics, three of the core upper-division physics theory classes. We conduct network analyses of their homework solutions to see which ideas are connected within problems, and what kinds of problems elicit which ideas. We analyze their in-class small-group problem solving to see how their epistemic framing affects (and is affected by) their peers, the instructor, and the kinds of problems they work on. We track how their ideas about "looking ahead" in numerical solutions vary by physics context, and we examine how they coordinate multiple representations to generate new ideas. In this talk, I'll highlight the connections between our research questions, our theoretical frameworks, and our methodological choices.

Session AD: Frontiers of Space Science & Human Space Flight

Location: International 7
Sponsor: Committee on Space Science and Astronomy
Date: Sunday, February 19
Time: 10–11:40 a.m.

Presider: Doug Lombardi

AD01: 10-10:30 a.m. Spectroscopic Mapping of Comets at Radio Frequencies

Invited – Amy J. Lovell, Agnes Scott College, 357 South Candler St., Decatur, GA 30030-3770; alovell@agnesscott.edu

Sublimation of ice from comets can reveal clues to the interior of the comet, provide insights on the formation of our solar system, and reveal interesting dynamical processes in a rarefied atmosphere. Water is the primary volatile in comet nuclear ices, but may be difficult to observe through Earth's atmosphere. As an immediate product of water molecule breakup, OH is easily observed at radio wavelengths and can be used to trace other gas phenomena in comets. We will review gas production rates, outflow velocities, and other physical processes as revealed by a 15-year survey of 18-cm OH spectra from dozens of comets, and the unique elements of computational modelling for data analysis.

AD02: 10:30-11 a.m. Hooke's Law Orbital Motion: A Zero-G Flight Experiment

Invited – Jeffrey R. Regester, High Point University, One University Parkway, Physics Department, High Point, NC 27268; jregester@gmail.com

This talk describes an experiment flown aboard NASA's reduced-gravity aircraft. The experiment explores the behavior of two masses, connected by a spring and set into rotation, resulting in orbital motion. The experimental apparatus consists of a turntable that accelerates a mass-spring-mass system to a predetermined angular speed before releasing it during a "zero-g" interval, while the aircraft is performing a parabolic maneuver that simulates the absence of gravity. A video camera recorded each run, allowing frame-by-frame analysis of the masses' trajectories. This talk will describe the apparatus development, aircraft integration, training, the actual flights, and data analysis. Use of the data in educational settings ranging from middle school to university physics major classes will be discussed as well.

AD03: 11-11:10 a.m. Developing STEM SOS Near Space Project

Contributed – Mehmet Gokcek, 9321 W Sam Houston Pkwy S, Houston, TX 77099; mgokcek@harmonytx.org

Space travel is still a very costly endeavor for most humans. As an educator it is our job to come up with innovative ways of bringing space technology and experience to the classrooms so that next generations can innovate affordable ways of space travel making what some might consider science fiction today into a reality. In 2014 STEM SOS students in Lubbock, TX, launched the first weather balloon among 45 HPS campuses where STEM SOS model has been implemented in the state of Texas. Their first goal was to collect sensor data as the weather balloon ascended to near space to the upper edge of stratosphere. However, mishaps caused by high winds led to an unsuccessful recovery and payload was lost to inclement weather, only to be found a year later on Oklahoma - Texas border by a cattle rancher, 200 miles away from the initial launch site. Same year HPS Sugar Land campus became part of this new initiative by doing a successful launch in the Houston area. A year later STEM SOS Near Space Project took another turn when El Paso STEM SOS students launched a payload close to the U.S.-Mexico border, where recovery took hours due to harsh conditions of the Chihuahuan desert. The project made it possible for teachers to collect sensor and media data that could later be part of the physics classes allowing more students to take a role analyzing the data. Moreover, in the last six months we have partnered with a computer engineer at University of Texas - Dallas to create an open source flight computer that would allow students build their own sensor and telemetry system to be launched in to near space. Technology used in the flight computer is a basic version of satellite communication systems. An average of 100 mile telemetry is possible over 900 Mhz frequency. Through this push a newly developed phase of STEM SOS Near Space Project will include affordable classroom applications of satcom sensor and telemetry systems that will use Arduino and Raspberry Pi as building platforms.

AD04: 11:10-11:20 a.m. High Altitude Balloon Cosmic Ray Detection at a TYC

Contributed – Rod Milbrandt, Rochester Community and Technical College, 851 30th Ave. SE, Rochester, MN 55904; rod.milbrandt@rctc.edu

Nathan Brown, Andrea Walker, Steve Keidl, Rochester Community and Technical College

For two successive years at RCTC we have launched a High Altitude Balloon (HAB) as a part of student research projects. This year we launched a home-built cosmic ray detector and acquired data from ground level to 38000 feet that matched theoretical predictions. This project allowed undergraduates at our TYC to do research on a reasonable budget and generated a lot of interest. We will describe our materials, methods, and hints we've learned regarding HAB cosmic ray experimentation.

AD05: 11:20-11:30 a.m. A Practice-based Model of STEM Teaching in Physics: "STEM Students on the Stage (SOS)™"

Contributed – Mehmet Keles, Harmony School of Nature, 8120 W. Camp Wisdom Rd., Dallas, TX 75249; mkeles@harmonytx.org

Harmony Public Schools have developed a STEM curriculum that incorporates project-based and inquiry-based learning titled STEMSOS "STEM Students on the Stage (SOS) ™". Students experience PBL projects at various levels at Harmony Public Schools. Level I is a short term project and targets 21st century skills within the context of the curriculum. Level II & Level III are long-term interdisciplinary projects connecting STEM curriculum to the humanities through rich, meaningful, and rigorous cross-disciplinary and multi-sensory projects that allow the application and development of critical 21st century skills. I will be showing some examples of PBL Level II websites and videos that were created by my physics students last year. You will also have some brochures created by students. This brochures will let you to get more information about the projects.

AD06: 11:30-11:40 a.m. 21st Century Skills in STEM SOS Harmony Near Space Project

Contributed – Nicolas Gonzalez, Harmony School of Science High Sugar Land 13522 W Airport Blvd., Sugar Land, TX 77498; nicolas.gonzalez@harmonytx.org

For students, it is difficult to transfer the knowledge they have gained in the classroom and utilize it during experiments. STEM SOS Harmony Near Space Project is a hands-on student-oriented college level project that helps walk the students through how to transfer what they have learned in the classroom to meaningful skills they can utilize outside the classroom. The students create a launch schedule with all the components necessary to complete the high-altitude weather balloon experiment, in which they collect sensor data such as altitude, temperature, and other variables; assign roles to their team members, and schedule a launch date and location based on environmental factors they have been observing; with the end goal to prepare a project portfolio showcasing what they learned. This leads to an opportunity for the students to share and shine in class during physics lessons that involve concepts visited during the launch, such as thermodynamics and gas laws, this also allows the teacher to use footage and data from launches to have the students analyze real-life data.

Session AE: Self-Efficacy, Resilience, and Persistence for Underrepresented Women: What Research Tells Us

Location: International 8
Sponsor: Committee on Diversity in Physics
Co-Sponsor: Committee on Women in Physics
Date: Sunday, February 19
Time: 10–11:50 a.m.

Presider: Rebecca Lindell

AE01: 10-10:30 a.m. Harnessing Affinity Towards Biology to Support Diversity in Physics

Invited – Vashti Sawtelle, 567 Wilson Rd., East Lansing, MI 48824-2320; davisvas@gmail.com

Chandra Turpen, University of Maryland, College Park

Access to a professional community of scientists must start from exposure to, participation in, and developing an affinity towards a variety of scientific practices. In this work we explore how a female biology student with an initial negative orientation toward physics grows to see herself as capable and willing to engage in the scientific practices of the discipline. In this work we will examine case study data of a student who initially describes herself as hating physics, but shifts in her appreciation for physics. We triangulate across data sources to build an understanding of how this student's relationship with physics shifts. We draw attention to ways that this shift may have been influenced by the ways our physics for life science majors course develops connections between the disciplines. We argue that harnessing students' affinity towards biology may be a way to support diversity in introductory physics classrooms.

AE02: 10:30-11 a.m. Success of Female Physics Majors: Self Efficacy and Identity Development

Invited – Sissi L. Li, California State University Fullerton, 800 N. State College Blvd., Fullerton, CA 92831-3547; sissili314@gmail.com

Michael E. Loverude, California State University Fullerton

As a part of becoming physics majors, students develop a relationship with the academic and professional physics communities. This relationship development is shaped by the way the individual makes sense of how to be a part of the physics community. A significant portion of this sense-making include learning how physicists approach and solve problems and developing a coherent framework for understanding a wide range of physics content. Every student pursuing physics will encounter these demanding tasks. Students from underrepresented groups, particularly female students, will face those tasks in addition to social and cultural challenges that are inherent in their minority status. Through qualitative case studies, we have examined successful female physics majors to understand the nature of their persistence through strong self-efficacy and resilient identities as legitimate members of the physics community.

AE03: 11-11:30 a.m. Domain Specific Self-Efficacy within STEM: The Role of Gender

Invited – John Stewart, West Virginia University, Department of Physics and Astronomy, Morgantown, WV 26506; jcstewart1@mail.wvu.edu

Rachel Henderson, Seth DeVore, West Virginia University

The self-efficacy subscale of the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1993) was modified to differentiate between the academic and professional environments of physics classes, mathematics classes, other science classes, and the student's planned profession. The modified instrument was applied to introductory physics students (N=1005) at a large Eastern land-grant university. Students displayed significant differences in self-efficacy toward the different domains. Significant gender differences in self-efficacy were also identified, but these were restricted to the physics domain. Gender differences within physics were not explained by either past achievement measured by standardized test score or current achievement measured by physics test scores. General academic self-efficacy mediated the effect of test scores on self-efficacy within physics, but the effect was differentiated by gender. The gender difference in physics self-efficacy narrowed as students moved from Physics 1 to Physics 2.

AE04: 11:30-11:40 a.m. Science Education for Female Pre-service Teachers in China

Contributed – David A. Osmond, University of North Georgia, 3820 Mundy Mill Road, Nesbitt 5150, Oakwood, GA 30566; david.osmond@ung.edu

During the summer of 2016, I applied to teach physical science to pre-service elementary teachers in the Province of Shandong China. The course was designed as a total of 40 hours over a four-week period. Of the students participating, 41 were female and three were male pre-service elementary education majors. The lab activities and lectures were designed as explicit modeling of science instructional strategies, physical and earth science topics, and some American educational philosophies. Because the region is financially under-privileged all of the activities were designed to be easily reproduced from available materials there in China. For the purpose of this talk, I would like to share some insights into how this group of students approached learning. These approaches will be expanded to focus on how recent female Chinese immigrants might be thinking during your physics courses and how the roles of teacher and student are viewed.

AE05: 11:40-11:50 a.m. Equity in the IMPRESS Program

Contributed – Florian Genz, University of Cologne, Albertus-Magnus-Platz, Cologne, 50923 Germany; Florian.Genz@uni-koeln.de

Ben J. Archibeque, Eleanor Sayre, Kansas State University

Paul Hutchison, Grinnell College

Maxwell Franklin, Swarthmore College

We are interested in how student groups' minority composition affect how equitable their discourse is. We follow several case study groups, chosen to have a broad range of students, to operationalize how discourse may be equitable. We look for moments when individuals are included or excluded and how the prevalence of those moments can create a more or less equitable environment during

activities. We compare these qualitative measures of equity with quantitative measures of who speaks when. We found that when white men are in a group they tend to marginalize other group members. The groups for our case study came from the IMPRESS program, which is a two week, pre-college program that prepares first generation and deaf/hard-of-hearing students to major in a STEM field. In this program, students focus on improving their metacognitive skills and cultural preparation for college life within a context of model building and climate change.

Session AF: Lessons from the Pre-HS Community – Panel

Location: International 9
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Teacher Preparation
Date: Sunday, February 19
Time: 10 a.m.–12 p.m.

Presider: Bill Reitz

What can those in the trenches teach us about physics education in the Pre-High School? Join us as elementary and middle school educators discuss the challenges (and successes) they have encountered and how the physics community can support their efforts.

Speakers:

Ann Robinson, University of West Georgia

David Todd, University of West Georgia

Sharon Kirby, University of West Georgia

Sheila Barnes, Arnall Middle School Newnan, Georgia

Nancy Easterly, Houston, TX

Stacy Gwartney, Jacksonville, TX

Session AG: Effective Practices for Integrating Computation into the Curriculum – Panel

Location: International 10
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Educational Technologies
Date: Sunday, February 19
Time: 10 a.m.–12 p.m.

Presider: Larry Engelhardt

This panel will discuss how and where computational problem solving can be integrated into an undergraduate physics curriculum. During the first 30 minutes of the session, each panelist will briefly introduce one computational activity and how they integrate this activity into their course/curriculum. During the next 45 minutes, you will choose one of the activities, and you will work through the activity in small groups (as a mini-workshop). During the final 45 minutes, we will discuss the opportunities and challenges associated with integrating computation.

AG01: 10 a.m.–12 p.m. Exploring the Chaotic Pendulum with the Maxima CAS

Panel – Todd Timberlake, Berry College, PO Box 495004, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

In this panel presentation I will discuss an activity from my computational physics course in which students explore the behavior of a driven, damped pendulum using the Maxima computer algebra system. The activity introduces the concepts of limit cycles, Poincare sections, period-doubling bifurcations, chaos, and strange attractors. Participants are encouraged to bring a laptop with Maxima pre-installed. A cross-platform version of Maxima called wxMaxima is available for free at wxmaxima.sourceforge.net. More information about exploring chaotic motion, and other physics topics, with Maxima can be found in my textbook *Classical Mechanics with Maxima* (Springer, 2015).

AG02: 10 a.m.-12 p.m. Deepen Understanding of Mathematical Methods through Python and Jupyter Notebooks

Panel – Joshua Samani, UCLA, 475 Portola Plaza, Los Angeles, CA 90095; jsamani@physics.ucla.edu

We explore a sequence of self-guided computational activities designed to deepen student understanding of linear algebra, ordinary differential equations, and how they are related. Working in pairs to complete Python coding exercises in Jupyter notebooks, students combine their understanding of matrix diagonalization and numerical solution of ordinary differential equations to compute and visualize the dynamics of systems of oscillators. Participants are encouraged to bring a laptop with Python 3 and Jupyter notebooks installed. Alternatively, participants can make a SageMathCloud account to experience how students can easily use Python and Jupyter in the cloud.

AG03: 10 a.m.-12 p.m. Coulomb Scattering in Glowscript for Intro Students

Panel – Dwain Desbien, Estrella Mountain Community College, 3000 N Dysart Rd., Avondal, AZ 85392; dwain.desbien@emcmail.maricopa.edu

During this panel discussion I will share my experiences using glowscript (VPython) in introductory physics classes. In particular I will be sharing the use of a simple Coulomb scattering activity that students code and explore scattering with. Student solutions to the activity will be shared as will student solutions. Follow-up questions to students and discussion of extensions to the activity will be discussed.

AG04: 10 a.m.-12 p.m. Problem-based Learning with VPython in Introductory Mechanics

Panel – Marcos Caballero, Michigan State University, 567 Wilson Rd., Department of Physics and Astronomy, Room 1310A, East Lansing, MI 48824; caballero@pa.msu.edu

In this panel discussion, I will discuss a series of activities designed to engage science and engineering students in computational modeling in the context of a group-based, introductory mechanics course called, "Projects and Practices in Physics" or P-Cubed (pcubed.pa.msu.edu). This series of activities emphasize using the Euler-Cromer method to model the motion of single particle systems experiencing no net force, constant force, or a position-dependent force. In the P-Cubed learning environment, students explore these activities, which are framed as investigatory modeling projects, in small groups of four. Participants are encouraged to bring a laptop with classic VPython installed (vpython.org). Participants with internet access may use Glowscript (glowscript.org) in lieu of installing VPython.

AG05: 10 a.m.-12 p.m. A Nuclear Physics Simulation Suitable for Classroom Use

Panel – Javier E. Hasbun, University of West Georgia, 1601 Maple St., Carrollton, GA 30118-0001; jhasbun@westga.edu

I discuss a nuclear physics activity in which we will apply a classical mechanical concept and adapt it to the modeling of a nuclear phys-

ics problem; i.e., the interaction between a nuclear particle and the rest of the remaining nucleus. The idea is to look at the two body problem and work with the center of mass and relative coordinates of the system to obtain the motion of the nuclear particle (neutron or proton) as well as the heavier nucleus.[1] We will use Matlab/Octave to perform the modeling and interested participants are encouraged to preinstall "Matlab" from http://www.mathworks.com or the open source compatible version "Octave" from https://www.gnu.org/software/octave/.

1. Benjamin E. Hogan and Javier E. Hasbun, Georgia Journal of Science, V71, No. 3 (2013).

Session BA: Introductory Courses (General)

Location: International 4
Sponsor: AAPT
Date: Sunday, February 19
Time: 2–3 p.m.

Presider: Richard Peterson

BA01: 2-2:10 p.m. Physics of Winter Olympics in STEM SOS Model

Contributed – Abdulkadir Akti, 6424 Wildwood Circle, West Apt no 418, Fort Worth, TX 76132; abd.akti@gmail.com

Winter Olympics are the best resource to connect physics lectures with daily life. Most of mechanic concepts from one dimensional motion to mechanical waves can be taught by using winter Olympics and video analysis. Besides being wonderful example of physics concepts, it is also a great tool to draw students attention to topics. Students also can use winter Olympics in our STEM SOS model as their pbl projects.

BA02: 2:10-2:20 p.m. From Physics to Technology

Contributed – Yusuf C. Eren, 4165 Old Dowlen Rd #80, Beaumont, TX 77706; yusuferentx@gmail.com

As physics teachers, we know the important of physics. Every single thing around us is related to physics. We are aware of that. However, our students don't know the important of physics in terms of how important it is. As a physics teacher, my main goal is to make physics relevant to our society. For that purpose, I would like to introduce Arduino. Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs—light on a sensor, a finger on a button, or a Twitter message—and turn it into an output—activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. Students start learning basic electrics. They learn how the electric works, series, and parallel circuits. After that we start building some electronics things like parking sensor. Students also get a lot of knowledge about modern technologies. As a result of that, students will gain valuable knowledge for their life. They will be excited to physics and technology.

BA03: 2:20-2:30 p.m. Elaborate Formula Recollection through a WORLDLY recognized Mnemonic Technique

Contributed – Shannon A. Schunicht, Texas A&M University, 3100 Barak Lane, Bryan, TX 77802-4707; animalwatch21@rocketmail.com

Most students when taking physics for the first time are exposed to a multitude of formulas. Such exposure to the non-physicist usually prevents further exploration, or studies. For this reason alternative venues other than physics are often sought. In 1985, this author was involved in a mid air collision to be rendered unconscious for three weeks. Everything had to be relearned, as nursing actions were reported as having been displayed upon awakening from the extended unconsciousness. A WORLDLY recognized mnemonic technique was made for memory compensation. Recent '16 notification as well since '01. Attendance will reveal: 1. this technique, 2. sample cards, 3. past acronyms created from simple to complex equations, as well as 4. equations submitted by attendees. The application of this mnemonic technique to ANY Western language is remarkable, whereas Eastern characters have yet to be explored. Regardless, its possibilities remain limitless as Delta X approaches 0. Come 2 C what acronym Dr. Seuss will show u.

BA04: 2:30-2:40 p.m. Remote Sensing, Big Data and Environmental Physics

Contributed – J. B. Sharma, University of North Georgia, 3820 Mundy Mill Rd., Oakwood, GA 30566; jb.sharma@ung.edu

The 21st century will see an exponential growth in the deployment of sensors on satellite and UAV platforms to quantify Earth surface phenomena. The confluence of fast computing, novel algorithms, ubiquity of broadband and powerful miniaturized sensors are creating very large data streams that need to be converted to actionable information. This enterprise is largely dependent on greater grassroots physics literacy. Physics applications such as remote sensing are a tangible way of getting students motivated to learn the physical principles underlying remotely sensed data. Typically this data is in the form of multiband optical imagery, laser reflectometry and radar. The underlying principles are the EM spectrum, interaction of radiation with matter, atmospheric scattering/absorption, orbital dynamics, wave optics and geometric optics. Scalable cloud computing platforms like Google Earth Engine are making planetary scale remote sensing capabilities available to faculty and students across the entire educational continuum from K12 to higher education.

BA05: 2:40-2:50 p.m. New Video Resource for Calculus-based Introductory Physics at TAMU

Contributed – Jonathan D. Perry, Texas A&M University, 4242 TAMU, College Station, TX 77843-0001; JPerry@physics.tamu.edu

William Bassichis, Tatiana Erukhimova, Texas A&M University

Use of videos as an additional component of education has been on a continual rise in recent years. Video engagement as an instructional technique can be beneficial if the material is designed at an appropriate level, and presented in an accessible manner. Many existing, popular resources have content designed for algebra-based courses, which are not suitable for STEM majors in calculus-based introductory physics. This work consists of the development of a new set of online video resources being developed at Texas A&M University to exhibit the fundamental physical concepts, laws, and equations in a manner appropriate for calculus-based physics courses of any institution. Preliminary assessment on the effectiveness of the modules, and user surveys concerning them will be presented for modules deployed during the spring and fall terms of 2016.

BA06: 2:50-3 p.m. Experiments in Ancient Chinese Science and Technology

Contributed – Matt Marone, Mercer University, 1400 Coleman Ave., Macon, GA 31207-0003; marone_mj@mercer.edu

We have developed a general education physics class for non-science majors based on the inventions and discoveries of ancient China. In this class, we explore these discoveries in their historical Chinese context and through the lens of our current scientific understanding. This is not just a theoretical course but there is a strong "hands on" emphasis. In our laboratory component, we re-create several different inventions or technologies used by the Chinese in ancient times. Students then analyze the ancient technologies using modern methods and tools. Each experiment has a two fold lesson that addresses the ancient technology and modern

laboratory techniques. Thus, making paper, becomes and exercise in statistical analysis. Experiments include making paper, building a steelyard balance, silk spinning, magnetism, musical instruments, optics, astronomy and bronze casting.

Session BB: Institutional Support For Elementary Teacher Physics Training

Location: International 5
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in Pre-High School Education
Date: Sunday, February 19
Time: 2–3:20 p.m.

Presider: Paula Heron

BB01: 2-2:30 p.m. These Important Science Teachers Need Our Support

Invited – Gay B. Stewart, West Virginia University, 140 Waitman St., Morgantown, WV 26501; gbstewart@mail.wvu.edu

Arguably, elementary teachers are among the most important science teachers. They encourage or discourage a love of science, touching all students. Unfortunately, many future elementary teachers do not have access to the type of college science classes that model the way they should teach these subjects, and often elementary preparation programs do not place a large emphasis on science methods. Excellent curricula exist to fulfill this need, particularly in physics, but they require a commitment of good faculty and potentially more resources than other physics courses for non-majors. How we effectively sought institutional support, at the department, dean and provost levels, at two institutions will be discussed. Time for questions and advice to those attempting to start such a program will be available.

BB02: 2:30-3 p.m. Is Physics by Inquiry Still Relevant?

Invited – Bruce Patton, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; patton.1@osu.edu

Andrew Dougherty, The Ohio State University

Physics by Inquiry (PBI) at The Ohio State University has evolved over several decades starting from the original University of Washington framework. Changing core science standards, equipment options, staffing involvement, online options, and experimental innovation have all played a role in the format of the current course as a key part of teacher education. The approach to active learning and meaning making in Physics by Inquiry is still extremely relevant to the preparation of teachers to deal with both the content and cognitive requirements of the new Common Core and NGSS standards. The role of the hands-on PBI structure has been investigated for both pre and in-service teachers, including their effects on students of diverse backgrounds in their classrooms. Extensive data collection now enables a comprehensive statistical analysis of the role of many factors such as student background, co-operative learning, and scientific reasoning ability.

BB03: 3-3:10 p.m. Replacing the Lab Manual with a Learning Management System in Physics Investigations for K-4 Pre-Service Teachers

Contributed – Stanley J. Sobolewski, Indiana University of Pennsylvania, Department of Physics, 56 Weyandt Hall, Indiana, PA 15705-1087; sobolews@iup.edu

Muhammad Z. Numan, Indiana University of Pennsylvania

The traditional laboratory investigation uses a procedure written on paper; students then record their responses on a supplied data page or laboratory notebook. In an attempt to make this process more efficient, the use of a Learning Management System (in this case D2L) was used to present the material and collect student feedback. Each student had a University supplied laptop, read the procedure from the screen, and submitted answers through D2L. As anticipated there was no change in content knowledge. However surprisingly, subjects felt the paper and pencil approach was easier to use than computer entry. In a subsequent study, the same population in the same course completed an online only lecture and lab course. We will discuss the student's reaction to this online class.

BB04: 3:10-3:20 p.m. Ozobot Physics: Robotics for K-5 Preservice Teachers and Their Students

Contributed – Matthew P. Perkins Coppola, Indiana University-Purdue University Fort Wayne, 2101 E. Coliseum Blvd., Fort Wayne, IN 46805-1499; matthewperkins@hotmail.com

Ozobots provide a simple way for K-2 students to learn the basics of coding. About the size of a quarter, these line-following robots interpret embedded patterns of color as commands to alter their speed and direction. In this presentation I will share how I prepare preservice elementary educators to use Ozobots to teach concepts of force and motion to their students.

Session BC: Interactive Lecture Demonstrations: What's New? ILDs Using Clickers and Video Analysis

Location: International 6
Sponsor: Committee on Research in Physics Education
Date: Sunday, February 19
Time: 2–3 p.m.

Presider: Priscilla Laws

BC01: 2-2:30 p.m. Interactive Lecture Demonstrations: Whats New? ILDs Using Clickers and Video Analysis

Invited – David R. Sokoloff, University of Oregon, 1430 E 43rd Ave., Eugene, OR 97405; sokoloff@uoregon.edu

Ronald K. Thornton, Tufts University

The results of physics education research and the availability of microcomputer-based tools have led to the development of the Activity Based Physics Suite.[1] Most of the Suite materials are designed for hands-on learning, for example student-oriented laboratory curricula such as RealTime Physics. 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 Suite materials designed to promote active learning in lecture—Interactive Lecture Demonstrations (ILDs),[2] including those using clickers and video analysis.

1. E.F. Redish, Teaching *Physics with the Physics Suite* (Wiley, Hoboken, NJ, 2004). 2. David R. Sokoloff and Ronald K. Thornton, *Interactive Lecture Demonstrations* (Wiley, Hoboken, NJ, 2004).

BC02: 2:30-3 p.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Tufts University, 12 Temple St., Medford, MA 02155; ronald.thornton@tufts.edu,sokoloff@uoregon.edu

David R. 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).

Session BD: PER: Diverse Investigations

Location: International 7
Sponsor: AAPT
Date: Sunday, February 19
Time: 2–3:20 p.m.

Presider: Craig Wiegert

BD01: 2-2:10 p.m. Effective Facilitation of Teams to Enact Departmental Change

Contributed – Joel C. Corbo, University of Colorado Boulder, 860 35th St., Boulder, CO 80303; joel.corbo@colorado.edu

Daniel Reinholz San Diego State University

Melissa Dancy, Noah Finkelstein, University of Colorado Boulder

We have facilitated Departmental Action Teams (DATs) in several departments as part of a change effort to improve undergraduate STEM education at a large research-intensive university. A DAT is a working group focused on addressing a broad-scale educational issue in a sustained, ongoing fashion. DATs consist primarily of faculty members from a single department, but may also include undergraduate and graduate students, postdocs, and staff. DATs are externally facilitated; the facilitators act as catalysts for change by providing DAT participants with expertise in education research and institutional change, logistical support, connections with related work across campus, and a functional process for achieving their goals. Through an analysis of DAT meeting minutes and focus groups, we identify the specific facilitation techniques that helped the DATs succeed and categorize them into goals, process, and support. We discuss these techniques to provide practical guidance for the facilitation of DATs and other similar groups.

BD02: 2:10-2:20 p.m. Mindset Research in Introductory Physics: Strengths of Student Interview Analyses

Contributed – Angela Little, Michigan State University, 4101 N. Broadway St, Suite 108, Chicago, IL 60613; angie.little@gmail.com

Vashti Sawtelle, Bridget Humphrey, Michigan State University

Mindset is a well-studied area of the psychology literature associated with Dweck and colleagues. Mindset research focuses on beliefs about the nature of intelligence: is it an unchangeable entity a person either possesses or not (fixed) or is it possible to improve (growth)? School success and mindset have been linked. The proposed mechanism behind this link is that students with growth mindset exhibit "mastery-oriented behaviors" in response to challenges, such as embracing hard work and strategizing how to improve. Mindset is typically studied through large-N survey measures with context-general Likert scale items measuring beliefs about the nature of talent and intelligence. We argue that such context-general survey measures are limited in application, particularly in the context of introductory college STEM courses. We describe recent work to improve a preliminary analysis framework that we have developed for coding mindset in interview data.

BD03: 2:20-2:30 p.m. Analysis of the NSF IUSE Physics & Astronomy Education Portfolio

Contributed – Kevin M. Lee, National Science Foundation, 4201 Wilson Blvd., Arlington, VA 22203; kelee@nsf.gov

The National Science Foundation's IUSE:EHR (Improving Undergraduate STEM Education) Program is now over three years old. This presentation will describe the characteristics of the awards presently in the physics & astronomy portfolio. Awards will be described based upon a) general characteristics (duration, total funding, PI rank, type of institution, etc.), b) applicability (intended audience, level, and arena of implementation), c) nature of project (educational research, practical implementation, or both), and d) pedagogical focus (curriculum, STEM recruitment, STEM retention, information collection, and tools and/or skills development). General trends and exemplars will be identified as well as voids in the portfolio. Understanding what has been funded will help attendees design future proposals that will make innovative contributions to the portfolio.

BD04: 2:30-2:40 p.m. An Immersive Research Program for High School Students

Contributed – Christina E. Love, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104; love@drexel.edu

Brean Prefontaine, Naoko Kurahashi Neilson, Eric Brewe, Drexel University

A four-week-long immersive summer program for high school students was developed, implemented, and assessed. The program was completely directed by an undergraduate physics major and it included a hands-on and student-led capstone project for the high school students. The goal was to create an adaptive and shareable curriculum in order to influence high school students' views of university level research and what it means to be a scientist. The program was assessed through various methods including a survey developed for this program, a scientific attitudes survey, weekly blog posts, and an oral exit interview. The curriculum included visits to local STEM laboratories, an introduction to particle physics and the IceCube collaboration, an introduction to electronics and computer programming, and creating and presenting their capstone project. Assessment results and details concerning the curriculum will be discussed.

BD05: 2:40-2:50 p.m. Preliminary Results from the Waves and Synthesizers in Physics Project

Contributed – Benedikt W. Harrer, San Jose State University, One Washington Square, San Jose, CA 95192-0106; benedikt.harrer@sjsu.edu

Nigel Pasman, San Jose State University

In this exploratory study, we investigate how tapping into students' experience, expertise, and interest in music and sound supports learning about waves using musical synthesizers. Waves are at the heart of modern physics, but students have great difficulty understanding basic wave properties, even after instruction. Research shows that students who explore physics phenomena in contexts they are familiar with and interested in enlist their prior experiences as productive resources for reasoning about physics and are more likely to spend the time to achieve expert-like understandings of complex phenomena. We will present preliminary findings from our investigation.

BD06: 2:50-3 p.m. PER Postdocs: Current Hiring Practices in the U.S.

Contributed – Alexis Knaub, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49008; avknaub@gmail.com

Manher Jariwala, Boston University

Charles Henderson, Western Michigan University

Based on the advertisements from the PERJobs blog, we estimate that there have been at least 120 PER postdoc positions in the past five years. Hiring for these positions poses several challenges that are unique from hiring postdocs in other fields: prospective postdocs hail from both traditional physics and PER, PIs may not have been PER postdocs, and these positions sometimes require skills that the PI has never used. We conducted an interview study of current and past PER postdocs and PIs who have hired PER

postdocs to learn more about hiring practices. This talk highlights some of the preliminary findings from this study regarding how postdocs find positions, what PIs are looking for in a postdoc, and advice that postdocs have for prospective postdocs.

BD07: 3-3:10 p.m. Understanding How Undergraduate Physics Research Experiences Shape Identity Trajectories

Contributed – Gina M. Quan, University of Maryland, College Park, 082 Regents Drive, College Park, MD 20740; gina.m.quan@gmail.com

Chandra Turpen, Andrew Elby, University of Maryland, College Park

In this talk, we analyze the development of students' identity trajectories as undergraduate physics majors participating in their first research experiences. Students in the study participated in an elective seminar in which they were paired with graduate student and faculty mentors on physics research projects and participated in weekly discussions about research. Using video data from student interviews, classroom observations, mentor interviews, and research observations, we study how students' research experiences and their experiences in the classroom community impact their identities. Our analysis draws on sociocultural theories of learning to study how positional dynamics between students and other members of the physics community contribute to the legitimization and delegitimization of students' physics identities. In particular, we attend to how research group environments and a reflective classroom community provide unique opportunities for these interactions.

BD08: 3:10-3:20 p.m. Investigating Students' Peer Review Practices and Attitudes

Contributed – Scott S. Douglas, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332; scott.s.douglas@gatech.edu

Edwin F. Greco, Emily Alicea-Munoz, Michael F. Schatz, Georgia Institute of Technology

John M. Aiken, Potsdam GFZ Research Center for Geophysics

Our group has incorporated peer review of video lab reports into several flipped and online-only introductory physics courses at Georgia Tech, and in previous work we have demonstrated an improvement in student-expert grading agreement over the course of the semester. This talk presents our qualitative findings stemming from a series of interviews conducted with our latest group of laboratory participants from the summer of 2016. We discuss student-reported attitudes toward peer review and scientific communication, and describe the features of the peer review process which students considered most salient. In particular, we find that the interviewed students learned very quickly during the peer review process that the instructors were "harsher" or "more critical" graders than they themselves were, and so developed a practice of routinely revising downward the ratings they assigned to their peers.

Session BE: Tools to Support the Conceptual Understanding of Magnetism and Quantum Mechanics

Location: International 8
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Educational Technologies
Date: Sunday, February 19
Time: 2–3:40 p.m.

Presider: Andre Bresges

BE01: 2-2:30 p.m. A Visual Approach to Quantum Physics

Invited – Stefan Heusler, WWU Münster, Germany, Wilhelm-Klemm 10, Münster, 48149 Germany; sheus_01@uni-muenster.de

In view of the complexity of the basic concepts of quantum physics and its significance for many technological applications, it is an important challenge how to teach quantum physics at high school and introductory university level. In our session, we want to investigate the potential and the power of new media (apps, animations, simulations) in combination with model building and experimental approaches for teaching quantum physics. In my talk, I will present a new visualization sheme for the periodic table of elements, which is based on counting modes of standing waves in one, two, three and four dimensions. A projection to three dimensions naturally leads to orbital and spin contributions of the electrons. First teaching experience at high school has been investigated in a qualitative survey, indicating the possible benefit of this approach.

BE02: 2:30-3 p.m. A Multi-Representational Approach to Teaching Diamagnetism, Paramagnetism and Ferromagnetism

Invited – Daniel Laumann, Institut of Physics Education - University of Münster, Wilhelm-Klemm-Str. 10, Münster, 48149 Germany; daniel.laumann@wwu.de

Teaching magnetism at high school and inroductory university level is typically limited to ferromagnetism and electromagnetism representing the most common types of magnetism. Although 85 elements of the periodic table are contributed to diamagnetism and paramagnetism and many important applications such as superconductivity (diamagnetism) or magnetic resonance imaging (paramagnetism), these forms of magnetism are often neglected in physics education. Nevertheless, considering the quantum physical nature of magnetic phenomena diamagnetism and paramagnetism reveal a great opportunity to involve orbital and spin contributions of electrons in an immediately accessible context. The talk presents a phenomenological approach to experience diamagnetism and paramagnetism in classrooms. Including multiple representations such as digital media and real experiments the quantum physical nature of magnetism as well as amazing phenomena reveal a teaching concept that has been tested in a qualitative survey.

BE03: 3-3:10 p.m. Comparing Classical and Quantum Spin Angular Momentum

Contributed – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; rclose@classicalmatter.org

Quantum mechanics is universally understood as a probabilistic theory of particles with similarities to classical physics. However, the equations of quantum mechanics also form a deterministic theory describing the evolution of spin angular momentum density. To understand quantum mechanics, students need to understand spin. The classical analogue of spin is found in the theory of elastic shear waves. Orbital angular momentum is associated with wave propagation (i.e. derivatives of wave amplitude), while spin angular momentum is associated with rotational motion of the medium. In this presentation we will examine the classical spin equation in vector and Dirac form, show the associated Lagrangian, Hamiltonian, and dynamical operators, and investigate similarities between classical and quantum spin.
Website: www.classicalmatter.org

BE04: 3:10-3:20 p.m. A Conceptual Understanding of the Quantum Origins of Magnetism

Contributed – Kevin M. Rasch, Rockhurst University, 3701 NE Grant St., Lee's Summit, MO 64064; kevin.rasch@rockhurst.edu

Physics-hero Richard Feynman describes magnetism in his famous Lectures on Physics as " . . . a completely quantum mechanical phenomenon." Unfortunately, an understanding of magnetism that begins with the wave function and leads to the varieties of

magnetic phenomena is elusive because the details incorporate many-electron wave functions. I will show that introducing the Slater determinant form of the wave function incorporates the axioms of quantum mechanics and also simplifies the readability and interpretation of the wave function. From there I build a description of Heitler-Fritz bonding theory that focuses on conceptual understanding. This framework naturally introduces chemical bonding and provides insight into the origins of magnetism. This path through topics remains suitable to a modern physics course or can be adapted to quantum mechanics classes.

BE05: 3:20-3:30 p.m. The Effects of van Hove Singularities on Intrinsically Localized Vibrations

Contributed – Benjamin A. Agyare, Stockton University, 101 Vera King Farris Drive, Galloway, NJ 08205; Benjamin.Agyare@stockton.edu

Peter S. Riseborough Temple University

Intrinsically Localized Modes (ILMs) have purportedly been observed in NaI but only for wave-vectors, q at the corner of the 3-D Brillouin Zone. It has been suggested that, for high-symmetry q vectors, several van Hove singularities may converge at one frequency producing a large peak in the two-phonon density of state and giving rise to ILMs with these q values. We fit the experimentally determined acoustic and the optic phonon modes using a nearest neighbor and a next-nearest neighbor force constant. We find that the two-phonon density of states, for fixed q exhibits non-divergent van Hove singularities. The frequencies of these features are found to vary as q is varied. We intend to search for q values at which the two-phonon density of states is enhanced and then examine whether the anharmonic interactions can bind the two-phonon excitations to produce a quantized ILM.

BE06: 3:30-3:40 p.m. Leveraging the Eyeball in Relativity: Fast Running Clocks

Contributed – Joseph O. West, Indiana State University, Department of Chemistry and Physics, Terre Haute, IN 47803; Joseph.West@indstate.edu

Nathaniel Shanklin, Indiana State University

All observers, whether inertial or not, who share a location must agree about what they see as a reading on (and can take a picture of) any third clock in the universe. The arrival of the photons that make the image is a well-defined event. In a two-dimensional variation of the classic Twin paradox we focus on what the accelerated twin actually sees (or records as video) that will explain why she sees the inertial twin age quickly, when inertial observers traveling along any leg of her motion with her would measure and record that her twin's moving clock runs slowly. Students are intrigued by, but often overwhelmed by the list of measurements that observers do not agree on: slow asynchronous clocks; length contraction; and order of events. Working from knowledge based on what the observers must agree on is a useful tactic for helping students.

Session CA: Maker Spaces in K-12

Location: International 4
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Educational Technologies
Date: Sunday, February 19
Time: 4–5:40 p.m.

Presider: Amber Henry

CA01: 4-4:10 p.m. Using CK-12's Open Educational Resources to Increase Student Engagement

Contributed – Sonia Tye, CK-12 Foundation, 3430 W. Bayshore Road #101, Palo Alto, CA 94303; Sonia.tye@ck12.org

CK-12 offers a variety of open educational resources (OER) that can be accessed anytime, anywhere, and on any device—for free! CK-12 FlexBooks® are digital textbooks that can be customized to fit your specific course—delete chapters, re-order sections, embed videos, edit the text and even download or print them for offline access. CK-12 also features an interactive Concept Map that provides students with visual pathways for learning and highlights important connections between math and science. In addition, CK-12 offers an Adaptive Assessment tool and a large collection of digital interactives, including over 85 Physics Simulations (SIMs) and 250 PLIXs (Play, Learn, Interact, Xplore) that are all aligned with the Next Generation Science Standards (NGSS). Join us in exploring how this large collection of physics resources can help you cut down on the cost of expensive textbooks, update your curriculum, and engage students.

CA02: 4:10-4:20 p.m. Classroom Design Informs Physics Curriculum & Vice Versa

Contributed – Taoufik Nadji, nadjit@interlochen.org 3552 Faculty Ln., Interlochen, MI 49643; NADJIT@INTERLOCHEN.org

The presenter will share how his contribution to the design of his new physics classroom would inform his curriculum and how his adoption of the Modeling approach to teaching physics informed the design of the lab space. In addition, the presenter hopes that sharing such experience with fellow physics educators may help them as they contemplate remodeling or moving unto to new learning spaces.

CA03: 4:20-4:30 p.m. Establishing STEM SOS Innovation Labs in Texas

Contributed – Mehmet Gokcek, 9321 W Sam Houston Pkwy S, Houston, TX 77099; mgokcek@harmonytx.org

Many schools have been showing great efforts to creating Maker Spaces for the last couple of years. However, experience has shown that it becomes very hard for schools with limited academic resources to implement this concept efficiently. Proper consultations and training are highly required to turn Maker Spaces into a project-based learning heavens, where teachers and students know how to utilize the equipment safely and extensively. Some school leaders have also expressed reluctance towards investing thousands of dollars in such learning environments due to concerns related to successful curriculum implementation. I will be sharing my personal experience, as an educator previously and a consultant currently, with creating STEM SOS Innovation labs in Texas that primarily serve students, teachers and parents, where advanced tools and technology such as Laser Cutters, CNC Milling and Routing, 3D design, scanning and printing are utilized.

CA04: 4:30-4:40 p.m. Physics Lab to Maker Lab

Contributed –Yusuf Dogan, Harmony Public Schools, 14233 The Lakes Blvd, Apt 1337, Pflugerville, TX 78660; ydogan@harmonytx.org

There are different approaches and understandings of science. Some people think that science is just a facts of life. When you start asking a question to understand it, you will not have a chance to test it. This what science is for the some of the teachers and students in the school. This approach to the science is against human nature. Because humankind starts exploring laws science when they born. They start observations they start experimenting gravity, projectile motion, etc. All the times they want to make changes they don't want to follow just one way. That is how their imagination and understanding of life is developing. When I check the National Science Standards, I see that teachers should prepare the learning environment and nurture students high order thinking skills—Instead of just remembering students will create or make judgments about the information and use this information to make something. The teacher will facilitate this environment and let

students design, test, and represent their findings. I will show some examples on how you can turn your regular class to the physics as a Maker Class.

CA05: 4:40-4:50 p.m. Fabrication of a Scanning Ultrasound System to Locate Objects Inside a Maze

Contributed – Brandon Mayle, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Connor Bramham, Joshua Fair, Neal Gallagher III, Jason Cannon-Silber, Socrates Preparatory School

Allana Wheeler, Beacon College

Neil Narwani, VEI Systems

Using two Ultrasound sensors mounted on a single scanning axis with servo motor, we locate objects within a maze. The use of two sensors differentiates between walls and objects. The signals from the two sensors are physically isolated using 3D printed shrouds for each sensor. We discuss our hardware and software design challenges.

*Sponsor: Neal Gallagher II

CA06: 4:50-5 p.m. The Joy of Fabricating our Own Lab Equipment

Contributed – Bob Brazzle, Jefferson College, 1000 Viking Dr., Hillsboro, MO 63050; rbrazzle@jeffco.edu

Rex Rice, Clayton High School

The authors are fans of fabricating their own laboratory equipment. While one author achieves this primarily through traditional power tools, the talk will focus on the use of a MakerBot 3-D printer. Although the lab equipment that can be produced remains limited, this new technology holds tremendous potential. The presenter will describe several accessories he has created using AutoDesk Inventor and the MakerBot 3-D printer. We are preparing a paper to be submitted to The Physics Teacher that focuses on equipment we've made for a current balance laboratory. Similar equipment is available from a popular supplier for around $280.

CA07: 5-5:10 p.m. 3D Printing in Laboratory MakerSpace at Socrates Preparatory School

Contributed – Neal Gallagher III, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com

Brandon Mayle, Connor Bramham, Jason Cannon-Silber, Joshua Fair, Socrates Preparatory School

Allana Wheeler, Beacon College, Neil Narwani, VEI Systems

AutoDesk Fusion 360 - designed 3D parts printed using our Wanhao i3 printer are heavily utilized in our robotics makerspace. We will share our experiences in using these tools to fabricate specialized parts for our maze tracking robot and First Tech Challenge robot. Our makerspace is within the classroom itself. Details on our hardware and software tools, and how we incorporate them into our curriculum will be discussed.

CA08: 5:10-5:20 p.m. Combined Classroom and Laboratory MakerSpace at Socrates Preparatory School

Contributed – Jason Cannon-Silber, Socrates Preparatory School, Casselberry, FL 32707; nealcg@gmail.com*

Connor Bramham Socrates, Brandon Mayle, Joshua Fair, Neal Gallagher III, Socrates Preparatory School

Allana Wheeler, Beacon College, Neil Narwani, VEI Systems

Most high school teams competing in the FTC (First Tech Challenge) robotics competition have a dozen or more members and legacy equipment from several previous years of competition. Our team from Socrates Preparatory School started with six members and a workshop-classroom with a few essential machines, beginning our work by constructing and modifying a VEX Robotics kit. In this presentation we will discuss our modest makerspace and the process of working therein, with analysis of the challenges and advantages presented by working in such a small but tightly knit group.

*Sponsor: Neal C. Gallagher III

CA09: 5:20-5:30 p.m. Autonomous Maze Tracking Robot

Contributed – Joshua Fair, Socrates Preparatory School, 3955 Red Bug Lake Road, Casselberry, FL 32707; nealcg@gmail.com*

Neal Gallagher, III, Brandon Mayle, Connor Bramham, Jason Cannon-Silber, Socrates Preparatory School

Allana Wheeler, Beacon College, Neil Narwani, VEI Systems

In our classroom MakerSpace, using a 32 bit ARM Vex microcontroller, multiple scanning ultrasound sensors, and a gyroscope our team has designed a robot that finds an object in a complex maze and then carries the object out of the maze via the shortest route rather than simply retracing its path out. This presentation discusses the construction of the path tree as the robot traverses the maze, and how the tree is pruned to find the shortest path exiting the maze.

*Sponsor: Neal C. Gallagher II

CA10: 5:30-5:40 p.m. Creating Makerspaces in the Public K-12 Environment

Contributed – Cori C. Araza, Paradise Valley Unified School District, 3950 East Bell Road, Phoenix, AZ 85032; caraza@pvlearners.net

Participants will walk away with the knowledge to implement a plan to inspire active learners in Makerspaces. Creating a science and technology-rich environment can transform public spaces to spark interest in creation and design. See how it's done in a public high school as CTE and Academic courses bridge the gap between theory and application. Passion Projects and/or Genius Hour focus allow for true Project Based Learning. Cori Araza brings extensive experience in creating Makerspaces in the high school environment. This course is designed to explain how to start a Makerspace in a classroom, Media Center, or school environment. It will focus on how to cultivate active learning using technology, science education, and hands-on projects that inspire future problem solvers and critical thinkers. Using a design-thinking model, makers of all ages can participate in transforming the learning environment of their public educational institution.

Session CB: Astronomy Education Research

Location: International 5
Sponsor: Committee on Space Science and Astronomy
Date: Sunday, February 19
Time: 4–6 p.m.

Presider: Doug Lombardi

CB01: 4-4:30 p.m. Astronomy Students' Epistemological Beliefs Regarding Science: Research and Interventions

Invited – Shannon Willoughby, Montana State University, Barnard Hall 264, Bozeman, MT 59717; United States shannon.willoughby@montana.edu

Keith Johnson, Montana State University

Within the last several years, education researchers have begun to look into student epistemologies regarding the learning of science. Several studies have focused on courses taken by STEM majors. We chose to study non-STEM majors taking a lower level astronomy course, primarily because this course is one of their only science experiences typically required for such majors. Our goal was to measure changes in student epistemologies regarding the learning of science in our baseline (unchanged) course. After two years of

collecting baseline data using the Epistemological Beliefs about the Physical Sciences Survey, which measures five aspects of epistemological development. We then used the data to guide our reforms for the course. Data was subsequently collected for two more years in the reformed course. This talk will focus on the baseline and reformed course results, as well as materials developed to improve student epistemologies. Future work will also be discussed.

CB02: 4:30-5 p.m. Using Refutation Texts and Graphics to Teach about Seasonal and Climatic Change

Invited – Robert W. Danielson, University of Southern California, 20331 Spring St., Riverside, CA 92507; danielsr@usc.edu

Teachers, instructors, textbook publishers, and journalists often pair texts and graphics together. The reasons seem obvious enough — learners of all ages greatly appreciate the pairing, and one of the most common complaints about texts is that they don't contain enough pictures. Most assume that these pairings are beneficial, but this is not always the case. Across a number of investigations, we have examined how pairing texts and graphics can facilitate learning and conceptual change on topics including seasonal and climatic change. Our results indicate that refutation texts—texts that explicitly mention a commonly held misconception and then directly refute the misconception (for example, that the proximity of the Earth to the Sun causes seasonal change)—can be effective at promoting conceptual change. The relationship with graphical additions is less clear—our results indicate that for some graphics comprehension was enhanced and maintained over time, whereas for other graphics students noticed a conflict between the text and their prior knowledge but performed poorer on tests of comprehension. Our results indicate that text-graphic pairs are not interchangeable, and educators must think carefully on the graphics they choose to pair with texts to explain complicated concepts.

CB03: 5-5:30 p.m. Investigating Students' Ideas about the Fate & Curvature of the Universe

Invited – Kimberly Coble, San Francisco State University, 1600 Holloway Ave., Dept. of Physics & Astronomy, TH 334, San Francisco, CA 94132; kcoble@sfsu.edu

Mallory Conlon, University of Illinois Urbana-Champaign

Janelle M. Bailey, Temple University

Lynn R. Cominsky, Sonoma State University

As astronomers further develop an understanding of the fate and curvature of the universe, it is essential to study students' ideas so that instructors can communicate the field's current status more effectively to their students. In this study, we examine undergraduate students' pre-instruction ideas in general education astronomy courses (ASTRO 101) at five institutions through pre-course surveys given during the first week of instruction [N ~ 250]. We also examine students' post-instruction ideas at a single institution through exam questions [N ~ 60] and interviews [N = 9]. Responses are analyzed through an iterative process of identifying self-emergent themes. We examine not only what students think the fate of the universe and the curvature of the universe are, but also "how we know."

CB04: 5:30-6 p.m. Improving Astronomy Literacy through Science Fiction Writing and Media

Invited – Donna L. Governor, University of North Georgia, 212 Azure Road, Dahlonega, GA 30533; donna.governor@ung.edu*

The Launch Pad writers workshop is an intensive, week-long retreat for writers of science fiction media hosted by the University of Wyoming. The goal of this program is to improve the content knowledge of authors, screen writers, and editors so that they are better able to present accurate astronomy concepts in their writing. Data from a recent program evaluation shows that these authors improved not only their understanding of astronomy concepts, but became more confident in their ability to present accurate science to their audiences. As a result of the workshop the attendees improved their self-efficacy in incorporating astronomy in their work, and were better able to illustrate how astronomers do science to the public.

*Sponsor: Doug Lombardi.

Session CC: New Resources and Pedagogy for the IPLS Course

Location: International 6
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, February 19
Time: 4–6 p.m.

Presider: Juan Burciaga

CC01: 4-4:20 p.m. IPLS-Portal: An Open Curated Resource for Building IPLS Classes

Invited – Edward F. Redish, University of Maryland, Department of Physics, College Park, MD 20742-4111; redish@umd.edu

There is great interest in both the physics and biology education[1] communities in a physics class that serves the need of biology and pre-health-care students. The NSF has been supporting the creation of materials for introductory physics for the life sciences (IPLS) for more than 15 years. An AAPT-sponsored conference on IPLS classes[2] drew 120 attendees, more than 50 of whom submitted syllabi or materials. Under a new NSF grant, AAPT, together with eight colleges and universities[3] will create IPLS-Portal, a website that combines the rich trove of already existing materials from multiple NSF-funded projects with a structure that will allow developers to submit new work for peer review, evaluation, and inclusion. Its course-building interface will allow instructors to create innovative and individualized courses tuned to their needs, mixing and matching from multiple sources.*

1. Vision and Change in Undergraduate Biology Education: A Call to Action (AAAS, 2009). [2] Conference on IPLS, March 14-16, 2014, Arlington VA [http://www.compadre.org/ipls] [3] U. of Maryland, George Washington U., U. of New Hampshire, Mercy College, Rockhurst U., Swarthmore College, Portland State, Montgomery College

* This work supported by US National Science Foundation grant DUE 16-24478.

CC02: 4:20-4:40 p.m. Vision and Change in Introductory Physics for the Life Sciences

Invited – Simon Mochrie, Departments of Physics and Applied Physics, Yale University, New Haven, CT 06520; simon.mochrie@yale.edu

Our department offers a re-imagined calculus-based introductory physics for the life sciences (IPLS) course, based on a selection of topics, that are relevant and meaningful to biology and premedical students, and permit them to acquire a number of key competancies, specified by the biology community. The overarching course goals are to: (1) introduce students to physical and mathematical principles and tools, that will enable a deeper scientific understanding of biological systems, including our bodies; (2) demonstrate the application of physics and mathematics to the life sciences and medicine via authentic examples; (3) seed an appreciation of the power of these approaches in biology and medicine; and (4) transform IPLS into an engaging subject, appreciated by students and faculty alike as essential to every biologist's undergraduate education. This presentation will describe our syllabus, and curricular materials, that will enable IPLS instructors to teach a similar course at their own institutions.

CC03: 4:40-5 p.m. Biomedically Inspired Physics Lab Activities for IPLS*

Invited – Ralf Widenhorn, Portland State University, Department of Physics, SRTC, 1719 SW 10th Ave., Room 134, Portland, OR 97201; ralfw@pdx.edu

Elliot Mylott, Portland State University

Too often IPLS students find it hard to relate to the material in both lecture and lab courses. However, there is currently much momentum in the physics teaching community to change this. Our approach is to teach physics starting with a medical authentic application and spark students interest in physics by making it relevant to them and their career goals. Here, we present a suite of lab activities that can be used in introductory physics or intermediate level physics courses for life science students interested in medical applications of physics. The labs emphasize the importance of physics concepts centered around electromagnetism and waves in medical technology. They aim to teach the physics of medical technology, which often uses ionizing radiation and expensive equipment, in a safe environment and at a relatively low cost that makes it affordable to setup multiple experiments in an undergraduate lab course.*This work was supported by grants (DUE-1141078 and DUE-1431447) from the National Science Foundation.

CC04: 5-5:20 p.m. IPLS Resources Inspired by TPT: Cross-Pollinating with AAPT's K-12 Efforts

Invited – Rebecca E. Vieyra, American Association of Physics Teachers, One Physics Ellipse, College Park, MD 20740; rvieyra@aapt.org

Caroline Hall, American Association of Physics Teachers

Learn about the AAPT's efforts to develop a coherent series of interdisciplinary lesson templates (including IPLS topics) inspired by articles published in *The Physics Teacher* journal, and supported by vetted collections of free, high-quality digital resources through comPADRE.org. In this session, hear from AAPT's K-12 Program Manager about at least four existing lessons appropriate for high school and introductory college students dealing with DNA modeling and diffraction, the nervous system and simple circuits, hydrostatic weighing and percent body fat, and flight physics and biomechanics, among others. Also hear from AAPT's comPADRE Content Manager about the development of Digi-Kits that support these activities with additional resources to deepen both students' and teachers' understanding of biological and physical topics. Opportunities for featuring your own IPLS-related work in this efforts will be discussed. Find IPLS-related TPT articles, associated student and teacher worksheets, and Digi-Kits at http://aapt.org/K12/All-Lessons.cfm.

CC05: 5:20-5:30 p.m. An Innovative, Interactive Course Solution for Algebra-based College Physics

Contributed – Michael J. Tammaro, University of Rhode Island, 2 Lippitt Rd., Kingston, RI 02881; tammaro@uri.edu

I will present an innovative, interactive online environment through which the student is actively engaged with the course content. The interactive pieces include concept questions, practice problems, interactive examples, videos, animations, click-to-open footnotes, and additional examples. The robust hints that accompany the assessment pieces, as well as the pop-up glosses, take the pedagogy to a new level, as the online environment is fully exploited in this first-of-its-kind product. With interactive questions embedded with the reading, and the usual compliment of assignable end-of-chapter problems, along with innovative tracking tools, the instructor has an excellent vantage point from which to track and evaluate student progress.

CC06: 5:30-6 p.m. An Investigation of Peer Tutoring in an IPLS Course

Poster – Sarah Durston Johnson, Simon Fraser University, Dept of Physics, 8888 University Drive, Burnaby, BC V5A 1S6 Canada; sjohnson@sfu.ca

Stephan Struve, Azadeh Akhtari Zavareh, Simon Fraser University

In the fall of 2014 the Physics Department at Simon Fraser University began a peer tutoring program to support the students enrolled in our two IPLS courses. Four undergraduate students who earned high grades in these courses were recruited to be volunteer peer tutors and run weekly drop-in tutoring sessions. We specifically chose students majoring in the life sciences and/or planning to attend medical school so that they would be true peers to the students in these courses. In the spring of 2016 we conducted a study to determine the impact of this peer tutoring program on both the students being tutored and the tutors themselves. We surveyed and conducted focus groups and interviews with both tutors and tutees. In addition we looked at the impact of peer tutoring on the academic performance of students who attended tutoring sessions. The results of these investigations will be presented.

CC07: 5:40-6 p.m. Biologically Oriented Lab Experiments at the St. Louis College of Pharmacy

Poster – Juan Rodriguez, St. Louis College of Pharmacy, 4588 Parkview Place, Saint Louis, MO 63110; Juan.Rodriguez@stlcop.edu

St. Louis College of Pharmacy recently added an IPLS course to support a new undergraduate major in Health Sciences. This presentation details some of the unique lab experiments that have been developed for this course. They include experiments on the physics of: diffusion (modeling and experimental); protein folding (Python coding and Molecular Dynamics simulations); thermoregulation, DNA electrophoresis; drug metabolism; spectra of bio-molecules. Additional experiments under development include nerve impulse propagation in worms and PET imaging using coincidence counting.

CC08: 5:30-6 p.m. Community Development of IPLS Course Materials

Poster – Juan R. Burciaga, Bowdoin College, Dept. of Physics & Astronomy, 8800 College Station, Brunswick, ME 04011-8448; jburciag@bowdoin.edu

Recently AAPT and eight colleges and universities were awarded inter-linked IUSE grants to pursue a revolutionary next step in curricular design, development, and dissemination. The primary distribution structure for the newly developed curricular materials will be "IPLS-Portal" based in ComPADRE. The site will serve as a resource for professional development in educational scholarship; provide a development environment for curricular materials; maintain an archive of peer-reviewed and tested instructional materials; and serve as a dissemination outlet of instructional materials for diverse Introductory Physics for the Life Sciences (IPLS) courses. But its greatest contribution may be as a model of an online, community-driven (by IPLS faculty and educational researchers) environment for the research, design, development, archiving and dissemination of instructional materials.

CC09: 5:30-6 p.m. Improving Student Attitudes and Beliefs with Primary Literature

Poster – Mariel J. Meier, Oglethorpe University, 4484 Peachtree Rd. NE, Atlanta, GA 30319; mmeier@oglethorpe.edu

It is well established that the majority of students in IPLS courses exhibit novice-like beliefs about physics at the beginning of the course, and that those beliefs tend to degrade over time. This can effect content learning gains and attitude towards physics long-term. In the first-semester IPLS course at Oglethorpe University, we have attempted to address this problem by incorporating primary source literature readings into the curriculum. Articles are chosen that illustrate the application of course content to research in biology and related fields. Students are asked to discuss the articles in a journal-club style lecture period. Questions related to the readings are included on each midterm exam to promote student engagement with the texts. Student gains on the Colorado Learning Attitudes about Science Survey are used to measure attitudinal shifts towards physics over the course of the semester.

Session CD: Results of APEX (Alabama Physics Excellent) Professional Development Project

Location: International 7
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Date: Sunday, February 19
Time: 4–6 p.m.

Presider: Jim Minstrell

CD01: 4-4:30 p.m. APEX Statewide Professional Development Project

Invited – James H. Nelson, Santa Fe College, 6871 SW 89th Way, Gainesville, FL 32608; nelsonjh@ix.netcom.com

The Alabama Physics Excellence (APEX) Program includes a statewide physics teacher professional development program stressing physics content, implementation of state and national standards, instructional strategies based on physics education research, infusion of instructional technology, and action research. The APEX Program has provided professional development for almost 80 high school teacher and physics leaders with about 250 hours of professional development during three summer institutes and nine follow-up sessions. This introductory presentation will discuss the essential and unique aspects of the APEX Program including the curriculum used, content assessment, instructional features and infrastructure. This introductory presentation will set the stage for the talks to follow today which will emphasize the evaluation, implementation and impact of APEX Program including evaluation and impact on teacher content knowledge and confidence, classroom implementation, and student achievement.

CD02: 4:30-5 p.m. What Has APEX Done for Teachers and Students in Alabama?

Invited – Sheri Humphrey, Oak Mountain High School, 5476 Caldwell Mill Road, Birmingham, AL 35242; shumphrey@shelbyed.org

Dan O'Halloran, Alabama Science in Motion

Martina Norton, Vestavia Hills High School

"In this teacher's opinion, APEX has been the most effective professional development in 16 years of teaching." The program provides teachers with skills, labs, and activities that are effective in an inquiry-based learning cycle. Teachers learn how to recognize and deal with student misconceptions, and strengthen their own conceptual ideas of physics so that they can be more effective facilitators of learning. In addition, teachers have the opportunity to network, share ideas, reflect, and learn the value of Socratic questioning. Students in the program learn how to develop mathematical models for physical phenomena, learn how to reason and think critically, verbalize their ideas about physics, and learn physics by doing physics. The Alabama state Science in Motion (ASIM) regional physics specialist teachers have also participated in the summer and academic year workshops. They have been charged with redrafting activities, technology, and regional teacher training for consistency with the Alabama Course of Study (ACOS). In drafting those activities, they are using materials from AAPT/PTRA, from Diagnoser.com and from other sources.

CD03: 5-5:30 p.m. Classroom Effects of Physics Focused Professional Development

Invited – Dennis W. Sunal, University of Alabama, Box 870232, Tuscaloosa, AL 35487; dwsunal@bama.ua.edu

Cynthia S. Sunal, James W. Harrell, Marilyn Stephens, University of Alabama

Mohan Aggarwal, Alabama A&M University

Does in-service physics focused teacher professional development (PD) make a difference? The study investigated physics classrooms across a large intact state-wide population relating findings to teacher's experienced PD. As part of a larger mixed method study, classrooms were visited before and during the APEX PD program experiences. Results of the four-day visits found the physics focused PD fostered significant differences in the way physics teachers structured their classrooms, conducted teaching, and engaged students in learning. The findings were supported in each of the three parallel studies conducted using a convergent parallel research design. The results provided a unique picture of interrelated variables concurrently affecting physics teaching and implications for addressing in-service physics teachers' professional development needs.

CD04: 5:30-6 p.m. APEX Formative Assessment and Responsive Teaching: Online Implementation and Results*

Invited – Jim Minstrell, Facet Innovations, 1314 NE 43rd St, Ste 207, Seattle, WA 98105; jimminstrell@facetinnovations.com

Dan O'Halloran, University of Alabama, Huntsville, AL

One goal of APEX is to increase teachers' knowledge and use of learning research and pedagogical implications. During summer and follow-up workshops, learning research and related online Diagnoser.com tools have been shared with all three cohorts of teachers and specialists. Learning goals and problematic facets of student thinking have been shared with teachers. Over 80% of the teachers have used questions and discussions to elicit student thinking early in units and are using online question sets formatively to monitor student thinking within units and check for retention later in the unit or school year. This session will present results of student performance on the short question sets and extent to which these data are helping monitor effects of the APEX Program in promoting deeper student conceptual understanding.

*APEX is a National Science Foundation funded project. Project statements are those of authors and may not represent those of NSF.

Session CE: High School

Location: International 8
Sponsor: AAPT
Date: Sunday, February 19
Time: 4–5:30 p.m.

Presider: Hsiapo Kuo

CE01: 4-4:10 p.m. Science 100: A Three-Credit Course for High School

Contributed – Donald G. Franklin, Penfield College of Mercer University, 39 West Main St., Hampton, GA 30228; donfranklin8@gmail.com

By combining the four major sciences, which are linked together by interaction of Energy, a school can have a class that will enable the students to earn college credit for their work during the year, rather than taking an AP Test at the end of the year. This will also help teachers to gain Adjunct Faculty Status with their local colleges. The advantage is that the students explore all sciences, not just one for college credit. This will give smaller schools a chance to have their students earn college credit without having the AP class canceled for lack of numbers. This also helps the high school teacher to develop a cross-curriculum approach.

CE02: 4:10-4:20 p.m. Role of After School Clubs in STEM Learning

Contributed – Ismail Eroglu, Harmony Science Academy Houston High School, 9431 w Sam Houston Pkwy S, Houston, TX 77099; ieroglu@harmonytx.org

Many of the kids attending America's public schools have experienced limited success in math and science. They lack motivation to reach higher in these subjects because they do not understand how the material connects to daily life. We offered after school clubs, Momentum clubs, to create a demonstration project for implementing math and science enrichment that dovetails and extends existing curriculum. Stem clubs we have in our school are Shell Eco Marathon, Rocketry, Robotics, Underwater robotics. There are 72 students engaged in those clubs.

CE03: 4:20-4:30 p.m. 21st Century Skills and Physics Education

Contributed – Oguz Celik, 3171 North Sam Houston Pkwy W, Houston, TX 77038; celikoguz0@gmail.com

Rapid changes in the world—including technological advancement, scientific innovation, increased globalization, shifting workforce demands, and pressures of economic competitiveness—are redefining the broad skill sets that students need to be adequately prepared to participate in and contribute to today's society (Levy and Murnane 2005; Stewart 2010; Wilmarth 2010). NSTA acknowledges the need for and importance of 21st-century skills within the context of science education and advocates for the science education community to support 21st-century skills consistent with best practices across a preK–16 science education system. Because of that 21st century skills have to be hearth of today educational system. We have to align our curriculum according to 21st century skills. I want to introduce how I use 21st century skills in my physics classes.

CE04: 4:30-4:40 p.m. Teaching Friction with a Discrepant Event – Inseparable Phonebooks Lab

Contributed – Guven Yilmaz, Harmony School of Science Euless, 701 S Industrial Blvd., Euless, TX 76040; guvenyilmaz@gmail.com

While making a description for an interesting phenomenon, students should reorganize their justifications by using scientific explanations. However, the inadequacies of their own explanations of phenomena create cognitive conflict on the student's mind. This early conflict should be generated to reach students and help them achieve cognitive change. This study is designed to understand one of the discrepant events deeply, called inseparable phonebooks demonstration. While total force is used as a dependent variable during this experiment, numbers of pages and amount of interleave are used as two independent variables. This experiment can be conducted as an example to show the agreement between theoretical and experimental results along with the confounding variables.

CE05: 4:40-4:50 p.m. Engaging Students by Modernizing High School Physics Curriculum

Contributed – Amber D. Henry, Paradise Valley High School, 3950 E Bell Rd., Phoenix, AZ 85032; MrsAmberHenry@gmail.com

Many students have the perception that physics is only boxes on ramps and boring formulas from the 19th century. They believe there is nothing new or interesting going on in physics today. As teachers we must modernize our curriculum and show them today's exciting world of physics. Particle physics and relativity are perfect for instilling awe in our students. The common sentiment is that these topics are too complex for high school students. In this talk I will discuss the successful modernization of the physics curriculum at Paradise Valley High School and how you can utilize the work of places like CERN and LIGO to engage and excite students.

CE06: 4:50-5 p.m. Learner-Centered STEM Education for Physics Teachers

Contributed – Levent Sakar, Harmony Public Schools, 9321 W Sam Houston Pkwy S, Houston, TX 77099; lsakar@harmonytx.org

What do you get when you mix project-based deeper learning, STEM, college prep and personalized learning in a small supportive physics class? Getting Smart and Harmony Public Schools partnered to share more about "Learner-Centered STEM" model to inform and inspire others. I will share the seven blogs in the series that are bundled in a collection STEM SOS (Student on the Stage) model and explore Getting Smart's findings after visiting and working with teachers and leaders to discover and unpack 11 key elements of learner-centered STEM. Physics is the effective course to implement the "Learner-Centered STEM" model. I will also share videos and images of the impressive STEM SOS Physics projects that students create with support of their teachers and expert mentors and links to more information on the events, STEM festivals and competitions available to students.

CE07: 5-5:10 p.m. Building a High School Solar Car from Scratch

Contributed – Ali L. Dal, Harmony Public Schools - West Texas, 11500 Pellicano Dr. B-11, El Paso, TX 79936; adal@harmonytx.org

Building full-size Solar Car in a high school level course is a challenge! The presentation will be on a middle-high school STEM program named STEM SOS (Students On Stage) Model. The presenter will talk about how small projects lead them to build an advanced project in a short period. STEM SOS Model targets to increase students' learning and hands-on experience. Students become active contributors rather than passive listeners. The program has been applied in a school system with most of the students are coming from low-income families. In this session, the contributor will mainly focus on one group of students and how the program works in their school, obstacles they faced and how the engagement process took place.

CE08: 5:10-5:20 p.m. A Student e-portfolio

Contributed – Ramazan Ozdemir, 13100 West Bellfort Ave., apt. 832, Houston, TX 77099; United States ramazan.ozdemir.harmony@gmail.com

In our school system students have different levels of yearlong projects and in order to complete these yearlong projects each student needs to prepare an e-portfolio, which is an individual website including a self-produced video about their own project. I will be focusing on the one of the those e-portfolios. I will display a part of the remarkable YouTube recording made by one of my students in his student e-portfolio demonstrates Visualization of Gravity.

CE09: 5:20-5:30 p.m. Appropriate Challenge: Multi-level Practices in Inclusive High School Physics Courses

Contributed – Emily James, Brewster Academy, 80 Academy Drive, Wolfeboro, NH 03894; emily_james@brewsteracademy.org

Inclusion classrooms strive to establish learning environments that are age appropriate and meet the needs of all students, regardless of learning profiles or academic abilities. This diversity has been shown to present enormous problems for teachers as they try to appropriately challenge all students at the same time regardless of learning profile while still keeping the entire class moving forward through the curriculum. At Brewster Academy, our classes are inclusive, and attempts are made to level each curricula into three different groupings and match each student to the most appropriate level. After 15 years of developing and teaching multi leveled physics curricula, this talk will present several teaching practices, that effectively meet the needs of individual students within such a diverse learning environment. Specifically, the examples provided will be presented in the context of Newton's Laws and Projectile Motion.

Session CF: Introductory Labs/ Apparatus

Location: International 9
Sponsor: AAPT
Date: Sunday, February 19
Time: 4–6 p.m.

Presider: Sam Sampere

CF01: 4-4:10 p.m. Incorporating Deductive Inquiry into Traditional Labs: Lab Reformation and Assessment

Contributed – Rex N. Taibu, Queensborough Community College/ CUNY, 222-05, 56th Ave., Bayside, NY 11364; rtaibu@qcc.cuny.edu

Vazgen Shekoyan, Queensborough Community College/CUNY

Conceptual physics course is required for most if not all elementary education majors across the nation. Being pre-service teachers, such students need to be equipped with teaching skills that foster scientific inquiry in pupils. This project focuses on reforming conceptual physics labs from traditional to deductive inquiry labs. In a deductive inquiry lab, the instructor presents the important science concepts and theory early as established knowledge followed by exploration of the implications of the theory. This is unlike inductive inquiry where the science concepts and principles are generated out of explorations. We will argue for the need to introduce deductive inquiry as yet another form of inquiry and a theory-driven instruction that reflects an important but often overlooked characteristic of both science and engineering practices. We will report preliminary results regarding the evaluation (students' cognitive as well as affective domain achievement) of the reformed labs as compared to the traditional labs.

CF02: 4:10-4:20 p.m. Subtle Issues in the Bullet-Block Experiment

Contributed – David P. Jackson, Dickinson College, Dept. of Physics, Carlisle, PA 17013-2896; jacksond@dickinson.edu

The bullet-block experiment is a beautiful example of an introductory mechanics problem that most students answer incorrectly. The correct answer appears to violate energy conservation, so the situation comes across as somewhat paradoxical to students. Although the resolution to the paradox is fairly easy for students to understand, the details of what happens physically are not completely obvious. In this talk, I will explore some of the subtle features of this problem in an attempt to find out if it is possible to experimentally demonstrate what is really happening.

CF03: 4:20-4:30 p.m. Capacitor Labs Which "Parallel" Resistance Labs

Contributed – Paul R. Simony, Jacksonville University, 3511 Uphill Terrace, Jacksonville, FL 32225-4313; psimony@ju.edu

In the 2nd semester introductory physics course the Ohm's Law and Serial/Parallel Resistance labs are easy to perform and provide results which support fundamental notions of conservation of charge and energy. Two similar labs based on capacitors are a bit more difficult to perform and analyze, and provide results that are not as precise, but they provide students with the opportunity to practice numerical integration and reinforce charge and energy conservation laws.

CF04: 4:30-4:40 p.m. A Fan-tastic Alternative to Bulbs: Learning Circuits with Fans

Contributed – Robert Ekey, University of Mount Union, 1972 Clark Ave., Alliance, OH 44601-3993; USA ekeyrc@mountunion.edu

Brandon Mitchell, West Chester University

Andrea Edwards, Roy McCullough, William Reitz, University of Mount Union

This talk describes a novel hands-on experience of learning simple resistive circuits using low-voltage computer fans. The magnitude of current through a fan is related to the frequency of the rotating fan blades, which can be seen, heard, and felt, whereas the traditional bulb utilizes only vision. With incandescent bulbs being replaced by more efficient compact fluorescent light bulbs and light emitting diodes, students will become less familiar with incandescent bulbs. Without familiarity, the pedagogical value of using them to teach circuits decreases. Simply replacing incandescent bulbs with either CFL or LED bulbs is not viable because their brightness doesn't correlate to the current flowing through each bulb. Ultimately, small computer fans are widely accessible, affordable, and easy to use. These qualities make them an ideal replacement for incandescent light bulbs while, at the same time, keeping alive the pedagogical spirit that makes bulbs so successful.

CF05: 4:40-4:50 p.m. Arduino on a Rocket

Contributed – Jeffrey R. Groff, Shepherd University, PO Box 5000, Shepherdstown, WV 25443; jgroff@shepherd.edu

This talk will discuss the construction and use of an Arduino-compatible model-rocket payload to teach Newtonian mechanics in introductory physics. The custom-made payload is approximately 20-g and consists of a data logger, an Arduino-compatible microcontroller, an accelerometer, and a lithium-polymer battery packed into a film canister. This payload allows the rocket's acceleration to be sampled and logged during a launch. Using discrete approximations of the integral, this data can be used to estimate the rocket's velocity and position as a function of time. In addition, Newton's second law can be used to estimate the force and total impulse generated by the rocket's engine.

CF06: 4:50-5 p.m. Engineering DIY Sensors by STEM SOS Model

Contributed – Mehmet Gokcek, 9321 W Sam Houston Pkwy S, Houston, TX 77099; mgokcek@harmonytx.org

Would you build your own sensors for physics class? Recent developments in the tech industry and the White House "Computer Science For All" initiative proved that coding is the new literacy. We must have students in physics class design, build and code their own sensors while covering state or federal curriculum objectives. Part of a STEM SOS model we have developed an example one-week curriculum for a DIY parking sensor that can help understand how signals travel over a parallel and series circuit. Later the class is introduced to a challenge where they must analyze the pattern of the sound waves to develop a complete affordable parking system for a car. This creates a connection to Electromagnetic Spectrum as they try to visualize the range and pattern of the waves. There is also a daily life connection going to animal kingdom as kids look in to how bats find their ways even though they are visually impaired. Moreover the circuit can also include a cheap LCD screen to show numerical data on the proximity of objects, which can be applied to topics like speed and velocity. There will be more sample Arduino sensor circuit examples related to other concepts in physics such as optics, energy and thermodynamics. Participants will have the opportunity to have access to some of the resources. STEM SOS is a rigorous, interdisciplinary, standards-focused, and engaging STEM teaching approach that is teacher-facilitated, student-centered and directed through sets of project- and inquiry-based (PBL) projects.

CF07: 5-5:10 p.m. Development of a Radiation Detector in a Project-based Laboratory Course

Contributed – Joshua Hamblen, University of Tennessee-Chattanooga, MC 2352, Chattanooga, TN 37403; joshua-hamblen@utc.edu

We have developed a project-based component of an upper-level

laboratory course that is focused on the construction of a Geiger counter/cosmic ray detector. The design is based on simple, inexpensive electronic and detector components that are connected to a portable Raspberry Pi computer which serves as both the power supply and data acquisition system. The students participate in the entire design, construction, calibration, and operation of the detector. The overall project provides crucial introductory experience in electronics, computation, and radiation detection to the students.

CF08: 5:10-5:20 p.m. Using OSP-ComPADRE Simulations on Mobile Devices in Class

Contributed – Wolfgang Christian, Davidson College, 167 Catalina Dr., Mooresville, NC 28117; wochristian@davidson.edu

Colleen Countryman North Carolina State University

Francisco Esquembre Universidad de Murcia

Smartphones contain sensors that can be utilized to take data and to simulate realistic demonstrations. We have developed activities using the EJS authoring tool that take advantage of these sensors and students' familiarity with their devices: a friction block on an incline and a simple harmonic oscillator. We use a web browser to display these systems with annotations, such as force-body diagrams, that respond to device motion and orientation. Our simulations and activities are freely available in the Open Source Physics Collection on the AAPT-ComPADRE website. During class testing, we found that 70% of students like using smartphones/tablets in class and self-reported data indicates that they found the activities valuable, and believed that the activities aided their understanding of the course material. These data are being used to modify the user interface and the activities for additional class testing. Preliminary data and ways to implement mobile-device activities will be presented.

CF09: 5:20-5:30 p.m. An Introductory Online Laboratory Effort at Stony Brook University

Contributed – Nicole Cronin, SUNY Stony Brook, 41 Friendly Court, Babylon, NY 11702; nicole.cronin@stonybrook.edu

Thomas Hemmick SUNY Stony Brook

At Stony Brook University, we have piloted an online laboratory course in which students can take and analyze data all in the comfort of their homes. This is possible with the use of the iOLab device developed by Mats Selen and his colleagues at the University of Illinois. Eleven labs were produced for the first semester of the introductory laboratory course, four of which were unique to Stony Brook. Lab manuals and introductory videos were delivered to the students through the associated iOLab software. These online labs were proven to be much more accurate than the labs in the traditional in-class lab setting. The success of this class, in terms of student performance and motivation, was assessed through surveys, focus groups, and lab quizzes. Full implementation for the course is planned for the summer of 2017.

CF10: 5:30-5:40 p.m. Embedding Research in Undergraduate STEM Curricula: The NEIU PEERS Project

Contributed – Paulo H. Acioli, Northeastern Illinois University, 5500 N. Saint Louis Ave., Chicago, IL 60625; p-acioli@neiu.edu

Sudha Srinivas, Elisabet Head, Ken Nicholson, Rachel Trana, Northeastern Illinois University

We present results of the implementation of mini-research components in the Undergraduate STEM curriculum at Northeastern Illinois University (NEIU). These are results of a funded NSF-IUSE grant to engage students, enhance learning, and improve retention in STEM. The primary emphasis in the modified physics courses was in the research process. The first lab was to choose a research topic following the steps, inquiry, literature review, planning, viability, and execution. Two additional lab sessions were dedicated to the projects. The culmination was the report and an oral presentation. The topics covered on the first year of the proposal ranged from Earthquakes to Asteroid Collisions, and Magnetic Trains to Cancer Therapy. The students were encouraged to seek projects in their own discipline that had a strong physics component at the university physics level. The challenges and success of the implementation and assessment of learning gains for each course will be presented.

CF11: 5:40-5:50 p.m. Bring Your Own Equipment! Using Smart Phones in Introductory Physics Labs

Contributed – Toni Sauncy, Texas Lutheran University, 1000 West Court St., Seguin, TX 78155; tsauncy@tlu.edu

Under most circumstances, students are not allowed to use their communication devices during class. However, over the past two years, students in freshman physics labs have been encouraged to find new ways that smart phone functions can be used in the design and execution of lab experiments. Several examples for both the intro mechanics and intro E&M labs will be discussed.

CF12: 5:50-6 p.m. DIY Cellphone Spectrometer for Online Physics and Astronomy Labs

Contributed – Brian Geislinger, Gadsden State Community College, 1001 George Wallace Dr., Gadsden, AL 35902; bgeislinger@gadsdenstate.edu

With a majority of students now having access to smartphones, there are growing opportunities to leverage this technology for student labs, particularly in conjunction with online coursework. There is also a small but growing market of add-on devices that increase the data collection capabilities of these devices. We present a cheap and easy to assemble DIY spectrometer designed for smartphone cameras. The hardware design is open-source as is the accompanying analysis software—meaning that students can access this technology very cheaply on their own. We will share our experience in utilizing this technology for student labs in our online Introductory Astronomy course at Gadsden State Community College.

Session CG: Creating Inclusive Environments at Conferences – Panel

Location: International 10
Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Diversity in Physics
Date: Sunday, February 19
Time: 4–6 p.m.

Presider: Gina Quan and Ellie Sayre

Increasing inclusiveness and diversity in AAPT is a major focus of our professional community and is related to the mission of AAPT. Inclusiveness at national meetings is of particular importance given that conferences play a major role in shaping the direction of physics education, networking and idea-sharing, and other opportunities for professional development.

CG01: 4-6 p.m. The APS Code of Conduct & Inclusion at APS Meetings

Panel – Arlene Modeste Knowles, American Physical Society, One Physics Ellipse, College Park, MD 20740; knowles@aps.org

APS has a long history of developing initiatives to increase diversity within physics and improve the climate for women, underrepresented minorities, and recently, LGBTQ physicists. As APS has expanded its focus to become a more inclusive organization

in the U.S. and globally, it has simultaneously put increasing effort into organizing conferences that meet the needs of all attendees. As an outgrowth of this, this year, APS developed a Code of Conduct for APS meetings to communicate and bolster its commitment to inclusive conferences free from harassing behavior. I will discuss the development of the APS Code of Conduct, including its benefits and challenges, and the value of a strategic dissemination plan. I will also touch on the importance of professional societies providing pathways for members to communicate their needs. Finally, I will discuss issues to consider when organizing meetings specifically centered on physicists and physics students from marginalized groups.

CG02: 4-6 p.m. Cross-Disciplinary Perspectives of Creating Inclusive Scientific Communities

Panel – Christopher L. Atchison, University of Cincinnati, 2610 McMicken Cir., 511E TDC, Cincinnati, OH 45221; christopher.atchison@uc.edu*

Regardless of the discipline, the scientific community as a whole is not fully embracing the diverse abilities of those who have physical, sensory, and intellectual differences. Recent inclusion statements created and endorsed by the member societies of the Science Council (UK) and the American Geosciences Institute are bringing the issue to the forefront. However, traditional perspectives of most disciplines still pervade science communities marginalizing students who may be interested in pursuing a scientific career, or practitioners who are unable to continue contributing to the discipline due to degenerative ailments or catastrophic events. This presentation will discuss the impact of these inclusion statements, and also share ways in which the Geological Society of America is creating a more inclusive scientific community by using basic accommodation strategies at their annual meeting.

*Invited by Gina Quan and Dimitri Dounas-Frazer

CG03: 4-6 p.m. Developing a Code of Conduct for AAPT

Panel – Janelle Bailey, Temple University, 1301 Cecil B. Moore Ave, RH 435, Philadelphia, PA 19122; janelle.bailey@temple.edu

Beth A. Cunningham, American Association of Physics Teachers

Mary E. Mogge, California State Polytechnic Univ - Pomona

In 2015, AAPT leadership began discussing the need for a Code of Conduct to help support our members and curb inappropriate behaviors at our events. The Code was developed by first reviewing several others in existence and in development, such as those for other scientific/professional organizations. Multiple revisions were created and reviewed, with input first from the Board of Directors and later a lawyer specializing in harassment-related issues for nonprofit organizations. A small group of about 20 AAPT members were also invited to provide feedback on the developing Code. The final version was approved July 10, 2016, and unveiled at SM16 in Sacramento. Subsequent work has focused on roll-out and implementation, as well as the development of investigative and disciplinary procedures.

CG04: 4-6 p.m. Inclusivity through the Lens of Data & Policy

Panel – Ramon Barthelemy, American Institute of Physics, 1 Physics Ellipse, College Park, MD 20002; rbarthelemy@aip.org

Survey research is a powerful tool in uncovering issues of inclusivity and diversity. This talk will present equity data on physicists and physics students from the American Institute of Physics Statistical Research Center, as well as the literature. The AIP SRC has steadily uncovered inequities for women in physics across the globe. Coupled with a strong literature on LGBT and People of Color physicists, this presents a unique research lens to understand the barriers and challenges faced by certain groups in physics.

Session TOP02: Physics & Society Topical Discussion

Location: International 3
Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on the Interests of Senior Physicists
Date: Sunday, February 19
Time: 6–7:30 p.m.

Presider: Chuck Winrich

Join your colleagues for an informal discussion about physics-related societal issues such as climate change, energy use, nuclear power, nuclear weapons, resource extraction, and pseudoscience. Share your ideas about effectively teaching these issues and communicating such information to the general public, and hear what others are doing as well.

Session TOP03: Graduate Student Topical Discussion

Location: M106
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Sunday, February 19
Time: 6–7:30 p.m.

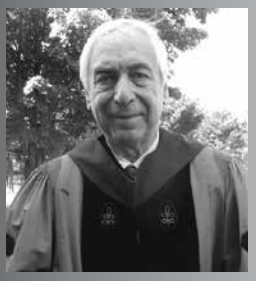
Presider: Daryl McPadden

This session is the primary opportunity for members of the PER graduate students community to meet and discuss common issues.

Awards Session

Location: Marquis Ballroom B
Date: Sunday, February 19
Time: 7:30–8:30 p.m.

Presider: Mary Elizabeth Mogge



Jay M. Pasachoff
Williams College
Williamstown, MA

2017 Richtmyer Memorial Lecture Award

Jay M. Pasachoff, Williams College, Williamstown, MA

Observing the Great American Eclipse of August 21, 2017

On August 21, a total solar eclipse's 70-mile-wide band of totality will sweep across the Continental United States from coast to coast for the first time in 99 years. The zone from which the partially eclipsed Sun will be visible includes all of the United States, Canada, and Mexico. But only during the 2+ minutes of totality will it get as dark as twilight and will the interesting solar phenomena—such as Baily's beads, the diamond-ring effect, and totality—become visible. At that time, the beautiful corona will show streamers and other structure, held in place by the Sun's magnetic field. The corona is about the same brightness as the full Moon and equally safe to look at. But before and after totality even in the band of totality, or off to the sides of the band where only a partial eclipse is visible, one can look safely at the Sun only with special partial-eclipse filters or by projection. Even when 99% of the Sun is covered, the remaining 1% is nearly 10,000 times brighter than totality (or the full Moon), so eye-protection precautions are needed. Still, seeing an eclipse in general and totality in particular is so exciting and so remarkable that it can be inspirational for students—not only causing some of them to go into science but also inspiring them about their other academic studies. Coverage in the U.S. will be over 70% of the solar diameter from Los Angeles and over 80% from Miami and New York, with 97% coverage from Atlanta, as the path of totality proceeds from Salem, OR, to Charlestown, SC; cloudiness statistics from decades of satellite images are available. I will not only describe the circumstances for viewing the 2017 eclipse, whether it is total or partial, but also show and discuss the beautiful images and spectra we have obtained at the most recent eclipses, including total eclipses in Easter Island (2010), Australia (2012), Gabon (2013), Svalbard (2015), and Indonesia (2016) as well as annular or partial eclipses observed elsewhere. My work at solar eclipses has recently been supported by the NSF and the Committee for Research and Exploration of the National Geographic Society, and I thank them both for research grants for our scientific studies of the 2017 total eclipse, including AGS-1602461 from the NSF and 987816 from National Geographic.

Come to Room L507 for some peace and quiet during the meeting!

* Relaxation
* Take a private phone call
* Prayer and reflection
* Lactation

Hours:

2/17 – 4:00 p.m. to 7:00 p.m.
2/18 – 7:00 a.m. to 10:00 p.m.
2/19 – 7:00 a.m. to 10:00 p.m.
2/20 – 7:00 a.m. to 10:00 p.m.
2/21 – 7:00 a.m. to 3:00 p.m.

Session TOP04: Two-Year College Issues

Location: International 3
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, February 20
Time: 8–9:30 a.m.

Presider: Joe Heafner

This session is an opportunity for two-year college physics and astronomy faculty to meet and discuss common issues, challenges, and possible solutions.

Session TOP05: Best Practices to Make Women Welcome in Physics Booklet

Location: International 4
Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Women in Physics
Date: Monday, February 20
Time: 8–9:30 a.m.

Presider: Karie Meyers

The AAPT and the CWP would like to publish a short monograph outlining the best practices for attracting girls and women to physics departments, helping them to succeed, and for supporting women physicists in general. This topical discussion will be a starting place for the planned booklet. We will try to define the scope of the booklet. Contributions of research on the subject will be welcome, and we hope to outline the project and form working groups for future work.

Session TOP06: Bring the 2017 Solar Eclipse into your Class!

Location: International 5
Sponsor: AAPT
Date: Monday, February 20
Time: 8–9:30 a.m.

Presider: Rebecca Vieyra

Join us for an interactive discussion on the upcoming 2017 total solar eclipse. We will provide a packet of research-based instructional materials utilizing the eclipse that can be used in pre-service teacher education, introductory physics and astronomy, or upper-division physics. We encourage participants to share any resources or approaches to instruction that you have on this topic. This effort is part of a Temple University / AAPT collaboration with the NASA Heliophysics Education Consortium.

PST1: Posters

Location: Marquis Ballroom Foyer
Sponsor: AAPT
Date: Monday, February 20
Time: 8–9:30 a.m.

Poster presenters are asked to mount their posters before 8 a.m. The posters should be taken down at 9:30 a.m. Persons with odd-numbered posters will present their posters from 8 to 8:45 a.m.; those with even-numbered posters will present from 8:45 to 9:30 a.m..

Astronomy

PST1A01: 8-8:45 a.m. The North American Solar Eclipse at Charleston, S.C.

Poster – Joel C. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, Charleston, SC 29409; berlinghieri@citadel.edu

Patrick R. Briggs, The Citadel

The August 2017 total solar eclipse will finish its path across the North American continent as it crosses into the Atlantic just north of Charleston, SC. Totality will last about two and a half minutes in our area. The Physics Department at The Citadel will be sponsoring undergraduate student developed experiments, conducting middle and high school safe viewing events, and presenting seminars open to the public.

PST1A02: 8:45-9:30 a.m. AER and PER Resources from the NASA Heliophysics Education Consortium

Poster – Ramon E. Lopez, University of Texas-Arlington, One Physics Ellipse, College Park, MD 20740; relopez@uta.edu

Janelle Bailey, Temple University / American Association of Physics Teachers

Shannon Willoughby, Montana State University

Ximena Cid, California State University - Dominguez Hills

Brad Ambrose, Grand Valley State University

Temple University, in coordination with the AAPT as a part of the NASA Heliophysics Education Consortium, has built a task force to develop astronomy and heliophysics resources for introductory and advanced astronomy and physics learning in higher education institutions (including for pre-service teacher education programs). High-quality resources have been developed based off of the work of the astronomy education research (AER) and physics education research (PER) communities. Early results from the task force's efforts will be shared, with special emphasis on resources developed to support content and skills associated with the upcoming summer 2017 total solar eclipse.

PST1A03: 8-8:45 a.m. Modern Eddington Experiment

Poster – William A. Dittrich, Portland Community College, PO Box 19000, Portland, OR 97280; tdittric@pcc.edu

On August 21, 1917 Eddington's experiment to verify gravitational lensing due to Newtonian and General relativistic shifts was attempted and failed. The second retry (1919) was successful and Einstein became an instant sensation worldwide. This famous experiment will be repeated exactly 100 years to the day later. This Modern Eddington Experiment (MEE) will be performed by faculty, undergraduate students, and citizen scientists at several locations along the 2017 eclipse path using modern amateur astronomical equipment. The recent availability of large pixel CCD cameras enable this experiment to be performed at an accuracy 20-100 times more accurately than all past attempts. The research method

and equipment will be discussed. What will you and your students be doing on August 21? For a reasonable sum, the equipment for the MEE can be purchased and your team can help improve the accuracy of this exciting multiple team experimental recreation, the Modern Eddington Experiment.

PST1A04: 8:45-9:30 a.m. Plans for the Solar Eclipse on August 21, 2017

Poster – Bob Powell, University of West Georgia, Department of Physics, Carrollton, GA 30118; bpowell@westga.edu

Ben Jenkins University of West Georgia

The first total solar eclipse visible in the southeastern United States since March 7, 1970 will occur on August 21, 2017. This eclipse will be observed at two locations. One is on campus in Carrollton, GA. About 95% of the solar disk will be covered at mid-eclipse. As a public service which has been a major role of the West Georgia Observatory since 1979, telescopes equipped with solar filters will be available for students, faculty and staff, and the community to observe the eclipse; photographs will be made of the partial eclipse. The second location is along the path of totality. Although the extreme northeastern section of the State of Georgia will be totally eclipsed, the most readily accessible locations from the campus are in South Carolina via I-20 or I-85. A group of West Georgia faculty and students will travel to the path of totality for observations and photography.

PST1A05: 8-8:45 a.m. Quasi-Static Plasma Flow Along the Pole of a Neutron Star

Poster – Kelli M. Little, Berry College, 2277 Martha Berry Hwy., Mount Berry, GA 30149; kelli.little@vikings.berry.edu*

Truong Le, Vedant Mehta, Brinkley Edge, Berry College

A neutron star is an astronomical object formed by the gravitational collapse of a massive star after a supernova. It is believed that a neutron star of a solar mass has a radius of about 10-16 km. The surrounding matter (plasma) ranges in temperature from 10^5–10^6 K, therefore possessing high electric conductivity while also attaining powerful magnetic fields with surface strengths ranging from 10^{12} – 10^{13} G. Consequently, the necessary consideration of both the gravitational and magnetic fields eliminates a solely hydrodynamic description of the accretion of matter towards the surface of a neutron star. This research investigates the accretion of matter as it flows from the space surrounding a neutron star to its surface along the magnetic poles using magnetohydrodynamics (MHD), utilizing both hydrodynamics equations and Maxwell's equations, through zero-order approximation. The results of the particles dynamics will be presented in this talk.

*Sponsor: Truong Le

PST1A06: 8:45-9:30 a.m. Using Interactive Java-free Web-based Interactive Simulations in Astro 101 Labs

Poster – Jeff Saul, Tiliadal STEM Education Consulting, 12200 Academy Road NE, Apt 312, Albuquerque, NM 87111; jsaul@tiliadal.com

Rebecca Lindell, Tiliadal STEM Education Consulting

Often Astronomy 101 courses include an associated indoor laboratory, which forces instructors to create indoor laboratory activities that allow students to take, and analyze data as well as visualize key concepts. We found the solution to this problem by utilizing web-based laboratory experiences that make heavy use of interactive simulations (applets embedded in webpages). Initially, the Java-based applets were either linked from other websites or incorporated into local webpages. Starting in 2013 Java security fixes started making it harder and harder to run the applets. In 2014 a student programmer began rewriting the applets in JavaScript and HTML 5. Almost all applets have been redone and include simulations for the inverse square law for stars of different luminosity, retrograde motion, the Milky Way galaxy, and identifying Cepheid Variable stars. This poster discusses the difficulties of creating the Java-free applets and how to use the applets in lab activities. Please find the online Astro 101 at http://physics.unm.edu/Courses/Rand/applets/ .

Labs/Apparatus

PST1B01: 8-8:45 a.m. Wind Tunnel Measurements in the Undergraduate Optics Laboratory

Poster – Joel C. Berlinghieri, The Citadel, Physics Department, Grimsley Hall, Charleston, SC 29409; berlinghieri@citadel.edu

Alexander C. Nagel, Jared W. Turnage The Citadel

Schlieren and shadowgraph optical techniques are used to visualize phenomena in transparent media. Qualitative and quantitative measurements are made on wind tunnel models as part of the undergraduate optics laboratory.

PST1B02: 8:45-9:30 a.m. Assessing Communication Skills in Laboratory Courses

Poster – Patricia E. Allen, Appalachian State University, Physics & Astronomy, Boone, NC 28608; allenpe@appstate.edu

As described in the AAPT Recommendations for the Undergraduate Laboratory Curriculum, a learning outcome is Communicating Physics— "present results and ideas with reasoned arguments supported by experimental evidence and utilizing appropriate and authentic written and verbal forms." During the capstone experiences at Appalachian State University, physics majors are required to communicate to departmental faculty multiple ways: formal written reports in AIP format, poster sessions, and oral presentations. Faculty evaluate student communication skills through in-house rubrics that are used both for generating student grades and assessing the health of the Physics and Astronomy program. Sample rubrics will be presented, along with areas in which students struggle when communicating physics to others. In addition, past and current efforts in the department to improve communication skills will be described.

PST1B03: 8-8:45 a.m. Common Difficulties in Causal Reasoning*

Poster – Lindsay Owens, The University of Cincinnati, 3843 Mantell Ave., Cincinnati, OH 45236; owensly@mail.uc.edu

Kathy Koenig, University of Cincinnati

Lei Bao, The Ohio State University

Students use causal reasoning in their everyday lives to generate hypotheses as to why an event occurred, or to create predictions about future events based on personal experience and/or data. Yet, students in introductory physics labs quickly demonstrated difficulties in causal reasoning when interacting with story-based scenarios and data. Qualitative think-aloud interviews were conducted with a variety of both algebra-based and calculus-based students; students verbally reasoned through causal scenarios which featured causal mechanisms, covariation data, or both. Students were categorized into low, medium, or high reasoning subgroups using additional questions given as part of a pre-test in the laboratory class. Common difficulties were noted among the group of students with low-causal reasoning skills, while a different set of difficulties were noted among the group of students with medium-causal reasoning abilities. Identification and frequency of these difficulties within each level of causal reasoning will be presented.

*This work is supported in part by NSF IUSE DUE 1431908.

PST1B04: 8:45-9:30 a.m. Including Wrist Flexion in the Human Arm Model Changes Everything!

Poster – William B. Laing, Southern Adventist University, PO Box,

Collegedale, TN 37315; LAING@SOUTHERN.EDU

Austin Johnson, Albert Gonzalez, Chris H. Hansen, Southern Adventist University

Does your introductory physics laboratory experiment that analyzes the human arm as a lever assume an inflexible wrist? If so, the analysis of the biceps force required to perform a biceps curl will lead to results that contradict experience: one does not expect the required biceps force to decrease as the mass is raised. We will show that allowing for wrist flexion leads to agreement with empirical data: that the required force does increase as the mass is raised if the wrist angle is allowed to be optimal.

PST1B05: 8-8:45 a.m. Lab Activities Developed for Introductory Physics*

Poster – Dwain M. Desbien, 3000 N Dysart Rd., Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

Thomas L. O'Kuma, Lee College

Twenty-five laboratory activities for introductory physics were developed by groups of two-year college and high school physics faculty during the last five years. In this poster, we will describe the process used, the testing and editing that was done, and list the 25 lab activities. The lab activities are available online for free and are modifiable to fit local needs. Examples of the labs will be available for viewing.

*Developed as one of the main components of the ATE Physics Workshop Project (NSF Grant #1003633)

PST1B06: 8:45-9:30 a.m. Learning Circuits With Fans

Poster – Robert Ekey, University of Mount Union, 1972 Clark Ave., Alliance, OH 44601-3993; ekeyrc@mountunion.edu

Brandon Mitchell, West Chester University

Andrea Edwards, Roy McCullough, William Reitz, University of Mount Union

This poster demonstrates a novel hands-on experience of learning simple resistive circuits using low-voltage computer fans. The magnitude of current through a fan is related to the frequency of the rotating fan blades, which can be seen, heard, and felt. Sample combination fan circuits will be demonstrated and compared to traditional incandescent bulb circuits. With incandescent bulbs being replaced by more efficient compact fluorescent light bulbs and light emitting diodes, students will become less familiar with incandescent bulbs. Without familiarity, the pedagogical value of using them to teach circuits decreases. Ultimately, small computer fans are widely accessible, affordable, and easy to use. These qualities make them an ideal replacement for incandescent light bulbs while, at the same time, keeping alive the pedagogical spirit that makes bulbs so successful.

PST1B07: 8-8:45 a.m. Ohm's Law and I-V Characteristics with Current and Voltage Sensors

Poster – Ponn Maheswaranathan, Winthrop University, Department of Chem/Phys/Geol, Rock Hill, SC 29733; MAHESP@WINTHROP.EDU

Ohm's law is introduced with electric circuits in introductory physics courses. In the laboratory it is verified and unknown resistances are determined by measuring the voltage across and the current through them. Current-Voltage (I-V) characteristics of diodes are introduced as an extension but seldom in the laboratory due to its complexities in measuring small currents and voltages, simultaneously. Observing and studying the I-V characteristics is much easier and straightforward with currently available interfaces and current & voltage sensors in an introductory physics laboratory. We use PASCO's 850 interface with its current and voltage sensors to observe the I-V characteristics of various circuit elements with ease and elegant results are obtained. The "Keep Mode" feature of the Capstone software is used to control the data. Data and curves are displayed instantly as the current and voltage are changed using a variable power supply. Current-Voltage characteristics of a resistor, an incandescent light bulb, and a silicon diode will be presented.

PST1B08: 8:45-9:30 a.m. Simulated Research Experiences as an Alternative to the Mechanics Laboratory

Poster – Robert P. Jaspersohn, Clarkson University, 8 Clarkson Ave, Box 5820, Potsdam, NY 13699-5557; jasperrp@clarkson.edu

Michael Ramsdell, Joshua Geary, Clarkson University

We have developed a project-based alternative to the traditional introductory mechanics laboratory course, including a semester-long "simulated research experience" where students analyze all aspects of a dynamics problem, including experimental design, mathematical modeling, and numerical prediction. Teams of students complete a progression of laboratories that explore different aspects of a single problem throughout the semester. The mechanical problem includes analysis of the motion of a foam dart fired from an elastic launcher. The role of the spring force, launch angle, release position and air resistance on the dart's flight is investigated. These parameters are employed to predict the dart's trajectory. Finally, teams compete in a series of challenges to see who most successfully predicts the performance of their dart launcher. Challenges include striking a bull's-eye, clearing a barrier, and colliding with a pendulum. Implementation and assessment of simulated research experiences as an alternative to the traditional laboratory will be presented.

Lecture /Classroom

PST1C01: 8-8:45 a.m. Create Better Working Teams in Introductory Classes with Cooperative Learning

Poster – Jeff Saul, Tiliadal STEM Education Consulting, 12200 Academy Road NE, Apt 312, Albuquerque, NM 87111; jsaul@tiliadal.com

Rebecca Lindell, STEM Education Consulting

Robert Beichner, North Carolina State University

Many introductory physics courses now incorporate student in-class teamwork. Commonly these in-class activities can range from Peer Instruction (polling with discussion) to more open-ended activities such as actual hands-on activities. However, in many classes, the student teams perform more like teams playing pick-up games of basketball rather than teams that practice working together well. To create better working teams in introductory physics classes, we applied the five key elements of cooperative learning: Positive Interdependence, Individual Accountability, Face-to-Face Interaction, Interpersonal Skills, and Group Reflection to develop in-class activities including brainstorming, team contracts, group roles, cooperative problem solving, and jigsaw activities. We have also applied these strategies to the other aspects of the course, including classroom design and classroom management techniques. Although optimized for SCALE-UP classes, many of these activities can be used in more traditional introductory physics and astronomy classes.

PST1C02: 8:45-9:30 a.m. Kirchhoff's Rules: Fundamental Principles vs. Rules of Thumb

Poster – Mikhail M. Agrest, The Citadel, 87 Droos Way, Charleston, SC 29414; MAgrest@Citadel.edu

Educating is creating ability to draw conclusions. Success in English 101 doesn't make a World Writer, neither Physics 101 is expected to make a Rocket Scientist. Narrowing Teaching to practical applications as apposed to comprehending the Fundamental Principles, may lead to "Rules of Thumb" sometimes resulting into misconception. "Know How guarantees a Job, Know Why makes

the Boss." The Kirchhoff's rules imply fundamental concepts of conservation of Energy and Charge into practical algorithms[1-4] for solving electrical circuits. It is important that students understand the concepts behind the formulas for parallel and/or series connections of elements. Unnecessary oversimplification of the algorithm for the general case can form rules of Thumb, which in turn lead to misunderstanding of the fundamental concepts, and therefore polluting the world outlook with pseudo-concepts.

1-4. M. Agrest. Lectures on Introductory Physics I&II; Lectures on General Physics I&II, Thomson /Cengage/ Learning. ISBN 1426625596; 0-759-39304-4; 0-759-35047-7; 0-759-36060-X; 2005-7

PST1C03: 8-8:45 a.m. Is Angular Displacement a Vector Quantity

Poster – William A. Dittrich, Portland Community College, PO Box 19000, Portland, OR 97280; tdittric@pcc.edu

Leonid Minkin, Robert Drosd, Portland Community College

Alexander Shapolov Saratov State University Russia

There are many reasons why angular displacement cannot be considered to be a scalar quantity. A new vector definition of angular displacement is introduced. The many reasons why this definition should be adopted in undergraduate physics courses is discussed, and the reasons why this misconception has persisted for over a hundred years. Like mathematics, physics pedagogy must be consistent from the very basic definitions to the advanced theories. It is argued that presenting angular displacement not only corrects these inconsistencies, but it is a far better way to teach rotational kinematics and dynamics.

PST1C04: 8:45-9:30 a.m. With All Due Respect: Physics Students Speak to Physics Teachers

Poster – Paul Hutchison, Grinnell College, Steiner Hall - 1120 Park St., Grinnell, IA 50112; hutchiso@grinnell.edu

Christian Clark, Jessica Daly, Jason Jennings, Major May, Elizabeth Nelson, Rachel von Holst, Grinnell College

The primary authors of this study are six undergraduate students who took a non-traditional introductory physics class. The class is a type that some call a "responsive science class". We will briefly describe the characteristics of the class. Then we present our investigation into aspects of the class that were important to our positive experience in it. We collected and analyzed after-the-fact reflections on the course written by us and a couple of other students from our class. Three key themes emerged in our analysis of those reflections: the importance of learning to talk about our understanding, the role of changing our expectations about knowledge, and truly collaborative inquiry. We make the case physics students at all levels will benefit if more physics teachers incorporate aspects of responsive science teaching in their pedagogy.

Other

PST1D01: 8-8:45 a.m. The NEIU Peer Enhanced Experiential Research in STEM (PEERS) Project

Poster – Sudha Srinivas, Northeastern Illinois University, 5500 N. St. Louis Ave., Chicago, IL 60625; s-srinivas@neiu.edu

Paulo Acioli, Elisabet Head, Joseph Hibdon, Rachel Trana, Northeastern Illinois University

Northeastern Illinois University, a comprehensive public Hispanic serving institution in Chicago, recently received a National Science Foundation Improving Undergraduate STEM Education (NSF IUSE) grant to enhance the academic engagement and learning experience of its undergraduate STEM majors. The PEERS project is a cross-cutting, curricular initiative that embeds open-ended enquiry-based mini "research" modules into entry-level courses in Physics, Chemistry, Earth Science, Mathematics and Computer Science, using a scale-up, scale-down strategy of engaging a larger group of students in guided research activities within a classroom setting through mini research projects incorporated across the curricula. Students from upper-level courses are selected to serve as peer leaders in the PEERS modified courses, are trained in peer led team learning through a new multidisciplinary STEM workshop course and guide students through discussions, activities and research. Results from the first round of implementation and assessments of learning gains in the modified courses will be presented.

PST1D02: 8:45-9:30 a.m. An Emerging Scholars Program (ESP) Engaging Underrepresented Students*

Poster – Joshua M. Grossman, Department of Physics, St. Mary's College of Maryland, 47645 College Drive, Department of Physics, Saint Marys City, MD 20686; jmgrossman@smcm.edu

Erin K. De Pree, St. Mary's College of Maryland

St. Mary's College of Maryland offers an Emerging Scholars Program (ESP) to first-year students in physics, along with ESPs in other STEM disciplines. The physics ESP targets underrepresented groups in physics, including women, members of racial/ethnic minorities, low-income students, and first-generation students, along with students taking calculus concurrently with physics. These programs support and engage students by involving them in collaborative work to solve problems more difficult than those discussed in class, by connecting students through social networks, and by encouraging them to establish relationships with faculty. ESPs are modeled on programs started at UC Berkeley by Uri Treisman. ESP programs at St. Mary's and across the nation have improved persistence and success relative to students with equivalent backgrounds who do not participate in an ESP. *Support from NSF S-STEM grant DUE-1154315.

*Support from NSF S-STEM grant DUE-1154315

PST1D03: 8-8:45 a.m. Equity in the IMPRESS Program

Poster – Florian Genz, University of Cologne, Albertus Magnus Platz, Cologne, 50923 Germany; Florian.Genz@uni-koeln.de

Ben J Archibeque, Eleanor Sayre, Kansas State University

Paul Hutchison, Grinnell College

Maxwell Franklin, Swarthmore College

We are interested in how student groups' minority composition affect how equitable their discourse is. We follow several case study groups, chosen to have a broad range of students, to operationalize how discourse may be equitable. We look for moments when individuals are included or excluded and how the prevalence of those moments can create a more or less equitable environment during activities. We compare these qualitative measures of equity with quantitative measures of who speaks when. We found that when white men are in a group they tend to marginalize other group members. The groups for our case study came from the IMPRESS program, which is a two week, pre-college program that prepares first generation and deaf/hard-of-hearing students to major in a STEM field. In this program, students focus on improving their metacognitive skills and cultural preparation for college life within a context of model building and climate change.

PST1D04: 8:45-9:30 a.m. Hiring a TEACHING Assistant Professor

Poster – Steven Iona, University of Denver, 2112 E Wesley Ave., Denver, CO 80208; steve.iona@earthlink.net

The University of Denver has established a non-tenure track Teaching Professor series with multi-year continuing contracts. The Physics and Astronomy Department recently made a new hire. The hiring process will be outlined including how we sought the video analysis of the teaching of others, comments about inclusive excellence, and the on-site teaching requests. This rigorous process by a team including a graduate student and teaching professor

from biology narrowed the field from over 100 applicants to our final candidate.

Technologies

PST1E01: 8-8:45 a.m. iPad Schlieren System

Poster – Bradley F. Gearhart, Buffalo Public Schools, 1982 Stony Point Rd., Grand Island, NY 14072; fizz6guy@yahoo.com

Dan MacIsaac, Buffalo State College

Allen Chan, Chris Kohler, Praxair

Using Schlieren imaging for visualizing transparent gas density variations provides unique opportunities where typically unseen phenomena are able to be imaged and experimented with in real time. Traditional Schlieren systems require expensive equipment (DSLR camera, telephoto lens, and several high-quality mirrors) and are difficult to set up. We outline a simplified approach to constructing a Schlieren system that uses only a single telescope mirror, an LED flashlight, and an iPad without any practical loss in sensitivity. Examples will be shown to highlight using this system to teach topics in high school science. This project was supported by Buffalo State College, Praxair, and the National Science Foundation (NSF)* funded Interdisciplinary Science and Engineering Partnership (ISEP) MSP project.

PST1E02: 8:45-9:30 a.m. Video Games Being Implemented Educationally in Physics and Teacher Preparation Classrooms

Poster – David Rosengrant, University of South Florida St. Petersburg, 140 USFSP Harborwalk Avenue South, St. Petersburg, FL 33701; rosengrant@usfsp.edu

Tracey Beyer, Philip Money, River Ridge High School

Berkil Alexander, Kennesaw Mountain High School

Video games whether console or desktop systems is a near $75 billion global market. Users spend on average about 24 minutes per day playing some type of game. This market is continuing to grow with virtual reality becoming cheaper and smart phones become more powerful. These games are a natural hook for many physics concepts and lessons since the games, to be realistic, adhere to the laws of physics. This interactive presentation shows: a) multiple ways to purposefully incorporate games into the classroom, b) student results on using games to supplement classroom instruction, and c) how pre-service candidates feel about using this in their own future classrooms. You will also learn how we created the lessons and vignettes so that you can use them in your own classroom.

PST1E03: 8-8:45 a.m. Integrating Programming into Modeling for Physics First

Poster – Rebecca E. Vieyra, American Association of Physics Teachers, One Physics Ellipse, College Park, MD 20740; rvieyra@aapt.org

Colleen Megowan-Romanowicz American Modeling Teachers Association

This poster will describe an ongoing pilot study by the AAPT, AMTA, STEMteachersNYC, and the Bootstrap team of Brown University to integrate computational modeling into Physics First courses using the Modeling Method of Instruction. Funded by both 100Kin10 and an NSF STEM+C grant, investigators of this project hypothesize that the use of computational modeling in the context of lower-grade, algebra-based Physics First courses improve underrepresented students' access to opportunities to learn and apply computational thinking practices in service of learning physics and solving physics problems. The first round of professional development for and curriculum development by 12 middle school and high school teachers occurred in the summer of 2016, and results associated with teacher change in computational skills and perceptions and initial implementation will be shared.

PST1E04: 8:45-9:30 a.m. Interacting with Simulated Charges and Fields via Augmented Reality

Poster – Steven Binz, 1514 Genesee St. Apt. 12, Utica, NY 13502; smbinz@utica.edu

Electric and magnetic fields can be difficult for students to understand because they cannot directly see the fields or physically manipulate individual charges. Computer simulations and videos have helped, however they have been limited to a 2D screen. Using recently developed augmented reality devices it is possible to assign real-world objects a simulated charge or current, and to see the changes in the fields as those values are changed or as the objects are moved around the room. The user can walk around the charges and currents to see the fields from any direction, as well as introduce simulated test charges. The intent is that student understanding will improve if the students can control the simulation intuitively and see the fields and forces in all three dimensions. Mixed reality recordings of the simulation will be shown and the limits and possibilities of the underlying technology will be discussed.

PST1E05: 8-8:45 a.m. Using iPads to Create Learner-Generated Physics Videos

Poster – Andrew J. Roberts, SUNY Buffalo State College, 16 Sheldon St., Norwich, NY 13815; mr.roberts.physics@gmail.com

Dan MacIsaac, David Abbott, Brad Gearhart, Kathleen Falconer, SUNY Buffalo State College

We describe the continual development of the iPad video physics project in the teacher preparation program at SUNY Buffalo State College. For the second consecutive summer, pre- and in-service teachers were tasked with explaining concepts and/or experiments through the creation of learner-generated physics videos. These bear many similarities to videos on the YouTube channels MinutePhysics and Veritasium, but conceptual learning is the intended outcome rather than professional quality. Videos are produced on the iPads using filming, editing, and voiceover features of apps like iMovie and iMotion. We will present and discuss suggestions, rubrics, guidance, and lessons learned for teachers wishing to assign and evaluate expository physics videos produced by students for credit. This work was supported by the NSF, SUNY IITG and the University of Cologne as well as SUNY Buffalo State Physics.

Plenary Session

Location: Marquis Ballroom B
Date: Monday, February 20
Time: 9:30–10:30 a.m.

Presider: Gordon Ramsey

Moogega Stricker

Mars 2020 Mission Overview and the Importance of Planetary Protection, by *Moogega Cooper Stricker,*

NASA's Jet Propulsion Laboratory, California Institute of Technology

The Mars 2020 (M2020) flight system consists of a cruise stage; an entry, descent and landing system (EDL); and a Radioisotope Thermoelectric Generator (RTG) powered roving science vehicle that will land on the surface of Mars. The M2020 Mission is designed to investigate key questions related to the habitability of Mars and will conduct assessments that set the stage for future human exploration of Mars. Per its Program Level Requirements, the project will also acquire and cache samples of rock, regolith, and procedural "blank" samples for possible return to Earth by a subsequent mission. The Planetary Protection Categorization letter assigned the M2020 Mission as a Category V Restricted Earth Return due to the possible future return of collected samples. As indicated in NPR8020.12D, Section 5.3.3.2, the outbound leg of a Category V mission that could potentially return samples to Earth, Mars 2020 would be expected to meet the requirements of a Category IVb mission. The entire flight system is subject to microbial reduction requirements, with additional specific emphasis on the sample acquisition and caching. Mars 2020 has a very unique biological contamination plan to both protect Mars as well as the scientific integrity of the collected sample. A mission overview and Planetary Protection activities will be discussed.

Session DA: Project-based Learning for Introductory Physics for Life Science

Location: International 7
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, February 21
Time: 11 a.m. –12:30 p.m.

Presider: Nancy Beverly

DA01: 11 a.m.-12:30 p.m. Incorporating Project-based Learning in a Competency-based IPLS course

Invited – Nancy Beverly, Mercy College, Mercy College, 555 Broadway, Dobbs Ferry, NY 10522; nbeverly@mercy.edu

The criteria for robust project-based learning includes projects with student voice and choice, authenticity, challenge, and connection to the larger world, with sustained student inquiry, reflection, critique, and revision. In addition, a course project should focus on the course learning outcomes and include skills such as critical thinking/problem solving, collaboration, and self-management. The project and competency-based IPLS course curriculum at Mercy College, serving pre-med, pre-vet, and pre-PT students, has been designed to incorporate as many project-based learning criteria as possible, to support students using introductory physics concepts and skills to probe the physical mechanisms of health and life phenomena they have authentic inquiries about. Summative final projects and formative mini-project assignments are used to assess student competence in the course learning outcomes. There are no exams. Curricular and assessment design, student project examples, and implementation challenges will be discussed.

DA02: 11 a.m.–12:30 p.m. Physics of the Body Student Projects

Invited – Nancy L. Donaldson, Rockhurst University, 1100 Rockhurst Rd., Kansas City, MO 64110; nancy.donaldson@rockhurst.edu

At Rockhurst University, we have been teaching our introductory physics classes with a relevance to medicine and healthcare for many years. In 2012, we received a collaborative NSF grant to develop Physics of Medicine active learning curriculum in Fiber Optics in Medicine, Physics of the Respiratory and Cardiovascular System and Nuclear Medicine and the Gamma Camera. Our emphasis on this type of learning has contributed to a growing number of students entering our major track in Physics of Medicine (POM.) We have developed a required two-semester project in our Physics of the Body I and II courses with an optional follow-up capstone for students to design, build and present a project that models a physical process based on physics principles. The students have excelled in these projects, demonstrating higher level critical thinking skills of analysis, evaluation and creation. Several of these projects and assessments will be shared in this presentation.

Session DB: Teaching Strong Gravity: Black Holes in the Classroom

Location: International 4
Sponsor: Committee on Space Science and Astronomy
Date: Monday, February 20
Time: 11 a.m.–12 p.m.

Presider: Amber Stuver

DB01: 11-11:30 a.m. Black Hole Basics

Invited – Deirdre Shoemaker, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332-0002; Deirdre@gatech.edu

Black holes capture the imagination. Sounding fantastical, these ultimate expressions of curvature are in reality one of the most important components of the Universe. I will give an introduction to both the theory of black holes and the evidence for their existence in the Universe. I will highlight their role in the recent discovery of gravitational waves by LIGO and discuss some of the compelling qualities that intrigue students of all ages.

DB02: 11:30-12 p.m. Supermassive Black Holes: The Powerful Engines of the Universe

Invited – Tamara Bogdanovic, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332-0430; tamarab@gatech.edu

Black holes are a best seller of the popular culture that continues to inspire curiosity for science and the universe we live in. They are also an active topic of scientific research from both observational and theoretical perspectives. I will summarize scientific evidence for existence of the supermassive black holes, their key properties, and will comment on the open questions in this dynamic research area of astrophysics.

Session DC: Effective Practices in Educational Technologies

Location: International 5
Sponsor: Committee on Educational Technologies
Date: Monday, February 20
Time: 11 a.m.–12:10 p.m.

Presider: Duncan Carlsmith

DC01: 11-11:10 a.m. Modeling PeerWise and CLAS Technologies in Secondary Physics Teacher Education

Contributed – Marina Milner-Bolotin, University of British Columbia, 2125 Main Mall, Scarfe Building, Vancouver, BC V6T1Z4 Canada; marina.milner-bolotin@ubc.ca

For the past seven years we have been experimenting with a wide variety of technologies in secondary physics methods courses at the University of British Columbia. Some of these technologies are well known (PhET simulations, data collection tool, sensors). While other technologies, despite being freely available, are rarely used in teacher education. We have collected data on the effectiveness of the pedagogies that incorporated these "new" technologies for supporting the development of Pedagogical Content Knowledge of future physics teachers. In this talk we will discuss two of these technologies: PeerWise – an online database for collaboration on multiple-choice questions developed at the University of Auckland, NZ; and Collaborative Learning Annotation System (CLAS) developed at the University of British Columbia. We will also share our tips on how these technologies can be incorporate more effectively and how future physics teachers can use these technologies in their own teaching.

DC02: 11:10-11:20 a.m. Effective iOS apps for Higher Education

Contributed – Shahida Dar, Mohawk Valley Community College, 1101 Sherman Dr., Utica, NY 13501; sdar@mvcc.edu

In this contributed talk I will focus on various iOS applications (for phones or iPads) that can be used in Higher Education Physics classroom and lab settings. These applications are designed to enhance students' learning experience through the use of mobile technology.

DC03: 11:20-11:30 a.m. A Model for Open-ended "Dorm Room" Physics Experiments

Contributed – Katherine Ansell, University of Illinois at Urbana-Cham-

paign, 1110 West Green St., Urbana, IL 61801; crimmin1@illinois.edu

Mats Selen University of Illinois at Urbana-Champaign

Recent technological developments have made it possible for students to do high-quality physics experiments in their homes, and instructors have developed distance learning and online hybrid laboratory materials that take advantage of these capabilities. At the University of Illinois, we have used online instruction to explore two different paradigms for physics experiments outside of the classroom: (1) A structured approach with prescribed experiments, designed to prevent students from making unchecked errors and (2) an open-ended approach where students are given room to explore a situation and tell their instructor what they think. In this talk we will focus on the implementation and results from the latter approach in a hybrid (online and classroom) laboratory course, including examples of open-ended experiment prompts and student responses to this style of instruction.

DC04: 11:30-11:40 a.m. Re-Creating On-Ground Lab Experiences for Online Students

Contributed – Sean M. Cordry, Walters State Community College, 500 Davy-Crokett Pkwy., Morristown, TN 37813; smcordry@ws.edu

Creating an on-ground lab experience for online physics courses can be difficult. The combined use of smart phone technology with carefully crafted spreadsheets goes a long way toward giving online students a parallel experience to that of their on-ground peers. Methods and techniques developed for use in a state-wide online campus context will be presented, as well as actual lab results obtained by online students.

DC05: 11:40-11:50 a.m. Integrating Typical Educational Games into Extended Curriculum

Contributed – Aryah Franklin, Legends of Learning 7747 Elmwood Lane Fulton, MD 20759 vadim@towerofknowledge.com

Vadim Polikov, Legends of Learning

Emily Tanner-Smith, Andrew Hostetler, Douglas Clark Vanderbilt University

In a study conducted in partnership with researchers at Vanderbilt University, "Substantial Integration of Typical Educational Games into Extended Curriculum," Dr. Polikov and four other researchers found that if teachers incorporated curriculum-aligned games across a three-week unit, the game-based learning curriculum significantly augment student learning (as compared to teacher-matched control sections). The study used a cluster-quasi-experimental design, with 13 teachers and 1002 students participating in the study and playing 55 games developed by 16 different game development companies. The results demonstrated significantly higher gains for the game condition in terms of multiple-choice, open-response factual outcomes, evidentiary depth, and student engagement outcomes. The games findings demonstrated the potential of typical games for enhancing instruction, particularly when combined with data from teacher surveys.

DC06: 11:50 a.m.-12 p.m. Charges in a Conductor and Gauss' Law

Contributed – Larry Engelhardt, Francis Marion University, 4822 E. Palmetto St., Florence, SC 29506; lengelhardt@fmarion.edu

I will present an activity developed for introductory calculus-based E&M for understanding the behavior of charges in a conductor and Guass' law. Students use a computer to simulate the equilibration of the charges in a conductor and to compute the net electric field, both outside and inside of a charged conductor.

DC07: 12-12:10 p.m. Capstone Projects Involving Computational Physics

Contributed – Jeffrey W. Emmert, Salisbury University, 1101 Camden Ave., Salisbury, MD 21801-6860; jwemmert@salisbury.edu

In an effort to provide students with experience in conducting open-ended research and communicating the results, every upper-division physics major at Salisbury University is required to develop and complete a capstone project prior to graduation. Limited equipment and funding, however, constrain these activities and provide some challenge in finding projects that are both educational and exciting, yet realizable. Several students have recently taken advantage of the low cost and ubiquity of computers to explore topics in computational physics with success. By sharing some of these projects and describing a couple of them in detail – one involving diffusion limited aggregation and another involving the chaotic dynamics of a compound double pendulum – I hope to spark ideas that you may in turn use with your students.

Session DD: Societal Influences on Students' Career Paths

Location: International 6
Sponsor: Committee on Diversity in Physics
Co-Sponsor: Committee on Teacher Preparation
Date: Monday, February 20
Time: 11 a.m.–12:20 p.m.

Presider: Ximena C. Cid

DD01: 11-11:30 a.m. Designing for Broadening Participation

Invited – Déana A. Scipio, TERC, 2067 Massachusetts Ave., Cambridge, MA 02140; deana_scipio@terc.edu

The dominant STEM broadening participation pipeline metaphor has key flaws: narrowing definitions of participation, creating drop-out narratives, and reifying existing paradigms. In this talk, Scipio explores the design and implementation of a layered learning environment intended to broaden participation in STEM by creating teaching and learning opportunities for youth and adults within an out-of-school time program. She conceives of broadening participation in two ways 1) increasing participation by peoples from non-dominant communities who are historically underrepresented in STEM and 2) broadening definitions of STEM participation. Using interviews and participant observations, she explores relationships between designed elements of learning environments and participant outcomes including new possible selves and identification with STEM domains. In particular, she discusses the concept of Deep Hanging, a way of learning in practice that led youth and adults to redefine participation within the context of a design-based research project.

DD02: 11:30-12 p.m. Mentoring, Networking, Support and Encouragement: How It Can Influence your Career Path?

Invited – Anitza M. San Miguel, Valencia College, 1800 Denn John Lane, Orlando, FL 34744; asanmiguel2@valenciacollege.edu

Students' career paths are influenced by a number of external factors such as mentoring, networking, and the support and encouragement they receive during their academic and professional journey. Researchers have found that these external factors can affect students' decision in paving their academic and professional careers. Mentoring can be very beneficial to a student especially when it includes multiple mentors. Networking is another important component which allows the student to learn from other individuals and it helps them create a personal connection that in the future might be helpful. The support and encouragement a student receives from their family and friends is also critical in helping the student persevere and succeed. This presentation will discuss how mentoring, networking and support and encouragement can influence students' career path.

DD03: 12-12:10 p.m. Environmental Impact on Students' Career Paths

Contributed – Michael J. Ponnambalam, M.Sundaranar University, Tamil Nadu, India, 7-40 Sannathi St., Vadakkankulam, Tirunelveli District, Tamil Nadu 627116 INDIA; michael.ponnambalam@gmail.com

In many countries, in the post World War II era, many bright minds chose STEM in high schools; some of these were attracted towards physics. However, that glow of STEM and physics seems to have evaporated in the late 1900s. Is there a correlation between the rise in materialism and the fall in interest in STEM and physics? In this connection, this author's experience in a few countries will be presented.

DD04: 12:10-12:20 p.m. Developing STEM Application of CANNED Food for Community

Contributed – Yusuf Karabalik, Harmony School of Discovery, 7202 Barker Cypress Rd, Apt 8206, Cypress, TX 77433; ykarabalik@harmonytx.org

"We CAN" is a friendly competition conceived to raise food for the Houston Food Bank, to help form a better connection between the Houston area Harmony high schools, and to provide the student body a unique opportunity to apply learned skills and serve the community. The competition involves a team from each campus building structures out of canned food goods. Each team member will pay a $20 fee to join the Club, $10 going to the CANstruction entrance fee and other expenses and the other $10 will be used to jump start their fundraising. Each team will be required to raise a specified amount ($500 minimum) which the Company Sponsor, and potentially the Grocery Sponsor, will match. The funds will be used to purchase the cans needed for the competition. An award will be given to the three top fundraising schools.

Session DE: 30 Demos in 60 Minutes

Location: International 9
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, February 20
Time: 11 a.m.–12:30 p.m.

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.

Panelists:

Adrianne N. Larson, Chicago Public Schools

Ansel Foxley, UNC

John Stewart, West Virginia University

Sam Sampere, Syracuse University

Derek Leadbetter, Duke University

Session DF: PER: Evaluating Instructional Strategies

Location: International 8
Sponsor: AAPT
Date: Monday, February 20
Time: 11 a.m.–12:30 p.m.

Presider: Ernie Behringer

DF01: 11-11:10 a.m. Effects of a Professional Development Program on GTA Teaching Effectiveness

Contributed – Emily Alicea-Munoz, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332; ealicea@gatech.edu

Joan Espar Masip, Universitat Politecnica de Catalunya

Michael F. Schatz, Georgia Institute of Technology

For the last three years, the School of Physics at Georgia Tech has been preparing new Graduate Teaching Assistants (GTAs) with a mentoring and development program that focuses on pedagogy, physics content, and professional development strategies. Our goal is to produce effective GTAs who have a positive impact on student learning, while honing the skills they need to succeed in their future careers. Approximately 70 graduate students have successfully completed the program. The content of the program is revised yearly, based partly on feedback from the participating GTAs. As part of our ongoing assessment, we want to determine the program's impact on GTAs' teaching effectiveness. To do that we performed a statistical analysis of students' responses to end-of-semester GTA evaluations. Here we present the results of our analysis, in particular the comparison between GTAs who participated in the program and GTAs before the program went into effect.

DF02: 11:10-11:20 a.m. Exploring Different Types of Faculty – Learning Assistant (LA) *

Contributed – Mel Sabella, Chicago State University, 9501 S. King Drive - SCI 309, Chicago, IL 60628; msabella@csu.edu

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

Collaborative relationships between faculty members and LAs can enhance the effectiveness of the LA model by leveraging the expertise of LAs and placing them in positions where they can co-think and co-design activities and lessons for the STEM classroom. Interviews with LAs and faculty members, in addition to video from weekly preparation sessions, illustrate the different types of partnerships that can evolve between LAs and faculty and help us understand the roles different factors play in these partnerships. We describe three types of partnerships that exist along a continuum: mentor-mentee, faculty driven collaboration, and collaborative. This data highlights the importance of student voice and weekly meetings between LAs and faculty members in an LA Program.

* Supported by the National Science Foundation (DUE#1524829) and the Department of Education.

DF03: 11:20-11:30 a.m. Understanding Two Similar Course Reforms

Contributed – Zeynep Topdemir, Georgia State University, 1 Park Pl NE, Atlanta, GA 30303; ztopdemir1@gsu.edu

Ebru Oncul, David N. Trusty, Brian D. Thoms, Georgia State University

The Physics Education Research Group at Georgia State University has implemented two different reforms in algebra-based and calculus-based introductory physics courses. The integrated lecture and lab SCALE-UP approach was implemented in half of the algebra-based introductory physics classes. The lab portion of all

of the calculus-based introductory physics classes has been redesigned to include the use of the University of Washington tutorials and learning assistants. Although these reforms are different they share common features of emphasizing conceptual understanding and applying inquiry-based experiments. This study reveals that even though both reforms are able to improve students' conceptual understanding and increase their success rates, changing only the lab portion of the class is not sufficient to affect students' attitudes and beliefs about learning physics. We will compare the effect of both course reforms on conceptual learning, withdrawal and success rates, and students' attitudes and beliefs.

DF04: 11:30-11:40 a.m. Impact of New Tutorial-based AP Curricula in High School

Contributed – Stephen J. Kaback, The Blake School, 511 Kenwood Pkwy., Minneapolis, MN 55403; skaback@blakeschool.org

Michael Gearen, Jamey Clark,Tiffany Coke, Punahou School

After five years of implementation and data collection, authors share their assessment of the effects of two new tutorial-based Advanced Placement physics curriculua on student AP scores and diagnostic test performances. Tutorial instruction has been overlooked as a mode of instruction in high school physics classrooms. While some teachers who teach AP physics courses use University of Washington Physics Education Group's "Tutorials in Introductory Physics" as a supplement to lessons, none have designed an entire curriculum with tutorials as the central classroom activity. These new complete AP courses were developed by Gearen at Punahou School in Honolulu, HI, and based heavily on materials from University of Washington. Currently, two schools are implementing Gearen's curricula for AP Physics 1 and 2 and AP Physics C, Punahou and The Blake School in Minneapolis, MN.

DF05: 11:40-11:50 a.m. Evaluating Scientific Practices in Introductory Physics Labs

Contributed – Natasha G. Holmes, Cornell University, Department of Physics, Cornell University, 1,09 Clark Hall Ithaca, NY 54732; ngholmes@cornell.edu

A great deal of time and money is spent on science lab courses, but there is little evidence they are providing good educational value, and there is some indication that they are not. In particular, labs suffer from a lack of consensus on goals and on accepted assessment instruments. In this talk, I will introduce the Physics Lab Inventory for Critical thinking, a new assessment under development and validation. It is aimed to assess students' proficiency with critical thinking as related to making sense of data, variability, and models and to assess the efficacy of lab courses at developing these skills. I will briefly outline the motivation and goals of the assessment, the development and validation efforts thus far, and the next steps in the development process.

DF06: 11:50 a.m.-12 p.m. Studio Physics Through the Lens of Universal Design for Learning*

Contributed Jacquelyn J. Chini, University of Central Florida, 4111 Libra Drive, Orlando, FL 32816; jchini@ucf.edu

Westley D. James, Jillian Schreffler, Cherie L. Yestrebsky, Eleazar Vasquez III, University of Central Florida

While our community is placing increased emphasis on supporting diverse learners, students with disabilities are rarely in the foreground of these efforts. Students with disabilities now make up more than 10% of students pursuing post-secondary degrees. Our project explores university science courses making use of active learning strategies from the perspective of students with executive function disorders, which is common in several disability diagnoses. While active learning strategies, such as studio physics, have been shown to improve learning and retention for many students, it is unknown what strategies represent support for, or barriers to, particular learners in STEM programs. Universal Design for Learning (UDL) is a framework supporting instructors to design a learning experience that enables all learners to naturally engage with the course, reducing the need for accommodations and supporting learning by all students. In this talk, we explore several studio physics courses through the lens of UDL.

*This work is supported in part by the U.S. National Science Foundation under grant DUE-1612009.

DF07: 12-12:10 p.m. Predicting the Performance of Groups on Two-stage Group Exams

Contributed – Jared Stang, University of British Columbia, 334 - 6224 Agricultural Road, Vancouver, BC V6T 1Z1, Canada; jared@phas.ubc.ca

Joss Ives, University of British Columbia

A two-stage group exam is an exam that students first write individually (solo phase), before getting into groups to write the same or a similar exam immediately afterward (group phase). This type of exam has been shown to promote both learning and positive affective benefits for students. To investigate how group exam design—including both question design and group composition—impacts student outcomes, we aim to construct a predictive model for performance on the group phase based on the performance of the students on the solo phase. We discuss preliminary results and implications for instructional design.

DF08: 12:10-12:20 p.m. Analytical Methods for Measuring Student Learning

Contributed – Jayson M. Nissen, California State University Chico 659 SW Jefferson Ave., Apt 2, Corvallis, OR 97333; jayson.nissen@gmail.com

Ben Van Dusen, California State University Chico

Amreen Nasim, Robert M. Talbot, University of Colorado Denver

We will discuss implications that researcher's choice between three commonly used methods for analyzing concept inventories has on making claims about student learning. These three methods are: normalized learning gains using class averages, normalized learning gains using individual student scores, and Cohen's d. Historically physics education research has used the first two whereas other fields primarily use Cohen's d. Data for the analyses came from the Learning Assistant Supported Student Outcomes (LASSO) database and included pre and/or post-test scores from more than 16,000 students on physics, chemistry, biology, and math concept inventories from 210 courses at 22 institutions across the country. The three methods were compared in aggregate across concept inventories. We will discuss advantages and disadvantages of the different methods and how the choice of method might lead to different inferences about student learning in a course.

DF09: 12:20-12:30 p.m. Science Education Research Journal Club

Contributed – Eric R. Weeks, Emory University, 400 Dowman Dr., mail stop 1131/002/1AB, Atlanta, GA 30322-0001; erweeks@emory.edu

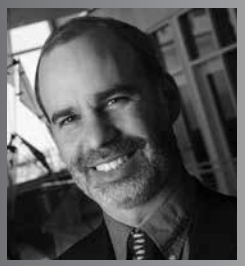
For 10 years I have organized a journal club[1] at Emory University that reads and discusses science education research articles. The club includes members from physics, chemistry, biology, math, computer science, psychology, and the medical school; it includes graduate students, postdoctoral fellows, and faculty. In this talk I will discuss how the journal club works, give a sense of the impact of this club on teaching at Emory, and give thoughts about how one might start a similar journal club at other schools.

1. Website for journal club: http://www.physics.emory.edu/~weeks/journal/

Plenary Session

Location: Marquis Ballroom B
Date: Monday, February 20
Time: 2–3 p.m.

Presider: Gordon Ramsey



Ken Bloom

Discovering the Quantum Universe at the Large Hadron Collider, by *Ken Bloom,* University of Nebraska, Lincoln

The Large Hadron Collider is one of the great scientific projects of our time. Hosted at CERN, the European particle physics laboratory, it brings together thousands of scientists from around the world to pursue a deeper understanding of the elementary particles and interactions that shape the our universe. In this presentation I will discuss the elements of particle physics that motivate the program, interesting technical aspects of the accelerator and detectors, and current hot topics.

Monday afternoon

Session EA: Astronomy Papers

Location: International 4
Sponsor: AAPT
Date: Monday, February 20
Time: 3:30–5:30 p.m.

Presider: Joe Heafner

EA01: 3:30-4 p.m. Williamina Fleming and the Women "Computers" of Harvard College Observatory

Invited – Misty C. Bentz, Georgia State University, 25 Park Place, Office 610, Atlanta, GA 30303; bentz@astro.gsu.edu

Women "computers" have a long history of important contributions to science and technology. In astronomy, the women computers of the Harvard College Observatory are recognized to have made numerous significant discoveries, but they received only partial credit, were paid less than male employees, at the time. The first woman "computer" at the Observatory was Williamina Fleming, a newly immigrated Scottish woman who was abandoned by her husband while heavily pregnant. Fleming became a housekeeper working for Edward Pickering, the director of the Harvard College Observatory. One day, Pickering famously declared that his maid could do a better job than his trained and educated male employees at the Observatory. This outburst from a frustrated Pickering in 1881 marked the beginning of Williamina Fleming's distinguished career in astronomy, which culminated in her election to the Royal Astronomical Society in 1906, the first woman from the United States to be so honored.

EA02: 4-4:10 p.m. Analyzing Astronomy Concepts in the NGSS

Contributed – Stephanie J. Slater, CAPER Center for Astronomy & Physics Education Research, 604 S 26th St., Laramie, WY 82070; stephanie@caperteam.com

Sharon P. Schleigh, East Carolina University

Timothy F. Slater, University of Wyoming

As the study of the entire universe, astronomy courses topics can range from studying the interior and formation of planets like Earth all the way out to studying the dynamics and interactions of the oldest and most distant galaxies of stars. In an effort to constrain the range of topics, the NRC Frameworks and Next Generation Science Standards documents make bold statements about which astronomy topics are to be included and which excluded, and at what age groups. For those teachers and curriculum developers who have not yet carefully reviewed these national documents, the new guidelines of which topics to teach and which topics to exclude, are perhaps surprising. From a cognitive science point of view, special allowances must be made for sequencing as some topics-to-exclude are pre-requisites for required topics. Moreover, some guidelines for high school astronomy topics become impractical because of the rarity of high school astronomy courses being offered.

EA04: 4:10-4:20 p.m. Holographic Scaling in Newtonian Gravity, Mass and Black Hole Physics

Contributed – Leo Rodriguez, Assumption College, 500 Salisbury St., Worcester, MA 01609; ll.rodriguez@assumption.edu

Emma Machado, Assumption College

Shanshan Rodriguez, Worcester Polytechnic Institute

Not typically part of an undergraduate education in physics, courses on general relativity have been on the rise and in continued demand by respective students. In this article, we wish to share some techniques inspired by and derived from modern gravitational research (holographic duality) that help bring advanced topics in gravity theory into the undergraduate classroom. This serves to satisfy students excitement and curiosities about topics in black hole physics and their properties (mass, orbits, thermodynamics). The techniques included have been developed over several years and implemented in teaching general relativity and gravitation to undergraduates at primarily undergraduate serving institutions and major state universities.

EA05: 4:20-4:30 p.m. The National Science Olympiad (NSO) NASA Astronomy STEM Outreach Network

Contributed – Donna L. Young, NASA/CXC/NSO, 2022 Merrill Lane 9E, Bullhead City, AZ 86442; dlyoung.nso@gmail.com

There are opportunities to become involved with the NSO NASA Universe of Learning Astrophysics STEM Learning & Literacy Network. NSO 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 incor-

porating Science Olympiad events into classroom curricula. Events address NGSS scientific practices, crosscutting concepts and core disciplinary ideas from every scientific discipline, including astronomy. Knowledgeable event supervisors and well-written events for all levels of competition are difficult to find for astronomy. Instructors and students can sponsor an invitational, write an invitational, regional or state event, become an event supervisor, or contribute questions to the test bank. The NSO website provides information on developing and supervising astronomy events.

EA06: 4:40-4:50 p.m. An Undergraduate Summer Program Through a University-Community College Partnership

Contributed – Carol E. Hood, California State University, San Bernardino, 5500 University Parkway, San Bernardino, CA 92407-2393; chood@csusb.edu

Michael Hood, Mt. San Antonio College

Laura Woodney, California State University, San Bernardino

We present a model for an undergraduate summer research program in astronomy targeted at 2-year and 4-year students and the short-term success of student participants. In an effort to involve students in research as early as possible, we selected two students from each campus to participate in the program. Students were not selected based on their grades, or specific courses completed, but on their expressed interest in astronomy. The only requirement was completion of at least one physics or astronomy class and selected students typically would be classified as freshmen or sophomores. As part of the program, students learned observational techniques, data reduction and analysis skills, and later worked on more complex faculty astronomical research projects. By the end of each summer, students were able to run the state-of-the-art campus observatory, and many chose to continue working on their research projects into the school year.

EA07: 4:50-5 p.m. Using Planetaria to Represent Scaled Distances with Correctly Scaled Time

Contributed – Richard Gelderman, Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101-1077; gelderman@wku.edu

A clear understanding of the vast distances and relative emptiness of our solar system, galaxy, and universe are critical to a meaningful grasp of astrophysical concepts. In our planetarium we use multiple models to give our visitors a grasp of the cosmic scales. An important addition to the more familiar spatial models is the use of correctly scaled time to evoke a clear feeling of the sparseness in our cosmos. Instead of the exponentially increasing velocity used in most videos and planetarium presentations, linear speeds can express the distances we want to convey.

EA08: 5-5:10 p.m. Flipping Astronomy to Actively Engage Cheapskates (but not lazy ones)

Contributed – Terry L. Ellis, Jacksonville University, 2800 University Blvd N, Jacksonville, FL 32211; tellis@ju.edu

A flipped classroom allows students to spend their time in class problem-solving, analyzing, and communicating ideas while engaged in group discussions, role-playing activities, or tutorials. The flipped format requires students to have done preparation work before class, which usually would consist of passively watching lecture videos, reading a textbook, and using online homework systems. However, many college students take astronomy to satisfy a science core requirement and are unwilling or unable to pay for the textbook and online homework subscription. I will describe the new series of daily pre-class assignments I've created to actively engage the students with the material before class (without requiring a textbook), some associated in-class activities, student-written "quests", and the effectiveness of a no-text-required flipped introductory astronomy class.

EA09: 5:10-5:20 p.m. Incorporating Student-Centered Pedagogies in an Undergraduate Astronomy Course

Contributed – Debbie A. French, Wilkes University, 84 W. South St., Wilkes-Barre, PA 18766; frenchd14@yahoo.com

Andrea C. Burrows, University of Wyoming

Teaching science using student-centered pedagogical techniques such as inquiry are more prevalent in K12 education than in collegiate science education. This study examined the effects of incorporating best pedagogical practices from K12 science education into an introductory undergraduate astronomy course. Forty-two students participated in this study. These students took the Test Of Astronomy STandards (TOAST) pre and post instruction. Students' TOAST scores showed an increase from an initial 37% to a final 62%; this final score is higher than the national average for college students and inservice teachers. Students reported their interest in astronomy increased because of this course (79%). Students also recalled the student-centered learning activities more than astronomical facts. These results show encouraging results for implementing best practices from K12 science education in undergraduate science classes. Suggestions on how to incorporate these pedagogical techniques will also be presented.

EA10: 5:20-5:30 p.m. Rapidly Changing Landscape of Publishing Astronomy Education Research

Contributed – Timothy F. Slater, University of Wyoming, 1000 E University, Laramie, WY 82071; timslaterwyo@gmail.com

As the decade-running Astronomy Education Review journal hosted by AAS & NOAO sunset, an academic void was left for scholars needing venues to publish their work in the domain of astronomy education and outreach. One solution, of several, was the creation of the Journal of Astronomy & Earth Sciences Education JAESE. JAESE makes use of an open-access business model where authors and their institutions bear the cost of running the journal instead of what has been a more typical library and members' subscription revenue model. As traditional journals have become more and more expensive to subscribe to, and page-charges growing ever higher, many new open-access journals of widely varying quality and levels of predation have been introduced into the academic workspace. The complex and changing publishing landscape poses difficulty for scholars trying to navigate where to publish their work. http://jaese.org

Session EB: Technologies

Location: International 5
Sponsor: AAPT
Date: Monday, February 20
Time: 3:30–4:40 p.m.

Presider: Kathleen Falconer

EB01: 3:30-3:40 p.m. Physics Projects with vCalc: A Wiki with Computational Capabilities*

Contributed – Joshua M. Grossman, Department of Physics, St. Mary's College of Maryland, 47645 College Drive, St. Mary's City, MD 20686; jmgrossman@smcm.edu

Tyler D. Jones, St. Mary's College of Maryland

Randolph K. Larsen, Department of Chemistry, St. Mary's College of Maryland

Kurt Heckman, vCalc

vCalc is a fast-growing online calculator, equation, and dataset library that helps users freely create and quickly calculate. Located at vCalc.com, it serves as a calculating encyclopedia by combining wiki technology with a math engine. Users may publish content visible to anyone, share it in a group, or keep it private. In this talk, after introducing vCalc, we report on a summer program in which students and faculty from physics, chemistry, math, psychology, economics, and computer science developed content and advised vCalc. Adding to vCalc's existing catalog, the physics content developed drew from mechanics, optics, atomic physics, and radar. We will present computational content pages and an example of a student-developed lab activity. Besides serving as a reference and computational tool, assignments to create calculators and accompanying wikis offer multifaceted learning opportunities in a course.
*Support provided by the Maryland Industrial Partnerships (MIPS) program and by vCalc.

EB02: 3:40-3:50 p.m. HTML5 Simulations for Introductory Physics

Contributed – Andrew G. Duffy, Boston University, 590 Commonwealth Ave., Boston, MA 02215; aduffy@bu.edu

This talk will cover a collection of over 100 free HTML5 simulations for the teaching and learning of introductory physics. These simulations can be used by instructors or students, and have been used in various settings, ranging from studio physics classrooms to massive open online courses. One goal of the simulations is to add value, in one way or another, to the standard way of teaching a topic, such as through the addition of a graph or other form of visualization, to produce added insight to a concept. Website: http://physics.bu.edu/~duffy/classroom.html

EB03: 3:50-4 p.m. 3D Printing Emphasizes and Broadens University Programs in Physics

Contributed – Magnus Karlsteen, Department of Physics / Chalmers University of Technology, Origovagen 6B, Gothenburg, SE-41296 Sweden; magnus.karlsteen@chalmers.se

Jonas Enger, Department of Physics / University of Gothenburg

Jonathan Weidow, Lars Hellberg, Department of Physics / Chalmers University of Technology

A new development in our department is that students in physics and teacher training now learn CAD and 3D printing. The teaching is based on a very brief introduction, after which the students will create final products that are later shown to other students and teachers during an exhibition. To further deepen the understanding and maintain the creativity of the students, a room with 3D printers all day accessible is provided. The students learn CAD and 3D printing well. In addition, the students use CAD and 3D printing in advanced experimental courses in physics where they benefit from creating different accessories to experimental setups. The students have also formed their own club for 3D printing to support other students, to produce creative solutions, and to test business ideas. This development has provided the first steps toward a maker movement environment in the teaching lab. We strongly believe in this concept.

EB04: 4-4:10 p.m. Interacting with Simulated Charges and Fields via Augmented Reality

Contributed – Steven M. Binz, 1514 Genesee St. Apt. 12, Utica, NY 13502; smbinz@utica.edu

Electric and magnetic fields can be difficult for students to understand because they cannot directly see the fields or physically manipulate individual charges. Computer simulations and videos have helped, however they have been limited to a 2D screen. Using recently developed augmented reality devices it is possible to assign real-world objects a simulated charge or current, and to see the changes in the fields as those values are changed or as the objects are moved around the room. The user can walk around the charges and currents to see the fields from any direction, as well as introduce simulated test charges. The intent is that student understanding will improve if the students can control the simulation intuitively and see the fields and forces in all three dimensions. Mixed reality recordings of the simulation will be shown and the limits and possibilities of the underlying technology will be briefly discussed.

EB05: 4:10-4:20 p.m. The Development and Implementation of a Flipped Physics Course

Contributed – Timothy A. Duman, University of Indianapolis, 1400 E Hanna Ave., Dept of Physics and Earth-Space Science, Indianapolis, IN 46227-3697; tduman@uindy.edu

The physics department at the University of Indianapolis has implemented a flipped classroom in their introductory calculus-based physics sequence. The department uses both Windows and Mac-based PCs to create online content. Attendees will find out what software we use, how we incorporated the online lecture into our courses, and how it has worked out.

EB06: 4:20-4:30 p.m. Blended Introductory Physics Course: Instructor's Experience of NCAT Redesign

Contributed – Tetyana Antimirova, Ryerson University, 350 Victoria St. Toronto, ON M5B 2K3, Canada; antimiro@ryerson.ca

This talk describes the instructor's experience of course redesign using one of NCAT redesign models. A large (500+ students) introductory physics course for science program at large Canadian university was redesigned following the National Council for Academic Transformation (NCAT) guidelines. The goal of the redesign was to turn the course into more active learning blended environment, with partially flipped lectures and with a significant online component to extend learning beyond classroom. A range of educational technology tools such as personal response systems (iClickers and web-based REEF), online tutoring and homework system, web-based tools facilitating peer collaborations, real-time data-acquisition, videos and screen capture was used to support the delivery of this course. The redesigned course demonstrated improved student engagement, better course retention and successful completion rates.

EB07: 4:30-4:40 p.m. Coding in the Classroom

Contributed – Stephen Robinson, Belmont University, 5040 Whites Creek Pike, Whites Creek, TN 37189; steve.robinson@belmont.edu

Jonathan Rankin, Belmont University

We examine the use of VPython in a small flipped classroom, including topics such as student attitudes, student performance, grading, effects on learning, and other practical considerations. Data was collected via grades and surveys.

Session EC: 21st Century Physics in the Classroom

Location: International 6
Sponsor: Committee on Modern Physics
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, February 20
Time: 3:30–5:30 p.m.

Presider: Kenneth Cecire

EC01: 3:30-4 p.m. Particle Physics Investigations in the High School Classroom*

Invited – Shane Wood, QuarkNet, 3439 Garfield Ave #104, Minneapolis, MN 55408; swood5@nd.edu

QuarkNet's free online Data Portfolio contains an ever increasing number of activities in which students analyze real data; some of these activities rely on data from large experiments (e.g., CERN's CMS and ATLAS detectors), while other activities rely on data collected by students (e.g., QuarkNet cosmic ray detectors). Learn how you can give your students authentic experiences learning and applying scientific practices by tapping into physics research of today. Many of the ideas and skills students learn by doing these activities relate directly to the introductory physics classroom and meet many academic standards, including the Next Generation Science Standards (NGSS).

*This work is sponsored under the QuarkNet program by the National Science Foundation and the Department of Energy Office of Science.

EC02: 4-4:30 p.m. Particle Physics Investigations in the High School Classroom*

Invited – Joel Klammer, Quarknet, 999 Ming Yue Road, Jinqiao, Pudong, Shanghai, 201206 China; joel.klammer@concordiashanghai.org

QuarkNet's free online Data Portfolio contains an ever increasing number of activities in which students analyze real data; some of these activities rely on data from large experiments (e.g., CERN's CMS and ATLAS detectors), while other activities rely on data collected by students (e.g., QuarkNet cosmic ray detectors). Learn how you can give your students authentic experiences learning and applying scientific practices by tapping into physics research of today. Many of the ideas and skills students learn by doing these activities relate directly to the introductory physics classroom and meet many academic standards, including the Next Generation Science Standards (NGSS).

*This work is sponsored under the QuarkNet program by the National Science Foundation and the Department of Energy Office of Science.

EC03: 4:30-4:40 p.m. Introducing Particle Physics to High School Students

Contributed – Nora Wurmbach, Drexel University, 3103 Haverford Ave., Philadelphia, PA 19104; nora.wurmbach@gmail.com

Nicholas Sfiroudis, Christina Love, Drexel University

Although the Standard Model of Particle Physics is our current best "theory of everything"—it is rarely mentioned in a high school physics curriculum. A complete teaching toolkit (lesson plans, interactive activities, and teaching slides) was developed using active learning methods, tested by three AP physics teachers with 150 students, and assessed using original surveys. The surveys asked a variety of questions, both on content and interest in science, and in a variety of formats, including open-ended, ranking, and multiple-choice questions. Although we found no significant change in the students' interest in science, we did find a difference between the gains in interest for males and females. The average content knowledge scores increased from 1.6 +/- 0.1 questions correct to 5.4 +/- 0.1. There was no significant difference for the content knowledge performance between males and females.

EC04: 4:40-4:50 p.m. QuarkNet Data Portfolio: A Resource for 21st Century Lessons

Contributed – Deborah Roudebush, Oakton High School, 4410 Mariner Lane, Fairfax, VA 22033; droudebush@cox.net

This talk will focus on particle physics lessons available in the QuarkNet Data Portfolio. The lesson on using cosmic ray detector data to determine muon lifetime will be featured as well as the process for vetting lessons to ensure that the QuarkNet Data Portfolio is a quality resource for 21st Century lessons for the high school classroom.

EC05: 4:50-5 p.m. Cosmic Rays, Proton Beams, and More

Contributed – Nathan A. Unterman, Glenbrook North High School, Emeritus, 7238 North Albany Ave., Chicago, IL 60645-1148; nunterman@gmail.com

High energy physics is not easily integrated into the current state and national high school science curricula. A high energy physics club was established at our school in 2004 using QuarkNet's cosmic ray detector as a stimulus. The club was the nucleus of students entering CERN's Beamline for Schools Contest. Although not being chosen for the CERN contest, the proposal was made to FermiLab, was accepted and run. Club activities and experiment ideas will be shared to show how high energy physics can be made available to students in the secondary setting.

EC06: 5-5:10 p.m. Cosmic Ray Study: Effect of Detector Area on Shower Rates

Contributed – Kamryn B. Abraskin, Glenbrook North High School, 2300 Shermer Road, Northbrook, IL 60062; avalsamis@glenbrook225.org*

Brian Burke, Kendall Crispin, Anthony Valsamis, Glenbrook North High School

Cosmic rays are immensely high-energy particles originating mainly from outside our solar system. Although they have been studied since the early 20th century, much remains unknown about their origin, properties, and behavior. These primary cosmic rays produce secondary particle showers through interaction with Earth's upper atmosphere. Using QuarkNet cosmic ray detectors, an investigation was conducted to measure the amount of cosmic ray events per hour as a function of detector area; both indoors and outdoors. Three counters placed in a triangular array were tested within a one-story building and inside of a greenhouse with a thin plastic roof. The data collected suggests that roofing material affects the measured shower rates.

*Sponsor: Anthony Valsamis, Glenbrook North High School.

EC07: 5:10-5:20 p.m. Dark Matter for the Classroom – Cutting-edge Science for Pupils

Contributed – Wolfgang H. Vieser, Christoph-Probst-Gymnasium, Soeltlstr. 24, Munich, Bavaria 81545 Germany; w.vieser@web.de

When starting physics pupils often think that they will learn formulas that will explain all of nature to them. Their preconceptions based on TV documentaries and movies lead them to believe either that scientists already know about everything or that the unsolved mysteries are too hard to understand. Both perceptions are wrong. We are far from knowing everything, our actual understanding of the universe explains only five percent of its constituents. Introducing students to the mystery of dark matter, using freely available scientific data on the internet, can show students our current understanding and just how much we still have to learn.

EC08: 5:20-5:30 p.m. Quantum Levitation and Superconductivity

Contributed – Vehbi Sonmez, Harmony Science Academy Houston High, 9431 W Sam Houston Pkwy., Houston, TX 77099; vsonmez@harmonytx.org

Superconductivity was discovered at 1991 and only discussed at the high school physics level as an interesting topic or an anecdote. The phenomenon couldn't be observed in class because it occurred only at extremely low temperatures – a few degrees above absolute zero (0 K). During the late 1980s, the rapid succession of newly discovered high-temperature superconductors which can operate at liquid nitrogen temperatures (77 K) turned the tables. Superconductivity was now well within the reach of high school students. It was now possible to perform classroom demonstrations of magnetic levitation and to easily observe quantum phenomena using relatively cheap liquid nitrogen! Quantum Levitation demonstrations always capture students' attention. They become entranced by an upside down levitated magnet, they wonder how it works and predict what it can be used for – scientific inquiry has begun! Students' curiosities will be limited only by their imagination

Session ED: Non-academic Career Trajectories

Location: International 7
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, February 20
Time: 3:30–4:30 p.m.

Presider: Toni Sauncy

ED01: 3:30-4 p.m. Career Training in the Undergraduate Physics Classroom – Call to Action!*

Invited – Brad Conrad, Society of Physics Students - American Institute of Physics, 1 Physics Ellipse, College Park, MD 20740; tsauncy@tlu.edu

Toni Sauncy, Texas Lutheran University

The session will begin with a talk focused on career development tools for undergraduates. The AIP Career Pathways Project will be highlighted and the resources that have been developed for faculty and students as a result of the project will be discussed. The session will focus on why career training belongs in the physics undergraduate experience and what we can do to help the community.

*This project was sponsored by the National Science Foundation Award Number 1011829

ED02: 4-4:30 p.m. Incorporating Career Development in Physics at William Jewel College

Invited – Blane Baker, William Jewell College, 500 College Hill, Liberty, MO 64068; bakerb@william.jewell.edu

In the Physics Department at William Jewel College, providing a robust, well-rounded curriculum for physics students is a top priority. As part of the commitment to best preparing our students for whichever path they might choose, intentional effort has been made to include resources about career options for our students in both curricular and extra-curricular settings. We will discuss how career development resources recently made available by the Society of Physics Students, designed specifically for undergraduate physics students, have been integrated regularly in our Society of Physics Students chapter meetings and also incorporated into a new course in our major called "Introduction to the Physics Major."

Session EE: Lab Guidelines Focus Area 4: Communication

Location: International 8
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, February 20
Time: 3:30–5:30 p.m.

Presider: Joseph Kozminski

EE01: 3:30-4 p.m. Developing Professional Communication Competencies in Physics Lab Classes

Invited – Benjamin Zwickl, Rochester Institute of Technology, 84 Lomb Memorial Drive, Rochester, NY 14623; ben.zwickl@rit.edu

Whether students are engaging in group work, presenting results, or keeping a lab notebook, communication is woven into the laboratory course experience. An emphasis on communication benefits the professional development of all physics students regardless of eventual career goals, and employers routinely cite communication skills as being a critically important competency. This talk will overview some of the education research and pedagogical approaches that support the AAPT recommendation that students should "present results and ideas with reasoned arguments supported by experimental evidence and utilizing appropriate and authentic written and verbal forms." Examples from scientific argumentation, communication in the disciplines, and data on workplace communication skills in physics-intensive careers will be presented.

EE02: 4-4:30 p.m. Visually Communicating Scientific Concepts, Data, and Results

Invited – Kelly Martin, Rochester Institute of Technology, 92 Lomb Memorial Drive, Eastman 3200, Rochester, NY 14623; kelly.martin@rit.edu

"When I make scientific figures I don't think about the rules. I just start creating and re-arrange based on trial and error." This sentiment reflects a common practice among scientists when communicating an intended message through visuals. Visuals are often seen as an add-on and are created with little thought given to graphic design principles. However, as presentations are common and information more complex, the necessity to communicate findings as clearly as possible should not be an afterthought. Just as students are taught to be mindful when collecting data and reporting findings, they should also be held to that same level of precision and critique when constructing visuals. Strong visuals support viewers' understanding and can help researchers gain new insights about their own work. This talk will cover best visual communication strategies and principles (e.g. alignment, contrast, proximity, etc.) when presenting scientific information in a report or a talk.

EE03: 4:30-5 p.m. The Letter Home: An Authentic Post-Lab Writing Experience

Invited W. Brian Lane, Jacksonville University, 2800 University Blvd. North, Jacksonville, FL 32211; wlane@ju.edu

Ramesh Adhikari, Jacksonville University

The traditional lab report as typically written by physics students is known to exhibit several deficiencies: Underdeveloped explanations of background material, incomplete reasoning to support results and conclusions, and vague demonstrations of student learning. We attribute such deficiencies to the inauthentic nature of the lab report, as it requires the student to repeat back to the instructor information the instructor already knows. We have found that replacing the traditional lab report with a Letter Home written to a non-physicist creates a more authentic post-lab writing

experience, promotes a deeper "unlearning" process for students, and results in student writing that is more complete and of higher quality than the traditional lab report. We outline the structure of the Letter Home assignment, present several samples of student writing, and discuss an initial assessment of this assignment's impact on student self-confidence.

EE04: 5-5:10 p.m. Organization by Topic Enhances Communication in Advanced Lab

Contributed – Tim Gfroerer, Davidson College, 209 Ridge Road, Davidson, NC 28035; tigfroerer@davidson.edu

Advanced Lab at Davidson College is a special capstone course: seniors work in pairs on different but complementary experiments, which progress in three-week increments through classical, statistical, optical, and quantum mechanical topics. After each round, students gather to present their work to their peers. This structure means that groups are always working on projects with shared themes, which facilitates meaningful exchange between peers. The outcome has been validated by unity gains in E-CLASS responses on questions about the value of communicating scientific results to peers. I conclude that this format, namely the simultaneous investigation of similar physical systems followed by the sharing of results, enables students to experience the benefit and appreciate the importance of communication in science.

EE05: 5:10-5:20 p.m. Communication Skills Throughout a Physics Curriculum

Contributed – Donald Andrew Smith, Guilford College, 5800 W. Friendly Ave., Greensboro, NC 27410; dsmith4@guilford.edu

The Guilford College Physics curriculum emphasizes communication skills throughout all the years of its program. From written lab reports in the first year, through oral and poster presentations in the second year, through colloquia, conferences, and senior thesis defenses, students present their thoughts and research in multiple ways to a variety of audiences. In this presentation, I will describe our program and illustrate how it has served our students to learn and gain confidence in the many forms of scientific communication. In particular, I will outline how our Experimental Physics II class guides the students through the process of doing science, from proposal through experiment to conference presentation and journal paper. Although our alumni have gone on to a wide variety of careers, they all speak of the importance of the public presentation skills they learned in Guilford College physics.

EE06: 5:20-5:30 p.m. Designing a "Lab-on-a-Ship": The Floating Physics of Fluid Dynamics

Contributed – Andre Bresges, University of Cologne, Institute of Physics Education, Gronewaldstrasse 2, Cologne, NRW 50931 Germany; andre.bresges@uni-koeln.de

Florian Genz, University of Cologne, Institute of Physics Education

We are applying U Stanford's "Design Thinking" approach to convert a 200 ft ship into a swimming science lab. The ship combines a research center for large river ecosystems with a training facility for teacher trainees, and a bionic lab where classes can study the impact of fluid dynamics on marine ecology, geography, and the design of ships and airplanes. Design Thinking applies on several levels. We declared the design process of the Science Lab a part of our "Future Strategy for Teacher Training". Space on a ship is always a precious resource, as is the time of the classes visiting the lab. Using the "Fail early, fail often" principle, teacher education students work closely with students of neighboring schools to develop, test and evaluate various prototypes. Thus, they combine theory and research to untangle all the problems and constrains, and to provide an rich, interesting and meaningful environment for students.

++ CLabs feature video: https://www.youtube.com/watch?v=8rebSfMbC2M
++ Future Strategy for Teacher Training: http://zus.uni-koeln.de/21122.html
++ Design Thinking resources: http://dschool.stanford.edu/dgift/

Session EF: Science Café – Panel

Location: International 9
Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Space Science and Astronomy
Date: Monday, February 20
Time: 3:30–5:30 p.m.

Presider: Bill Reitz

Panelists:

Donna Governor, University of North Georgia

Rishi R. Masalia, Athens Science Café

Richard Gelderman, Western Kentucky University

Michelle Hall, 4200 W. Jemez Rd., Suite 322 Los Alamos, NM

Marc Merlin, Atlanta Science Tavern

EF01: 3:30-5:30 p.m. Science Cafe at SACNAS

Contributed – Juan R. Burciaga, Bowdoin College, Dept. of Physics & Astronomy, 8800 College Station, Brunswick, ME 04011-8448; jburciag@bowdoin.edu

The National Society of Hispanic Physicists (NSHP, www.hispanicphysicists.org) has hosted Science Cafe at the annual meeting of SACNAS (Society for the Advancement of Chicanos and Native Americans in Science). This meeting is the largest gathering of under-represented students in STEM bring together over 2000 students, primarily of Hispanic/Latinic or Native American background. Our first goal of the Science Cafe at SACNAS is to open our science to the students and faculty of other disciplines. In addition, we (the NSHP) are demonstrating how to run a Science Cafe, so that faculty can add this important (and growing) technique to their educational outreach activities. Our third goal is to illustrate that interesting questions in science transcend any one discipline. A vital fourth goal is to provide leadership opportunities by encouraging our students to serve as facilitators. Our hope is that other STEM disciplines will start hosting their own Science Cafes.

Session EG: Report of the APS/ AAPT Joint Task Force on Undergraduate Physics Programs: Case Studies and Recommendations

Location: International 10
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Research in Physics Education
Date: Monday, February 20
Time: 3:30–5:30 p.m.

Presider: Ernest Berhinger

Brief presentations by representatives of the "case study" institutions in the J-TUPP report followed by general discussion of the report and its recommendations.

Speaker:

Paula Heron, University of Washington, Dept. of Physics, Seattle, WA

Session FA: Solar Eclipse

Location: International 5
Sponsor: Committee on Physics in Two-Year Colleges
Co-Sponsor: Committee on Space Science and Astronomy
Date: Monday, February 20
Time: 7–8:10 p.m.

Presider: Joe Heafner

FA01: 7-7:30 p.m. The Great American Eclipse of 1900

Invited – Tom English, Guilford Technical Community College, 601 East Main St., Jamestown, NC 27282; trenglish@gtcc.edu

The solar eclipse of 1900 May 28 occurred as American astronomy was asserting itself on the world stage. The early generation of home-grown astrophysicists, the likes of Charles A. Young and Samuel P. Langley, was giving way to the new breed, led by George Ellery Hale. By 1900 Hale had founded the AAS, started the Astrophysical Journal, and built his first great observatory at Yerkes. The 1900 eclipse, visible along a line from New Orleans to Norfolk, gave Hale an opportunity to orchestrate a coordinated effort to attack the eclipse with all available American resources. Parties were dispatched throughout the American South, and several dozen institutions put expeditions in the field, ranging from individuals with modest equipment to major undertakings occupying large tracts of land on which tons of apparatus were assembled. This presentation outlines the organization of the American eclipse effort and highlights the significant expeditions and their observations.

FA02: 7:30-8 p.m. Modern Eddington Experiment

Invited – William A. Dittrich, Portland Community College, PO Box 19000, Portland, OR 97280; tdittric@pcc.edu

On August 21, 1917 Eddington's experiment to verify gravitational lensing due to Newtonian and General relativistic shifts was attempted and failed. The second retry (1919) was successful and Einstein became an instant sensation worldwide. This famous experiment will be repeated exactly 100 years to the day later. This Modern Eddington Experiment (MEE) will be performed by faculty, undergraduate students, and citizen scientists at several locations along the 2017 eclipse path using modern amateur astronomical equipment. The recent availability of large pixel CCD cameras enable this experiment to be performed at an accuracy 20-100 times more accurately than all past attempts. The research method and equipment will be discussed. What will you and your students be doing on August 21? For a reasonable sum, the equipment for the MEE can be purchased and your team can help improve the accuracy of this exciting multiple team experimental recreation, the Modern Eddington Experiment.

FA03: 8-8:10 p.m. A Total Solar Eclipse Celebration 117 Years in the Making

Contributed – Kristen L. Thompson, Davidson College, Box 7133, Davidson, NC 28035; krthompson@davidson.edu

The August 21, 2017 total solar eclipse has generated much excitement and has prompted many to organize expeditions to view the event. Similarly, the small town of Winnsboro, SC, was the target of an expedition by early American astronomy programs to study the May 28, 1900 total solar eclipse. Then Davidson College professor Dr. H.L. Smith joined an expedition to set up an observing station in Winnsboro. Now, 117 years later, the path of totality for the 2017 eclipse will once again pass through the town. Davidson College, in collaboration with the Fairfield County Museum in Winnsboro, is planning to commemorate the 1900 expedition by returning to the site of the original observing station for a 2017 solar eclipse celebration. Guided by archives documenting details of the 1900 station, the celebration will include public lectures, eclipse viewing, and a museum exhibit featuring 19th century astronomy and the 1900 eclipse.

Session FB: UTeach in Physics

Location: International 6
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, February 20
Time: 7–8:30 p.m.

Presider: David Rosengrant

FB01: 7-7:30 p.m. A Transitioned and Unique U-Teach Experience at Kennesaw State University

Invited – Erin Sutherland, McLean High School, 1633 Davidson Rd., McLean, VA 22101; sutherec@icloud.com

David Rosengrant, University of South Florida St. Petersburg

When Southern Polytechnic State University became a UTeach site in 2010 they were the first university to have a program without a school of education. Just three years after this, Southern Polytechnic State University consolidated with Kennesaw State University to form a new Kennesaw State University. Kennesaw State University has a college of education but secondary education faculty are housed in the departments of their discipline. The university also prides itself on content specific pedagogies. As a result of the consolidation the UTeach program was modified to form the new undergraduate teacher preparation program for the sciences (Physics, Chemistry and Biology). This presentation highlights the initial program, the process of consolidation and the end resulting program along with the strengths and the challenges still faced.

FB02: 7:30-8 p.m. Student Learning in Classes of UTeach Graduates

Invited – Michael Marder, The University of Texas at Austin, UTeach and Department of Physics, Austin, TX 78712; marder@mail.utexas.edu

I will discuss the retention of UTeach alumni in teaching and the gains in student learning in classrooms of novice UTeach graduates compared with alternatively certified teachers in the same schools. The data come from Texas, which is the only state where UTeach has been present long enough and at sufficient scale that these comparisons can be made. Most of the results come from mandatory tests in Algebra I and Biology. No results from physics tests are available, but student course-taking patterns in physics will also be examined.

FB03: 8-8:10 p.m. The Maker Movement in a UTeach Physics Class

Contributed – Jill A. Marshall, University of Texas, 1 University Station D5700, Austin, TX 78712; marshall@austin.utexas.edu

The Maker Movement, publicized by Make Magazine and Maker Faires now happening across the U.S., has begun to make inroads into STEM education. Maker Spaces, where students have access to technological tools and a safe environment in which to create, are appearing in elementary school libraries, high school shop classes, and engineering departments at the undergraduate level. A recent Noyce teacher preparation grant to the UTeach program at the University of Texas at Austin has as one of its aims an investigation of the incorporation of Making into pre-service teacher education. I will report on the incorporation of a Maker strand into a class using the University of Washington Physics by Inquiry curriculum (McDermott et al., 1996). I used a project-developed framework and rubric to evaluate the effect on student learning of optics and circuits, and the development of students' identity as both makers and as users of physics.

FB04: 8:10-8:20 p.m. UTeach and PhysTEC, a Winning Combination

Contributed – Gay B. Stewart, West Virginia University, 140 Waitman St., Morgantown, WV 26501; gbstewart@mail.wvu.edu

John C. Stewart, West Virginia University

The speakers have now been part of two PhysTEC/UTeach implementations. In the first, at the University of Arkansas, we introduced a UTeach replication to a mature PhysTEC site. UAteach was designed based on our PhysTEC experience. There was a strong influence of how to incorporate the best aspects of a Teacher in Residence into the Master Teacher (MT) position. We looked at full role of all MTs in a mature UTeach program and built the induction and mentoring into all of the MT job descriptions, instead of having separate staff. At West Virginia University, we launched the two programs in parallel, with the background and experience of having done both programs before. One year in, things are moving well, with almost 70 STEM majors in the WVUteach program, and nine new physics teachers in the PhysTEC pipeline.

FB05: 8:20-8:30 p.m. STEMteach: Enabling Physics Degree-Holders to Become Physics Teachers*

Contributed – Earl D. Blodgett, University of Wisconsin - River Falls, 410 S 3rd St., River Falls, WI 54022; earl.d.blodgett@uwrf.edu

Rachelle Haroldson, University of Wisconsin - River Falls

STEMteach is a novel one-year graduate course of study designed for STEM degree holders who wish to become certified to teach in their area of qualification. Inspired by the UTeach program at the University of Texas – Austin, the program at the University of Wisconsin – River Falls brings together STEM professionals from many areas of science and mathematics for an intensive one-year cohort experience. STEMteach students can seek licensure in biology, chemistry, math, computer science, environmental science, and physics. This presentation will focus on the experiences of physics degree holders in the first two cohorts of this multi-disciplinary program.

*Funded in part by NSF Noyce Capacity Building Grant 1439768.

Session FC: Building Institutional Support for your Physics Teacher Preparation Program

Location: International 7
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Professional Concerns
Date: Monday, February 20
Time: 7–8:10 p.m.

Presider: Monica Plisch

FC01: 7-7:30 p.m. Getting Buy-in for Physics Teacher Preparation: Lessons from GSU Experience

Invited – Brian Thoms, Georgia State University, 25 Park Place, Suite 605, Atlanta, GA 30303; bthoms@gsu.edu

Building and sustaining a physics teacher preparation program requires confronting a number of challenges. One of these challenges is to develop buy-in at the department, college, and university level to support the efforts and recognize the successes of the program. The five-year history of the physics teacher path within the BS in Physics at Georgia State University is used to examine some key questions related to these challenges. How do we change the minds of faculty who don't understand or value teaching as a career path for physics majors? Will the college of sciences embrace teacher preparation as part of its mission? How can a physics department work effectively with the education departments and college? What does it take to get the university to see physics teacher preparation as furthering its own objectives?

FC02: 7:30-8 p.m. The Virginia Tech Physics Teacher Preparation Program

Invited – John Simonetti, Virginia Tech, Physics Department, Blacksburg, VA 24061; jhs@vt.edu

At Virginia Tech, we have a multi-department—indeed, multi-college—approach to preparing physics teachers, and considerable support. Outside the Physics Department, we collaborate with the School of Education to produce new physics teachers with a BS or BA in Physics, plus a Masters of Education (MAEd) degree. This collaboration had grown over many years of personal interaction between myself, other physics faculty, and the faculty in the School of Education, and was ready-made for use when we became a Physics Teacher Education Coalition (PhysTEC) comprehensive site. Even before becoming a PhysTEC site, our institutional support included Graduate Teaching Assistantships (GTAs) for physics students pursuing an MAEd. This particular aspect of our program is very important in our recruitment and production of physics teachers. I will discuss our program in general, the GTA support model, and other aspects of institutional support we enjoy.

FC03: 8-8:10 p.m. Enhancement Program for In-Service Physics Teachers at TAMU

Contributed – Tatiana Erukhimova, Texas A&M University, Department of Physics & Astronomy, 4242 TAMU, College Station, TX 77843-4242; etanya@tamu.edu

Many high school physics teachers in Texas have insufficient background in physics and did not take any college-level physics courses. These teachers have limited opportunities for professional development. To help them, the Mitchell Institute for Fundamental Physics and Astronomy runs a two-week summer boarding school. The school, called MIPEP (Mitchell Institute Physics Enhancement Program), provides intense training in physics which includes lectures, physics labs, hands-on demos, tours of various campus research facilities, telescope observations, discussions and meetings with top researchers, and many other physics-related activities. We will present the results of five years of the program, address difficulties, and outline plans for the future.

Session FD: PER: Examining Content Understanding and Reasoning

Location: International 8
Sponsor: AAPT
Date: Monday, February 20
Time: 7–8:20 p.m.

Presider: Hunter Close

FD01: 7-7:10 p.m. The Effect of Prior Knowledge and Gender on Physics Achievement

Contributed – John C. Stewart, West Virginia University, 235 White Hall, Morgantown, WV 26506; jcstewart1@mail.wvu.edu

Rachel Henderson, West Virginia University

Gender differences on the Conceptual Survey in Electricity and Magnetism (CSEM) have been extensively studied. Ten semesters (N=1621) of CSEM data is presented showing male students outperform female students on the CSEM post-test by 5% (p<.001). Male students also outperform female students on qualitative in-semester test questions by 3% (p=.004), but no significant difference between male and female students was found on quantitative test questions. Male students enter the class with superior prior preparation in the subject and score 4% higher on the CSEM pre-test (p<.001). If the sample is restricted to students with little prior knowledge who answer no more than eight of the 32 questions correctly (N=822), male and female differences on the CSEM and qualitative test questions cease to be significant. This suggests no intrinsic gender bias exists in the CSEM itself and that gender differences are the result of prior preparation measured by CSEM pre-test score.

FD02: 7:10-7:20 p.m. Student Understanding of Balancing, Mass Distribution and Center of Mass

Contributed – Paula Heron, University of Washington, 3910 15th Ave. NE, Department of Physics, Seattle, WA 98195-1560; pheron@uw.edu

Understanding the relationships between balancing, mass distribution and the center of mass is challenging for students. In particular there is a widespread tendency to attribute a balanced state to equal amounts of mass to both sides of the fulcrum if the mass distribution is continuous.[1] A number of explanations have been proposed, including a recent suggestion that perceptual difficulties in locating the center of mass are, at least in part, to blame.[2] Recent experiments suggest that it is unlikely that perceptual difficulties play a significant role.

1. Ortiz, Heron and Shaffer, American Journal of Physics, 2005.
2. Sattizahn et. al., Mind, Brain and Education, 2015. Supported in part by the NSF through DUE 1022449 and DUE 1432765.

FD03: 7:20-7:30 p.m. Algebra-based Students & Vectors: Assessing ijk Coaching Effects on Arrow Performance

Contributed – John B. Buncher, North Dakota State University, Department of Physics, PO Box 6050, Fargo, ND 58102; john.buncher@ndsu.edu

Students in calculus- and algebra-based introductory physics courses have been shown to perform significantly better on vector addition and subtraction tasks using the ijk representation than identical tasks given in an "arrows-on-a-grid" representation. Evidence has also been provided that calculus-based students exhibit a knowledge hierarchy, with the ability to correctly solve questions in the ijk format necessary to correctly solving questions in the arrow format. The absence of explicit ijk instruction in a typical algebra-based course may cause difficulties experienced by most physics students with vector addition and subtraction in the arrow representation to be exacerbated in the population that typically takes algebra-based physics. In this study we investigate to what degree an instructional intervention in the ijk format improves algebra-based students' ability to correctly answer questions in the arrow representation over a similar instructional intervention in the arrow format. Results and instructional implications will be discussed.

FD04: 7:30-7:40 p.m. Investigating Student Difficulties Solving Systems of Equations*

Contributed – Matthew I. Jones, Arizona State University, Polytechnic campus, 7271 E. Sonoran Arroyo Mall, Santa Catalina, Hall Mesa, AZ 85212; mijones1@asu.edu

David E. Meltzer, Arizona State University

Mathematical difficulties of introductory physics students are well documented, but not all such difficulties have yet been carefully examined. One of the most frequently encountered types of mathematical problem to arise in introductory physics is the solution of systems of equations involving just two or three variables. For example, when balancing force vectors in a plane, students are often confronted with two equations and two unknowns, and are asked to find the values of the variables. As part of a larger study, we have developed a diagnostic that includes multiple questions about solving such small systems of equations. This diagnostic was given to over 600 students in first- and second-semester physics courses, and preliminary results show that many students struggle to solve these problems. We will present our methods and findings, including possible insights into how students approach the problem of solving systems of equations.

*Supported in part by NSF DUE #1504986.

FD05: 7:40-7:50 p.m. Exploring the Factors Underlying Physics Students' Mathematical Difficulties*

Contributed – David E. Meltzer, Arizona State University, 7271 E. Sonoran Arroyo Mall, Mesa, AZ 85212; david.meltzer@asu.edu

Matthew I. Jones, Arizona State University

We are continuing an investigation of mathematical difficulties that pose obstacles for students in introductory university physics courses. We have documented that a substantial proportion of students consistently make errors on high-school-level trigonometry and algebra problems; error rates vary from 10-30% in second-semester calculus-based courses to 70% and higher in first-semester algebra-based courses. Based on analysis of students' responses to written diagnostics and on one-on-one problem-solving interviews, we observe that these student difficulties have three primary components: (1) simple carelessness; (2) inadequate skill levels; (3) difficulties with mathematical concepts. We are exploring the relative magnitude of these components along with the nature and strength of their interaction, in an effort to find effective methods for improving students' performance.

*Supported in part by NSF DUE #1504986

FD06: 7:50-8 p.m. Physics Majors' Development of Metacognitive Gimmicks

Contributed – Gary D. White, The George Washington University, Corcoran Hall, 725 21st St NW, Room 105, Washington, DC 20052; gwhite@gwu.edu

Tiffany-Rose J. Sikorski, Justin M. Landay, The George Washington University

We report on the initial phases of a study to investigate how and to what extent physics majors at a small private urban university campus develop three particular metacognitive gimmicks, namely: checking units for consistency, discerning whether limiting cases match physical intuition, and computing numerical values for reasonable-ness. Students in a one semester Griffiths electromag-

netism course for physics majors are conditioned to respond to explicit prompts that encourage adopting these three methods for checking answers to typical textbook physics problems. We explore the time development of student use of these gimmicks in a given course and in a subsequent course. While the term "gimmick" carries with it some pejorative baggage, we feel it describes the essential nature of the pedagogical idea adequately in that it gets attention, is easy for the students to remember, and represents, albeit perhaps in a surface way, some key ideas about which professional physicists care.

FD07: 8-8:10 p.m. System-based Problem Solving in Physics

Contributed – Youngrae Ji, Seoul National, Bld 13 Rm 327, 1 Gwanak-gu, Seoul, 151 742 Republic of Korea; jyr1@snu.ac.kr

Jinwoong Song, Seoul National University

This study evaluates and analyzes understanding and application that undergraduate students have regarding the conception of system. The participants were majors in physics education in Seoul National University, Korea. The research was composed of the survey and interview. Surveys consisted of open response questions that concerned the concept of system and problems in terms of conservation laws. And the interview items were a definition of system and importance of system in physics learning, and what is the function of system in problem solving. Results show that the concepts of system was explained by using one or two keywords; and their explanations were not same with previous research. Participants had difficulties with considering the concept of system and applying the conservation law in the process of problem solving. We discuss the conditions of system-based understanding and hierarchy of conditions.

FD08: 8:10-8:20 p.m. Teaching Mathematics and Physics to Tibetan Buddhist Monks in India

Contributed – Chamaree de Silva, Mercer University, 1501 Mercer University Drive, Macon, GA 31207-0003; desilva_C@mercer.edu

The Emory-Tibet Science Initiative (ETSI) is designed to introduce modern science to Tibetan Buddhist monks studying in monastic institutions in India. Participating monks are exposed to concepts of Philosophy of Science, Biology, Neuroscience, and Mathematics & Physics every summer over the course of six years. First-year students learn basic mathematics and an overview of physics concepts such as kinematics, Newton's laws, and astronomy. Second-year students learn mechanics, third-year students learn thermodynamics, and fourth-year students learn electricity and magnetism. The physics portion of the program is currently in its fourth year of planning. Here, instructors travel to one of the three different participating monasteries in India for two-three weeks in summer. This program is sponsored by Emory University. https://tibet.emory.edu/emory-tibet-science-initiative/

Session FE: Labs/Apparatus (General)

Location: International 9
Sponsor: AAPT
Date: Monday, February 20
Time: 7–8 p.m.

Presider: David Sturm

FE01: 7-7:10 p.m. Game Development for Teaching Physics

Contributed – Gerd Kortemeyer, Michigan State University, Lyman Briggs College, East Lansing, MI 48825; kortemey@msu.edu

The talk describes two computer games developed using the Unity 3D platform: "A Slower Speed of Light" designed to teach Special Relativity, and "Kirchhoff's Revenge," which is currently under development to teach circuit laws. The talk includes a short demo of both games, a discussion of the effort required to develop immersive game environments, as well as the beginnings of the analysis of gameplay videos that users posted to YouTube.

FE02: 7:10-7:20 p.m. "Grappling" Success in Speed Runners!

Contributed – Richard P. Hechter, University of Manitoba, Department of Curriculum, Teaching, and Learning, Winnipeg, MB R3T2N2; richard.hechter@umanitoba.ca

Quinn J. Morris, University of Manitoba

Is understanding the physics behind the grapple tool the key to winning the game Speed Runners? Our students seem to think so (and we agree)! What started as an introduction of a widely accessible, user friendly, multiplayer PC game led to a discussion of problem- solving techniques that had students deconstructing gameplay through the lens of physics. Come join us as we share our findings from introducing the game into our secondary level physics class!

FE03: 7:20-7:30 p.m. The Origin of 'Cookbook' Laboratories

Contributed – Joanna Behrman, Johns Hopkins University, 3400 N. Charles St. - Gilman Hall 301, Baltimore, MD 21218; joanna.behrman@gmail.com

The term "cookbook laboratory" is nearly ubiquitous in modern science education research. This paper outlines the likely origins of the term and its roots in gender-stereotyping certain professions in the early 20th century. At the turn of the 20th century, industrial chemists, and analysts in particular, were held in low regard by business as well as by the general chemical community. Education became both the locus of concerns and the means of improvement for the industrial chemical community, and "cookbook" became the way to distinguish good education from bad. But at the same time, "cookbook" was also the means of denigrating chemical analysis as the profession for the women and other less-capable scientific practitioners. Other types of chemical professions were distinguished by their non-"cookbook" education and marked as exclusively male occupations.

FE04: 7:30-7:40 p.m. Short, Demonstrative Lab Activities for an Upper-division Lasers Course*

Contributed – Christopher M. Nakamura, Saginaw Valley State University, 7400 Bay Road, University Center, MI 48710-0001; cnakamur@svsu.edu

Lasers and optoelectronics are an important component of physics in which experiment is of critical importance, yet lecture courses can focus on very abstract, challenging theory, leaving the student

failing to learn central concepts, and perhaps questioning the value of studying the material at all. Here I discuss short, demonstrative lab activities that I implemented in an upper-division lasers course. The project grew out of a practical constraint—it was not feasible to introduce an additional lab course to address the experimental aspects of the discipline, but neglecting those aspects was pedagogically unacceptable. Challenges, primarily associated with strong time-constraints, and equipment use will be discussed. As will benefits, primarily the shared context for discussion of the theory ideas that can be generated by providing students with a guaranteed shared experience in which they've seen relevant phenomena. Future development plans, and alternative implementations will be discussed.

*This work is supported in part by a Herbert H. and Grace A. Dow Professor Grant through the Saginaw Valley State University Center for Academic Innovation

FE05: 7:40-7:50 p.m. Student Ownership of Optics Projects: A Multiple Case Study

Contributed – Dimitri R. Dounas-Frazer, University of Colorado Boulder, Department of Physics 390 UCB, Boulder, CO 80309-0390; dimitri.dounasfrazer@colorado.edu

Jacob T. Stanley, Laura Kiepura, Heather J. Lewandowski, University of Colorado Boulder

Part of what it means to "be a physicist" is to have ownership over a physics project, i.e., to feel and be responsible for project design, execution, and outcome. Many physics lab courses culminate in multi-week projects, providing students with opportunities to engage in projects over which they have ownership. However, because this phenomenon has not been well studied in the context of physics education, it is unclear what instructional features facilitate student ownership in this context. We report results of a multiple case study that focuses on three student groups who felt ownership over their seven-week-long projects in an upper-division optics lab course. These success stories shed light on the role of cycles of struggle and success in students' development of a sense ownership over their project. This work is one step towards the goal of developing a framework for ownership that can inform future curricular and research designs.

FE06: 7:50-8 p.m. Shoe Box Labs: Designing Labs for Local High School Students

Contributed – Brent G. Lunsford, Mercer University, 1501 Mercer University Drive, Macon, GA 31207; brent.grainger.lunsford@live.mercer.edu

Andrew Wilzman, Jeff Pullen, Chamaree de Silva, Mercer University

In collaboration with teachers from a local high school, we designed a set of physics and mathematics activities for students in the International Baccalaureate (IB) program. The annual science budget for the entire school is about $600, so the students do not have an opportunity to conduct proper labs as part of the curriculum that could prepare them for college-level material. Funded by the "Research that Reaches Out" Quality Enhancement Plan at Mercer University, we designed activities for 2D-kinematics, vectors, standing waves, circuits, and probability and statistics. This included a home-built wooden catapult to demonstrate projectile motion at three different initial angles.

PST2: Posters

Location: Marquis Ballroom Foyer
Sponsor: AAPT
Date: Monday, February 20
Time: 8:30–10 p.m.

Poster presenters are asked to mount their posters before 12 noon. The posters should be taken down at 10 p.m. Persons with odd-numbered posters will present their posters from 8:30 to 9:15 p.m.; those with even-numbered posters will present from 9:15 to 10 p.m..

Physics Education Research

PST2A01: 8:30-9:15 p.m. Utilizing IRT to Investigate Gender Difference on the FCI

Poster – Rebecca Lindell, Purdue Universiy, 525 Northwestern Ave., West Lafayette, IN 47907; rlindell@purdue.edu

Alexis Papak, Florida International University

John Stewart, Adrienne Traxler, Wright State University

Item Response Theory (IRT) describes methods and procedures for evaluating test items based on individuals item responses to their overall performances on the entire test. It goes beyond classical test theoretical models to evaluate individual items for appropriateness and fairness of the individual items. In previous research, we utilized classical test theory to flag 13 unfair items on the FCI that were poorly functioning for female students. In the next stage of the research, we utilized IRT to discover if the remaining 17 items on the FCI are also poorly functioning. In this portion of the research we greatly increased our sample size. As with the previous study, we chose to create two different samples, one with only female students and the other with only male students, to reduce the affects of the gender-imbalance inherent in a single sample of all physics students.

PST2A02: 9:15-10 p.m. Why Undergrads Leave STEM

Poster – Chloe Chambers, Columbus State University, 2840 Warm Springs Road, Columbus, GA 31904; chambers_chloe@columbusstate.edu

Kim Shaw, Columbus State University

Inspired by the work of Elaine Seymour and Nancy M. Hewitt as well as our curiosity to know how things may or may not have changed since their work in the early 1990s, the purpose of this project is to determine why undergraduate students who initially declare a science, technology, engineering or mathematics (STEM) major leave their field of study, as well as investigating potential means to improve retention rates in STEM. After conducting multiple one-on-one interviews with students at two southern universities, one regional comprehensive and one state university, data was coded independently by researchers to find common themes, those with both positive and negative influences, among students who chose to remain a STEM major, or among those that chose to change to a non-STEM major. Common themes among STEM majors will be addressed as well as potential solutions for increasing the STEM retention rates.

PST2A03: 8:30-9:15 p.m. Analytical Methods for Measuring Student Learning

Poster – Jayson M. Nissen, California State University Chico, 659 SW Jefferson Ave., Apt 2, Corvallis, OR 97333; jayson.nissen@gmail.com

Ben Van Dusen, California State University Chico

Amreen Nasim, University of Colorado Denver

Robert M. Talbot, University of Colorado Denver

We will discuss implications that researcher's choice between three commonly used methods for analyzing concept inventories has on making claims about student learning. These three methods are: normalized learning gains using class averages, normalized learning gains using individual student scores, and Cohen's d. Historically physics education research has used the first two whereas other fields primarily use Cohen's d. Data for the analyses came from the Learning Assistant Supported Student Outcomes (LASSO) database and included pre and/or post-test scores from more than 16,000 students on physics, chemistry, biology, and math concept inventories from 210 courses at 22 institutions across the country. The three methods were compared in aggregate across concept inventories. We will discuss advantages and disadvantages of the different methods and how the choice of method might lead to different inferences about student learning in a course.

PST2A04: 9:15-10 p.m. Can Lecture Be as Effective as SCALE-UP? Teaching Old Dogs New Tricks

Poster – Ebru Oncul, Georgia State University, One Park Place, 4th floor, Atlanta, GA 30302-3999; eoncul1@student.gsu.edu

Zeynep Topdemir, Brian Thoms, Georgia State University

In 2008, GSU started offering algebra-based introductory physics courses using the SCALE-UP approach in addition to the traditional courses. To determine the effects on conceptual learning we have compared FCI normalized gains for traditional and SCALE-UP classes over the past seven years. Normalized gains improved rapidly in the first two years of the SCALE-UP implementation and remained relatively constant over the later years. By comparison, normalized gains increased slowly over seven years in the traditional classes, and have become similar to the gains of SCALE-UP classes in the last two years. We hypothesized that the reason behind this similarity was that instructors employed active learning strategies in their traditional classrooms similar to those used in SCALE-UP classes. To investigate this we have administered a web-based survey for instructors who teach both classes. This poster reports on the results of our survey of physics faculty regarding their actual classroom practices and the characteristics of their classrooms.

PST2A05: 8:30-9:15 p.m. The Impact of Paired Teaching on the Teaching Practices of Faculty

Poster – Jared Stang, University of British Columbia, 334 - 6224 Agricultural Road, Vancouver, BC V6T 1Z1 Canada; jared@phas.ubc.ca

Linda Strubbe, University of British Columbia

Paired (or co-) teaching is an arrangement in which two faculty are collaboratively responsible for all aspects of teaching a course. By pairing an instructor experienced in research-based instructional strategies (RBIS) with an instructor with little or no experience in RBIS, paired teaching can be used to promote the adoption of RBIS. Through interviews pre- and post-paired teaching, we investigate how paired teaching impacts the participants' approach to teaching and evaluate the efficacy of paired teaching for the dissemination of RBIS. We present preliminary results of this qualitative analysis.

PST2A06: 9:15-10 p.m. Student Conceptual Resources for Understanding Wave Phenomena

Poster – Lisa Goodhew, University of Washington, 3910 15th Ave NE, Physics and Astronomy Building, Seattle, WA 98195; goodhewl@uw.edu

Amy Robertson, Rachel Scherr, Seattle Pacific University

Paula Heron, University of Washington

Informed by a resources theory of knowledge, we describe some of the preliminary results from our analysis of written responses to questions given to introductory physics students across the United States. We describe some of the prevalent conceptual resources (i.e., the productive, potentially useful ideas) that students use to reason about wave phenomena. This research responds to a need for large-scale, resources-oriented research on students' conceptual understanding and has the potential to support the development of an underexplored dimension of pedagogical content knowledge: the knowledge of student resources for understanding physics.

PST2A07: 8:30-9:15 p.m. Differences in Students' Treatment of Forces on Solid and Liquid Objects

Poster – Shannon Armstrong, Grove City College, 980 Centennial Drive, West Chester, PA 19382-2352; ArmstrongSA1@gcc.edu

Peter Shaffer, University of Washington

Many introductory physics classes introduce the concept of pressure by discussing the forces acting in a fluid. In order to accurately analyze these forces, students need to be able to treat a section of a fluid as an object and identify the forces acting on that object in the same way they would for a solid object. We do not know of any research that investigates student abilities to complete this task. We developed a question requiring students to compare forces acting on a solid object and an object made of a liquid. This question was given to students in a calculus-based introductory class, after a lecture introduction to pressure but before completing all instruction on fluids. This poster discusses the results from this question, which show that a significant portion of students do not treat the liquid object the same way that they would treat a solid object.

PST2A08: 9:15-10 p.m. Does Physics Instruction Enhance Identification of Physics Errors in Games?

Poster – Theodore J. Sobolewski, Indiana University of Pennsylvania, Department of Physics, 56 Weyandt Hall, Indiana, PA 15705-1087; vjwt@iup.edu

Stanley J. Sobolewski, Indiana University of Pennsylvania

Video games and computer simulations have become ubiquitous in teaching physics. It is possible for a student to take a course in physics where all of the demonstrations and examples are presented on a screen. While the models presented in a class correctly portray physical laws, this may not be true when the learner plays a video game. Video games may not accurately portray reality. We wonder if formal instruction in physics will allow the subject to identify physics errors in the game. Subjects are presented with a physics simulation video game where the rules of physics may be obeyed or ignored. Subjects are then asked if the parts of the video game correctly represented the real life situation. Preliminary findings indicate that students do not notice physics inaccuracies.

PST2A09: 8:30-9:15 p.m. Student Attitudes, Network Positions, and Conceptual Gains in Introductory Physics

Poster – Adrienne L. Traxler, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435-0001; adrienne.traxler@wright.edu

Raym Alzahrani, Wright State University

We compare students' attitudinal shifts with their initial and final positions in a classroom collaborative network for several sections of introductory calculus-based physics. Attitudes toward physics typically worsen over the first semester of introductory physics, as measured by instruments like the Colorado Learning Attitudes about Science Survey (CLASS). Larger courses are particularly linked with these negative shifts, with positive shifts mostly measured in smaller courses using active learning. However, students in all course sizes may have very different experiences depending on whether they work in isolation or in collaborative groups. We will use the tools of social network analysis to distinguish between isolated and well-connected students within the same course and examine this possible latent variable in attitudinal shifts. Where available, we will also compare CLASS scores and shifts to students'

conceptual gains to form a more complete picture of their physics experience over the semester.

PST2A10: 9:15-10 p.m. Flight Physics Concept Inventory: Current Challenges and Design for the FliP-CoIn

Poster – Florian Genz, University of Cologne, KoernerStr. 55, Cologne, NRW 50823 Germany; Florian.Genz@uni-koeln.de

The Flight Physics Concept Inventory (FliP-CoIn) provides feedback to college students, introductory physics courses and their teachers about common (mis)conceptions in fluid dynamics in the context of flight. Since this tool is still in development, the author is thankful for scientific exchange to concept inventory designers as well as PER and fluid dynamics experts. Also an online-based implementation is planned. Therefore individuals familiar with the implementation of auto-evaluated online diagnostic tests or researchers interested in new (open) question formats, which can be evaluated automatically, are welcome to engage in discussion with the presenter.

PST2A11: 8:30-9:15 p.m. Impact of Contrasting Cases Scaffolds on Students' Problem Solving

Poster – Carina M. Rebello, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; rebelloc@purdue.edu

David M. Beardmore, Bryce A. Towle, Purdue University

Research has shown that the inclusion of contrasting cases can potentially improve students' conceptual understanding and reasoning skills. However, research has also shown that the success of such tasks depends on how the cases are appropriately scaffolded. We investigate three forms of scaffolds – one designed to facilitate comparisons among multiple problem cases, another designed to prompt students to produce a general explanation of how to approach solving problems that would work across all provided cases, and one designed to facilitate evaluation of multiple general explanations to produce an argument for a "good" general explanation. We integrated these scaffolds within physics problems utilized during calculus-based physics recitations, and assessed their impact on students' learning. Results of these investigations will be presented.

PST2A12: 9:15-10 p.m. Improving Student Performances with Remodeled Laboratory Practices

Poster – Ravin Kodikara, Webster University, 470 East Lockwood Ave., St. Louis, MO 63119; ravinkodikara30@webster.edu

Contemporary research in physics education has identified certain weaknesses in conventional physics teaching-laboratory practices. One such weakness of the "cookbook" structure is its inadequacy to promote critical thinking, creativity, design and innovation. Another common drawback is the lack of opportunity given to students to identify their failures, as most of the activities are designed to be fail-proof. Webster University's undergraduate physics labs were redesigned with the goal of addressing the above issues. Redesigned (new) labs were given to a group of students and the post-lab academic performances and retention were compared to the controlled group (students who received standard, conventional physics labs). The underlying hypothesis was that modifications to instructional delivery and approach enhances performance outcome. Quantitative comparisons between the two groups showed significant improvements among the students who received new labs.

PST2A13: 8:30-9:15 p.m. Network Analysis of Students' Representation Use in Mechanics and E&M

Poster– Daryl McPadden, Florida International University, 11200 SW 8th St., Miami, FL 33199; dmcpadden621@gmail.com

Eric Brewe, Florida International University

In this study, we analyzed the representational tools that students in the Modeling Instruction – Introductory E&M (MI–E&M) course use on introductory physics problems. Representational competence is a critical skill needed for students to develop and communicate a sophisticated understanding of science topics, particularly in physics where multiple representations are often used within a single problem. The Modeling Instruction curriculum highlights representation development as a part of the modeling process, making the MI-E&M course a rich context to collect data. In the spring 2015 and spring 2016 semesters, over 150 students total (from three sections of MI–E&M) were given a survey of 25 physics problem statements both pre- and post- instruction, covering both Newtonian Mechanics and Electricity and Magnetism (E&M), and asked which representations they would use in that given situation. Using network analysis, we compare how students use representations in Mechanics and E&M contexts.

PST2A14: 9:15-10 p.m. Sticky Liquids Make Things Float? Probing "Interesting" Buoyancy Conceptions.

Poster – DJ Wagner, Grove City College, 100 Campus Drive, Grove City, PA 16127; djwagner@gcc.edu

While developing a taxonomy of alternate conceptions about buoyancy, we identified over 100 different conceptions. Some of the conceptions identified by other researchers such as "sticky liquids make things float",[1] inspired us to investigate the reasoning behind the conception further. Other conceptions, such as the idea that the direction of the force by water on an object changes with depth, were identified in individual interviews or low-n studies, and we wondered how prevalent the conceptions were in the college population. We designed questions to probe selected "interesting" conceptions and asked those questions of students at both the University of Washington and Grove City College. This poster will discuss the conceptions, the questions, and the results.

1. Y. Yin, M.K. Tomita, and R.J. Shavelson, Science Scope 31 (8), 34-39 (2008).

PST2A15: 8:30-9:15 p.m. Examining the Utilities of Different Classroom Observational Protocols

Poster – Cassandra Paul, San Jose State University, One Washington Square, San Jose, CA 95192; cassandra.paul@sjsu.edu

Kevin D. Hartman, Zairac Smith, San Jose State University

There are many different classroom observational protocols an observer can choose from, depending on his/her goals. In order to choose the right protocol, an observer will consider the questions he/she wants to answer and weigh the affordances and constraints of each protocol in this context. However, it is not always easy for a researcher or agent of professional development to do diligent research to determine which protocol would best suit their needs. We present the results from three different observational protocols (COPUS, RIOT, and RTOP) used to observe the same classroom event. The comparison of these results will provide an illustration of the utility of each observation protocol, so that observers may make more informed choices regarding their observing instruments.

PST2A16: 9:15-10 p.m. Statistical Correlations between Introductory Physics and Performance in Engineering Courses

Poster – Jonathan D. Perry, Texas A&M University, 4242 TAMU, College Station, TX 77843; JPerry@physics.tamu.edu

William Bassichis, Texas A&M University

Introductory physics forms part of the foundation of knowledge for all engineering majors, independent of field and institution. Instruction of introductory physics courses can vary greatly due to professor, textbook, and overall course design. This poster presents an examination of statistical correlations between introductory

physics credits earned by engineering majors at Texas A&M with their performances in follow on, high enrollment, engineering courses, overall GPA, and matriculation rates. This work specifically focuses on variations in student performance based on whether their introductory physics credits were earned through high school credit, transfer credit from a community college, or completion of either of the two types of introductory physics offered at Texas A&M University.

PST2A17: 8:30-9:15 p.m. Comparison of Pedagogical Features of Introductory Physics Learning Environments

Poster – Kevin D. Hartman, San Jose State University, 1540 Chiri Court, San Martin, CA 95046; kevin.hartman96@gmail.com

Cassandra A. Paul, Zairac Smith, Eric Hickok, San Jose State University

Instructor-researchers at San José State University (SJSU) have implemented the Collaborative Learning through Active Sense-making in Physics (CLASP) curriculum in our algebra-based, introductory physics course. Originally developed at UC Davis, CLASP is characterized by the use of models and integrated discussion-labs where hands-on, small-group activities promote sense-making and problem-solving skills. Using the Real-time Instructor Observing Tool, we examine classroom interactions in multiple contexts at SJSU, and compare those to the original RIOT observations at UC Davis. Preliminary results indicate that while classroom interactions fall on a spectrum depending on the instructor and given day, certain types of courses have pedagogical features identifiable by the RIOT.

Pre-college/Informal and Outreach

PST2B01: 8:30 PM-9:15 p.m. Teaching Physics at a Buddhist Monastery in India

Poster – Todd K. Timberlake, Berry College, PO Box 495004, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

Chamaree de Silva, Mercer University

Come learn about the Emory-Tibet Science Initiative, a program that invites physics teachers to travel to India and teach a two-week course in physics to monks at a Buddhist monastery. This program supports His Holiness the Dalai Lama's stated goal of incorporating modern science into the education of Tibetan Buddhist monks. ETSI is currently recruiting teachers for four different physics courses at several different monasteries for the summer 2017 physics program. The presenters will share their experiences teaching in this program and provide information to anyone interested in participating. Come find out about this exciting opportunity to share your love of physics with an eager and engaged, but underserved, audience. More information about ETSI can be found at https://tibet.emory.edu/emory-tibet-science-initiative/.

PST2B02: 9:15-10 p.m. The National Science Olympiad (NSO) /NASA Space Science STEM Outreach Network

Poster – Donna L. Young, NASA/CXC/NSO, 2022 Merrill Lane 9E, Bullhead City, AZ 86442; dlyoung.nso@gmail.com

There are opportunities to become involved with the National Science Olympiad/NASA Universe of Learning; Astrophysics STEM Learning & Literacy Network. NSO is a national non-profit organization dedicated to improving the quality of K-12 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/or national Science Olympiad tournaments, and incorporating Science Olympiad events into classroom curricula. Events address the NGSS scientific practices, crosscutting concepts and core disciplinary ideas from every scientific discipline, including astronomy. Knowledgeable event supervisors and well-written events for all levels of competition are difficult to find for astronomy. Instructors and students can sponsor an invitational, write invitational, regional or state events, becoming event supervisors, or contribute questions to the test bank. The NSO website provides information on developing and/or supervising astronomy events.

PST2B03: 8:30-9:15 p.m. Using Puns to Teach Physics Concepts

Poster – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; robert.close@classicalmatter.org

Learning physics is generally considered an analytical, or "left-brain" activity. However, many students learn better through more creative "right-brain" activities. Since many physics terms have alternative "everyday" meanings, it is important for students to distinguish between the two. Rather than simply having students memorize definitions, I have written a story in which physics terms are intertwined with their everyday meanings in the form of puns. The task for students is to identify both meanings of each pun. This task builds association between physics concepts and the words used to describe them in a creative manner appropriate for "right-brain" learners.

PST2B04: 9:15-10 p.m. Fun with Photons – An Interactive Learning Experience

Poster – Felix Kaess, North Carolina State University, 1616 Park Drive, Raleigh, NC 27605; fwkaess@ncsu.edu

Andrew Klump, Qiang Guo, Seunghyun Yoo, Zlatko Sitar, North Carolina State University

Graduate students from the lecture "MSE704: Interaction of Photons with Solids" partnered with The Exploris School in Raleigh to create a mutual learning experience with a selected group of middle school students. The graduate students became teachers in the five-week long "Exploration" project and successfully transformed the rather abstract lecture materials into tangible scientific experiments and taught the 5th graders about the four different fields of photonics. This process of translating theoretical insights into practical demonstrations for a non-scientific audience helped the PhD candidates to reflect on their own research and role as scientists in society. As a result of this project, both sides learned a lot about science, education, and communication -- from each other. Furthermore, all participants got excited to keep studying the fascinating field of light and deepen their understanding of science when they grow up / finish graduate school.

PST2B05: 8:30-9:15 p.m. Launching Baseballs with Georgia Tech and the Atlanta Braves

Poster – Jack W. Wood, Georgia Tech Research Institute, 925 Dalney Street, Mail Code 0834, Atlanta, GA 30332-0002; jack.wood@gtri.gatech.edu*

Michael Knotts, Georgia Tech Research Institute

The Atlanta Braves are partnering with the Georgia Tech Research Institute to boost STEM excitement among metro-Atlanta middle schoolers. Together they are developing a year-long program centered around a custom baseball launcher. GTRI designed the launcher which was delivered to participating schools in kit form. The schools created after-school clubs to build the instruments then practice launching baseballs with an eye toward an end-of-the-year competition for bragging rights and a chance to demonstrate on the field before a Braves game. Teams will be judged on the accuracy of their ball launches. In fact, the goal is to launch a ball, analyze its proximity to a target, make adjustments to the instrument, then improve on the second shot. In addition, students will have curriculum-matching activities that reinforce their knowledge of relevant physics topics. In the end, teams will

be judged on multiple aspects of the program, including notetaking and communication.
*Sponsor: Michael Knotts

PST2B06: 9:15-10 p.m. Making Music: Learning Physics and STEM Through Making Electric Guitars

Poster – Debbie A. French, Wilkes University, 84 W. South St., Wilkes-Barre, PA 18766; frenchd14@yahoo.com

R. Mark French, Purdue University

Sean Hauze, San Diego State University

Thomas Singer, Sinclair Community College

Imelda Castenada-Emenaker, University of Cincinnati

Many students may enter physics classes with a solid academic background, but have limited experience with making things and using appropriate tools. This study showcases the successes and challenges of having pre-college students make a solid-body electric guitar. The guitar is used as a vehicle to teach physics and integrated STEM concepts. Through guitar making, students solder circuits, learn woodworking skills, use hand and power tools, and implement guitar intonation techniques. Science and engineering practices such as design, problem-solving, analyzing and interpreting data, using mathematics and computational thinking, designing solutions are emphasized throughout the guitar build. Successes include increased student learning gains, interest and confidence in STEM, class attendance and registration, and number of female students in physics. Challenges include logistical issues, administrator support, and lack of curriculum maps including the guitar lessons. Direct participant quotes, student data, and teacher survey responses are used as evidence for these findings.

Teacher Training/Enhancement

PST2C01: 8:30-9:15 p.m. Designing a "Lab-on-a-Ship": The Floating Physics of Fluid Dynamics

Poster – Andre Bresges, University of Cologne, Institute of Physics Education, Gronewaldstrasse 2, Cologne, NRW 50931 Germany; andre.bresges@uni-koeln.de

Florian Genz, University of Cologne, Institute of Physics Education

We are applying U Stanford's "Design Thinking" approach to convert a 200ft ship into a swimming science lab. The Ship combines a research center for large river ecosystems with a training facility for teacher trainees, and a bionic lab where classes can study the impact of fluid dynamics on marine ecology, geography, and the design of ships and airplanes. Design Thinking applies on several levels. We declared the design process of the Science Lab a part of our "Future Strategy for Teacher Training". Space on a ship is always a precious resource, as is the time of the classes visiting the lab. Using the "Fail early, fail often" principle, teacher education students work closely with students of neighboring schools to develop, test and evaluate various prototypes. Thus, they combine theory and research to untangle all the problems and constrains, and to provide an rich, interesting and meaningful environment for students.

CLabs feature video: https://www.youtube.com/watch?v=8rebSfMbC2M
Future Strategy for Teacher Training: http://zus.uni-koeln.de/21122.html
Design Thinking resources: http://dschool.stanford.edu/dgift/

PST2C02: 9:15-10 p.m. Rowan's PhysTEC Program: Successes and Challenges

Poster – Trevor I. Smith, Rowan University, 201 Mullica Hill Rd., Glassboro, NJ 08028-1701; smithtr@rowan.edu

Issam H. Abi-El-Mona, Philip R. La Porta, Patrick L. Chestnut, Karen P. Magee-Sauer, Rowan University

Rowan University is in the middle of a three-year PhysTEC project to increase our production of highly qualified physics teachers for New Jersey schools. We have seen a rapid growth in our physics major population in recent years, and we are working to translate this into increased numbers of teacher candidates as well. The main thrusts of the project are holding targeted advising and information sessions for physics majors, providing research opportunities for undergraduates focusing on physics education, creating a Rowan Area Physics Teachers network, and growing the learning assistant (LA) program in physics (including placing two LAs in a local high school classroom). We report on the various successes and challenges of these efforts. We are particularly interested in the effects of the LA program both on the LAs (in terms of content understanding and dispositions toward teaching) and on the students in classes that have an LA.

PST2C03: 8:30-9:15 p.m. Special Physics Teaching Major and Minor at Vassar College

Poster – Cindy Schwarz, Vassar College, 4 Connelly Drive, Staatsburg, NY 12580; schwarz@vassar.edu

Brittany Tompkins, Alexandra Trunnell, Vassar College

At Vassar, we have a unique program for physics majors planning to get Physics Teaching Certification. Physics majors who wish to obtain Secondary Certification in physics must complete three additional courses beyond the six core courses. An independent project focused on physics education, independent work of Lab Development (developing and building three labs for HS physics) and Lab Apprenticeship (where they help the lab tech set up all the intro physics labs for the full year introductory physics course). Physics Minor with Teaching Emphasis is intended for those with other majors: students complete the following coursework above the introductory level, modern physics, classical mechanics, Lab Apprenticeship and, Lab Development and Senior Independent Work on physics education. Both programs also have recommended and required education courses. This poster will be presented by Professor Schwarz, the advisor for the program and two seniors who are currently enrolled in the program.

Upper Division and Graduate

PST2D01: 8:30-9:15 p.m. The Classical Theory of Spin Angular Momentum

Poster – Robert A. Close, Clark College, 1933 Fort Vancouver Way, Vancouver, WA 98663; robert.close@classicalmatter.org

One difficulty in teaching quantum mechanics is that students are not first taught to understand classical wave angular momentum. In the classical physics of elastic shear waves, orbital angular momentum is associated with wave propagation (i.e. derivatives of the wave amplitude), and spin angular momentum is associated with rotational motion of the medium that carries the wave. Specifically, spin density is the quantity whose curl is equal to twice the momentum density. In this poster we will derive the equation of evolution of classical spin density in vector and Dirac form. The Dirac equation for elementary particles is evidently a special case of the more general classical equation for spin. We will also derive the associated Lagrangian, Hamiltonian, and dynamical operators, which are essentially identical to their quantum counterparts. We will also investigate other similarities between classical and quantum spin angular momentum. Website: www.classicalmatter.org

Session GA: Astronomy Outreach & Planetarium Education

Location: International 4
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Matthew Perkins

GA01: 8:30-9 a.m. New Lessons from the Last 200 Planetarium Education Research Dissertations

Invited – Timothy F. Slater, University of Wyoming, 1000 E University, Laramie, WY 82071; timslaterwyo@gmail.com

The synthesis-oriented literature review is a ubiquitous component of any comprehensive science research program. Few scholars would argue against the notion that discipline-based astronomy education research studies need to be firmly situated within the existing scholarly landscape in order to establish relevance and theoretical underpinnings. Yet, some well-meaning journal reviewers have proposed all references and citations should focus first on recent papers published within the last five years. Such a constraint is often welcomed by nascent researchers, as it dramatically limits the scope of literature that must be surveyed. At the same time, some reviewers admonish writers to focus only on peer-reviewed journal articles at the expense of looking at unpublished dissertations. Through the iSTAR international Study of Astronomy Reasoning project at istardatabase.org, we have found more than 200 dissertations on planetarium education research from the last 100-years, which yield results largely unpublished in journals providing insight into longstanding planetarium education efforts.
http://www.istardatabase.org

GA02: 9-9:30 a.m. The Role of the Planetarium in Outreach Astronomy Education

Invited – Ken Brandt, Robeson Planetarium, 420 Caton Road, Lumberton, NC 28360; ken.starsabove@gmail.com*

What role can a planetarium play in facilitating outreach education in astronomy? Several strategies will be discussed, and various volunteer network connections described which help me deliver effective astronomy outreach to my audiences locally, regionally, and nationally.
*Sponsor: Matthew Perkins

GA03: 9:30-10 a.m. Science on a Sphere Used as an Interactive Instructional Tool for Students

Invited – Monique Wilson, James E. Richmond Science Center - Charles County Public Schools, 5305 Piney Church Road, Waldorf, MD 20603; mwilson@ccboe.com

The goal was to create 21st century learners and to be a leader in STEM education. Using the data collected from our test scores and listening to area industry leaders, it was apparent that a home grown STEM workforce was needed and the school systems had to answer the call. Under the leadership of Mr. Richmond, the school district began to invest heavily in this endeavor. The largest culmination of these efforts was the creation of a Science Center that is located on the same campus as the district's newest high school, St. Charles High School. The Science Center is part of the instructional strategy bring the "WOW" factor to education. The Science Center houses a 184-seat planetarium, Discovery Lab classroom and a Science on a Sphere. The Science on a Sphere is visualization technology that allows students to see the Earth and its systems in ways that flat screen technology cannot. The Science on a Sphere is being used to unlock the mysteries of Science for our student population in more ways than originally believed and has empowered our students to see themselves in relation to the word. www.ccboe.com/sciencecenter

GA04: 10-10:30 a.m. Using a Planetarium for Teaching and Outreach

Invited – Philip R. Groce, Helping Planetariums Succeed, 619 Orange St., Macon, GA 31201; hps4075@bellsouth.net

Planetariums in both formal and informal educational institutions have been used to teach and inspire students and the general public about the physical nature of the universe. Planetariums have the unique ability to illustrate astronomy and physics concepts that are difficult, if not impossible in the classroom. Participants in this workshop will discover though live presentations and hands-on operation better teaching methods through the use of planetariums. This workshop will focus on the August 21, 2017 Solar Eclipse. Goals of the workshop include: Providing a participatory and practical professional development opportunity by focusing on the 2017 Solar Eclipse. Sharing information about available educational resources and products for this Eclipse. Demonstrating the multi-disciplinary nature of planetariums. In addition to the physics and geometry of this eclipse, observations of changes in animal behavior during an eclipse can lead to better understanding of "light-dark" behavior in animals.

Session GB: Phys Rev Focused Collection on Gender in Physics

Location: International 5
Sponsor: Committee on Research in Physics Education
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Vashti Sawtelle

GB01: 8:30-9 a.m. Editorial Introduction to Focused Collection on Gender in Physics

Invited – Vashti Sawtelle, Michigan State University, 567 Wilson Road, Rm 1310E BPS Bldg, E. Lansing, MI 48824; vashtis@msu.edu

Eric Brewe, Drexel University

In this talk, we present an editorial overview of the 2016 Physical Review Physics Education Research Focused Collection on Gender in Physics. The focused collection includes 17 published papers drawn from 42 submitted proposals. The published collection includes papers from four broad categories: review papers describing how the literature has examined gender in a variety of arenas; evidence-based papers that use tools from outside traditional gender work in physics; research that looks at gender gaps in outcomes and works to understand why those gendered outcomes exist; and work that situates studying gender in physics in a broader context of STEM education. We will discuss the categories and highlight findings from authors that are not part of the invited session.

GB02: 9-9:30 a.m. Social Cognitive Perspective of Gender Disparities in Undergraduate Physics

Invited – Angela Kelly, Stony Brook University, 68 St Marks Place #4, New York, NY 10003; angela.kelly@stonybrook.edu

Sociopsychological theories and empirical research provide a framework for exploring causal pathways and targeted interventions for the low representation of women in post-secondary physics. Women earned slightly below 20% of physics undergraduate degrees in 2015. This disparity has been attributed to a variety of factors, including unwelcoming classroom atmospheres, low self-efficacy, and few female role models in academic communities. Recent studies have suggested gender disparities in physics and related STEM fields may be more amenable to social cognitive interventions than previously thought. Social psychologists have found that female students improved physics self-concept when adopting a malleable view of intelligence, when they received support from family and teachers, and when they experienced interac-

tive learning techniques in communal environments. By exploring research-based evidence for strategies to support female students in physics, pre-college and university faculty and administrators may apply social cognitive constructs to improve the representation of women in the field.

GB03: 9:30-10 a.m. The Physics-Learning Environment Inequitably Harms Women's Self Efficacy

Invited – Jayson M. Nissen, University of Maine, 120 Bennett Hall, Orono, ME 04469; jayson.nissen@gmail.com

Jonathan T. Shemwell, University of Maine

Men's and women's physics self-efficacy, their beliefs about their capabilities to learn physics, tends to be reduced after taking university physics courses. This reduction is reliably larger for women than for men. However, it is an open question whether this gender difference is caused by physics instruction, per se. We investigated this question using an in-the-moment measurement technique to collect college students' self-efficacy thoughts and feelings as they experienced physics instruction, other coursework, and in their daily lives. We combined these data with published data based on similar measurements for high school students. Female students in both populations experienced much lower self-efficacy than their male peers in physics, but not in other coursework. Evidently, physics-learning environments tend to harm women's self-efficacy. We explore possible explanations for this effect, focusing on the nature of the subject matter, typical approaches to teaching it, and the role of stereotype threat.

GB04: 10-10:30 a.m. Exploring Middle School Students' Perceptions of Physics: A Gender Study

Invited – Emily A. Dare, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295; eadare@mtu.edu

Gillian H. Roehrig, University of Minnesota

This study examined the perceptions of 6th grade students regarding physics and physics-related careers. The goal of this work was to understand similarities and differences between girls' and boys' perceptions surrounding physics and physics-related careers as part of an effort to increase female interest and representation in this particular field of science. A theoretical framework based on the literature of girl-friendly and integrated STEM instructional strategies guided this work to understand how instructional strategies may influence and relate to students' perceptions. Our findings indicate very few differences, but show that boys are more interested in the physics-related career of engineering. While girls are just as interested in science class as their male counterparts, they highly value the social aspect that often accompanies hands-on group activities. These findings shed light on how K-12 science reform efforts might help to increase the number of women pursuing careers related to physics.

Session GC: Developing Project-based Lab Courses

Location: International 6
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Educational Technologies
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Stephen Spicklemire

GC01: 8:30-9 a.m. Project-based Undergraduate Lab Courses at Bethel University

Invited – Chad Hoyt, Bethel University, 3900 Bethel Dr., Saint Paul, MN 55112; hoycha@bethel.edu

Nathan Lindquist, Keith Stein, Bethel University

We describe the development of project-based laboratory courses at Bethel University. These courses include rigorous lecture portions and open-ended labs that last approximately seven weeks. We discuss methods and recent student projects in Lasers, Optics, Quantum Mechanics, Fluids and Material and Devices.

GC02: 9-9:30 a.m. High Altitude Balloons and Other Projects in a Medium Sized Department

Invited – Ernie Behringer, Eastern Michigan University, 3730 Tremont Ln., Ann Arbor, MI 48105; ebehringe@emich.edu

David Pawlowski, Eastern Michigan University

For the past five years, the Capstone course at Eastern Michigan University (EMU) has been using open-ended projects to challenge students in their final year of undergraduate studies. During different semesters, the students have attempted several high-altitude weather balloon projects, built a wind tunnel, and have developed multiple schlieren imaging apparatuses. This presentation will focus on the highs and lows of these projects and the approach that is taken at EMU to give the students the best chance to have a successful project.

GC03: 9:30-10 a.m. Project-based Labs for an Electric Fields and Circuits Course

Invited – Dale Syphers, Bowdoin College, 8800 College Station, Brunswick, ME 04011-8448; dsyphers@bowdoin.edu

Following years of trying to modify the labs in our existing course for majors in Electric Fields and Circuits, we decided to switch to project-based labs. In the summer of 2016 we developed an entirely new set of labs which consisting of a three-week project, a four-week project, and a final three-week project. The new labs included all the basic elements of our prior labs, basic bench equipment, resistors, capacitors, inductors, diodes, transistors, op-amps, RL and RC circuits, and all the same conceptual elements, including input and output impedance, rectification, amplification, complex impedance, phase of AC signals, etc. The first two projects are structured around experiments that place materials appropriately according to their triboelectric response. The final project uses RC and RL circuits as crossovers for identical speakers, where phase is observed visually with a 1000 frame per second camera as well as on an oscilloscope.

GC04: 10-10:30 a.m. Project-based Lab Course Experience

Invited – Kurt Wick, University of Minnesota, 116 Church St. SE, Minneapolis, MN 55455; wick@umn.edu

A vital component of our advanced lab course is the 10-week project. The project topics are inspired either by students' ideas and interests and/or from a list of previous projects that we think could be improved or from recently published articles, mostly in

AJP. To be approved, students must have a prediction or model of the outcome and we expect them to build or assemble components of their experimental setup. At the start, students submit a detailed proposal and at the end a 10 to 15 page report in the form of a scientific paper. In addition, each student gives an oral presentation and we end the semester with a popular poster/pizza session. Students typically work in pairs and in a typical year we have about 25 projects. The talk highlights the strengths and pitfalls of this approach.

Session GD: Work/Life Balance – Panel

Location: International 10
Sponsor: Committee on Women in Physics
Co-Sponsor: Committee on Professional Concerns
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Anne Cox

How do you try to maintain a balance between your professional and personal life? What type of challenges do you face: The two-body problem? Multi-generational care-giving? Finding time for yourself? The panelists will first share their stories: both challenges and ways they have addressed these challenges. Then, we will open the floor to questions and discussion between the panelists and audience-participants. Come and learn new ways to think about this issue and contribute your strategies for finding balance.

Panelists:

Heather Whitney, Wheaton College, Wheaton, IL

Kimberly Shaw, Columbus State University, Columbus, GA

Sathya Guruswamy, University of California Santa Barbara

Kim Titus, High Point University

Session GE: Engaging the Public with Festivals – Panel

Location: International 8
Sponsor: Committee on Science Education for the Public
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Shawn Weatherford

Panelists:

Jordan Rose, Atlanta Science Festival

Andrew Young, Atlanta, GA

Tatiana Erukhimova, Texas A&M University

Pati Sievert, Northern Illinois University

GE01: 8:30-10:30 a.m. Texas A&M Physics & Engineering Festival

Poster – Tatiana Erukhimova, Texas A&M University, Department of Physics & Astronomy, 4242 TAMU, College Station, TX 77843-4242; etanya@tamu.edu

Texas A&M Physics & Engineering Festival attracts 5000-6000 visitors annually. People come not only from Texas but also from other states. The festival features over 200 interactive exhibits displayed by faculty and students, public lectures by world-renowned scientists and astronauts, professional bubble shows, and many other activities. I will report on the structure of the festival as well as strategies for involving undergraduate and graduate students and faculty in public outreach. I will further discuss the results of an independent evaluation of the 2016 Festival by the NSF-funded EvalFest program.

GE02: 8:30-10:30 a.m. Family Physics Night at Texas Lutheran University

Poster – Toni Sauncy, Texas Lutheran University, 1000 West Court St., Seguin, TX 78155; tsauncy@tlu.edu

Erin Scanlon, Texas Lutheran University

Texas Lutheran University is located in a small town in south central Texas. Each fall, the Society of Physics Students and the Department of Physics work together to present an evening of hands-on physics activities to which the community is invited. This event draws hundreds of visitors from the rural communities in the area, spurred by the strong enthusiasm of high school physics teachers, along with middle and elementary science teachers, many of whom encourage their students to attend for enrichment (and extra credit). The success of the program, which has grown steadily each year, can be attributed to directed communication with the K-12 teachers in the area and the support of the TLU marketing team. In this poster, we will present the history of the event, secrets for success, and highlights of thematic activities presented over the past three years.

GE03: 8:30-10:30 a.m. Puzzles, Mysteries and Demonstrations

Poster – Juan R. Burciaga, Bowdoin College, Dept. of Physics & Astronomy, 8800 College Station, Brunswick, ME 04011-8448; jburciag@bowdoin.edu

The National Society of Hispanic Physicists (NSHP, www.hispanicphysicists.org) has been an active participant of all four USA Science and Engineering Festivals. In particular we have hosted a table "Puzzles, Mysteries and Demonstrations" during the closing weekend extravaganza in Washington, D.C. This past year we hosted our own table and contributed to the AIP Big Top Physics booth. The poster will focus on the objectives of our outreach, the activities/demonstrations selected for the table, some of the challenges we have encountered, and the particular needs that we are trying to address.

GE04: 8:30-10:30 a.m. Science Across the Bluegrass: A Just-Add-Science initiative by SKy Science Festival

Poster – Richard Gelderman, Western Kentucky University, 1906 College Heights Blvd., Bowling Green, KY 42101-1077; gelderman@wku.edu

Michael T. Carini, Western Kentucky University

The SKy Science Festival was founded to bring science out where the people are, instead of having them come to our labs. Our successful EXPO Day runs all day on Saturday at a large downtown park featuring a carnival atmosphere with food, music, art, stage performances and booths with interactive hands-on experiences. However, we discovered from our surveys that people attending our EXPO Day are still choosing to attend a science event rather than a festival event. So we decided to infiltrate music, art, and culture festivals with our science activities, not otherwise interested in seeking out opportunities to explore science. With assistance from the Science Festival Alliance, our Just-Add-Science tent has traveled to reaches a greater number of minorities & women, people who are underrepresented in science, math & engineering.

Session GF: Video of the Week – Panel

Location: International 9
Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Educational Technologies
Date: Tuesday, February 21
Time: 8:30–10:30 a.m.

Presider: Sam Sampere

Attempts to bring classical and contemporary physics into the public view can be accomplished by creating interesting videos and publishing them in various online formats. Creating good content, stories, and publicizing your efforts can be quite challenging. Please bring your questions and thoughts and contribute to this panel discussion. The panelists are composed of those who successfully attempted this feat. Learn from them and you can perhaps circumvent some pitfalls.

Panelists:

James Lincoln, PhysicsVideos.com

Paul Nord, PIRA

Dan MacIsaac, Buffalo State University

Andre Bresges, University of Cologne

Other surprise experts

Session GG: Introductory Courses

Location: International 7
Sponsor: AAPT
Date: Tuesday, February 21
Time: 8:30–10:10 a.m.

Presider: Katie Ansell

GG01: 8:30-8:40 a.m. Using You-tube Clips to Further Emphasize Physics Concepts in Real-world Situations

Contributed – Flavio H. Fenton, Georgia Institute of Technology, 837 State St., Atlanta, GA 30332; flavio.fenton@physics.gatech.edu*

We present a comprehensive list of about 50 short videos that can be used to explain physics concepts from inertia to angular momentum. We have been using these videos for over two years in an Introductory Physics course (Mechanics) at Georgia Tech. The everyday events allow students to better appreciate how the concepts learned can actually be applied to explain the actions observed in the videos. The videos can be interspersed throughout the lecture to encourage students to think about how physics is used to describe and understand real-world events. Students' comments at the end of the courses by far have centered on the use of the videos as a way to keep them motivated and interested in learning more physics.

*Sponsor: Emily Alicea-Munoz

GG02: 8:40-8:50 a.m. Conceptual Physics Understanding through Augmented Reality

Contributed – Sergio Flores Garcia, UACJ, Avenida del Charro 450 Nte. Col. Partido Romero, Ciudad Juarez, MX 32310 Mexico seflores@uacj.com

Osiel Ramirez, Maria D. Cruz, Juan E. Chavez, UACJ

Maria D. Gonzalez, ITCJ

The Augmented Reality's capacity of inserting virtual objects in the real life has converted it in a very helpful technological tool to present entertainment and educative contents. Moreover, it has demonstrated its pedagogical function in different scenarios as in museums, where the object is presented in an attractive and didactic way simultaneously. These kinds of virtual environments allow the observation of objects created from mathematical figures or equations, as students would do with real models. The understanding of conceptual nucleus of projectile motion by students in the Engineering and Technological Institute of University of Ciudad Juarez' students taking the Physics II course is our particular goal. Two groups were selected to collaborate in this project: the experiment and the control groups. The control group was exposed to a traditional instruction. Meanwhile the experiment group was exposed to an Augmented Reality lab. Analysis of the results indicates that the experiment group showed a greater knowledge gain than the control group.

GG03: 8:50-9 a.m. A Hybrid Introductory Physics Sequence in Review

Contributed – Grant D. Thompson, Wingate University, 220 N Camden Rd., Wingate, NC 28174; g.thompson@wingate.edu

James W. Hall, Kenneth S. Kroeger, Wingate University

Increased enrollments in health-related professional programs at our institution has driven our department to devise a hybrid two semester introductory physics sequence that meets the demands of our majors and those in the health fields. This sequence requires all students to enroll in an algebra-based Physics I succeeded by the option to pursue either an algebra-based Physics II course or an enhanced calculus-based Physics II course that revisits Physics I and its calculus applications. The pilot offering of this hybrid physics track was held during the 2015-2016 academic year. This talk will present the successes and shortcomings of the modified introductory sequence and future avenues of development.

GG04: 9-9:10 a.m. Mathematical Modeling of Newton's Cooling Law

Contributed – Maria G. Castro, ITCJ, 500 W University, El Paso, TX 79912; seflores@uacj.mx

Maria D. Gonzalez, ITCJ

Sergio Flores, Osiel Ramirez, Maria D. Cruz, UACJ

Although the exponential function is part of the curriculum of mathematics since primary and secondary educational levels, the extent of programs in higher education institutions limit the time this issue is discussed. In addition, the traditional education system only includes some changes in representation. Also, according to The Theory of Registers of Representation, proposed by Raymond Duval, they are not enough for students to gain a meaningful understanding of this function. This research was developed based on the design and implementation of laboratory practices. Students were exposed to a dynamic contextualization of the concept of exponential function. This article describes the cognitive effect of the instruction received by the coefficient-normalized gain of Hake and the possible relationship with the level of understanding of Hitt. The results show a correlation of 0.5 between these two indices.

GG05: 9:10-9:20 a.m. Student Confidence and Performance Outcomes in an Introductory Physics Class

Contributed – Ramesh Adhikari, Jacksonville University, 2800 University Blvd N, Jacksonville, FL 32211; radhikari@ju.edu

W. Brian Lane, Jacksonville University

Introductory physics classes bring students from various departments and backgrounds. For some students, the materials covered

in these classes are review of their advanced level high school physics, while for others, they are completely alien. Despite this discrepancy in preparation of the students, it is expected that designing a course that requires active participation of the students, would help improve the performance of the disadvantaged students while retaining the performance of the high achieving students. However, the level of self-confidence of the students based on their perception of the materials assigned or presented during the course may influence the extent of their preparation outside of class or lack thereof. In this study, we track the evolution of self-confidence of students in an introductory level calculus-based electricity and magnetism class throughout a semester and investigate how it relates to their performance.

GG06: 9:20-9:30 a.m. A New Instrument to Develop Assessments that Align with PER

Contributed – James T. Laverty, Kansas State University, 1228 N. 17th St., Manhattan, KS 66506; laverty@ksu.edu

Between the introduction of the Next Generation Science Standards, changes to the AP Physics curriculum, and the steady advances from Physics Education Research, physics education is advancing and changing at a rapid pace. As with most advances in science, there is a gap between the introduction of new ideas and their routine use in educational environments. Recently, a team of disciplinary experts and discipline-based education researchers at Michigan State University released a new instrument, the Three-Dimensional Learning Assessment Protocol (3D-LAP). One of the goals of this instrument is to aid practitioners in the identification or development of assessments that align with the current transformations in physics education. In this talk, I will briefly describe the idea of "scientific practices," what it means to assess them, and demonstrate the use of the 3D-LAP to help align assessments with them.

GG07: 9:30-9:40 a.m. Quizzing to Improve Homework Efficacy in Physics

Contributed – Mark V. Mayer, US Air Force Academy, 2638 Hatch Circle, Colorado Springs, CO 80918; mark.mayer@usafa.edu

College physics courses generally include assigned homework to provide problem solving challenge and consolidation of conceptual understanding. In coordination, on-line grading systems are often used. Some studies have shown that successful homework completion does not correlate with higher exam performance. Kontur et al. [F.J. Kontur, K. de La Harpe, N.B. Terry., "Benefits of completing homework for students with different aptitudes in an introductory electricity and magnetism course," Phys. Rev. PER. 11,010105 (2015)] found this to be the case, in particular, for the lower-scientific-aptitude students. To increase student benefits from homework, a homework quiz process was instituted in General Physics II courses at the United States Air Force Academy. This presentation will explain the quiz process and discuss our understanding of its efficacy.

GG08: 9:40-9:50 a.m. Exploring Dynamics of Instructor Credibility in Active-learning Physics Classes

Contributed – Jon Gaffney, Eastern Kentucky University, 521 Lancaster Ave., NSB 3140, Richmond, KY 40475-3102; jon.gaffney@eku.edu

"Instructor credibility" refers to how students perceive their instructor as competent, trustworthy, and caring. Credibility is a convenient construct because it is repeatedly shown to be related to student satisfaction and learning. However, perceptions of credibility are formed over time, not from singular behaviors or interactions. Because interactive-engagement physics classes require instructors to interact with their students frequently and directly, it is important to understand the dynamics of how instructors gain or lose credibility through those interactions. This talk provides early results of a pilot study to investigate those dynamics over a semester of algebra-based physics, with an eye toward how understanding such dynamics can inform instructors of similar courses.

GG09: 9:50-10 a.m. With all Due Respect: Physics Students Speak to Physics Teachers

Contributed – Paul Hutchison, Grinnell College, Steiner Hall - 1120 Park St., Grinnell, IA 50112; hutchiso@grinnell.edu

Christian Clark, Jessica Daly, Jason Jennings, Major May, Elizabeth Nelson and Rachel von Holst, Grinnell College

The primary authors are six undergraduate students who took a non-traditional introductory physics class. The class is a type that some call a "responsive science class". The course instructor will briefly describe some characteristics of the class. Then we present our investigation into aspects of the class that were important to our positive experience in it. We collected and analyzed after-the-fact reflections on the course written by us and a couple of other students from our class. Three key themes emerged in our analysis of those reflections: the importance of learning to talk about our understanding, the role of changing our expectations about knowledge, and truly collaborative inquiry. We make the case physics students at all levels will benefit if more physics teachers incorporate aspects of responsive science teaching in their pedagogy.

GG10: 10-10:10 a.m. Can We Prevent Students from Googling Answers to Their Homework?

Contributed – Debora M. Katz, U.S. Naval Academy, 719 Mills Way, Annapolis, MD 21401; dkatz@usna.edu

We know that problem-solving is one of the best ways to really learn physics. So why would a student cheat himself or herself of such an important learning opportunity? In my talk I will discuss what motivates some students to search for homework solutions online, rather than doing their own work. I will also talk about some practices we can use to prevent cheating. One practice is to provide students with right-on-time homework help. Along those lines, I will show online homework-help videos I've recorded.

Session HA: Challenges Faced by LGBT Physicists

Location: International 5
Sponsor: Committee on Diversity in Physics
Co-Sponsor: Committee on Research in Physics Education
Date: Tuesday, February 21
Time: 12:30–1:50 p.m.

Presider: Ramón Barthelemy

HA01: 12:30-1 p.m. Queer in STEM: Emergent Issues from Research on Academia and Industry

Invited – Erin A. Cech, University of Michigan, 500 S. State St., 3115 LSA Building, Ann Arbor, MI 48109-1318; ecech@umich.edu

Science prides itself on being an objective and neutral space where who one is and who one loves is supposed to matter least. In this presentation, I will discuss findings from my ongoing research on the experiences of LGBTQ-identifying persons in STEM academic departments and in STEM industry. This research, supported by National Science Foundation grants, point to a variety of processes at the interactional level, such as informal peer interactions, and the profession level, such as biased perceptions of competence, that disadvantage LGBTQ-identifying scientists. This presentation will provide a broad overview of these processes and offer suggestions for their amelioration.

HA02: 1-1:30 p.m. Report of the APS Ad-Hoc Committee on LGBT Issues

Invited – Timothy J. Atherton, Tufts University, 574 Boston Ave 412L, Medford, MA 02155-5555; Timothy.atherton@tufts.edu

In 2014 the Executive Officer of the American Physical Society (APS), Kate Kirby, created an Ad-Hoc Committee on LGBT Issues (C-LGBT) charged with reporting on the obstacles to inclusion of LGBT physicists, a term that for the purpose of this report refers to persons who self-identify as lesbian, gay, bisexual, transgender, queer, questioning, intersex, or asexual, as well as other sexual and gender minorities. The committee was charged to "advise the APS on the current status of LGBT issues in physics, provide recommendations for greater inclusion, and engage physicists in laying the foundation for a more inclusive physics community. More specifically, the committee will investigate LGBT representation in physics, assess the educational and professional climate in physics, recommend changes in policies and practices that impact LGBT physicists, and address other issues that affect inclusion." In this talk, I present the findings and recommendations of the C-LGBT final report, as well as provide some perspectives on its implementation.

HA03: 1:30-1:40 p.m. Creating Space for Mental Health at CUWIP

Contributed – Andrea J. Welsh, Georgia Institute of Technology, 302 Deering Rd. NW #6314, Atlanta, GA 30309; awelsh8@gatech.edu

As a college sophomore in 2009, I attended a Conference for Undergraduate Women in Physics (CUWIP) at Yale. While I learned some valuable things, what should have been a great experience was tempered by my social anxiety and depression spending the conference feeling scared and unsuccessful. In 2016, I had an opportunity to chair a CUWiP. Remembering my difficulty at my first CUWiP, I decided to take a risk: we would host a breakout session on mental health. The session was well-attended, with over 30 students in the audience. This demonstrated to me and other CUWiP facilitators that this was a necessary topic to cover, and in 2017, a few sites have chosen to include this workshop. This talk will discuss the trial of creating a space to specifically talk about mental health topics and how to help students get the most out of new and stressful opportunities.

HA04: 1:40-1:50 p.m. Lessons Learned from LGBTQ+ Roundtable Discussions at CUWiP

Contributed – Robin Bjorkquist, Cornell University, 117 Clark Hall, Ithaca, NY 14850; rb532@cornell.edu

I first attended CUWiP in 2009, a few months before my college graduation. It was a powerful and inspiring experience, and I returned home feeling hopeful about my future as a physicist. I encountered CUWiP again as a graduate student, when I joined the local organizing committee for the 2013 conference at Cornell. Since then, I have attended three more conferences as a graduate panelist and workshop leader (2014 Penn State, 2016 Ohio State and 2017 Wisconsin). Most recently, I have been leading LGBTQ+ roundtable discussion workshops, to give LGBT participants an opportunity to meet each other and discuss their experiences, needs, and available resources. I will share some take-away messages from these sessions, as well as best practices for LGBT inclusion at CUWiP, other women-in-physics events, and physics as a whole.

Awards Session

Location: Marquis Ballroom B
Date: Tuesday, February 21
Time: 10:30 a.m.–12 p.m.

Presider: Mary Elizabeth Mogge

Jan Tobochnik

Oersted Medal, *presented to Jan Tobochnik*

The Changing Face of Physics and the Students who Take Physics

Jan Tobochnik, Department of Physics, Kalamazoo College, Kalamazoo, MI

I've never found teaching physics to be as interesting as it is now for two reasons. Students are changing rapidly and it is an intellectual challenge to figure out the best way to work with them. Simultaneously, it is becoming increasingly clear that there is a major disconnect between what we teach, which has barely changed since I started teaching, and what physicists and other scientists are actually doing in their research. I will discuss these changes and what is being done at Kalamazoo College and elsewhere to address these challenges.

Homer L. Dodge Citations for Distinguished Service to AAPT

Ernest R. Behringer
Eastern Michigan University

Richard Gelderman
Western Kentucky University

Sharon Kirby
University of West Georgia

Kenneth S. Krane
Oregon State University

Ann M. Robinson
University of West Georgia

2016 SPS Outstanding Chapter Advisor Award

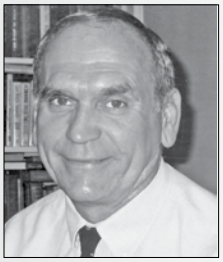
presented to Professor Blane Baker, William Jewell College

Blane Baker

Dr. Baker has shown extraordinary dedication to student development, a commitment to servant leadership, a heart for service and a true commitment to improving the world around him. His efforts have had impacts both locally and globally. On-campus he is renowned for his accessible teaching and demonstrations and has established partnerships with local disadvantaged elementary schools. Off-campus, he has taken students on work trips to Haiti, Guatemala, a correctional facility in Eagle Pass, Texas, and the Lakota community in South Dakota. Dr. Baker has also played a critical role in the Society of Physics Students national governance, serving as a Zone Councilor since 2013 and hosting a Zone 12 meeting. It is for the accomplishments and his steadfast commitment that we recognize Dr. Blane Baker as the 2015-16 Outstanding Chapter Advisor.

AAPT Presidential Transfer Ceremony

Janelle M. Bailey
Temple University
2016 President



George A. Amann
Rhinebeck, NY
2017 President

Session HB: Cold War Physics

Location: International 6
Sponsor: Committee on History and Philosophy in Physics
Date: Tuesday, February 21
Time: 12:30–1:30 p.m.

Presider: Harvey Leff

HB01: 12:30-1 p.m. Atoms for Peace – Or for Proliferation

Invited – John Krige, Georgia Institute Of Technology, 221 Bobby Dodd Way, Atlanta, GA 30332-0225; john.krige@hsoc.gatech.edu

In December 1953 President Eisenhower made his famous Atoms for Peace Proposal to the General Assembly of the United Nations. It was directed at the Soviet Union as a disarmament measure, and at the rest of the world as an instrument to spread the positive benefits of nuclear power to all those who could use them, above all in 'developing countries'. By 1960 the Atomic Energy Commission had distributed nuclear material and nuclear power knowledge to almost 40 countries throughout the globe. At about this time too there was growing concern that nuclear weapons would proliferate dramatically and that 10, 20, N countries would soon have them. Did Atoms for Peace make the world a safer place, or did it contribute to the spread of nuclear weapons beyond U.S. control? This paper will address this dilemma and explore both the costs and benefits of nuclear collaboration.

HB02: 1-1:30 p.m. Our Machine in Havana: The Cuban Missile Crisis and Espionage

Invited – Kristie Macrakis, Georgia Institute of Technology, 221 Bobby Dodd Way, Atlanta, GA 30332; macrakis@gatech.edu

This paper argues that U.S. intelligence nearly missed the fact that the Soviets had nuclear medium-range missiles in Cuba by 1962 because they relied too much on technical intelligence instead of using human intelligence. Agents and refugees had been telling the U.S. intelligence about missiles on Cuba for quite some time but they were discounted because the U-2 spy plane could not verify their existence. It wasn't until late in 1962 that the Central Intelligence Agency heeded warnings by human agents and then verified reports with the U-2 spy plane the existence of medium-range missiles on Cuba. Traditional narratives of the story argue that the U-2 spy plane found the missiles. It was, in fact, humans that found the missiles. The plane only verified their reports.

Session HD: Professional Skills for Graduate Students – Panel

Location: International 9
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Tuesday, February 21
Time: 12:30–2:30 p.m.

Presider: Daryl McPadden

This interactive panel focuses on developing professional skills for graduate students and other early-stage researchers. This session will address professional concerns brought up by graduate students during the past Crackerbarrels/ Topical Group Discussions. Topics covered may include: preparing for careers after graduate school, becoming integrated with the community, developing research skills, and disseminating your work.

Panelists:

Adrienne Traxler, Wright State University
Angie Little, University of California - Berkeley
Joel Corbo, University of Colorado - Boulder

Session HE: Induction and Mentoring of Early Career Teachers

Location: International 8
Sponsor: Committee on Teacher Preparation
Date: Tuesday, February 21
Time: 12:30–2:30 p.m.

Presider: John Stewart

HE01: 12:30-1 p.m. Seeking Different Kinds of Understanding: Research with Middle School Teachers*

Invited – Michael C. Wittmann, University of Maine, 5709 Bennett Hall, Orono, ME 04469-5709; mwittmann@maine.edu

In middle school physical science teaching, the focus is typically on conceptual understanding and rich descriptions of a situation, without using much math. Working with many collaborators in the Maine Physical Sciences Partnership (MainePSP), I have spent several years investigating middle school students' understanding of energy and their teachers' knowledge of energy and non-uniform motion. In our professional development activities, we have teachers engage with student data in order to develop their content understanding and their knowledge of students' ideas. To analyze our observations, we use a resources perspective, recognizing the context-dependence of teaching decisions regarding the multiple goals of instruction. As an extension of our work, we have used our findings to guide medication of our graduate courses in Integrated Approaches to Physics Education for pre-service teachers. Our goal is to help teachers be more responsive to the creative and useful ideas their students bring to the classroom.

*Sponsored in part by NSF grants DRL-0962805, DRL-1222580, and DUE-1340033.

HE02: 1-1:30 p.m. Mentoring Teachers Through Professional Learning Communities

Invited – David R. Henry, SUNY Buffalo State, 1300 Elmwood Ave., Buffalo, NY 14222; HENRYD@BUFFALOSTATE.EDU

Michael Belling, Williamsville North High School

Providing effective support for in-service teachers is a critical component to addressing the existing teacher shortage. U.S. attrition rates are hovering near 8% compared to high-achieving jurisdictions like Finland, Singapore, and Ontario, Canada—where only about 3 to 4% of teachers leave in a given year. This presentation will discuss two programs, the grass-roots Western New York Physics Teacher Alliance and the well-funded New York State Master Teacher Program. Both programs provide supportive professional communities for physics teachers that can make a critical difference in teacher attrition. I will compare the characteristics of these two distinct organizations and share lessons we have learned related to the role of Professional Learning Teams in effective professional development.

HE03: 1:30-1:40 p.m. AP Physics Professional Learning Team*

Contributed – Michael Belling, Williamsville East High School, 151 Paradise Rd., East Amherst, NY 14051-1783; mbelling@williamsvillek12.org

As part of the New York State Master Teacher Program, a professional learning team (PLT) was formed in the Buffalo area to address the needs of teachers teaching AP physics. Emphasis has been placed in helping those new to the Advanced Placement curriculum, which often includes teachers outside of the Master Teacher Program. Meetings often include both the sharing of existing laboratory practices and the development of new AP-centric labs, along with discussions of pedagogical techniques. I will discuss how our PLT has evolved, and the direction to which it is headed.

*Funded by the New York State Master Teacher Program

HE04: 1:40-1:50 p.m. edTPA (teacher certification program) and the Challenge of Preparing Well Qualified H.S. Physics Teachers

Contributed – Frank D. Lock, Georgia Stae University, c/o 4424 Sardis Rd., Gainesville, GA 30506; flock@gsu.edu

There are 704 Educator Preparation Programs in 38 states and the District of Columbia participating in edTPA. Georgia is among those 38 states. During my two years as a physTEC Teacher In Residence, I found the edTPA certification program inhibited the preparation of high school physics student teachers. My experience indicates that university teacher education programs requiring students to complete edTPA hamper the preparation of those students for their first year in a classroom. Evidence for this will be presented in this talk.

HE05: 1:50-2 p.m. 21st Century e-portfolios: Outreach, Tracking and Training with Share & Shine Model

Contributed – Fatih Gozuacik, Harmony Science Academy - Brownsville, 1124 Central Blvd., Brownsville, TX 78520; fgozuacik@harmonytx.org

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

HE06: 2-2:10 p.m. Sharing STEM with the World: Opportunities in China

Contributed – John P. Lewis, Northern Illinois University, 1420 Magnolia St., Glenview, IL 60025; yesmoment1@yahoo.com

In 2015 a unique partnership was formed between the Beijing School District and the Northern Illinois University STEM Outreach program. NIU was contracted to do numerous professional development sessions which shared secrets of STEM with the Beijing teachers. Wanting more, the school officials asked if NIU could provide teachers to actually come in to their schools and teach STEM processes to their students for the entire school year. Eighteen months into the program, it looks as though things are flourishing and ready to grow. NIU offers a summer STEM training program to prepare teachers for such an excursion and then provides tremendous support while the teachers are in China. Interested? Find out more at this informative talk which will describe the process and experience of teaching STEM to middle-schoolers in China.

HE07: 2:10-2:20 p.m. Modeling Workshops, Representational Tools, and Assessing Scientific Processes

Contributed – Kathleen A. Harper, Dept. of Engineering Education; The Ohio State University, 244 Hitchcock Hall, 2070 Neil Ave., Columbus, OH 43210; harper.217@osu.edu

Lin Ding, School of Teaching & Learning; The Ohio State University

Ted M. Clark, Dept. of Chemistry & Biochemistry; The Ohio State University

Workshops in Modeling Instruction[1] for physics have been offered in central Ohio for 13 years. Their evaluation has largely focused on changes in the conceptual understanding of the participating teachers, as well as of their students, using the Force Concept Inventory.[2] However, in an effort to better understand how specific modeling practices may influence the participant's problem-solving, an additional evaluation was introduced to address participants' scientific process skills in 2016. Participants were given the "lab question" from a recent AP Physics 1 exam, without being told that it was an AP question. After the participants' answers were collected, they were asked to describe how, if at all, their workshop experience had influenced their answers. Analysis of the responses shows the workshops influenced the methods applied by the teachers. In addition, participants that utilized new representational tools gained through the workshop outperformed those who did not.

1.M. Wells, D. Hestenes, and G. Swackhamer, "A Modeling Method for High School Physics Instruction," Am. J. Phys. 63: 606-619 (1995). 2.D. Hestenes, M. Wells, and G. Swackhamer, "Force Concept Inventory," The Physics Teacher 30: 141-158 (1992).

HE08: 2:20-2:30 p.m. STEM Training for K-12 Teachers: A Pilot Program in Upstate South Carolina

Contributed – Chad Sosolik, Clemson University, 118 Kinard Laboratory of Physics, Clemson, SC 29634; sosolik@clemson.edu

Sean Brittain, Clemson University

Jody Penland, Laurens County School District 55

Brenda Schrantz, Laurens County School District 56

We present our experiences from a pilot program in K-12 teacher training formed through a state-funded Math/Science Partnership (MSP). The MSP's goal was to provide expert content-based instruction in physics, technology, and math through monthly workshops where teachers received content-based instruction, including hands-on activities and discussions about careers. The monthly events culminated in a four-day workshop where the teachers applied the skills they had developed to design power generation systems. While these workshops generated a positive response and increased connections between the university and the district school, the measured changes in teacher performance on content-specific testing was mixed. The program has shown that a focus on exposing teachers to high level materials with hands-on opportunities makes them more comfortable with the content and empowers them to conduct their own STEM-themed lessons. This applies even in classes considered non-STEM (art, writing, special education) which broadens the impact of their STEM training.

Session HF: The Wonderful World of AJP

Location: International 10
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, February 21
Time: 12:30–2:30 p.m.

Presider: David Jackson

HF01: 12:30-1 p.m. A Few Experiment-based Video Resources for Teaching Modern Physics

Invited – Gabriel C. Spalding, Illinois Wesleyan University, 201 E. Beecher St., Bloomington, IL 61701; gspalding@iwu.edu

Intended for class discussions of the (basic) weirdness of quantum physics, we offer an intro to single-photon ghost imaging. ("Ghost" references Einstein's concern over spooky action at a distance.) Our *AJP* paper provides freely available video data of the dynamic evolution of single-photon ghost imaging and diffraction patterns, as well as more traditional (non-ghost) single photon imaging and diffraction. We point out the current (and future) availability of educationally priced instructional lab setups allowing students to directly grapple with quantum phenomena, and add how such equipment can be used for teaching other parts of Modern Phys-

ics, e.g. introducing, more simply, the idea of time reversals, as a prequel to teaching Special Relativity.

HF02: 1-1:30 p.m. Digitally Controlling Light for Optical Interference

Invited – Benjamin Perez-Garcia, Tecnologico de Monterrey, Eugenio Garza Sada 2501 Tecnologico, Monterrey, NL 64849 Mexico; b.pegar@gmail.com

David Gossman, Andrew Forbes, University of the Witwatersrand

Raul I. Hernandez-Aranda, Tecnologico de Monterrey

In the 19th century, Thomas Young presented his landmark experiment proving the controversial wave nature of light. He observed fringes in the intensity and thus attributed this phenomena to the interference between coherent light sources. In this study, we revisit this venerable with a modern twist using digital holograms. We then ask "fringes in what?", and show how that depending on how the optical fields interfere, fringe patterns in different observables can be observed. A tutorial approach to the topic is presented, aided by modern laboratory practices for the implementation of the underlying physics.

HF03: 1:30-2 p.m. The Enticing World of Quantized Wheels

Invited – Eduardo De Campos Valadares, Federal University of Minas Gerais (UFMG), Av. Antonio Carlos, 6627, Belo Horizonte, Minas Gerais, 31270901 Brazil; ecamposv@fisica.ufmg.br

A simple approach is presented allowing one to determine all possible wheels that can roll smoothly without slipping on a periodic roadbed, while keeping their center of mass at fixed height. The inverse problem of obtaining the roadbed profile compatible with a specific wheel and all other related "quantized wheels" is also addressed. In contrast with geometrically quantized nanosystems like carbon nanotubes, the "ground state" might have a lower symmetry than that required by the periodic roadbed and hence is a "forbidden state." In this cases a new road profile must be found compatible with the "ground state" wheel. Several illustrative examples are discussed that highlight the different possibilities related to non-conventional wheels, including possible applications and the impossibility of "stars" rolling smoothly.

HF04: 2-2:30 p.m. Predicting the Influence of Plate Geometry on the Eddy Current Pendulum

Invited – Timothy J. Atherton, Tufts University, 574 Boston Ave 412L, Medford, MA 02155-5555; Timothy.atherton@tufts.edu

In our graduate electrodynamics class, we quantitatively analyzed a familiar classroom demonstration, Van Waltenhofen's eddy current pendulum, to predict the damping effect for a variety of plate geometries from first principles. Results from conformal mapping, finite element simulations and a simplified model suitable for introductory classes are compared with experiments. Perspectives on how this pedagogical technique might be used in graduate education are also presented.

Session IA: Post-Deadline Abstracts I

Location: International 3
Sponsor: AAPT
Date: Tuesday, February 21
Time: 2:30–4 p.m.

Presider: James Laverty

IA01: 2:30-2:40 p.m. A C# Program for Transferring Assessment-Marks from Socrative to Blackboard

Contributed – M. Qasim Syed, Mount Royal University, 4825 Mount Royal Gate SW, Calgary, AB T3E 6K6 Canada; qsyed@mtroyal.ca

Jedidiah C. Ong, Mount Royal University

Socrative is an online student response system that can easily be used to conduct in- or out-of-class physics assessments containing multiple choice, true/false or simple short answer questions. Students log into Socrative's free version, using any internet-accessible device like a smartphone, simply by entering a unique identifier (called Room Name) preselected by the instructor through his/her Socrative account. At the conclusion of an assessment, Socrative produces an Excel file containing corresponding student marks. These marks can be uploaded to the grade center/book of a learning management system either manually or after being adjusted in Excel. A computer program written in C# (pronounced as C sharp) has been developed to expeditiously transfer the student marks from a Socrative Excel file to the Grade Center of Blackboard Learn — a widely used learning management system. We present this C# program and the associated process of transferring student marks.

IA02: 2:40-2:50 p.m. Comparing Learning in Flipped and Standard Introductory Physics Classes

Contributed – M. Elizabeth Parks, Colgate University, 13 Oak Drive, Hamilton, NY 13346-1338; meparks@colgate.edu

Colgate University's introductory physics course, Atoms and Waves, was taught in both standard and flipped formats in the same semester. In the standard format, lecture alternated with problem-solving classes. In the flipped classroom, students watched lecture videos online and answered multiple-choice questions, then came to class only for problem-solving sessions. (Both groups of students also had a three-hour lab once per week.) In addition to discussing the technology that enabled this flipped classroom, I will report on the results of this experiment, including student-reported use of educational resources (lecture, videos, textbook, problem-solving classes) and grades earned, both in Atoms and Waves and in the following Introduction to Mechanics, which was taught purely in the standard format. The student performance in the two sections was not significantly different. The students in the flipped classroom expressed enthusiasm for this method of learning and wished it were available in future courses.

IA03: 2:50-3 p.m. The Logic of Science in Teaching Physics

Contributed – Genrikh Golin, Touro College, 448 Neptune Avenue#15K, Brooklyn, NY 11224; Genrikhgolin@yahoo.com

The rapid developments of science and technology, as well as the introduction of scientific methods into all spheres of human activities, have revealed the necessity to further develop cognitive and creative abilities and intellectual potential of each student. The efficiency of teaching physics is now judged not simply by the total subject knowledge acquired by students, but mainly by their abilities in gaining new knowledge independently in class (inquiry method). When particular facts, formulas, and definitions are forgotten, what must remain as an ultimate result of the whole process of education is the fundamental knowledge and skills that

enable people, regardless of their type of activities, to grasp new phenomena. We have come to the conclusion that logic physics as educational subject does not necessarily follow from the logic of physics itself. The same content of the physics course can be realized with the help of several structures (designs) consistent with the existing logic of physics as science. The choice of pedagogical design of lessons is determined by educational aims and types of education institutions. The problem under consideration has not only theoretical value but practical value as well. This analysis will be illustrated with examples taken from High School Physics Program.

IA04: 3-3:10 p.m. The Educational 3-bodies Planar Motion Simulation Based on HTML5

Contributed – Wonkun Oh, Chungbuk National University, Dept. Physics Education, Cheongju, 28644 Republic of Korea; wkoh@cbnu.ac.kr

This paper suggests a way of using the HTML5 based simulation for 3-body planar motion problem in the education of celestial dynamics in physics or astronomy. Three different reference frames —screen frame, CM frame, a body frame—were enabled in the simulation to understand the observation of motions of bodies in each frame. This simulation might help students understand the various features of complex 3-body motions interacting in mutual gravitational fields such as stellar bodies.

IA05: 3:10-3:20 p.m. Teleology as Placeholder: Experts' and Novices' Explanations of Newton's Cradle

Contributed – Luke D. Conlin, Salem State University, 15 Central St., Nahant, MA 01908; luke.conlin@gmail.com

Physics students often use teleological (goal-directed) reasoning to make sense of complex phenomena (e.g., 'atoms bond in order to fill electron shells'), a practice debated by educational researchers. Some view teleology as a misconception held by novices (Keleman, 1999), inferior to experts' mechanistic reasoning; others follow Aristotle in treating these as complementary modes of scientific inquiry (Talanquer, 2007). Researchers on both sides rely more on theoretical commitments than empirical data. I present findings from a microgenetic analysis of 20 interviews with both novices and experts as they spontaneously constructed explanations of the behavior of Newton's cradle. Analysis reveals that both experts and novices used teleological reasoning productively, as a placeholder (Carey, 2004) for a more mechanistic account. The difference between experts and novices was not in which mode of reasoning they used, but in how they coordinated both perspectives. Implications for research and instruction will be discussed.

IA06: 3:20-3:30 p.m. Studying the Relation Between the Pressure and Temperature Using the Dot-39 Cylinder and a Wireless Temperature Sensor

Contributed – Mohammad S. Alshahrani, Bisha College of Tech - TVTC, 2228 Radh St., Bisha, Aseer 61922 Saudi Arabia; msscti@gmail.com

The relation between the volume, pressure, and temperature is one of the most important concepts in thermodynamics. The following activity is an attempt to introduce the student to the idea of learning by doing. In fact, they do what was taken in class on the white board in a practical way. Simply, It is by using the Dot 39 cylinder, a wireless temperature sensor, a tablet, refrigerator compressor, and other cheap stuff such as tubes and tapes. Through doing this activity the student will be able to answer the following question. What happens to the inner tank's temperature when its air is removed. This activity expands the students' horizon by making them think, imagine, discuss, and even ask: what if? This also helps to achieve one of the NGSS standards.

IA07: 3:30-3:40 p.m. Students' Resources for Solving a Partial Derivative Problem in Thermodynamics

Contributed – Rabindra R. Bajracharya, Missouri Southern State University, 3950 E Newman St., Webb City, MO 64870; bajracharya-r@mssu.edu

Corinne A. Manogue, Oregon State University

We investigated students' common knowledge resources while dealing with a partial derivative problem posed in multiple representations. We conducted structured-interviews with eight middle-division students in a restructured thermodynamics course. They were asked to determine a partial derivative using a contour map and a numerical table in a thermodynamic context. Since the partial derivative cannot be computed directly from the numerical data or the graph alone, one first needs to express it in terms of other computable partial derivatives or plot a constant pressure path on the graph using the numerical data. Although students did not exhibit much difficulty finding the individual partial derivatives from the table and the graph, they struggled substantially while deriving the above expression. They used both productive and unproductive knowledge resources including the ideal gas law, the cyclic chain rule, the first law of thermodynamics, total differentials of given variables, and tree diagrams.

IA08: 3:40-3:50 p.m. STEM Incorporated into a NASA Payload

Contributed – Peter Spacher, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623; pjsgsh@rit.edu@hws.edu

Ileana Dumitriu, Hobart and William Smith Colleges

For the past four years, undergraduate students at Hobart and William Smith Colleges have been involved in multiple NASA competitions. In 2014, HWS students won first place in National Student Solar Spectroscopy Competition for designing, building, and collecting data using a solar spectroscope. During the academic year 2015/2016 students designed and built a payload for a sounding rocket launch under the RockSat-C program at NASA's Wallops Flight Center VA. The students implemented three experiments in their canister – muon detectors to determine muon flux at various altitudes and a spectrometer to record spectra through layers of atmosphere. The participation of students in these programs has an enormous impact on physics programs at HWS and tripled the number of majors.

IA09: 3:50-4 p.m. Revised Curriculum for the Mechanics IPLS Course at Towson University

Contributed – Katarzyna A. Oldak, Towson University, 7800 York Rd (Smith Hall 475), Towson, MD 21252-0001; koldak@towson.edu

We report our improvements to the introductory algebra-based mechanics course to make it more accessible and relevant to life-science majors. We have modified the usual curriculum to include more fluids and expanded on the topic of air resistance and how it might affect the motion of small organisms. These changes in the lecture are also reflected in the labs (one two-week lab sequence has the students modeling air drag using Euler's formula in Excel as objects fall from rest) and in-class activities (worksheets are passed out during some lecture days and students solve problems in class with the help of the lecturer and TAs). Emphasis is placed on problem solving, so the students can apply the concepts before they are faced with similar questions on homework assignments. There is higher student interest in enrolling in these revised sections, rather than traditional mechanics course, which is still offered.

Session IB: Post-Deadline Abstracts II

Location: International 4
Sponsor: AAPT
Date: Tuesday, February 21
Time: 2:30–3:30 p.m.

Presider: Ben Jenkins

IB01: 2:30-2:40 p.m. Developing a Visual Programming Editor for VPython*

Contributed – Hunter G. Close, Texas State University, 601 University Dr., San Marcos, TX 78666; hgclose@txstate.edu

Cody Blakeney, Michael Dube, Aimee Roundtree, Texas State University

Programing skills are becoming increasingly more important in physics and other STEM fields. Existing tools for teaching physics and engineering using computational modeling, like VPython, can require students to already have a foundation of programming, thus narrowing students' learning opportunities. Block programming with visual environments like Blockly provides a way to engage learners with algorithmic thinking without extensive pre-requisite knowledge of keywords, functions, and syntax. It has also been observed to have various benefits for beginning programmers. We have created a prototype for a visual programing environment that allows students to create physics simulations utilizing the open source projects VPython and Blockly. We discuss lessons learned during development and initial user testing about the challenges of making a visual programming environment for physics simulations.

*Supported by the Office of Research and Federal Relations at Texas State University

IB02: 2:40-2:50 p.m. Edwin James Houston (1847-1914) Author, Educator and Electrical Engineer

Contributed – William Pitt Palmer, Associate at Curtin University, 1/57 Male St., Brighton, Victoria 3186 Australia; drspalmer@optusnet.com.au

This study is intended to honor the memory of a successful educator, known for his well-written school textbooks, his contributions to children's literature and his engineering inventions. The study will use the opportunities that the internet offers to integrate biographical and bibliographical information about his life and work. Edwin James Houston was an amazingly hard-working man who used his talents in many diverse fields. He was born at Alexandria on July 9th, 1844; his family later moved to Philadelphia, where he studied and worked for most of his life. He was a student at Philadelphia Central High School and eventually became Professor of Engineering and Physical Geography. With his former student, Elihu Thomson, he invented and developed the Thomson-Houston system of arc-lighting and he wrote several school textbooks. Houston passed away on 1st March, 1914.

IB03: 2:50-3 p.m. Effectiveness-based Learning Problems in the Academic Achievement of Course Physics

Contributed – Silvia M. Espinoza, Tecsup Av. Cascanueces 2221 Sta. Anita., Lima, PE 43 Peru sespinoza@tecsup.edu.pe

The present work shows the efficiency of learning based on problems (ABP) in the academic performance of the course of physics, specifically how learning arises across the experience. For it, the existing methodologies were adapted on ABP in order to generate six methodological offers originated in specific situations of the profession, which were developed during an academic semester. The impact of the ABP was demonstrated on having concluded the above mentioned period, across the application of the test not paramétrica of Mc-Nemar, with a confidence level of 95%. One concluded that the ABP turned out to be highly effective, especially in the highest levels of academic performance, which are of application and analyses, in which they found substantial differences with regard to the group of control. On the contrary, the area of comprehension did not observe such a difference, which indicates that the application of the above mentioned methodological strategy with regard to this capacity is not interesting for the teacher. This investigation contributes with a program that relies on instruments that they measure the comprehension, application, and analysis of the beginning of the classic physics in the students of the course of physics. Likewise, a guide of fieldwork provides guidelines of employment for the course of physics in the top level, and examples for its later use.

IB04: 3-3:10 p.m. Fostering Authentic Communication in an Intermediate Physics Lab Course

Contributed – Muhammad Z. Numan, Indiana University of Pennsylvania, Physics Department, IUP, Indiana, PA 15705; mznuman@iup.edu

John L. Bradshaw, Indiana University of Pennsylvania

We describe a redesigned junior level lab course where assignments include writing an initial proposal, maintaining a lab notebook, oral presentations followed by question and answer sessions, lab reports, and a journal style paper. Students designed and performed experiments, some based on classic ideas and a few selected from recent literature, utilizing available resources. They analyzed and interpreted data, collected through computer interfacing, utilizing appropriate software. Scaffolding was provided through instructor and peer feedback and an opportunity to revise their reports initially. We will share preliminary assessment data on the effectiveness of the instructional design.

IB05: 3:10-3:20 p.m. Fully Flipping a Large Enrollment Introductory Physics Course: Successes and Challenges

Contributed – Alexandru Maries, University of Cincinnati, 3405 Telford St., Cincinnati, OH 45220; mariesau@ucmail.uc.edu

"Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn." This quote, by Herb Simon, a Nobel Prize laureate and one of the pioneering researchers in the area of problem solving perfectly encapsulates the basic idea of effective teaching: carefully design students' learning to influence what they do every day in and outside of class to help them develop the thinking skills required for learning. One promising course design is the flipped classroom approach in which students are required to watch educational videos and read assigned sections of a textbook before coming to class, while nearly the entire class time is devoted to active learning: clicker questions, group problem solving, interactive demonstrations etc. I have adopted the flipped model for a large-enrollment introductory physics course over the past two semesters and have been assessing the effectiveness of this approach via pre-post conceptual assessments, comparison with parallel sections, student surveys and informal observations, all of which show promising results. This presentation will focus on these results and lessons learned from implementing this approach.

IB06: 3:20-3:30 p.m. LIGO, CERN, and Python: Cutting Edge Physics in the Classroom

Contributed – Charles K. Payne, North Carolina School of Science and Mathematics, 1219 Broad St., Durham, NC 27705; paynec@ncssm.edu

Data from LIGO and CERN are readily available and are easily analyzed by students. The Python programming language can be used to analyze and interpret data, and also develop simulations for other areas of physics. This can be a conduit for particle physics, gravitational fields, and relativity to be placed into a high school curriculum. LIGO and CERN have educational resources in addition to the data, and QuarkNet provides eLab experiences and resources that supplement and enhance the student's knowledge of gravitational waves, particle collisions, and cosmic rays. In addition, students can either use prewritten code, or develop their own within the Python language and modules. Examples of data analysis and simulations will be shown and explored.

Session IC: Post-Deadline Abstracts III

Location: International 5
Sponsor: AAPT
Date: Tuesday, February 21
Time: 2:30–3:10 p.m.

Presider: Shannon Willoughby

IC01: 2:30-2:40 p.m. Pedagogic Challenges in Technology Intense Introductory Online Astronomy Laboratories

Contributed – Ulrike G. Lahaise, Georgia State University - Perimeter College, 555 North Indian Creek Drive, Clarkston, GA 30021; ulahaise@gsu.edu

Pass-Withdrawal-Fail and course assessment data show higher WWF percentages for online than face-to-face, ftf, students in Introductory Astronomy Laboratories, but similar averages on end-of-semester common course exams. Hence, online students perform equally well as ftf students but a lot more are dropping out before completion. In addition to known hurdles for non-science majors, online students face course mode challenges like technology, social-academic isolation, life situations prohibiting ftf classes, etc., that significantly increases their cognitive load and time commitment beyond that of ftf students. In contrast, ftf students work in groups with immediate instructor access. Data show that only 20 percent of online students are available for groups, And viable groups rarely form consistently in classes of fewer than 60 students. The instructor can ameliorate these issues by actively fostering a learning environment with frequent participation, interaction, communication, well-organized, consistent, support materials, and regular performance check-points starting early in the semester.

IC02: 2:40-2:50 p.m. Quantification of Harmful Algae Blooms Using UAS Imagery

Contributed – Ileana Dumitriu, Hobart and William Smith Colleges, 300 Pulteney St., Geneva, NY 14456; dumitriu@hws.edu

Peter Spacher, Rochester Institute of Technology

John Halfman, Hobart and William Smith Colleges

Harmful Algal Blooms (HABs) occurrence has increased in recent decades. Traditional monitoring program are expensive and time consuming. The use of UAS (Unmanned Aerial Systems) assures high-resolution space and time monitoring for HABs, and is economical for small bodies of water. By using UAS (Matrice100 and Phantom3) we obtained aerial photographs of eight Finger Lakes which span the oligotrophic to eutrophic spectrum of algal productivity. Water samples were collected/analyzed simultaneously. The Green/Blue (G/B) ratio extracted from the aerial photos was proportional to chlorophyll-a abundance. The algal pigments are characterized by unique light absorbance and reflectance features, and spectral images obtained from two up-down visible spectrometers revealed a prominent feature ~790 nm which correlates to the concentration of algae in the water.

IC03: 2:50-3 p.m. Review on Discovery Based Learning Laboratories in Physics Education

Contributed – Muhammad Riaz, Florida Institute Of Technology, 150 E University Blvd., Melbourne, FL 32901; muhammad.riaz@fullbrightmail.org

Thomas J. Marcinkowski, Florida Institute of Technology,

This review of theory, research, and practice pertaining to Discovery Based Learning Laboratories (DBLL) is composed of five major sections. The first section discusses problems in physics education, particularly those related to discovery-based learning laboratories (DBLL). The second section discusses the origins, development, and design of DBLLs in physics education. These DBLLs serve as both a response to these problems in physics education and the basis for the redesign of physics labs. The third section introduces the underlying theories that underlie the design and conduct of this study. The review will then outline uses and effects of DBLLs. The final section will conclude with a summary of practices and their implications in physics education.

IC04: 3-3:10 p.m. Seismology at Loyola University of Chicago

Contributed – Daniel X. Checca, Loyola University Chicago, 1032 W. Sheridan Rd., Chicago, IL 60660; dchecca@luc.edu

John D. Cunningham, University of Chicago

Upholding a 104-year tradition of seismological research at Loyola University of Chicago, we have collected data from a series of seismometers in an attempt to present a visual aid for understanding ongoing seismic activity and what it means. With the data we are receiving, we are creating a live stream interface that shows physics students a graphical representation of Chicago's seismic activity—broadcast in the main hall of the physics building. As well as an educational tool, we seek to present a medium for relevant seismological data to be accessed by any who are lucky enough to experience an event. Overall, our research is focused on creating a digestible and immersive outlet for students to interact with real-world physics data on a daily basis.

PST3: Post-Deadline Posters

Location: Marquis Ballroom Foyer
Sponsor: AAPT
Date: Tuesday, February 21
Time: 2:30–4 p.m.

Poster presenters are asked to mount their posters before 8 a.m. The posters should be taken down at 4 p.m. Persons with odd-numbered posters will present their posters from 2:30 to 3:15 p.m.; those with even-numbered posters will present from 3:15 to 4 p.m..

PST3A01: 2:30-3:15 p.m. College Research Experience for Students from High School: Inquiry-based Learning of Laboratory Sciences

Poster – Firouzeh Sabri, University of Memphis, Dept. of Physics and Materials Science, Director-MemphisCRESH, 219 Manning Hall, Memphis, TN 38152; fsabri@memphis.edu

Participating in scientific practices by engaging in authentic, laboratory-based research projects has been recognized as an effective approach for teaching and learning scientific methods. The MemphisCRESH program, a summer research internship program for high-school students held on the University of Memphis campus, offered a unique context for investigating the influence of this type of experiential learning on the acquisition and retention of scientific facts and methods. A total of 42 students, male and

female, with no prior research experience were placed in an active scientific laboratory for 6-7 consecutive weeks and were integrated into the laboratory's research dynamics as a contributing member. Results support the influence of several key factors in students' impression of the importance of scientific inquiry and research. Namely, applicability and utilization of scientific formulae and methods taught in high school science courses. These results confirm the utility of using experiential learning to teach scientific concepts, even in students that are not yet in college.

PST3A02: 3:15-4 p.m. Constructing Teams to Maximize Productivity and Enhance Conceptual Understanding

Poster – Corey S. Gerving, Department of Physics and Nuclear Engineering, United States Military Academy, Bartlett Hall Science Center, West Point, NY 10996; corey.gerving@usma.edu

Mark W. Haseman, Andrew P. Gillick, Carolann Koleci, Department of Physics and Nuclear Engineering, United States Military Academy

At the United States Military Academy, teamwork is paramount and cadets in introductory physics classes have diverse abilities and experiences in math and science. Research in team-based learning demonstrates that in the past 20 years, over 99.95% of teams have outperformed their best member by an average of almost 14%; moreover, the worst team typically outperforms the best student in class [1]. How can teams be crafted to maximize productivity and enhance conceptual understanding? What sort of predictive analytics or metrics can be applied to form such teams in the introductory physics classroom? How does one assess the success of these teams? We will explore the use of well-established metrics, in addition to peer and self-assessment rubrics. [1] Michaelsen, L., & Sweet, M. (2008). The essential elements of team-based learning. New Directions for Teaching and Learning, 2008(116), 7-27.

PST3A03: 2:30-3:15 p.m. Developing a Model for Predictive Analytics to Signal Outlying Performance

Poster – David W. Hutchinson, Department of Physics and Nuclear Engineering, United States Military Academy, Bartlett Hall Science Center, West Point, NY 10996; david.hutchinson@usma.edu*

John B. Davis, Andrew P. Gillick, Nathaniel M. Kaminski, David O. Kashinski, Department of Physics and Nuclear Engineering, United States Military Academy

Our intent to develop a model for forecasting a student's performance in an introductory physics program using previous performance metrics. Some of the metrics included will be achievement in other STEM coursework, entrance examination scores, major choices, and extracurricular participation. The predictive analytics can then be employed to provide an immediate indication of outlier performance. Identifying these atypical performances among individuals brings to attention situations that may otherwise go unnoticed. Identifying atypical performance across a test group within a larger population may also provide a metric for other pedagogical studies. This poster presents techniques for constructing the predictive analytics model, the parameters and relative weighting used, as well as possible applications and improvements.
*Sponsor: Corey Gerving

PST3A04: 3:15-4 p.m. Developing Project Based Labs for a Sophomore Level Electronics Course

Poster – Muhammad Z. Numan, Indiana University of Pennsylvania, Physics Department, IUP, Indiana, PA 15705; mznuman@iup.edu

Andrew F. Zhou, Indiana University of Pennsylvania

Project Based Labs were introduced into our sophomore level Electronics course by challenging students with open-ended real world problems. Students acquired domain knowledge, critical-thinking ability, and problem solving skills by investigating and solving these problems, while developing practical hands-on skills. We describe the teaching methodology and present examples of the student projects along with initial assessment data and student feedback.

PST3A05: 2:30-3:15 p.m. Differentiation in a Preservice Physics Class

Poster – Richard Williams, University of Missouri, 223 Physics, Columbia, MO 65211; rlwt33@mail.missouri.edu

Karen E.L. King, University of Missouri

While teaching at the pace of learning should always be the goal, a one-size fits all approach leaves room for disengagement of more advanced students. Differentiation is a method of designing and delivering instruction to best reach each student. Our university offers a physics course requirement for all early childhood and elementary education majors. It also enrolls middle school education majors, and recently was accepted as an elective for secondary physics majors. The course is aligned to NGSS, emphasizing scientific and engineering practices, especially developing and using models. To better fit the needs of our range of preservice teachers, methods of differentiation were applied to a unit on force and motion using Bybee's 5E learning cycle as a framework.

PST3A06: 3:15-4 p.m. Figuring Out What Works

Poster – Irene Guerinot, Maryville College, 502 E. Lamar Alexander Pkwy., Maryville, TN 37804; irene.guerinot@maryvillecollege.edu

Every physics instructor has heard the phrases: "I understand the concepts, I just cannot do the math", or, "What does the equation mean"? Pre-health, biology, and exercise science students are required to take physics courses at Maryville College. The vast majority of these students do not have a very strong math background and unsatisfactory performance is a strong possibility. The last three years we have been working on modifying delivery of our courses in an attempt to mitigate this failure in a sustainable way. We will discuss our findings as well as student surveys analyzing how students perceive these modifications.

PST3A07: 2:30-3:15 p.m. General Physics Instruction Interventions at SC State University*

Poster – Daniel M. Smith Jr., South Carolina State University, P.O. Box 7709, Orangeburg, SC 29117-0001; dsmith@scsu.edu

Jennifer Cash, Donald Walter, Reginald Williams, South Carolina State University

As part of the NSF-sponsored "Targeted Infusion Project," two interventions have been developed to enhance General Physics instruction at South Carolina State University: graphic invention instruction materials, and the flipped classroom. Graphic invention instruction materials are a variation of the "Invention Instruction" developed at Stanford, Rutgers, and New Mexico State University that lead students to invent a measurement outside of the physics topic area where a concept is needed so that transfer to the desired physics topic is more easily achieved. The Flipped Classroom component consists of pre-lecture video tutorials paired with pre-lecture quizzes so that the main concepts are delivered to students before class. Class time can then focus on application and problem solving practice. We will present details on these methods and initial evaluation results.
*Support for this work has been provided by the NSF HBCU-UP award to SCSU HRD-1332449.

PST3A08: 3:15-4 p.m. Holographic Scaling in Newtonian Gravity

Poster – Emma L. Machado, Assumption College, 8 Entrance Road, Plymouth, MA 02360; emma.machado@assumption.edu*

Many high school and college students are required to take physics,

but few actually learn to discover the mysteries of the field because they are too busy trying to memorize equations and solve "plug and chug" style problems. Looking in to the calculations and equations of physics, a holography can be seen within the subject. By studying the duality that exists between electricity and gravity this holography can be discovered and made accessible to general physics students. Furthermore, the concept of mass in physics (ADM mass) can be calculated within this holography for various black holes along with orbits of massive and massless particles.

*My adviser for this thesis was Professor Leo Rodriguez at Assumption College

PST3A09: 2:30-3:15 p.m. Metacognitive Scaffolding of PhET-based Inquiry Activities

Poster – Jonathan Massey-Allard, 8 University of British Columbia, 2329 West Mall, Vancouver, BC V6T 1Z4; jmassall@phas.ubc.ca

Sarah Perez, Joss Ives, Ido Roll, University of British Columbia

PhETs are a family of science and mathematics interactive simulations that leverage the concept of implicit scaffolding to support productive inquiry learning.[1] In classroom activities, studies have demonstrated that student interaction and exploration is maximized for lightly guided activities.[2] An important question remains: what type of scientific inquiry practices are actually fostered by such forms of guidance? Developing a domain-independent scaffold could also support students in acquiring specific inquiry strategies, such as those used by expert physicists, and for engaging in productive inquiry learning in PhET simulations. Here we propose a form of faded metacognitive scaffolding that adapt to learners and allows students to identify, explain, and reflect on strategies used while engaged in an otherwise minimally scaffolded PhET activity.

1. Wieman, et. al. (2008). Science, 322, 682–683. 2. Chamberlain, et. al. (2014), Chemistry Education Research and Practice, 15, 628–638.

*Sponsor: Joss Ives

PST3A10: 3:15-4 p.m. Wave Superposition: Pseudo-Paradoxes and Energy Conservation

Poster – David Chappell, University of La Verne, 1950 3rd St., La Verne, CA 91750; dchappell@laverne.edu

V. Preisler, University of La Verne

The standard textbook treatment of the superposition of waves and total destructive or constructive interference can often lead to counterintuitive results that superficially appear to violate the laws of energy or momentum conservation. We survey simple examples of diffraction and interference for different types of waves that exploit these apparent paradoxes and present them as topics for active learning problems. In particular, we compare the double slit experiment to two closely spaced antennas in the limit where the distances between the slits or antennas is less than the wavelength of the electromagnetic waves.

PST3A11: 2:30-3:15 p.m. Quantum Physics for HS Teachers

Poster – Karen Jo Matsler, UT Arlington, 3743 Hollow Creek Rd., Arlington, TX 76001; kmatsler@uta.edu

Tom L. O'Kuma, Lee College

Thanks to a grant provided by the American Institute of Physics, workshops targeting quantum concepts were offered in the summer of 2016 at Lee College and UT Arlington. The PD format was unique in that both high school students and teachers attended the workshop. The curriculum used resources developed by the Perimeter Institute for Theoretical Physics. We will share the strengths and weaknesses of this model as well as the data.

PST3A12: 3:15-4 p.m. Redesign of an Introductory Physics Laboratory Program

Poster – Corey Gerving, Department of Physics and Nuclear Engineering, United States Military Academy, Bartlett Hall Science Center, West Point, NY 10996; corey.gerving@usma.edu

Thomas Halverson, Mark Haseman, Carolann Koleci, Department of Physics and Nuclear Engineering, United States Military Academy

The laboratory program of the introductory physics program at the United States Military Academy has been largely unchanged for many years. Combined with major changes to the introductory physics course, it is appropriate to conduct an assessment and restructure of the laboratory program that supports the course. This poster will introduce the initial planning process for the assessment of the program, as well as highlight other key elements of the planned redesign.

PST3A13: 2:30-3:15 p.m. Students' Resources for Solving a Partial Derivative Problem in Thermodynamics

Poster – Rabindra R. Bajracharya, Missouri Southern State University, 3950 E. Newman Rd., Joplin, MO 64801; ab_study@yahoo.com

Corinne A. Manogue, Oregon State University

We investigated students' common knowledge resources while dealing with a partial derivative problem posed in multiple representations. We conducted structured-interviews with eight middle-division students in a restructured thermodynamics course. They were asked to determine a partial derivative using a contour map and a numerical table in a thermodynamic context. Since the partial derivative cannot be computed directly from the numerical data or the graph alone, one first needs to express it in terms of other computable partial derivatives or plot a constant pressure path on the graph using the numerical data. Although students did not exhibit much difficulty finding the individual partial derivatives from the table and the graph, they struggled substantially while deriving the above expression. They used both productive and unproductive knowledge resources including the ideal gas law, the cyclic chain rule, the first law of thermodynamics, total differentials of given variables, and tree diagrams.

PST3A14: 3:15-4 p.m. The Influence of Experiential Learning of Applied Sciences on Scientific Skills and Career Interests

Poster – Firouzeh Sabri, University of Memphis, Dept. of Physics and Materials Science, 219 Manning Hall, Memphis, TN 38152; fsabri@memphis.edu

Martina Sala Rodriguez, University of Memphis, Dept. of Physics and Materials Science

Holland Aguayo, Stephanie S. Ivey, University of Memphis, Department of Civil Engineering

In this study, the authors investigated the relationship between exposure to targeted career exploration activities and understanding of related scientific content and interest in specific disciplines among high school seniors and juniors. Students were exposed to Packaging Science, Materials Science, and Mathematical Sciences concurrently, both in an academic setting and industrial setting. Relevance of fundamental materials properties analysis and mathematical skills to advanced engineering packaging solutions were explored and tabulated. A survey model was utilized targeting student academic skills, understanding of the disciplines, and prior exposure to technological advances in the fields of interest. Although the number of students engaged was small, results suggest gender differences and may indicate that varied approaches are needed to encourage self-confidence and identity in packaging and materials sciences with both genders.

PST3A15: 2:30-3:15 p.m. What Can You Do with Your Students' Smartphones While Teaching Physics?

Poster – Arturo C. Marti, Universidad de la Republica, Igua 4225, Montevideo, 11400 Uruguay; marti@fisica.edu.uy

Martin Monteiro, Universidad ORT Uruguay

Cecilia Cabeza, Cecilia Stari, Universidad de la Republica, Montevideo, Uruguay

At present most of the students own smartphones and carry them everywhere and everytime. From the educator point of view, this fact set a challenge. It is impressive that smartphones usually incorporate several sensors, including accelerometer, gyroscope, magnetometer, and barometer. Although these sensors are not supplied with educational intentions in mind, they can be employed in a wide range of physical experiments, especially in high school or undergraduate laboratories. During the last years several experiments have been proposed using smartphones. In this poster we exhibit several simple experiments we have recently proposed which can be useful resources for physics educators. Additional information including references to our work can be found at http://smarterphysics.blogspot.com.

PST3A16: 3:15-4 p.m. A New App for Physics Simulations

Poster – Sonia Tye, CK-12 Foundation, 3584 Hatfield Circle, Oceanside, CA 92056; Sonia.tye@ck12.org

The CK-12 Foundation has generated over 85 free, HTML5-based interactive Physics Simulations (SIMs). The recent release of the free CK-12 Physics Simulations App for both iOS and Android tablets facilitates quick access to the SIMs and the added ability to download SIMs for offline use. This poster presentation is one part of our efforts to engage in a discussion with the physics education community about how these SIMs can be used to facilitate classroom instruction, challenge student misconceptions, and foster an interest in science.

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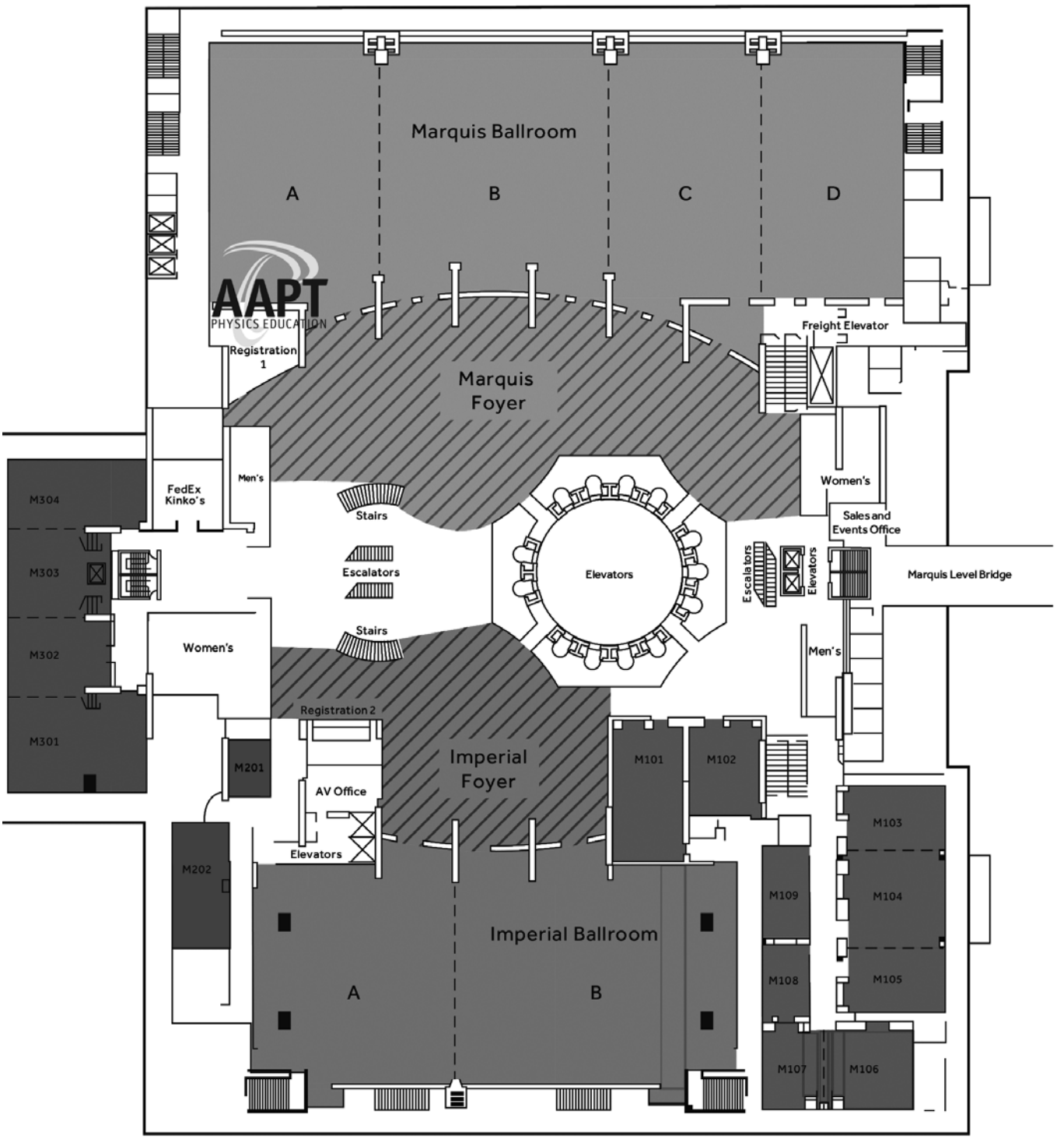

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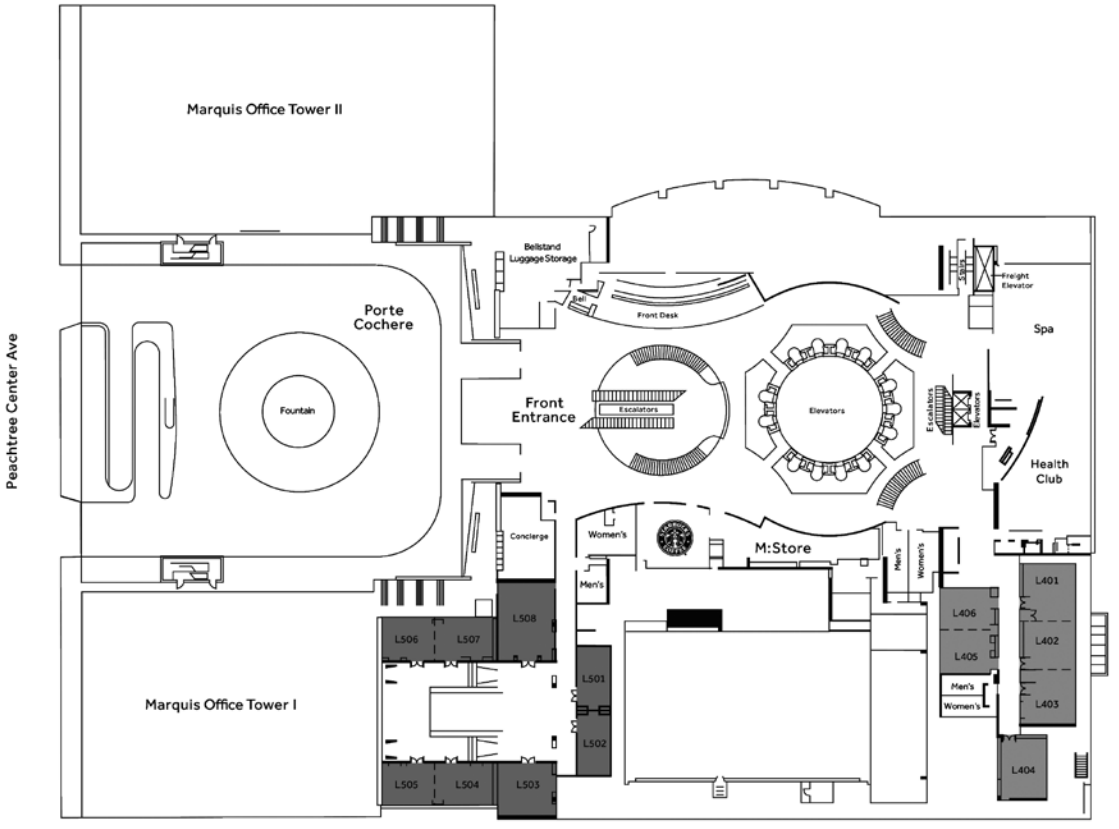

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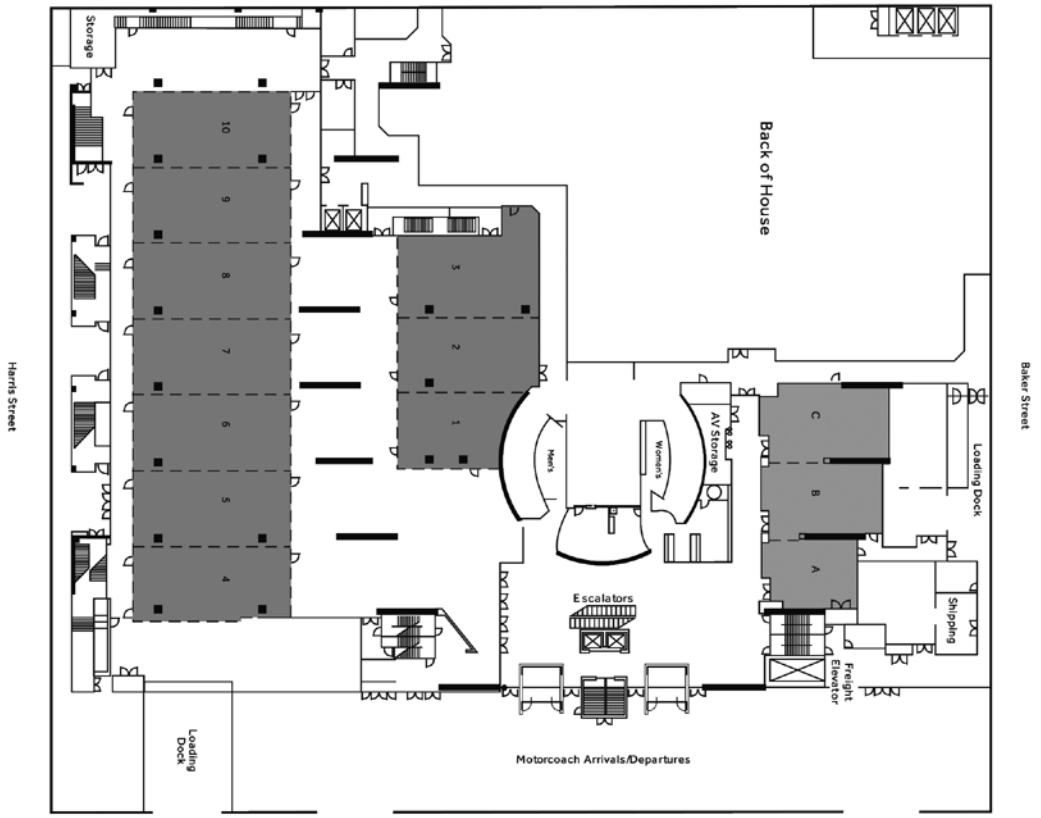
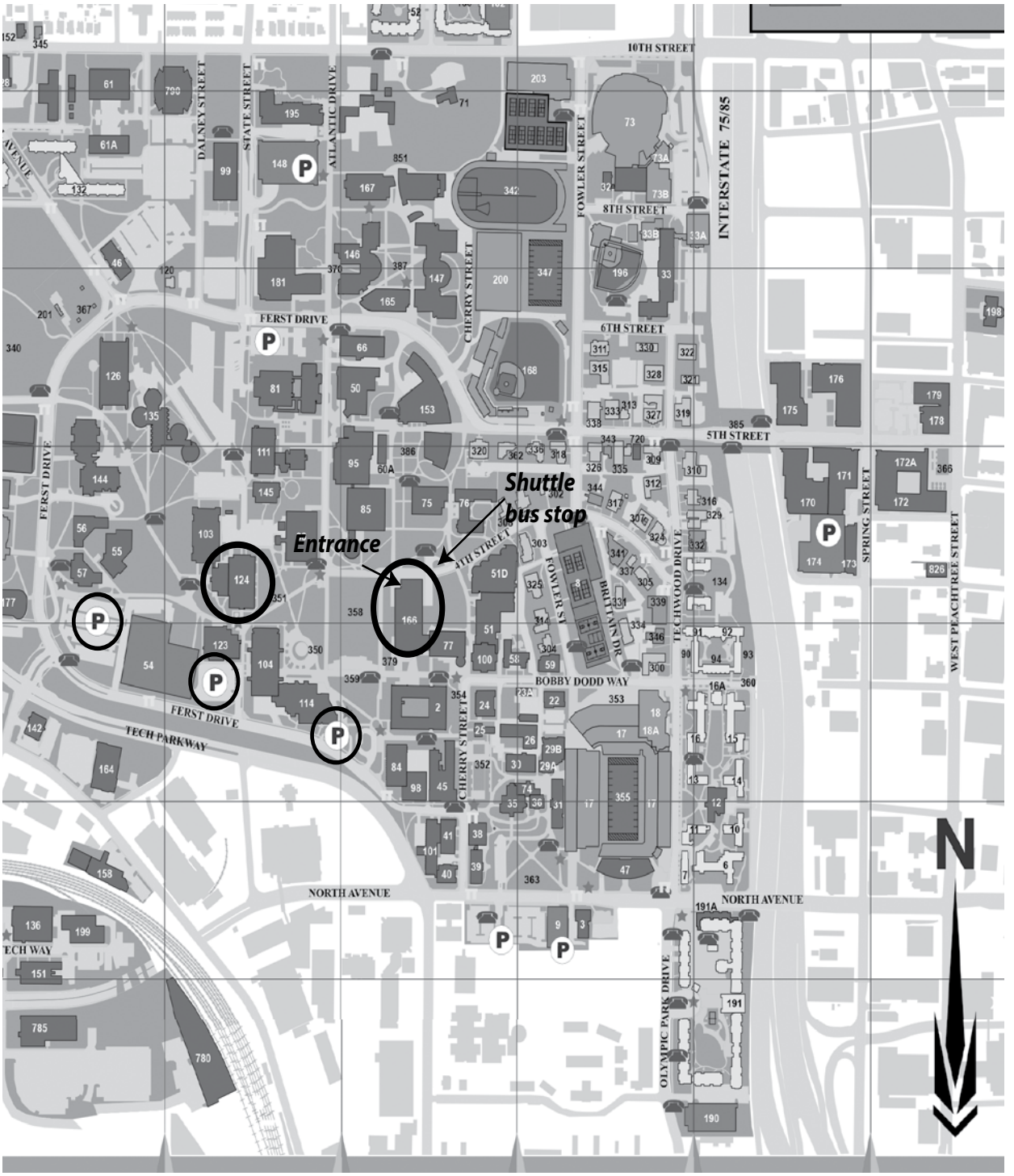


Georgia Institute of Technology Map



KEY: Workshops will be held in Bldg. 166: Clough Undergraduate Learning Commons
Saturday plenaries will be in Bldg. 124: Ferst Center for the Arts
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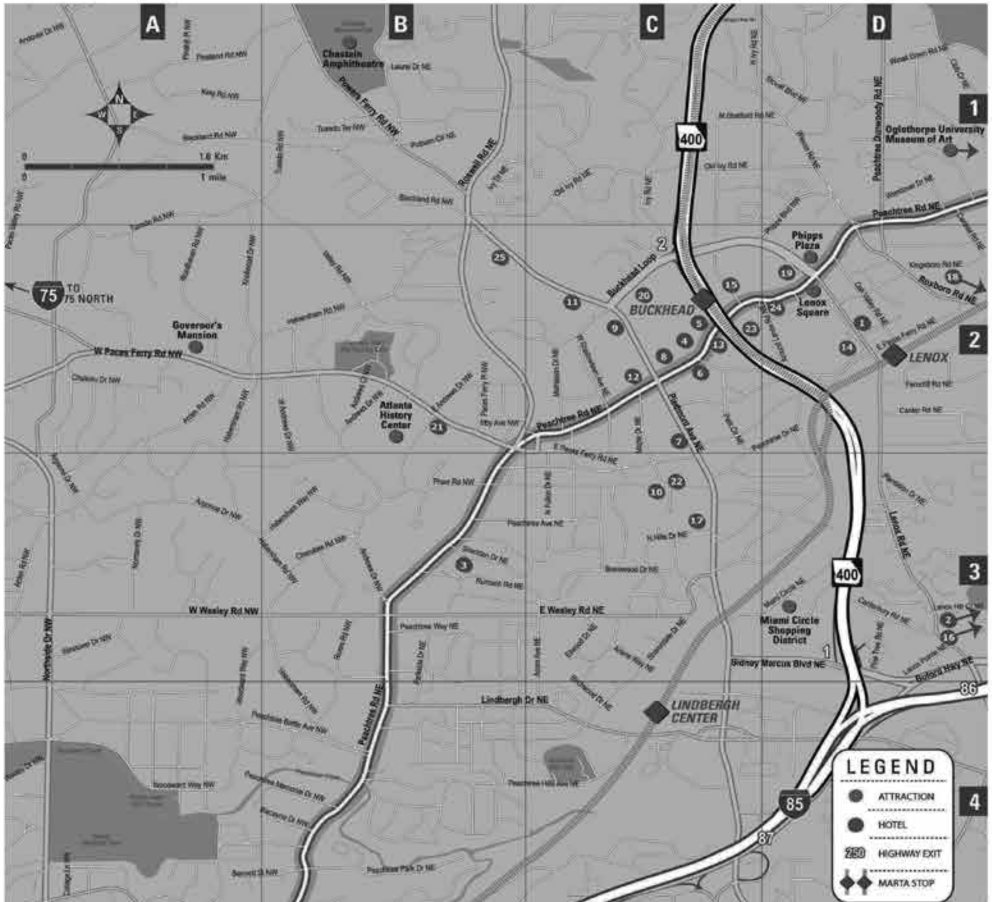

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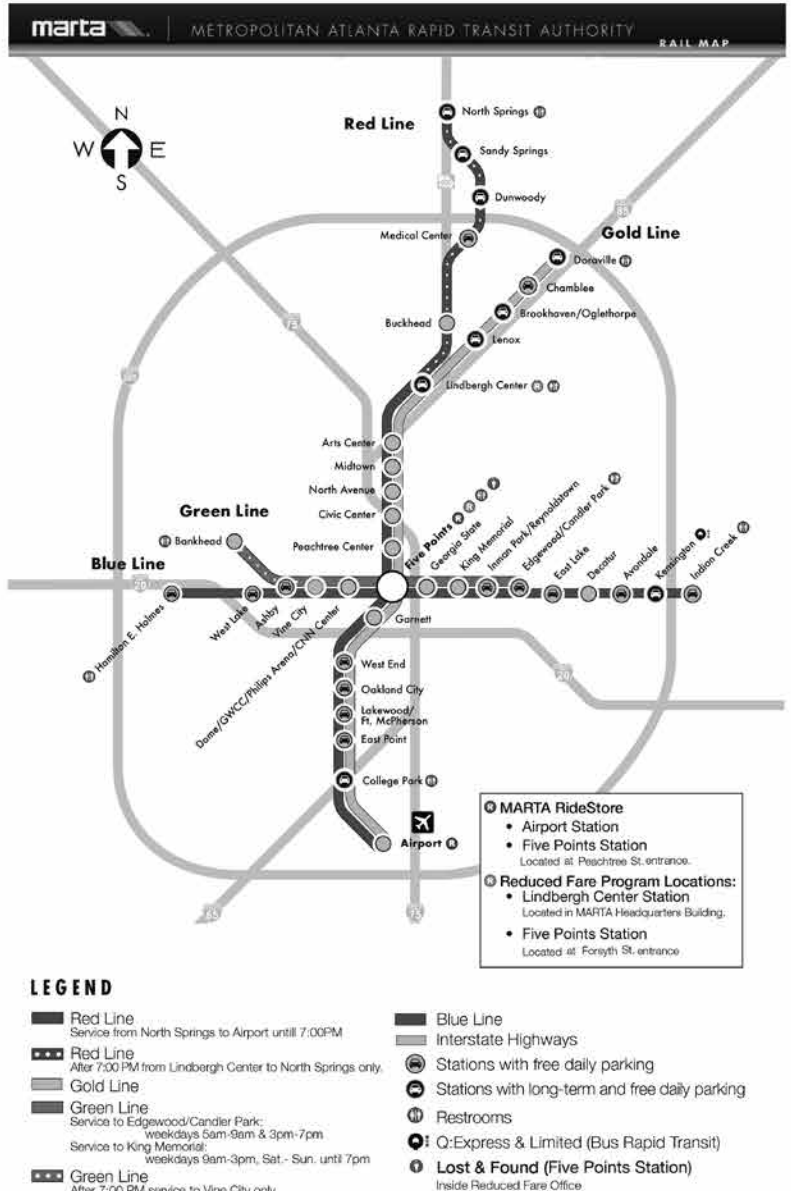

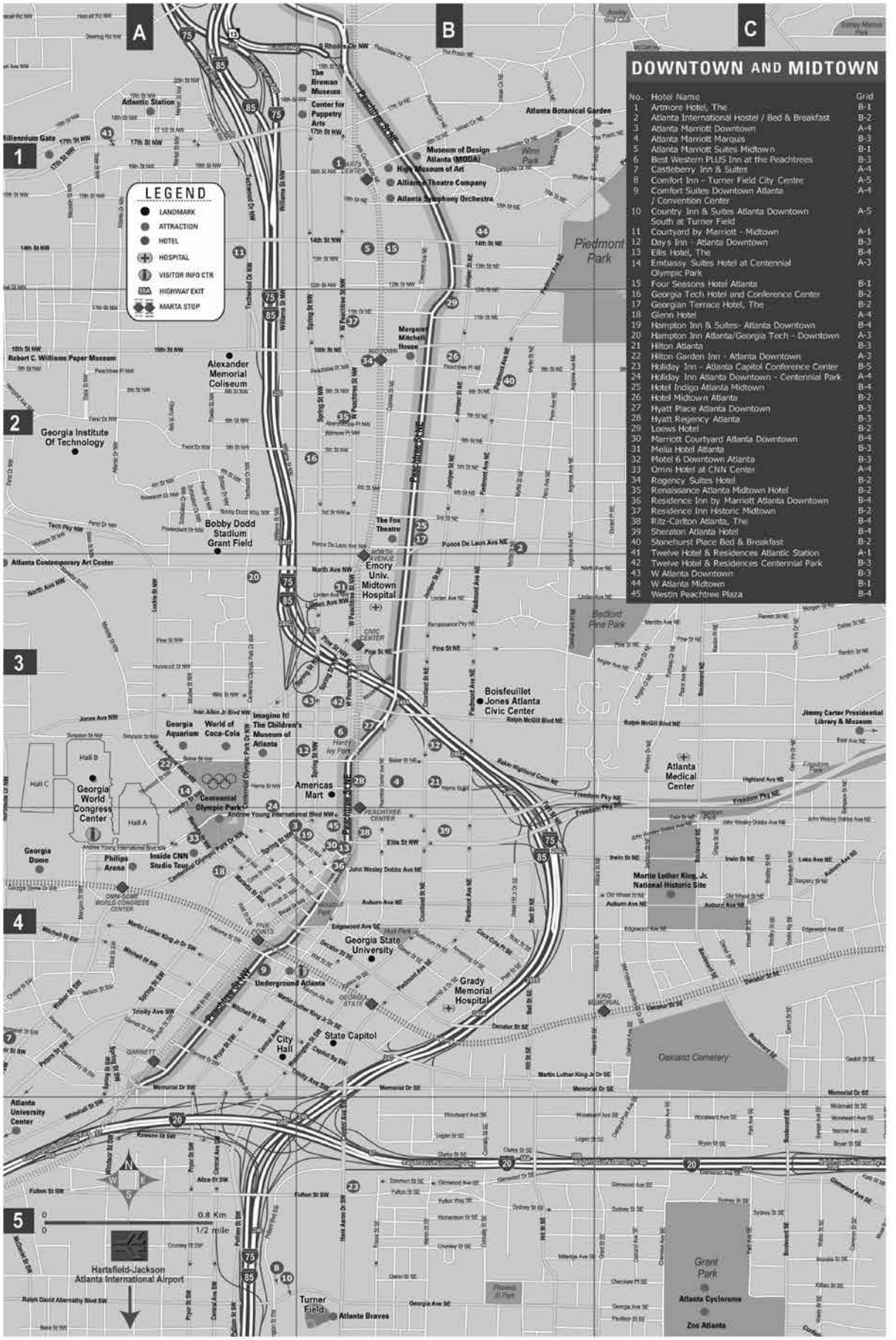
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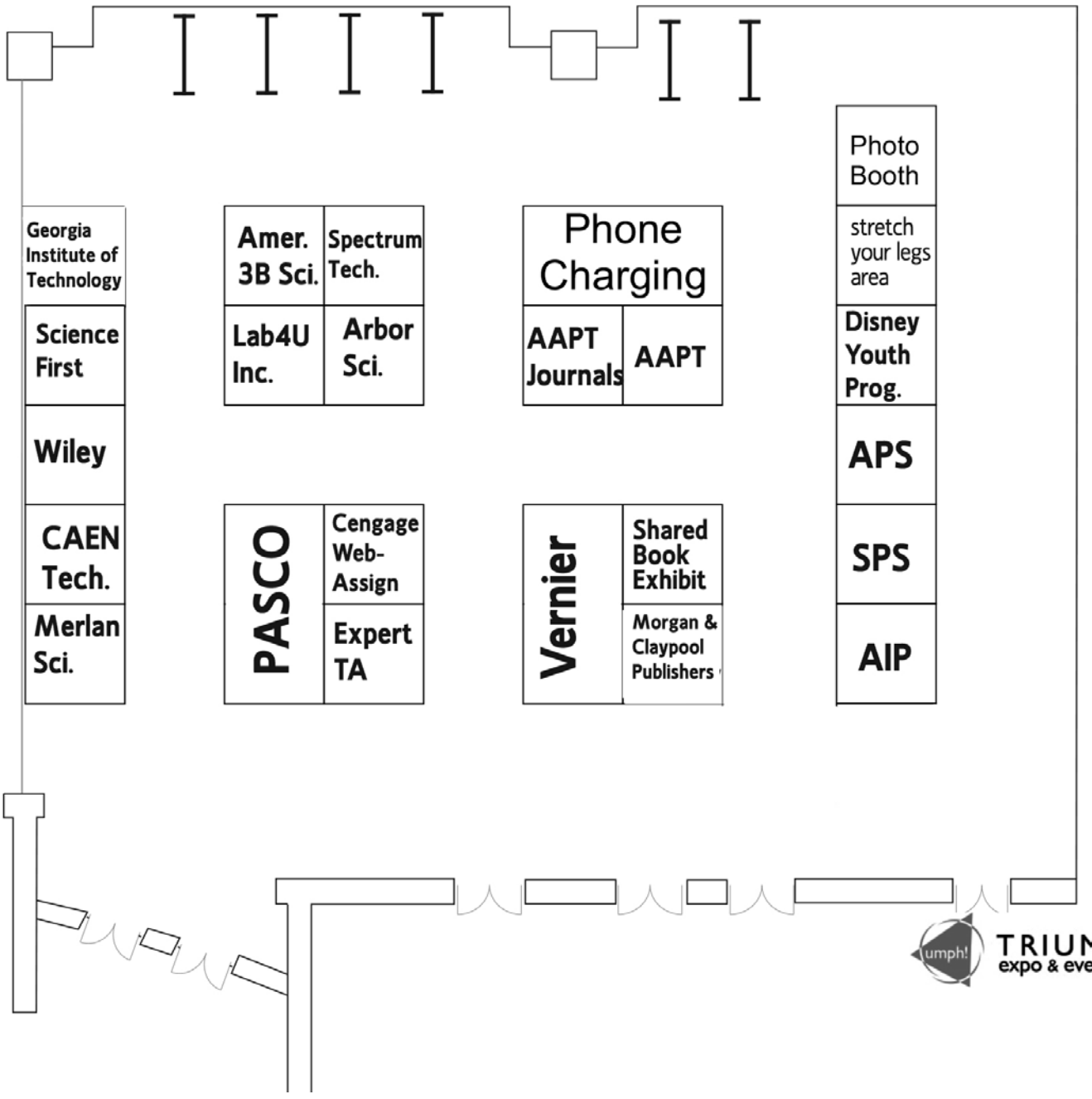

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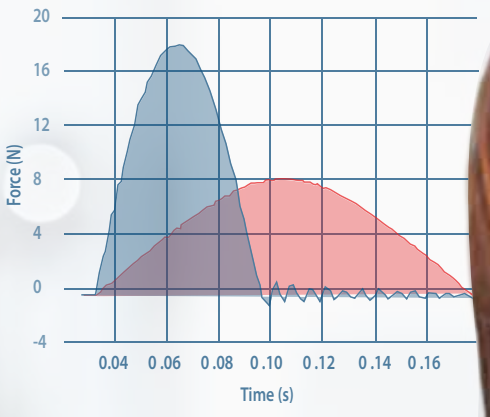

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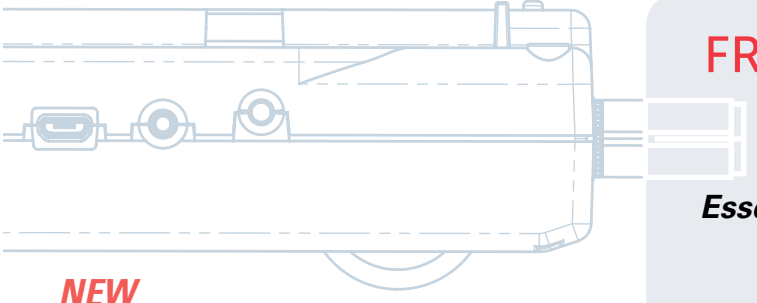

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