APS physics™

Forum on Education
American Physical Society

Spring 2015 Newsletter

Beth Lindsey, Editor

In this issue:

From the Chair:

Michael Fauerbach, Florida Gulf Coast University

The national Meetings in March and April are almost upon us. Randy Knight and the program committee did a great job to provide a variety of interesting sessions for both meetings. If you attend one of the meetings with colleagues or students, please make sure to mention the FEd sponsored sessions to them. Sometimes the forum sessions get lost in the wide variety of topics offered. We should especially encourage more undergraduate and graduate students to attend our sessions. Oftentimes students are so engulfed in their own work that it is hard for them to consider topics outside their direct field of study as being of interest to them. Yet many of them would benefit from attending our sessions. I work at a primarily undergraduate institution and it always amazes me how few of the people that apply for jobs here have a well-thought-out teaching philosophy or can answer questions related to engaging undergraduate students in the classroom or in their research. Those people would have clearly benefitted from attending some of our sessions. This is especially true as our sessions are held in a more intimate setting and it is therefore not so daunting to ask questions or to engage the speakers in discussions after their talks.

Springtime is also the time many legislative issues dealing with (physics) education are coming to the forefront. I strongly urge you to pay close attention to education related issues at the federal, state and local level. At the federal level a new congress is in charge and Tennessee Senator and education committee chair Lamar Alexander already announced plans to revamp the country's all-important primary and secondary education funding law known as "No Child Left Behind." Currently the draft bill circulated has two options, one would give states a lot of leeway in the amount of testing, and the other one would basically default back to the annual testing schedule. There is an increasing outcry by parent groups about too much testing in schools. I feel that it is time for a national dialogue – led by experts – about the topic of 'how much is too much' and in general about the value of standardized tests versus alternative assessments. Unfortunately, this has not yet happened. My local school district gave in to angry parents who demanded a stop to all state and federally mandated tests. The school district decided to opt out of all the mandated tests. This would have led to none of the students receiving a high school diploma or bright futures scholarships (lottery funds), and the loss of state and federal funds to the school district, because all of these things are coupled to standardized tests. The school district reversed their vote a week later, and only killed all the district-mandated tests. Many parents are still unhappy, but after a couple of highly publicized state-wide meetings, the issue has gotten on the back burner. It is important that we have a national dialogue on many issues relating to education, and this dialogue should not be led by politicians or parents, but by the experts in the field. It should not become a shouting match and the loudest voice should not win by default. Instead it should be a dialogue in which clearly laid out arguments and alternatives are being discussed. That is why it is so important that all of us pay close attention to what is going on in the legislature – at all levels. There are many ways and venues for each one of us to get involved. It can range from contacts with local schools and teachers, to attending school board meetings, writing newspaper editorials, or being engaged with your state's department of education – they are always looking for 'experts' for input and once they know your name they are more inclined to listen. As a member of the APS and the Forum on Education, you are already engaged in some of the national discussions. It is up to all of us to be actively engaged and to ask ourselves what else we can do to make a difference.

Proposed Revisions to the FEd Bylaws

Randy Knight, California Polytechnic State University

The Forum on Education was established in 1995. The organization's bylaws have had only one minor amendment in the intervening 20 years. Times change, and some of our bylaws are at odds with how the Forum and the APS do business today. Other bylaws were borrowed from the bylaws of the larger divisional units of APS and are not really relevant to a forum.

The new APS Constitution and Bylaws prompted us to look carefully at our own bylaws and led to the realization that they need a significant overhaul to bring them up to date. The first two steps of revising the bylaws are now complete: A proposed revision has been approved by the Forum Executive Committee and by the APS Council. The final step is approval by you, the members of the Forum.

You can view the proposed new bylaws on the FEd website http://www.aps.org/units/fed/. In addition, an email with a link to the proposed bylaws will be sent to all members in March.

The Forum's annual business meeting will be held at the APS April 2015 Meeting in Baltimore on Monday, April 13. Look for the time and place in the meeting program. Any Forum member is welcome to comment on the proposal at the business meeting. In addition, you can use the Send a Message to the Chair link on the FEd website to send comments to the Executive Committee.

Soon after the April Meeting, and with any changes prompted by member comments, the proposed bylaw revisions will be sent to all members for a vote. It takes a two-thirds vote of those voting to approve the proposal.

Please take a few minutes to look at the proposed changes and let us know what you think.

Randy Knight is Chair-Elect of the Forum on Education

FEd Invited Sessions at the APS March and April 2015 Meetings

Randy Knight, California Polytechnic State University

Sponsoring invited sessions on physics education at the March and April Meetings is perhaps the Forum's most visible activity. It's an opportunity to reach out to the larger physics community. We have some very interesting sessions lined up for this year's meetings, so please show your support by attending if you plan to be in San Antonio or Baltimore.

APS March 2015 Meeting in San Antonio

Inspirational Teaching of Physics and the History of Physics
Monday, March 2 at 11:15
Co-sponsored by the Forum on the History of Physics

- *The use of theater and the performing arts in science education and the teaching of history,* Brian Schwartz, City University of New York
- *Bruno, Galileo, Einstein: The value of myths in physics,* Alberto Martinez, University of Texas
- *Teaching physics to future presidents,* Bob Jacobson, UC Berkeley
- *Composing science: Integrating scientific inquiry and writing instruction,* Leslie Atkins, California State University, Chico
- *How Things Work: Teaching physics in the context of everyday objects,* Louis Bloomfield, University of Virginia

NSF-Funded Physics Education: Celebrating Accomplishments and Looking Forward
A session to honor Duncan McBride upon his retirement from NSF
Tuesday, March 3 at 11:15

- *NSF support for physics at the undergraduate level: A view from inside,* Duncan McBride, NSF (retired)
- *NSF-funded physics education research at the University of Washington,* Paula Heron, University of Washington
- *The Maryland PERG: Two decades of learning how students learn,* Edward (Joe) Redish, University of Maryland
- *Compounding intellectual merit and broader impacts: NSF, physics education and beyond,* Gary White, AAPT
- *SCALE-UP: Active learning for large classes,* Robert Beichner, North Carolina State University

Undergraduate Teaching at the Intersection of Physics and Biology
Co-sponsored by the Division of Biological Physics
Wednesday, March 4 at 8:00

- *What physics do biophysicists need to know?,* Jonathon Howard, Yale University
- *Hands-on activities for stochastic dynamics and entropy,* Mark Reeves, George Washington University
- *Rethinking physics for biologists: A design-based research approach,* Vashti Sawtelle, University of Maryland

Reichert-Award Session: Re-imagining the Advanced Lab
Wednesday, March 4 at 11:15

- *Preparing physics students in an era of virtual reality,* Carl Akerlof and Ramon Torres-Isea, University of Michigan
- *A hands-on introduction to quantum mechanics,* David Jackson, Dickinson College
- *Preparing students for experimental research through instructional labs,* Heather Lewandowski, University of Colorado
- *Autonomy,* David Van Baack, Calvin College
- *Investigating student learning in upper-division laboratory courses on analog electronics,* MacKenzie Stetzer, University of Maine

Growing the Physics Major
Thursday, March 5 at 2:30

- *Physics majors in the US: trends and implications,* Ted Hodapp, APS
- *Strengthening the physics program at Brigham Young University - what have we learned?,* Scott Sommerfeldt, Brigham Young University
- *Losing and saving and losing physics in Texas,* Michael Marder, University of Texas
- *Morehouse physics and the Dual Degree Engineering Program: We C.A.R.E. Approach,* Willie Rockward, Morehouse College
- *How to double the number of undergraduate physics majors,* Sacha Kopp, Stony Brook University

APS April 2015 Meeting in Baltimore

Excellence in Physics Education Award Session
Saturday, April 11 at 1:30

- *Student resources for learning physics,* David Hammer, Tufts University
- *Why instructors other than Joe Redish should care about epistemological framing,* Andrew Elby, University of Maryland
- *Learning to listen: Implications for interdisciplinary instruction,* Edward (Joe) Redish, University of Maryland

Moving Astronomy Education Research Results into Teaching
Sunday, April 12 at 8:30

- *Impacting society through introductory astronomy courses,* Sharon Schleigh, University of Wyoming
- *ASTRO 101 labs and the invasion of the cognitive scientists,* Stephanie Slater, University of Wyoming
- *An new international agenda for astronomy education research,* Paulo Bretones, University Federal de São Carlos, Brazil

STEM Education: What's Happening and How to Influence It
Sunday, April 12 at 1:30

- *A disciplinary perspective on educational policy,* Noah Finkelstein, University of Colorado
- *STEM Education Policy: Active engagement by APS,* Tyler Glembo, APS
- *The faculty role in advocacy: What, why, and how,* Scott Franklin, Rochester Institute of Technology

Research-Based Instruction in Quantum Mechanics
Co-sponsored by AAPT
Monday, April 13 at 10:45

- *Improving student understanding of quantum mechanics,* Chandralekha Singh, University of Pittsburgh
- *QuVis interactive simulations: Tools to support quantum mechanics instruction,* Antje Kohnle, University of St. Andrews, Scotland
- *A case study of teaching quantum mechanics using research publications,* Manjula Sharma, University of Sydney, Australia

What You Need to Know about the New AP Physics 1 and 2
Co-sponsored by AAPT
Tuesday, April 14 at 10:45

- *AP Physics 1 and 2: Some things old and some things new,* Robert Morse, St. Albans School
- *The new AP Physics exams: Integrating qualitative and quantitative reasoning,* Andrew Elby, University of Maryland
- *Bringing together best practices and best acceptance with real resources: AP Physics 1 and 2,* Gay Stewart, West Virginia University

New APS Fellow Nominated from the Forum on Education

This year we welcome one new APS fellow, nominated by the FEd. His "citation" is below. Please send suggestions for new Fellows for the coming year to mfauerba@fgcu.edu.

Vincent LaBella, State University of New York, Albany
Citation: For his extensive development of instructor-friendly computer software (H-ITT) and handheld student hardware (H-ITT clickers), the use of which has significantly improved large-lecture classroom learning.

2015 Excellence in Physics Education Award Recipient

The Excellence in Physics Education Award recognizes and honors a team or group of individuals (such as a collaboration), or exceptionally a single individual, who have exhibited a sustained commitment to excellence in physics education. The award may be a given for, but not necessarily restricted to, such accomplishments as: outreach programs; a specific program or project that has had a major ongoing influence on physics education at the national level; outstanding teacher enhancement or teacher preparation programs over a number of years; long-lasting professional service related to physics education that has had a demonstrated positive impact.

The Forum on Education is pleased to announce that this year's award celebrates the contributions of an exceptional individual. In 2015, this award recognizes Edward (Joe) Redish from the University of Maryland. The citation reads,

For leadership in the use of computers in physics education, applying cognitive research to improve student learning and critical thinking skills, tailoring physics instruction for nonphysicists, and guiding the field of physics education research through a period of significant growth.

Joe's contributions to the field of Physics Education will be recognized in a special Award Session at the APS April Meeting in Baltimore.

The Award Session will be held on Saturday, April 11th at 1:30 pm.

Award for Improving Undergraduate Physics Education Awardees

The American Physical Society's (APS) Committee on Education (COE) seeks to recognize physics departments and /or undergraduate-serving programs in physics (hereafter "programs") that support best practices in education at the undergraduate level. These awards are intended to acknowledge commitment to inclusive, high-quality physics education for undergraduate students, and to catalyze departments and programs to make significant improvements. In contrast to the Excellence in Physics Education Award, this award recognizes multiple institutions, and seeks to focus specifically on undergraduate programs.

In 2015, there were four awardees:

Indiana University Purdue University Fort Wayne

The Department of Physics at the Indiana University Purdue University Fort Wayne (IPFW) has shown a strong enrollment increase during the past six years (275%) based on a coherent effort by their faculty and commitment to their students and community. Their approach is based on using interactive engagement pedagogy in the classroom, innovation in laboratory experiences, computational physics and a research oriented senior thesis. Seven years ago the Department of Physics was small, in fact the smallest on campus and on the verge of termination. Then the faculty decided to adopt drastic changes and create an exemplary physics program using social media as a communication aid with different Facebook groups such Women in Physics, SPS, research groups, and specific class groups to allow students to openly discuss their classwork and research with advisors and fellow students, providing a forum to share their successes and help others. The department has created new concentrations also allowing students to design their own concentration with courses outside of physics (for example pre-law or chemical physics). The faculty are strongly engaged in obtaining external funds for new methods aimed at increasing student participation in the departments activities.

Middle Tennessee State University

Middle Tennessee State University (MTSU) is a comprehensive regional university offering a B.S. as their highest degree in physics. Formerly a "low-producing" department, the MTSU Department of Physics and Astronomy has consciously adopted a mission to provide exceptional classroom experiences, career-focused courses and pathways, and intensive research opportunities to prepare students for targeted careers. The department has over the past half-decade successfully refocused its degree programs and course offerings to emphasize the possibilities inherent in a wide range of career choices beyond graduate programs in physics, including teaching careers, and teaches the skills necessary to attain them, including freshman career seminars, required capstone research experiences, and a senior-level career skills course. MTSU is among the most successful PhysTEC sites and became a UTeach replication site, in addition to thoughtfully reforming its entire curriculum in accord with research-based pedagogies, dramatically reducing DFW rates in introductory courses, and improving recruiting and retention at all levels of the curriculum, resulting in a significant increase in graduation rates.

North Carolina State University

The Department of Physics at North Carolina State University (NCSU) has gone through significant changes and transformations in its program such as the implementation of aspects of physics education that not only have increased the number of physics majors in their undergraduate program, but also has enhanced learning to all the students that the department has served. They focused on improving students understanding of physics, encouraging under-represented populations, enabling K-12 teaching careers, expanding undergraduate research opportunities, introducing career preparation and recognizing student success. NCSU is a PhysTEC site and the success of these implementations also led eight of their current faculty to become members of the NCSU Academy of Outstanding Teachers, and three being recognized with the highest honor for teaching in the UNC System, the Board of Governor's Award for Teaching Excellence. Three faculty have also received Pegram Medals for Excellence in Education from the Southeastern Section of the APS. Two were CASE North Carolina Professors of the Year. Their faculty have won national (2011 McGraw Prize in Education) and local (2010, 2011 Martin Award for Teaching Excellence) awards for innovative approaches to teaching physics.

Rochester Institute of Technology

Rochester Institute of Technology (RIT) is a comprehensive private university offering a B.S. as their highest degree in physics and a Ph.D. degree in Astrophysical Sciences and Technology. Over the past 14 years, the faculty has made a conscious effort to transform a stagnant department with outdated pedagogy into a thriving department. Their success is seen in a tripling of the number of physics majors, from 41 in 2000 to an average 135 for the past few years. Several factors have contributed to this success, including an overhaul of all introductory physics classes to a SCALE-UP-style active-learning environment, special attention for at-risk students, introduction of a freshman "gateway" course on relativity for physics majors, a significant overhaul of the advanced laboratory, establishment of a Learning Assistant program to get majors into the introductory classroom, and initiation of a year-long capstone requirement for seniors. In addition, the department has hired three faculty members who specialize in physics education. A commitment to improvement is shared by all faculty members in the department.

2015 Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction

This award is to recognize and honor outstanding achievement in teaching, sustaining (for at least four years), and enhancing an advanced undergraduate laboratory course or courses at US institutions. The course(s) should provide a selection of experiments in a range of the various areas of physics, for example atomic physics, electronics and optics.

This year there are two recipients of the award: **Carl Akerlof and Ramon Torres-Isea, both of the University of Michigan**.

The citation reads,

For dedication to the spirit of hands-on experimental instruction in Physics, inspirational teaching in the Advanced Undergraduate Laboratory of the University of Michigan, and continued contributions to physics laboratory instruction in the United States.

New Members elected to the APS Forum on Education Executive Committee

Congratulations to the newly elected members of the Executive Committee of the FEd: Vice Chair John Stewart, Member at Large Andrew Heckler and AAPT Member at Large Geraldine Cochrane.

Director's Corner

Ted Hodapp, APS Director of Education and Diversity

As you have undoubtedly heard, the APS formally changed the organizational structure of its Council and Board over the past year, with a formal vote in November that established a new "Board of Directors" that manages financial decisions and strategic planning, and a "Council of Representatives" that oversees physics policy concerns, awards, and programmatic endeavors.

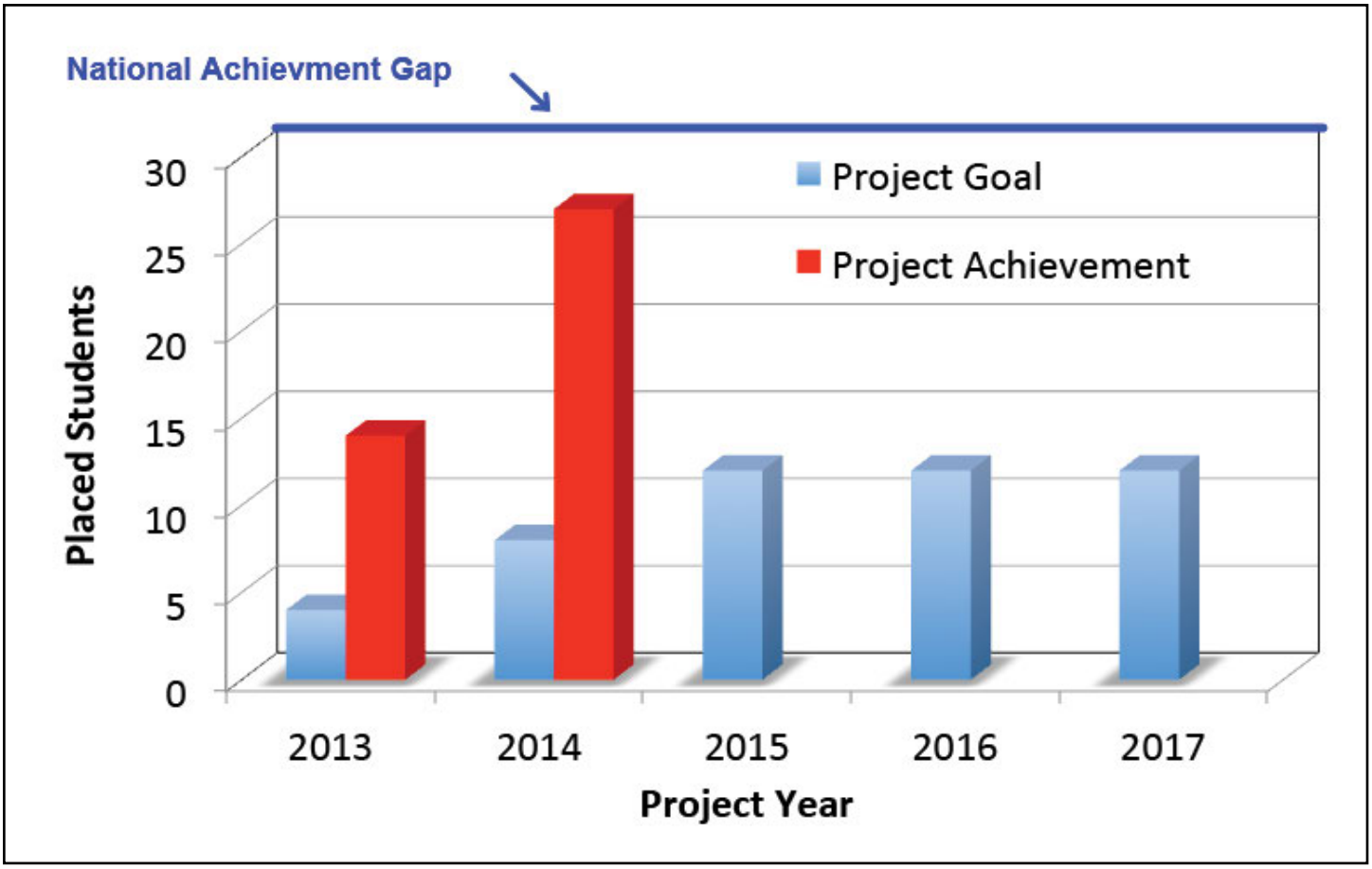
While the details of how these changes will impact APS education and diversity initiatives is still being fleshed out, I am happy to report that the Council and Board approved establishing a new initiative at its November meeting: Building a National Mentoring Community (NMC), which will work to increase the number and fraction of underrepresented minority students who receive undergraduate degrees in physics. The NMC will host its first gathering in October 2015, and provide travel support to bring together mentors and their mentees to provide professional development for students, and support and improve mentoring throughout the physics community. **If you know of an individual who you think would make an excellent mentor of an underrepresented minority student, please contact me** (hodapp@aps.org), as we will be contacting the first prospective mentors very soon. More details will be available early in 2015.

APS, in collaboration with AAPT, is proud to announce the most recent PhysTEC comprehensive site awards: West Virginia University, Rowan University, Texas State University, and a partnership between University of Northern Colorado and Colorado School of Mines. In addition, Sonoma State University, Bowdoin College, Indiana University South Bend, East Tennessee State University, Boise State University, Salisbury University, University of Wyoming, University of Massachusetts Dartmouth, and a consortium of Oklahoma institutions led by Northwest Oklahoma State University will receive funding to improve recruiting efforts to educate more high school physics teachers. PhysTEC will be publishing its second book this spring, tentatively titled: *Recruiting and Educating Future Physics Teachers: Case Studies and Effective Practices*. The book will include more than 20 articles on effective practices that increase education of future physics teachers. And perhaps most importantly, PhysTEC, now led by Monica Plisch, is currently developing plans to expand the impact of its very successful efforts. Our goal is to lay the groundwork for solving the shortage of physics teachers by widespread implementation of best practices established by the project's participating universities over the past decade. The results of our current efforts show this is clearly possible – now we need to broaden implementation to solve the problem nationwide. More information is available on the website: phystec.org.

APS is also moving forward to understand the concerns of physicists who identify as lesbian, gay, bisexual, transgender (LGBT) and other gender and sexual minorities. An *ad hoc* Committee on LGBT Issues (C-LGBT) has been formed, chaired by Professor Michael Falk (Johns Hopkins University), and will have its first in-person meeting in January. C-LGBT has been charged with pro-

viding guidance to APS policy makers on how we can make physics and the APS more inclusive to members of the LGBT community, and reduce barriers to studying and practicing physics. Like many such activities, we expect the outcomes to benefit everyone, with the result being a more welcoming environment for all. If you would like to contact the committee with thoughts or concerns, please email lgbtcontact@aps.org. In addition, a self-organized group, LGBT+ Physicists, offers more information and ways to stay connected at lgbtphysicists.org.

Finally, APS will be sending out a call for student applications to the APS Bridge Program (apsbridgeprogram.org). Last year we were able to place 26 students into graduate programs either as bridge students, or directly into graduate degree tracks. This number was more than three times our stated goals, and enticingly close to closing the achievement gap for underrepresented minorities: 30! Please encourage underrepresented students to apply to the program that you think would do well in graduate studies but who, for whatever reason, would be unsuccessful in gaining admission. APS was able to help these students last year by distributing their applications to more than 70 institutions – all free to the students.



A Guide for an Automated Digital Signage with a Raspberry Pi

Minjoon Kouh, Drew University

Drew Physics Department uses a Raspberry Pi (RPi) to run custom-made slideshows about its course offerings, research opportunities, student activities, as well as "Physics InSight" about careers and opportunities for undergraduate physics students (published by American Physical Society). The following is a short guide on how to set up and maintain an automated digital signage system with a RPi, in case other departments might want to adopt a similar outreach solution. Some familiarity with the Linux environment is assumed.

Raspberry Pi (RPi) is a $35, credit-card-sized, single-board computer, which can serve well as a low-cost platform for teaching/learning computer programming or electronics and for deploying various DIY projects. It is equipped with an HDMI output, and can be easily hooked up to a TV for displaying slideshows or video clips.

Among many benefits of using a RPi for driving a digital signage are its low cost, low power consumption (< 5 Watts), and ease of automation. One could use Microsoft PowerPoint to run a slideshow on a regular PC; however, it not only consumes unnecessarily more power (~ 60 Watts), but also is more difficult to automatically start various applications.

Necessary Hardware

- TV with an HDMI input
- Raspberry Pi (Model B+, in our case)
- SD Card (containing a version of the Linux operating system for RPi)
- HDMI cable
- USB keyboard and mouse

Setup

RPi-driven signage can be set up in many different ways. Our particular solution runs "qiv" (for images) and/or "omxplayer" (for video clips) at specified times with a simple shell script.

First, install a Linux operating system on an SD card, and start up your RPi. Configure the RPi to boot into a Desktop environment directly when it powers on, by running "sudo raspi-confi" from the command line and following the options. You may also want to change the password for security. More information on this basic setup of RPi is available at www.raspberrypi.org.

Second, install "qiv" (quick image viewer) by running "sudo apt-get install qiv" from the command line. The movie player, "omxplayer," should already be installed by default. You can use "lxterminal" to execute a command.

Third, create a shell script such as the following. Use "nano" within "lxterminal" as a text editor.

```
#!/bin/bash
# Countdown to the slideshow.
sec=5
while [ $sec -ge 0 ] do
       echo "Starting slideshow in $sec seconds"
       sleep 1
       sec=$((sec1))
done

mintime="0830"
maxtime="1800"
while true do
       t=$(date +%H%M) # Get time.
       w=$(date +%w) # Get weekdays (0=Sunday)
       echo "Current time: $t"
       if [ $t -le $maxtime ] && [ $t -ge $mintime ] \
       && [ $w -ge 1 ] && [ $w -le 5 ]
       then # Do the following slideshows.
       qiv -fismCd 10 /home/pi/Drew_Science/*.jpg
       omxplayer -b /home/pi/Physics_InSight.mp4

       else
              sleep 60
       fi
done
```

The above shell script is the major part of the setup. The command "qiv -fismCd 10" goes through the jpg files in the specified directory every 10 seconds in the full screen mode. Then, the command "omxplayer -b" plays the specified movie file with a black background. It checks the current day of the week and time. If it is a weekday (i.e., "$w" is between 1 and 5) and the current time is between 08:30 and 18:00, the programmed slideshows will run. If those conditions are not met, the program sleeps for 60 seconds. Since RPi does not have an onboard clock, it needs to be connected to the internet to update its time. The shell script is programmed to run continuously, unless it is canceled with ctrl-C. In our case, we saved it as "play_slideshow.sh."

The shell script must be made executable by running "chmod +x play_slideshow.sh" from the command line.

Four, add the following lines to "/etc/xdg/lxsession/LXDE/autostart" by using "sudo nano":

```
@xset s noblank
```

```
@xset s off
@xset -dpms
@lxterminal -e /home/pi/play_slideshow.sh
```

These commands disable the screensaver and dpms (display power management system), so that the screen does not go blank during the presentations. The last line executes the slideshow shell script as soon as the Desktop starts. Hence, the slideshow can be restarted, just by rebooting the RPi. The initial countdown in the shell script gives its user an opportunity to stop the slideshow at the beginning.

Maintenance

Maintaining the slideshows is relatively easy. In order to add/remove/update a slideshow program, files need to be transferred to the RPi, and the shell script should be edited accordingly. PowerPoint slides can be saved as individual images within Microsoft PowerPoint. If you need to convert a .pdf file into a sequence of images, you can install "imagemagick" on RPi by running "sudo apt-get install imagemagick" and run the following shell script.

```
#!/bin/bash
pg=0
maxpage=100
while [ $pg -le $maxpage ] do
      convert -quality 100 -density 300 \
            your_file.pdf[$pg] $(printf
"img%04d.jpg" $pg)
      let pg=pg+1
done
```

Minjoon Kouh is an Assistant Professor of Physics at Drew University. His primary research area is in Computational Neuroscience, but he has also published several articles on the teaching of physics, particularly on incorporating the Wii-mote into physics labs as an inexpensive accelerometer.

Teacher Preparation Section

Alma Robinson, Virginia Tech

Increasing the diversity of the physics teacher workforce has proven to be an enduring challenge. This edition of the Teacher Preparation Section features two articles from PhysTEC institutions, Georgia State University (GSU) and Chicago State University (CSU), that have had success in recruiting physics teachers from underrepresented minority groups and includes a profile of one of CSU's alumni.

Brian Thoms of Georgia State University explains how GSU's efforts to increase the flexibility and efficiency of the physics degree program requirements, introduce a freshman seminar course, and support the Society of Physics Students were instrumental in growing GSU's physics program, especially among underrepresented minorities. Through a synergy of this growth and a new physics teaching certification program, active recruitment from the Teacher in Residence, and a Learning Assistant Program, GSU has been successful in recruiting preservice teachers from diverse backgrounds.

Mel Sabella and Andrea Gay Van Duzor of Chicago State University (CSU) describe the importance of community partnerships in CSU's preservice teacher program. By establishing collaborations between local teachers, two-year college faculty, and educators at Chicago Science museums, CSU's preservice teachers are given opportunities to build relationships with local institutions and participate in early teaching experiences throughout the surrounding communities. CSU faculty also recognize that because many CSU preservice teachers come from communities similar to the ones they will eventually serve, they can provide significant insight into understanding the culture of the secondary students.

Finally, I had the wonderful opportunity to interview Angela Newton, a Chicago native and second-career teacher who earned her science teaching certification from Chicago State University. After teaching five years in Chicago Public Schools, she now serves as the Assistant Principal STEM Coordinator at Lake View High School. During our conversation, she shared her teaching experiences with me and offered us some advice for our physics teacher programs.

Enhancing Diversity in Physics Teacher Preparation through the Georgia State University PhysTEC Project

Brian Thoms, Department of Physics and Astronomy, Georgia State University

Introduction

As a PhysTEC (Physics Teacher Education Coalition) comprehensive site in the second year of a three year grant, the Georgia State University (GSU) team is working to further develop our model of physics teacher recruitment and development at a diverse, urban research university. One of our goals is to prepare and support more physics teachers from under-represented minority (URM) groups. In addition to creating a well-qualified physics teacher work force in the Atlanta area, this also creates role models and mentors for a diverse high school student population to inspire them toward pursuing careers in science and engineering (and maybe even physics teaching).

Recent efforts to build a thriving physics program with increased minority student success have established the foundation for producing more diverse physics teachers. Our PhysTEC project attempts to use a teacher-in-residence, learning assistants, and recruiting to bring more and more diverse students into physics teaching.

Physics at an Urban Research University

The setting of the university provides an excellent opportunity to increase the involvement of URM in physics and physics teaching. GSU is a growing urban research university whose 25,000 undergraduates form a vibrant and diverse community consisting of 37% White, 38% African American, 13% Asian, and 8% Hispanic students. GSU is diverse in other ways with half of all undergraduates being PELL eligible, over one third are first-generation college attendees, and one quarter are adult learners. Although there are no engineering programs at GSU, 18% of undergraduates are majoring in a STEM area.

Just having URM students at the university doesn't bring them into the physics program or the teacher track. We followed successful efforts such as those described in the SPIN-UP report[1] to build a thriving BS program, doubling the number of physics majors in five years, and tripling the number of physics BS degrees in the last three years as seen in the tables below.

Increasing Diversity in the Physics Program

Also of note is that these increases in the physics program have produced a substantially larger impact on the number of minority students receiving Physics BS degrees. Although efforts to build the physics program were not aimed at minority students, removing the barriers proved to be more important for these students. Among these efforts were increasing the flexibility of the degree program requirements and making student class schedules more efficient. These program changes were important because many, if not most, of our students work outside of classes, and anecdotally we have seen that minority students often work more hours than our majority students. Further, a new concentration was developed for physics teacher education in which students are certified as high school physics teachers within their bachelor's degree program.

Another significant change affecting minority participation in physics is the introduction of a freshman seminar. Our physics majors enter with a wide range of math preparation and most students take several math courses before they can begin the introductory calculus-based physics courses, meaning that they had little contact with the physics department or other physics majors in their first year. By introducing a class required for freshman physics majors, "Gateway to Physics," aimed not at physics content but rather at physics as a career, students have the opportunity to develop their physics identity. This course has a much larger percentage of minority students compared with upper division physics courses, emblematic of the pipeline issues in physics. The Gateway course is an opportunity to present students with a realistic view of physics careers, including high school physics teaching, and provides the opportunity for students to see and meet a diverse group of physics majors.

Tables I and II: Data on degrees and majors in GSU Physics BS program.

Year	Physics BS Degrees	URM	Female
2009-2010	8	1	3
2010-2011	8	1	2
2011-2012	6	1	1
2012-2013	15	5	4
2013-2014	23	6	5

Term	Physics BS Majors
Fall 2009	91
Fall 2010	113
Fall 2011	127
Fall 2012	154
Fall 2013	161
Fall 2014	195

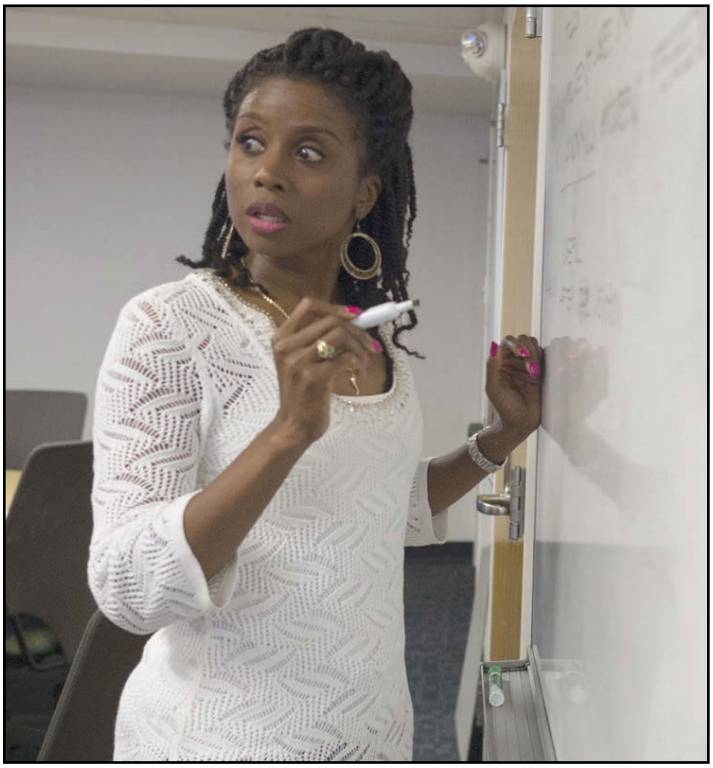
The third significant action to build the program was the reinforcement of the physics club (Society of Physics Students). By giving them control of their room (even over furniture and paint) and support from faculty members, membership in SPS increased from less than 20 to over 50 students. This is another opportunity for students to find support as they make their way through the program which may be particularly important for first generation and minority students.

Student Teacher Rick Farfan

Increasing Diversity in the Physics Teacher Program

A key element involved in the recruiting and mentoring of future physics teachers for the PhysTEC program nationally is the Teacher in Residence (TIR). In the first year of our PhysTEC project we were fortunate to have Elizabeth Walker, an African-American woman with over 20 years of physics teaching experience, as our TIR. Through visits to the freshman Gateway class and other classes, Elizabeth was a living demonstration of the opportunities for successful careers in physics teaching for students from URM groups. She also mentored students through their internships in high school teaching and served as a resource for those considering teaching as a career.

Student Teacher Sebastian Ortiz



Teacher in Residence Elizabeth Walker

Another element of the PhysTEC model is the use of undergraduate Learning Assistants (LAs). Our goal is to recruit top students to serve as LAs with special attention to including minority students. A diverse team of LAs serves as role models demonstrating physics teaching as a path open to everyone. Our course redesign will be complete in Spring 2015 with LAs leading tutorials in all sections of introductory calculus-based physics. It's already clear that LAs have a tremendous effect on the recruitment of other LAs.

Our efforts to increase minority involvement in physics teaching are recent and there has been some success. The education concentration leading to physics certification was introduced in Fall 2012 and graduated its first students in December 2013. One of four students certified in 2013-2014 was an URM as are two of the five students performing internships in 2014-2015.

Brian Thoms is an Associate Professor of Physics at Georgia State University where he has taught for 19 years. He also serves as Associate Chair and Undergraduate Director for the Department of Physics & Astronomy and as PI for the GSU PhysTEC Comprehensive Site Grant.

1. The Strategic Programs for Innovations in Undergraduate Physics (SPIN-UP): Project Report is available at the APS website: http://www.aps.org/programs/education/undergrad/faculty/spinup/spinup-report.cfm.

Not just Great Science Teachers ... Great Chicago Science Teachers: The role of local communities in diversifying the Physics Teaching Workforce

Mel Sabella and Andrea Gay Van Duzor, Department of Chemistry, Physics and Engineering Studies, Chicago State University

Universities and colleges in urban environments that serve mainly local communities play an important role in increasing diversity in the teaching workforce. One of the hallmarks of the Chicago State University preservice STEM teacher program is a focus on communities working together to promote science education. Traditionally, university faculty work with preservice teachers to help them individually develop as science teachers. At CSU, we have expanded on this model by looking at the resources of the local community and by encouraging preservice teachers to examine their own development within the context of the local community. We seek for our candidates to not just become great science teachers, but to become great Chicago science teachers.

University faculty direct the preservice program at CSU, but they have actively sought involvement from local partners interested in improving science education in the city. The secondary education program at CSU has benefited from the shared experiences of a number of communities with different areas of expertise. These communities include high school teachers in the Chicago area, two-year college faculty, and educators at Chicago science museums. High school teachers are the lead instructors of CSU's Teaching Immersion Institute and CSU has had a retired high school science teacher on staff for almost 10 years.[1] The high school teachers provide crucial voices grounding educational theory in real-world experience. Our high school teacher collaborators have also joined our research teams and now bring their expertise not only to our programs but also to the national science education community through talks, posters and papers. Two-year college faculty collaborate through a multi-institution Learning Assistant Program that serves as a supportive early teaching experience.[2] Their contributions have guided the revision of curricula and broadened the means of recruitment into the teaching field. Chicago area museums provide exciting opportunities for teachers looking to utilize local resources and our preservice teachers have benefited from internships and workshops supported by our NSF-Noyce grant.

One of the most important local partners interested in improving science education in the city is a group that can easily be overlooked: our preservice teacher candidates themselves. Preservice STEM students attending Chicago State University usually come from neighborhoods close to the university and often enter teaching careers in communities that are similar to those in which they have grown up. About 80% of the CSU student body identifies as African-American and about 70% are from the City of Chicago.[3] Supporting the local community is an important aspect of teaching for many of our preservice students who want to positively impact their neighborhoods or neighborhoods similar to the ones in which they grew-up. We support this motivation through different types of early teaching experiences for CSU students who are either interested in exploring teaching or have committed to teaching. One example is a yearly event that is embedded in our "Readings in Science Education Course," in which our students develop STEM lessons for local elementary school students who visit CSU. In these early teaching experiences, our science education students foster a learning environment where the younger students can discuss science and engage in inquiry-based instruction. Because this type of pedagogy is implemented in the majority of science courses at CSU and the culture of our CSU students aligns with this type of teaching, our preservice teachers rarely question its importance in their own teaching, even in these early teaching experiences.

CSU students work on developing a lesson on sound to implement in the High School Classroom as part of the APS PhysTEC Program

The shared experiences of our preservice teachers and the secondary students whom they will teach is a feature that we capitalize on in our secondary education program. In addition, having faculty know about the culture and the everyday lives of the student teachers they work with is essential in promoting effective teaching and building trust between these communities.[4] In our science professional education courses, we actively encourage our candidates to compare their (and often their children's) schooling experiences with educational research and theory. We seek to have them reflect on both their individual and shared experiences to craft engaging and meaningful lessons that they may implement in their future classrooms. This reflection also helps them recognize how their own experiences have shaped their understanding

CSU students present their work from the Teacher Immersion Institute at the annual PhysTEC Conference in Austin, TX

of science education. This recognition, along with the understanding that their experiences do not necessarily align with those of their future students, is critical for culturally responsive teaching.[5]

Additionally, our preservice teachers have played a necessary and important role in informing the secondary education program at CSU. Just as high school teachers need to understand the communities they work with, CSU Faculty need to know the culture and lives of the students with whom we work, beyond academics. Often the lives of our students can be quite complicated and the juggling of family, work, and school can often mean that the path to a degree is not linear.[6] Because of this, it is often a challenge to foster a cohort model, and although we maintain high standards in our courses, we also need to be extremely flexible. Our students develop a rich set of tools to overcome obstacles and adapt to different types of situations. When these preservice students become teachers, many of their students will encounter similar situations, and it is these shared experiences that will assist our preservice students in supporting their own students in the classroom.[7] Our recent graduates are often in contact with us and provide critical feedback as to the structure of the program.

Listening to the local communities has had a major impact on the science education program at CSU. The experiences of high school teachers, two-year college faculty and museum educators have played a major role in developing the richness of our program. The preservice teachers we work with, who have shared much of their lives with us, have made the most significant impact. By listening to these students, we have been able to develop a science education program that it uniquely adapted for the Chicago area.

Mel Sabella and Andrea Van Duzor are faculty in Physics and Chemistry respectively in the Department of Chemistry, Physics and Engineering Studies at Chicago State University. They co-lead a number of efforts in CSU's science education research program and work closely on CSU's NSF Noyce Program, APS PhysTEC Program, and the Department's growing Learning Assistant Program.

1. Sabella, M. S., Van Duzor, A. G., Passehl, J., & Weisenburger, K. (2012). A Collaboration Between University and High School in Preparing Physics Teachers: Chicago State University's Teacher Immersion Institute). *The Physics Teacher,* 50(5), 296-300.
2. Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: *The Colorado learning assistant model. American Journal of Physics,* 78(11), 1218-1224.
3. http://www.csu.edu/IER/
4. Rodriguez, A. J., & Zozakiewicz, C. (2010). Facilitating the integration of multiple literacies through science education and learning technologies. *Science education as a pathway to teaching language literacy*, SensePublishers, 23-45.
5. Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education*-Washington DC-, 53(2), 106-116.
6. http://www.aps.org/programs/women/reports/gazette/upload/GAZ-fall2012.pdf
7. Sabella, M., & Van Duzor, A. G. (2013, January). Cultural toolkits in the urban physics learning community. In *American Institute of Physics Conference Series* (Vol. 1513, pp. 34-37).

Educator Profile: Angela Newton

Alma Robinson

While on a recruiting trip for the United States Army Recruiting Command, Chicago native Angela Newton noticed that the high schools she visited in the windy city didn't have the vibrancy that she remembered; there was no excitement. She wanted to change that. Using the education benefits she earned through the Illinois Veterans Grant, she received her teaching certification from Chicago State University (CSU) and taught science and engineering in Chicago Public Schools (CPS) for five years. Angela's current position is Assistant Principal STEM Coordinator at Lake View High School in Chicago's north side. Despite her incredibly busy schedule, Angela took some time to speak with me about the unique path that led her to STEM education.

With an undergraduate degree in chemistry, pursuing a science teaching certification seemed like a natural choice. Because Angela's certification program endorsed her to teach all sciences, she was extremely grateful for all the help she received from the mentor teachers in each of the science disciplines at CSU. She found the help of the chemistry mentor teacher, Ms. Koziarski, a retired teacher with decades of service in CPS, particularly valuable.

After receiving her certification but before her first year teaching, Angela spent the summer taking CSU's Pedagogical Content Knowledge (PCK) course, a professional development class for in-service teachers funded by the Illinois Board of Higher Education. Angela spoke highly of her experiences with the program, including learning about POGIL (Process Oriented Guided Inquiry Learning), developing standards-based instruction, and gaining access to one of CSU's outreach efforts: The Chemistry Van.

Angela's first teaching job was at VOISE Academy, a technology-focused high school in Chicago's west side, where students are assigned laptops instead of textbooks. As the sole physical science teacher, she was responsible for designing curriculum and ordering all the chemicals, glassware, and lab equipment during her first year. Thankfully, through her experiences with CSU's PCK summer program, the Chemistry Van delivered lab equipment right to her classroom door! In addition, Angela felt comfortable reaching out to her CSU mentors for guidance and support.

After teaching two years at VOISE, Angela took a position at Chicago Military Academy, a CPS school on the south side. During her three years there, she taught chemistry, physics, engineering design, engineering digital future, and forensic science. Angela excitedly told me about a handful of the engineering design projects her students created, some of which sounded like they could easily be the next infomercial craze: a USB-powered fan for bedrooms with only one outlet, dishwashing gloves with sponges at the tips of the fingers, and a combination comb and hair spray, an invention to "brush, then flip to spritz" created by a student who was tired of waiting for his girlfriend to find both items individually. In addition to offering her a chance to teach new courses, Chicago Military Academy also had a much larger science department than the one at VOISE, giving Angela the opportunity to learn from experienced teachers.

At both schools, Angela took on administrative roles as well, serving as department chair, participating on the Instructional Leadership Team, and helping with curriculum development efforts. Knowing that she wanted to be an instructional support leader, essentially a coach for STEM teachers, she received her Master's degree in Educational Administration from Governors State University.

Angela found her administrative home in a science-based position: Assistant Principal STEM coordinator at Lake View High School. Angela passionately spoke of her new position and the school's climate. At Lake View, Angela has been able to use her science background to help broaden the focus of STEM education beyond technology by incorporating more aspects of science, math, and engineering. With support from the NSF and corporate partners, Lake View participated in Computer Science week this past fall, a computer science initiative for all. Ten sophomores from Lake View even participated in an outreach program to teach elementary students how to code! Lake View students can also take dual credit courses, earning college credit within the walls of their high school.

Angela Newton, Assistant Principal STEM Coordinator, Lake View High School

Given Angela's current position as STEM coordinator, I asked her what colleges and universities could do to help K-12 schools. She quickly responded that the new teachers coming out of higher education teacher preparation programs are fantastic: they know how to break down their lessons to match the goals of the Next Generation Science Standards, bring wonderful interdisciplinary ideas to the table, and are excelling in the classroom. In her eyes, the next step is for colleges and universities to provide professional development for in-service teachers, much like the program she took at CSU. Many of these experienced teachers don't know about things like POGIL and PCK, and Angela thinks colleges and

universities could serve as valuable resources for their continued professional development.

As a product of Chicago Public Schools, Angela is able to connect with her students in a very genuine way. In her, they see someone from their neighborhood be successful; they know that she gets it. When the students think that she "works them too hard," they trust that she cares about them and they stick to it because they love her.

Browsing the Journals

Carl Mungan, United States Naval Academy, mungan@usna.edu

- In the November 2014 issue of *The Physics Teacher* (http://scitation.aip.org/content/aapt/journal/tpt), Michael O'Shea argues that the maximum backpack weight a person can carry does not simply equal a percentage of one's body weight. Rather, there is some intermediate hiker's weight at which the backpack mass is maximized, because a person has to carry not just the pack but also their own upper body. The author's photographs of mountain hiking reminded me fondly of my own month-long Outward Bound trek in central BC (a long time ago). Hewitt's solution to *Figuring Physics* on page 564 of the December 2014 issue seems slightly wrong to me. He says the weight of a can of air and of an evacuated can would be equal. My issue is that should only be true if the evacuated can collapsed down to zero internal volume, which by inspection is not true for the partly collapsed can in his sketch. I invite some reader to actually try the experiment and see if they can measure a difference in weights. Page 34 of the January 2015 issue has a lovely example of the numerical simulation of the motion of a charge in a nonuniform magnetic field (namely that of an infinite straight wire) as an interesting counterpoint to the standard textbook example of helical motion in a uniform field. The authors do a nice job of deriving the two coupled differential equations. Although they cannot be solved analytically, they do have a simple dimensionless form which I find appealing.

- I have previously seen granite sphere fountains, such as the one shown in Fig. 1 of the article by Snoeijer and van der Weele in the November 2014 issue of the *American Journal of Physics* (http://scitation.aip.org/content/aapt/journal/ajp), but I did not realize they are actually levitating a one-ton stone on a thin film of flowing water. The authors convincingly show that the levitation is due to lubrication (like a giant ball bearing) not buoyancy. In the December 2014 issue, Garfinkle and Rojo explain why meteors impact Earth with speeds that are always in the range 16 to 72 km/s. I have published a simplified analysis of the same issue at http://usna.edu/Users/physics/mungan/_files/documents/Publications/WAS2.pdf. Finally, Kagan has a thorough review of the method of analyzing electrical circuits using nodal potentials (rather than the standard introductory physics method of branch currents) in the January 2015 issue. I have summarized his key example of a Wheatstone bridge of resistors at http://usna.edu/Users/physics/mungan/_files/documents/Scholarship/WheatstoneBridge.pdf for use in my classes.

- Page 693 of the November 2014 issue of *Physics Education* presents a simple model of drafting of one race car closely following behind another. The idea is that if the front car totally cancels quadratic air drag on the second car (because they essentially form one longer car of the same cross-sectional area) then we expect the terminal speed to increase by the square root of 2, i.e., by as much as 40%. Also I was amused by the simple but clear explanation of why a superball thrown under and bouncing off the underside of a table (after hitting and returning to the floor) will retrace its path back to the thrower on pages 125 and 126 of the January 2015 issue. Turning to the *European Journal of Physics*, article 065012 in the November 2014 issue discusses anharmonicity in various oscillating systems: a disk bouncing between two bumpers on a horizontal air table, a marble rolling along a V-shaped track, an interrupted pendulum, a quartic rather than the usual parabolic potential, and the combination of linear damping with Hooke's law. Article 015005 in the January 2015 issue analyzes the normal modes of a vertically hanging chain with a point mass at its lower end. The addition of the mass enables Neumann functions as solutions, rather than just the Bessel functions one gets in its absence. Both journals are accessible at http://iopscience.iop.org/journals.

- Page 2195 of the December 2014 issue of the *Journal of Chemical Education* at http://pubs.acs.org/toc/jceda8/91/12 discusses the thermodynamics of a rubber band, including a comparison of the theoretical equation of state with experimental results on the tension as a function of temperature and length. The references include a link to a YouTube video at https://www.youtube.com/watch?v=dBXL93984cQ of a heat engine constructed by replacing the spokes with rubber bands and heating one region with a lamp. Additional theoretical and experimental details are available in the online Supplementary Info for the article.

- The Indian Academy of Sciences publishes the journal *Resonance* of science education. Physics articles in the November 2014 issue at http://www.ias.ac.in/resonance/php/toc.php?vol=19&issue=11 include a review of nonlinear ocean waves on page 1047, and a brief derivation of Wien's displacement law starting from classical action on page 1058.

Web Watch

Carl Mungan, United States Naval Academy, <mungan@usna.edu>

- AlphaGalileo at http://www.alphagalileo.org/ collects together information from around the world about scientific news.
- The official website of Richard Feynman is http://www.richardfeynman.com/.
- Lawrence Livermore National Lab has an education page devoted to fusion at http://fusedweb.llnl.gov/.
- A website about the South Pole Neutrino Observatory (IceCube) is at http://icecube.wisc.edu/.
- A down-to-earth explanation of why blue LEDs deserved the 2014 Nobel prize can be found at http://scienceblogs.com/principles/2014/10/07/nobel-prize-for-blue-leds/.
- Wouldn't it be useful to have one site where physics books were reviewed by academic peers (rather than just by any old Joe on Amazon, although those reviews can also be helpful)? The Canadian Association of Physicists has attempted to do that at http://www.cap.ca/BRMS/PRdb.asp and I only wish the list of titles were longer.
- 2015 is the International Year of Light, as detailed at http://www.light2015.org. Last year was the International Year of Crystallography and a blog posted a new crystal structure for every day of the year at https://crystallography365.wordpress.com/.
- One website dedicated to creating and sharing online presentations is http://www.knovio.com/. Another one is https://present.me/content/. Educators may also benefit from the video editing tools at https://edpuzzle.com/.
- A free tool to extract numerical data from a published plot is http://arohatgi.info/WebPlotDigitizer/.
- Wired Magazine discusses the accuracy of the physics in the movie *Interstellar* with Kip Thorne at http://www.wired.com/2014/10/astrophysics-interstellar-black-hole/.
- AAPT annually offers a New Faculty Workshop. An entire set of video presentations from these workshops has been posted at https://www.youtube.com/playlist?list=PLx_woo78JX4myOgPUllIH8EfSrkVVWgAL.
- UNC Chapel Hill has a detailed student handout about writing research lab reports at http://writingcenter.unc.edu/handouts/scientific-reports/.
- A global map of large asteroid impacts since the year 2000 can be found at http://cdn.static-economist.com/sites/default/files/imagecache/original-size/20140426_STM972_0.png.
- A recent review of U.S. military directed-energy weapons systems is online at http://www.osa-opn.org/home/articles/volume_25/october_2014/features/high-energy_lasers_new_advances_in_defense_applica/#.VLbXyyenHDN.
- The Institute for Science + Math Education has a list of their partnerships at http://sciencemathpartnerships.org/.
- Videos at http://time.com/3606721/cat-dog-drinking/ show why dogs are sloppier than cats in using their tongues to drink.
- IEEE has a history of Maxwell's equations at http://spectrum.ieee.org/telecom/wireless/the-long-road-to-maxwells-equations.
- PhysicsGirl shows how to make a vortex at the surface of a swimming pool by dragging a vertical plate across it at https://www.youtube.com/watch?v=pnbJEg9r1o8. Another fascinating demo is a magnetic train consisting of rare-earth magnets on the poles of an AAA battery moving inside a helical wire coil at http://www.wimp.com/releasesbattery/.
- National Geographic has a webpage exploring such forces of nature as tornadoes, volcanoes, and earthquakes at http://education.nationalgeographic.com/education/multimedia/interactive/forces-of-nature/?ar_a=1. More broadly, Columbia University has a well-organized collection of material related to terrestial physics at http://www.ldeo.columbia.edu/research.
- We all know atoms can be laser cooled, but it's trickier to optically cool molecules because of their internal modes of vibration and rotation. So what's the current record lowest temperature for a dilute gas of molecules in a magneto-optical trap? Yale physicists have attained 2.5 mK for SrF at http://news.yale.edu/2014/08/20/yale-s-cool-molecules-are-hot-item.
- You might be amused by browsing Altmetric's list of 2014's top 100 academic articles judging by public interest at http://www.altmetric.com/top100/2014/?utm_source=announcement&utm_medium=social&utm_term=2014top100&utm_campaign=top1002014social. Not surprisingly, the majority of them concern biomedical research.
- Finally, a video of a Rube Goldberg machine using optics at http://laserclassroom.com/follow-bouncing-beam/ might be fun to show in class.

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