AAPT Program

Welcome to the nation's capital!

It has been nearly 15 years since the AAPT last held a national meeting in Washington, D.C., and that was one of the last joint AAPT/APS Spring Meetings. (How many of you can remember that we used to hold THREE meetings each year!?) Now the "April" APS meeting and the "January" AAPT meeting have both been moved to February, and we are poised for what will likely be one of the best meetings our organization has had. Combining the availability of the scientific sessions of APS with our own usual high-quality workshops and sessions is bound to appeal to our members. Add to this, the excitement of being in the Nation's Capital—with all of its historic, cultural, recreational, and political activities, and personally, I can't wait to experience the fruition of these many months of planning!

You will experience a number of changes for this winter's meeting, for example, 36-minute invited talks and 12-minute contributed ones, two exciting plenary sessions featuring three talks each, and a joint exhibit area with a gala reception at 7 p.m. on Sunday. A very special Bridging Session on Saturday evening begins a dialogue that will focus on ways in which the United States is addressing President Obama's call to make STEM education a national priority. (I hope that the significance of this session and the high caliber of the speakers will hush the grumbling about Saturday workshops beginning at 7:30 a.m.!)

Our proximity to the Smithsonian Institution has inspired a workshop entitled "Behind the Scenes at the Smithsonian," and a session called "Exploring the Nation's Attic," and hopefully you will also schedule some time to walk to the corner Woodley Park Metro station, and visit one or more museums. Our presence in the U.S. seat of power has inspired the sessions "Physicists Inside the Beltway," "Selling Physics Research and Education to Congress," and "Policy and Women," and the meeting's theme, "Physics for the Nation's Future." And, perhaps you will feel inspired to share your views with our lawmakers on Congressional Visit Day, Friday, Feb. 12, organized by APS. If all of this hasn't piqued your interest, maybe the session "Secrecy and Physics," and the showing of "Secrecy"—a film about the vast, invisible world of government secrecy—will!

The headquarters hotel, the venerable red brick Marriott Wardman Park, dates from the 1920s, and is located in a delightful area of D.C. with tree-lined streets, many international restaurants, and the National Zoo. (The oldest portion of the hotel is listed on the National Register of Historic Places, and has been home to three U.S. presidents!)

Best regards,

David R Sokoloff

David Sokoloff
AAPT Vice President and Winter Meeting Program Chair
University of Oregon
Eugene, Oregon

Special Thanks

AAPT thanks the following persons for their help in organizing the winter meeting:

Paper Sorters: Jeff Marx, Lili Cui, Diane Riendeau, and Gerald Feldman

Recognizing Laser's 50th Anniversary

LASER FEST
CELEBRATING 50 YEARS OF LASER INNOVATION
WWW.LASERFEST.ORG

Monday, February 15,
7:00 p.m. - 8:30 p.m.

Public Lecture: "From Edible Lasers and the Search for Earth-like Planets, Five Decades of Laser Spectroscopy"

by Theodor W. Hänsch, *Recipient of the 2005 Nobel Prize in Physics with John L. Hall, Director, Max-Planck-Institute für Quantenoptik Professor of Experimental Physics and Laser Spectroscopy, Ludwig-Maximilians Universität München, Germany*

To hear more about the laser, check out these sessions:

- **NSF Course Curriculum & Laboratory Improvement Grant Report**, Tuesday, 3:30–5:30 p.m.
  Integrating Laser Tweezers into the Introductory Physics Curriculum, Mark Reeves
  Diode Lasers as a Platform for Updating the Advanced Laboratory, Eric Wells
- **A Physics Teacher's Introduction to Research Frontiers at the National Institute for Standards and Technology (NIST)**, Tuesday, 3:30–5:18 p.m.
  Research with Laser-Cooled Atoms at NIST, Paul Lett

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Contacts:

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Cerena Cantrell: Assistant Director of Programs & Conferences
Janet Lane, Program Coordinator
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American Association of Physics Teachers
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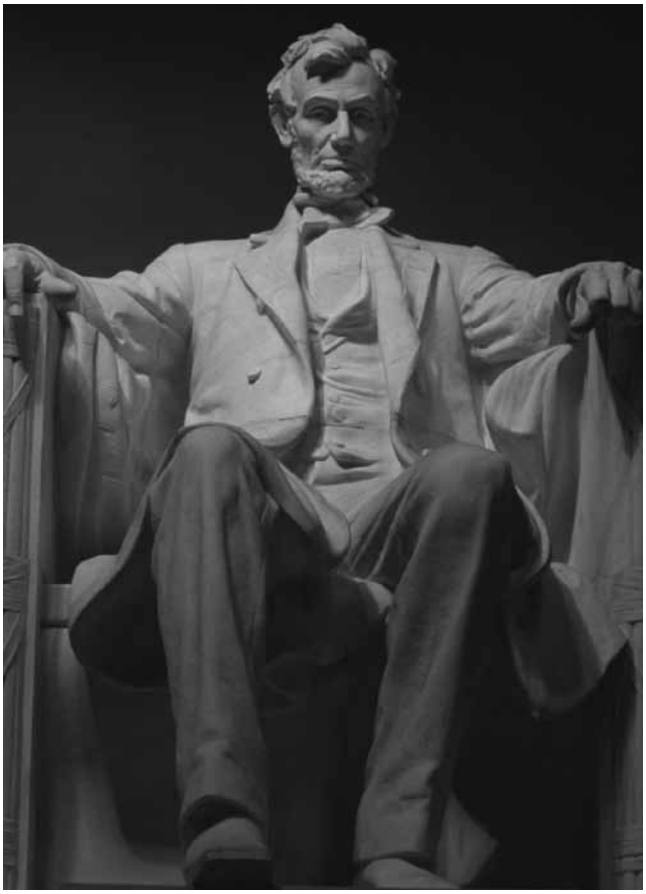
College Park, MD USA 20740-3845
301-209-3300, fax: 301-209-0845
meetings@aapt.org, www.aapt.org



Welcome to Washington, D.C.!

Take advantage of the location of our joint meeting! The nation's capital offers unique opportunities for culture, history, and government in action.

History

The site for the nation's capital along the Potomac River was chosen by George Washington himself, and in 1788, the governments of Maryland and Virginia ceded land for the new city. In 1791, President Washington appointed Pierre Charles L'Enfant to devise a plan for the city in an area of land at the center of the federal territory, including a system of circles with plazas later honoring notable Americans. The streets radiate out from the circles, with the U.S. Capitol located on a hill at the center of the grid. After disputes with commissioners, L'Enfant was dismissed and the plan was amended without his permission, but finally, in 1800, the government moved to the new city!

Education

Many notable private universities are located in Washington, including the George Washington University (GW), Georgetown University (GU), American University (AU), the Catholic University of America (CUA), Howard University, Gallaudet University, and the Johns Hopkins University School of Advanced International Studies (SAIS). The Corcoran College of Art and Design provides specialized arts instruction, and other higher-education institutions offer continuing, distance and adult education. The University of the District of Columbia (UDC) is a public university providing undergraduate and graduate education.

Things to do in D.C.

Smithsonian

Start at the Smithsonian Institution Building on the mall where you can pick up a map and information on all of the museums. All buildings are free. There is a small charge for the IMAX movies at the Natural History Museum and the National Air and Space Museum.

Monuments and Memorials

Washington, D.C., is a city of monuments and memorials. We honor the generals, politicians, poets, and statesmen who helped shape the nation. Most famous monuments and memorials are on the National Mall: Washington Monument, Lincoln Memorial, and Viet Nam Memorial are near each other. WW II Memorial is recently added.

Arlington National Cemetery
Arlington, VA

The Tomb of the Unknown Soldier changing of the guard, grave of John F. Kennedy.

U.S. Capitol

The U.S. Capitol is open to the public for tours Monday through Saturday. Tickets are required to tour the U.S. Capitol. To guarantee availability, you should reserve your tour in advance online at www.visitthecapitol.gov or through your congressional representative or senator. A limited number of same-day tour tickets may also be available at the Capitol Visitor Center. Tickets are not required to tour the Capitol Visitor Center, which is open 8:30 a.m.– 4:30 p.m., Monday through Saturday. Visit www.aoc.gov for more information.

Ford's Theatre
511 10th St., NW

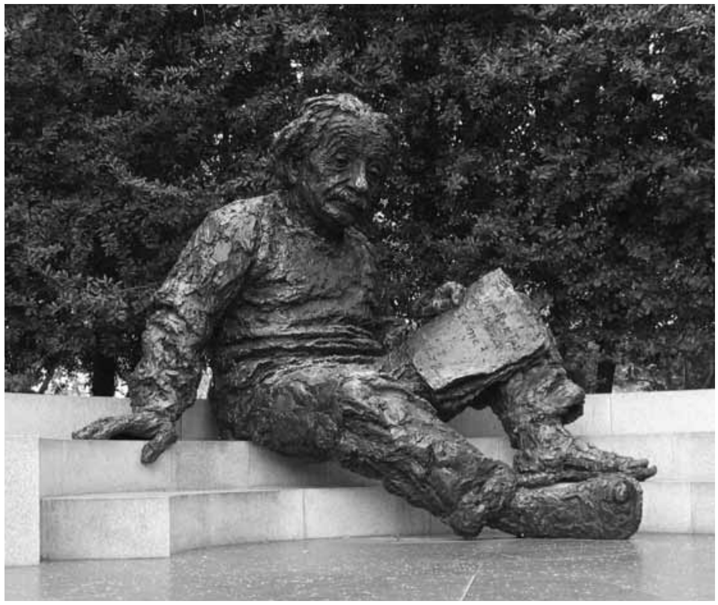
The museum at Ford's Theatre was renovated in August 2009. The theatre is restored to look just like it did in 1865 when Lincoln was shot there. Also open is the Peterson House, across the street, where he died. www.fordstheatre.org/home

Mount Vernon
Alexandria, VA

The home of George Washington has been recently upgraded so visitors can learn much more about Washington's life: new exhibits, new buildings, and a new visitor's center.

National Zoo
3001 Connecticut Ave., NW

Open daily 10 a.m. to 5 p.m., free to the public. Located very near the Marriott Wardman Park, the zoo is home to 2,000 individual animals of nearly 400 different species. The best known residents are our giant pandas, Tian Tian and Mei Xiang.



You can see this famous statue when you visit the National Academy of Sciences, located at 500 5th St., NW.

AAPT PHYSICS EDUCATION

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Join AAPT on the web during the meeting!

Through Twitter and Facebook you can follow and join in on the discussion during the meeting! Just visit **aapt.org/Conferences/wm2010** for the most recent tweets about the meeting. To make sure your tweets make it into the stream, use the hashtag **#apsaapt** in your tweets!

www.aapt.org/facebook

www.twitter.com/physicsteachers

First time at an AAPT meeting?

Welcome to the 2010 APS/AAPT Joint Meeting in Washington, D.C.! 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 on page 18 in this guide. 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 7:30–8:30 a.m. on Monday in Virginia B. It is a wonderful way to learn more about the meeting and about AAPT.

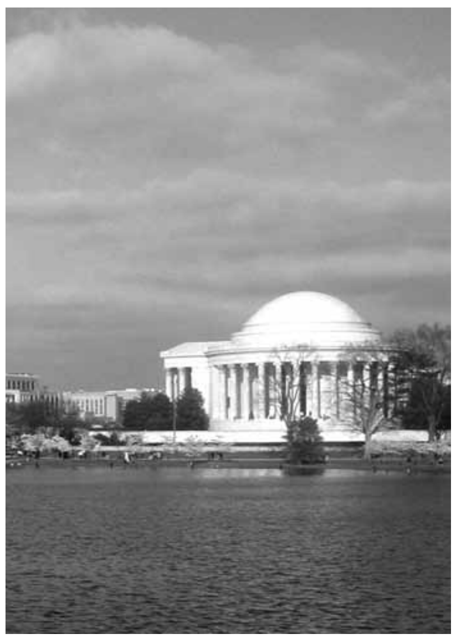
— Awards and other plenary sessions have distinguished speakers and are especially recommended. Invited speakers are experts in their fields and will have half an hour or more to discuss their subjects at some depth. Posters will be up all day and presenters will be available during the times indicated in the schedule. Contributed papers summarize work the presenters have been doing. You are encouraged to talk to a presenter 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 crackerbarrels are entirely devoted to such discussions.

— Be sure to make time to visit the exhibits. This is a great place to learn what textbooks and equipment are available in physics education.

Internet Access

AAPT is pleased to offer you complimentary wireless access in public areas during the meeting, including hallways, Exhibit Hall, and lobby areas.

There will also be an Internet Cafe where you can check email in the Exhibit Hall during Exhibit Hall hours.



Award Winners

Melba Newell Phillips Medal

Mary Beth Todd Monroe, Southwest Texas Junior College, Uvalde, TX

The Faces of AAPT

Monday, Feb.15, 1:30–3:18 p.m.

Mary Beth Monroe

Mary Beth Monroe, long-time AAPT member, has quietly and tenaciously served the organization at the state and national level for more than three decades. She served as AAPT Secretary and Chair of the Publications Committee from 2001-2007 and is currently serving as a member of the Committee on the Interests of Senior Physicists and as Chair of the Governance Review Committee. She has played a leading role in developing networks among physicists teaching in two-year colleges that have led both to their increasing involvement in AAPT and better teaching for the quarter of all introductory physics students who are students in the Two Year Colleges.

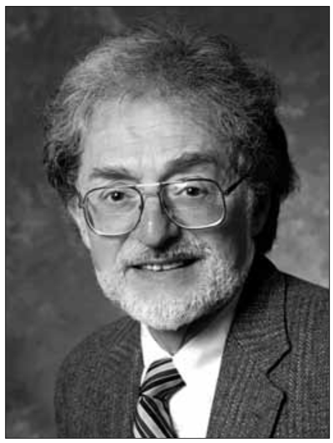
Monroe received her BS degree in physics from Sam Houston State University, Huntsville, TX, and her MS in Physics (research field, plasma physics) with double minor in Junior College Teaching (HEW intern) and Math, 1973. She is a dedicated proponent of quality physics education in two-year and community colleges. She served on the AAPT Executive Board as Member-at-Large Representing Two-Year colleges, and as a member of the Committee on Physics in the Two Year College. Additionally, she served as Principal Investigator and Project Director for TYC21 and as Co Principal Investigator for Strategic Programs for Innovations in Undergraduate Physics at Two Year Colleges from 2002-2005.

J.D. Jackson Excellence in Graduate Education Award

Eugene D. Commins, University of California, Berkeley, Berkeley, CA

Some Personal Reflections on Physics Graduate Education

Monday, Feb. 15, 1:30–3:18 p.m.



Eugene Commins

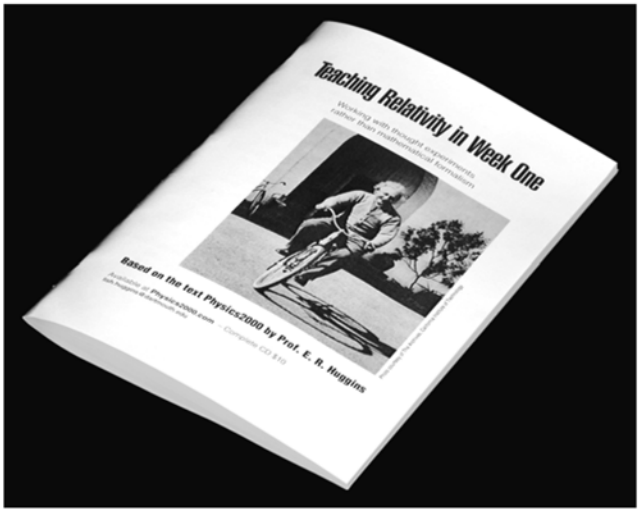
Eugene Commins, physics professor emeritus at the University of California, Berkeley, is the first recipient of the J.D. Jackson award. This award is given in recognition of contributions to graduate physics education, and awardees are chosen for their extraordinary accomplishments in communicating the excitement of physics to their students. Commins earned his BA with Honors in Mathematics and Physics at Swarthmore College and his PhD in Physics at Columbia University, New York City. He began his teaching career at Columbia University before moving to the University of California Berkeley in 1960.

Many distinguished scientists were taught and mentored by him, got their PhD's working with him, and speak passionately about him to their colleagues. Many of his students have gone on to sterling careers in their own right: our current Energy Secretary, Nobel Laureate Steve Chu, is an outstanding example of a student who was taught and mentored by Commins.

Physics2000 texts, both the calculus & non calculus versions, are now available.

Come visit us at booth 411 to learn more about the workshop.

The new non calculus version of the printed texts & CD, all for $35.



Free Workshop: Physics2000.com Tuesday From 11:30 - 1:30 PM, Room Balcony D

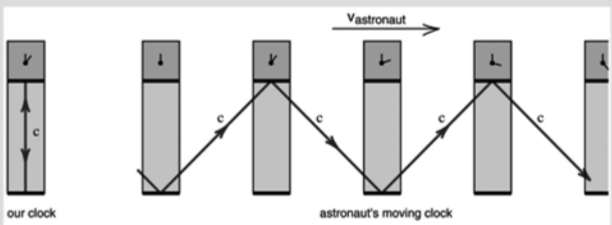
Come to the popular Physics2000 workshop where you learn how to include 20th and 21st century physics in the basic Introductory Physics course. This is done by starting with **Special Relativity** in Week 1, using thought experiments rather than mathematical formalism. For example, you can easily show that, by combining the already familiar **Lorentz contraction** with **Coulomb's law,** you end up with the **Magnetic Force law**, **Maxwell's formula for the speed of light** and the **formula for the magnetic field of a current in a straight wire**.

Attendees receive complimentary copies of the either the calculus or non calculus version of the Physics2000 texts and CD.

The first of our September 2009 TPT ads.

The Physics2000 texts begin with Special Relativity in Week One

Using thought experiments rather than mathematical formalism, we begin with special relativity in week one. The muon lifetime movie on the included CD provides experimental support for the theory and allows an intuitive introduction to the Lorentz contraction. (Mountains do contract.) We also see that information cannot travel faster than the speed of light. Then we go on to Chapter 2.



We need the Pythagorean theorem to calculate the length of seconds in the astronaut's moving clock.

www.physics2000.com

Award Winners

AAPT Distinguished Service Citations

Monday, Feb. 15, 1:30–3:18 p.m.

Karen Williams

Karen Williams is Professor of Physics at East Central University in Ada, OK. She earned her MS in Physics from the University of Arkansas, Fayetteville and her PhD in Physics Education from the University of Oklahoma. Through her work with the Society of Physics Students, Dr. Williams has influenced thousands of future physics teachers.

An AAPT member for 20 years, she has been extremely active in the Arkansas-Oklahoma-Kansas Section, having held every office, including President, and hosting a section meeting at East Central University. Williams has presented several workshops at section meetings, attended countless workshops herself, and been involved as Co-PI or lead teacher in two NSF grants training teachers in teaching physical science. She has generously donated her time and shared her expertise as a presenter at numerous AAPT national meetings.

Patrick Whippey

Patrick Whippey, The University of Western Ontario physics professor emeritus**,** is a very knowledgeable and dedicated physics teacher who is a role model to both educators and students. A willing and effective mentor to new and experienced teachers, he is well-respected among all of the OAPT Section members and hundreds of physics teachers and students across the province.

Whippey's service to AAPT, the physics profession, and the physics students and teachers of the Ontario section of the AAPT has spanned over 40 years. He has made significant contributions to the Ontario section as a member of the Executive Board, OAPT section representative, and web master. He has made contributions to numerous activities for physics teachers such as a physics contest; physics photo contest; science shows and presentations for elementary, middle school, and high school students; science olympics; and science fairs. He is an OAPT member at large, organizer of the section and national conferences (one of them was the Canadian Association of Physicists – AAPT joint conference), and contributor to the Science Teachers Association of Ontario events.

Trina Cannon

Beverly T. Cannon earned her BS in Chemistry at Mississippi State College for Women, her MS in Science Education from the University of Southern Mississippi, and her PhD from Louisiana State University. She has actively sought to spread her enthusiasm for physics as a high school teacher and as a Physics Teaching Resource Agent in Texas where she regularly gives workshops to help high school teachers.

For nearly three decades she has devoted her time to serving in AAPT. Perhaps her most unique and respected contribution is her heroic efforts for the AAPT's video contest. Every year, there are new technological issues as students get more and more sophisticated and Trina has dealt with these changes in a timely and professional manner. AAPT is an organization of volunteers, and Trina is one of our organization's best.

SPS Outstanding Chapter Advisor Award

Diane Jacobs

Diane Jacobs, professor of physics, Eastern Michigan University, Ypsilanti, MI, received her PhD in physics from University of Texas in Austin in 1985. She has been the SPS and Sigma Pi Sigma advisor at Eastern Michigan for more than two decades, having initiated the chapter when she arrived. Her chapter has been named Outstanding many times, which means she and her students have led many outreach events for local school children and teachers. Her influence goes far beyond her own department since she and her students have served on the SPS Council many years. The students nominating her for this award wrote, "Dr. Diane Jacobs ... [uses] the most diverse and creative multi-dimensional approaches to teaching that I have ever seen."

Plenary Sessions

Plenary Session I
The Kavli Foundation Joint Plenary

Saturday, Feb. 13, 4–6 p.m. • Salon 1 and 2

Re-Energizing America's Focus on STEM Education

Jointly organized by APS, AAPT, the National Society of Black Physicists, and the National Society of Hispanic Physicists

Presider: Alex Dickison

Speakers include:

Catalyzing Widespread Implementation of Good Teaching Practices
Linda Slakey (Acting Executive Officer of the Education and Human Resources Directorate, NSF)

The Value of Diversity in STEM
Shirley Malcom (American Association for the Advancement of Science)

The Algebra Project's Strategy to Accelerate the Nation's Bottom Quartile Students' Math Education and Get Them Ready for College Math
Robert P. Moses (The Algebra Project)

This bridging session focuses on President Obama's call to make STEM education a national priority.

Algebra Project

Sunday, Feb. 14, 2–3:30 p.m. • Washington 2

A Module from the Algebra Project: Mathematical Sentences in Elementary Algebra: What They Mean, and Why They Are True or False on the Basis of What They Mean

Robert Moses, assisted by students and teachers from New York City, will present a classroom demonstration.

Plenary Session II

Monday, Feb. 15, 8:30–10:18 a.m. • Salon 1 and 2

Co-sponsored by APS and AAPT

Session Chair: Barry C. Barish (Caltech)

A Space Program Worthy of a Great Nation
Norman R. Augustine (Retired Chairman and CEO, Lockheed Martin Corporation)

Nucleon Spin Puzzle
Naomi Makins (University of Illinois, Urbana-Champaign)

Surface Temperature Responses to Natural and Anthropogenic Influences: Past, Present and Future
Judith Lean (Naval Research Laboratory)

AAPT Awards

Monday, Feb. 15, 1:30–3:18 p.m. • Salon 3

Melba Newell Phillips Medal: *The Faces of AAPT*
Mary Beth Monroe (SW Texas Jr. College)

J.D. Jackson Award: *Some Personal Reflections of Physics Graduate Education*
Eugene D. Commins (UC Berkeley)

Distinguished Service Citations

AIP's SPS Outstanding Chapter Advisor Award

LaserFest Lecture

Monday, Feb. 15, 7–8:30 p.m. • Salon 3

From Edible Lasers and the Search for Earth-like Planets: Five Decades of Laser Spectroscopy

Nobel Prize winner Theodore Hänsch, Director, Max-Plank-Institute für Quantenoptik and Professor, Ludwig-Maximilians Universität, München, Germany

Plenary Session III

Tuesday, Feb. 16, 8:30–10:18 a.m. • Salon 1 and 2

Co-sponsored by APS and AAPT

Session Chair: Michael Turner (University of Chicago)

Cosmology with the Cosmic Microwave Background
John Carlstrom (Kavli Institute, University of Chicago)

Early Results from the Kepler Mission
William Borucki (NASA Ames Research Center)

The Search for the Higgs Bosons and More at the Tevatron Collider
Rob Roser (Fermilab)

AAPT's Symposium on Physics Education

Tuesday, Feb. 16, 1:30–3:18 p.m. • Salon 3

Educating Physics Teachers: A Call to Action for Physics Departments

The symposium is dedicated to the memory of Len Jossem. Speakers include: Sheila Tobias, Mary Ann Rankin, and Stamatis Vokos.

AAPT Presidential Transfer

Wednesday, Feb. 17, 10:30–11 a.m. • Washington 6

Outgoing President Alex Dickison hands over the reigns to new President, David Cook.

Special Events

Contact Congress

Saturday, Feb. 13–Monday, Feb. 15

Atrium/Exhibit Hall C

Stop by the Contact Congress booth to sign your name to letters to your Congressional representatives on the importance of federal funding for basic research.

APS/AAPT Welcome Reception

Sunday, Feb. 14, 7–9 p.m. • Exhibit Hall C & B

held in conjunction with SPS Poster Reception and APS Poster Session.

"Secrecy," a film by Peter Galison and Robb Moss

Sunday, Feb. 14, 9–10:30 p.m. • Park Tower 8209
Monday, Feb. 15, 4–5:30 p.m. • Park Tower 8209
Tuesday, Feb. 16, 7–8:30 p.m. • Park Tower 8209

A film about the vast, invisible world of government secrecy.

First Timers' Gathering

Monday, Feb. 15, 7:30–8:30 a.m. • Virginia B

Learn more about AAPT and the meeting at this breakfast event.

Two-Year College Breakfast

Monday, Feb. 15, 7:30–8:30 a.m. • McKinley

Join colleagues teaching in two-year colleges during this social breakfast event. (*ticket required*)

Retirees' Breakfast

Monday, Feb. 15, 7:30–8:30 a.m. • Thomas Paine

Join your colleagues during this social breakfast event. (*ticket required*)

Spouses' Gathering

Monday, Feb. 15, 9–10 a.m. • Thomas Paine

Create connections with other spouses and partners of AAPT attendees. Start with a light breakfast and plan an afternoon of sightseeing in the nation's capital.

Young Physicists' Meet and Greet

Monday, Feb. 15, 12:33–1:30 p.m. • McKinley

A place for 20 and 30 something physicists to mix and mingle.

APS/AAPT Job Fair

Monday, 10 a.m.–6 p.m.
Tuesday, 9 a.m.–4 p.m. • Exhibit Hall

TEACHFORAMERICA

Teach For America: SPS Recruiting Session

Saturday, Feb. 13, 6–7 p.m. • Tyler Room

By the eighth grade, students in our low-income communities are, on average, two to three grade levels behind their higher-income peers in both science and math. As an SPS member, you are uniquely positioned to change this.

Meet with a Teach For America recruiter and learn more about how teaching for two years in a low-income community can fit with your long-term career goals. Refreshments will be provided. www.teachforamerica.org

Undergraduate Awards

Monday, Feb. 15, 5–7 p.m. • Hoover

Future Faces of Physics Jeopardy to be played by all, with prizes for the winning teams. The session will conclude with recognition of Vera Rubin as an Honorary Member of the physics honor society, Sigma Pi Sigma, its highest distinction.

Multi-Cultural Luncheon

Tuesday, Feb. 16, 12:33–1:30 p.m. • Washington 1

Enjoy your colleagues and friends and learn about the multiculturalness of AAPT. (*ticket required*)

Physics Exhibit Show – Exhibit Hall

Sunday, Feb. 14, 7–9 p.m.
Monday, Feb. 15, 10 a.m.–6 p.m.
Tuesday, Feb. 16, 10 a.m.–4 p.m.

Daily Poster Sessions • Exhibit Hall A

Poster Session 1, Monday, 8:30–10 p.m.

Odd numbered: 8:30–9:15 p.m.

Even numbered: 9:15–10 p.m.

Poster Session 2, Tuesday, 9–10:30 p.m.

Odd numbered: 9–9:45 p.m.

Even numbered: 9:45–10:30 p.m.

Great Book Giveaway

Tuesday, Feb. 16, 5:45–6:30 p.m. • Registration

Bring your raffle ticket and get ready to win a great physics book. Tickets are available at the AAPT booth in the Exhibit Hall until 3 p.m. Tuesday.

Workshop bus schedule

February 13-14, 2010

(Buses will pick up at the 24th Street entrance of the Washington Marriott Wardman Park, located on the lobby level next to Harry's Pub)

Date: Saturday, February 13

7:00 a.m.	Bus departs Washington Marriott Hotel to UDC
7:15 a.m.	Bus departs Washington Marriott Hotel to UDC
8:30 a.m.	Bus departs Hotel to Smithsonian (W06 workshop)
11:15 a.m.	Bus departs Washington Marriott Hotel to UDC
11:45 a.m.	Bus departs UDC, returning to Marriott Hotel
12:30 p.m.	Bus departs UDC, returning to Marriott Hotel
3:00 p.m.	Bus departs Smithsonian, returning to Marriott Hotel
3:45 p.m.	Bus departs UDC, returning to Marriott Hotel
4:00 p.m.	Bus departs UDC, returning to Marriott Hotel

Date: Sunday, February 14

7:15 a.m.	Bus departs Washington Marriott Hotel to UDC
7:30 a.m.	Bus departs Washington Marriott Hotel to UDC
12:00 p.m.	Bus departs UDC, returning to Marriott Hotel
12:10 p.m.	Bus departs Washington Marriott Hotel to UDC
12:20 p.m.	Bus departs Washington Marriott Hotel to UDC
12:30 p.m.	Bus departs UDC, returning to Marriott Hotel
3:00 p.m.	Bus departs UDC, returning to Marriott Hotel
4:45 p.m.	Bus departs UDC, returning to Marriot Hotel
5:00 p.m.	Bus departs UDC, returning to Marriot Hotel

Pick-up Location/Meeting Hotel:

Washington Marriott Wardman Park
2660 Woodley Rd., NW
Washington, DC 20008 (24th St. Entrance)

Workshop Location:

University of the District of Columbia (UDC)
4200 Connecticut Ave., NW
Washington, DC 20008

METRO directions to UDC:

Take Red Line from hotel stop (*Woodley Park-Zoo*) two stops north toward Shady Grove, to UDC stop (*Van-Ness UDC*).

Fourth Annual

SYMPOSIUM on Physics Education

Educating Physics Teachers:
A Call to Action for Physics Departments

Dedicated to the memory of Len Jossem.

Tuesday, February 16, 1:30–3:18 p.m.
Washington Marriott Wardman Park • Salon 3

Science Teaching as a Profession. Why it isn't. How it could be, Sheila Tobias

Teacher Preparation - UTeach, Mary Ann Rankin

Transforming the Professional Preparation of Physics Teachers in the United States: Findings and Recommendations of the T-TEP Report,
Stamatis Vokos, Chair of the Task Force on Physics Teacher Preparation

Sponsored in part by the PhysTEC Project, an NSF-funded partnership of APS, AAPT and AIP.

Session Sponsors List

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Minorities: SA CF FA IA

Pre-High School: AB AF HH

Professional Concerns: BB FE CG EB

Research in Physics Education: SA AC AI BB CD CI DG DH EB FJ GC GI HC HD HI IB IC

Science Educ. for the Public: BC DC FH HI

Space Science and Astronomy: AD DA HF IA IG

Teacher Preparation: BD CF FB FD GD

Two-Year Colleges: CB FF DE EA GA GE

Undergraduate Education: DF FK GB GC GE HA ID

Women in Physics: FA HE

Sessions sponsored with APS:

SA DB ID HC CH HG AH CI CD AC CA FE FJ CG

Not yet an AAPT Member?

Your meeting registration may qualify you for Free membership.

Ask how at membership@aapt.org

Committee Meetings

Saturday, February 13

Awards Committee	8–10:30 a.m.	Congressional

Sunday, February 14

Publications Committee	8–10:30 a.m.	Taylor
Meetings Committee	8–10:30 a.m.	Truman
Mini-retreat for Area Chairs and Section Reps	10:30 a.m.–12:30 p.m.	Virginia B
Resource Letters Editorial Board	11:30 a.m.–2:30 p.m.	Jackson
Mini-retreat Luncheon	12:30–1:30 p.m.	Virginia C
Mini-retreat for Area Chairs	1:30–4 p.m.	McKinley
Mini-retreat for Section Representatives	1:30–4 p.m.	Balcony C
Programs Committee I	4–5:30 p.m.	Washington 2
AAPT Council Meeting	5–6:30 p.m.	Washington 3
Nominating I	5–6:30 p.m.	Jefferson
Graduate Education in Physics Committee	5–6:30 p.m.	Jackson
High School Share-A-Thon	5–7 p.m.	Washington 1

Monday, February 15

Teacher Preparation Committee	7–8:30 a.m.	Truman
The Interest of Senior Physicists Committee	7–8:30 a.m.	Jackson
International Physics Education Committee	7–8:30 a.m.	Jefferson
Physics in High School Committee	7–8:30 a.m.	Johnson
Physics in Pre-High School Education Committee	7–8:30 a.m.	Buchanon
PIRA Business meeting	7–8:30 a.m.	Park Tower 8217
Physics Bowl Advisory Group	7–8:30 a.m.	Park Tower 8223
Bauder Endowment Committee	12:33–1:30 p.m.	Jackson
Review Board Committee	12:33–1:30 p.m.	Jefferson
Barbara Lotze Scholarship Committee	12:33–1:30 p.m.	Park Tower 8223
Venture Fund Committee	12:33–1:30 p.m.	Ethan Allen
Finance Committee	12:33–1:30 p.m.	Park Tower 8217
Chesapeake Section Meeting	3:30–5:45 p.m.	Taft
Physics in Undergraduate Education Committee	5:45–7 p.m.	Truman
Laboratories Committee	5:45–7 p.m.	Jackson
Professional Concerns Committee	5:45–7 p.m.	Jefferson
History and Philosophy Committee	5:45–7 p.m.	Johnson
Minorities in Physics Committee	5:45–7 p.m.	Nathan Hale
PERTG	5:45–7 p.m.	Buchanon

Tuesday, February 16

Women in Physics Committee	7–8:30 a.m.	Jackson
Physics in Two-Year Colleges Committee	7–8:30 a.m.	Johnson
Apparatus Committee	7–8:30 a.m.	Buchanon
PTRA Advisory Board	7–8:30 a.m.	Congressional
Governance Review Committee	7–8:30 a.m.	Jefferson
Members and Benefits Committee	12:33–1:30 p.m.	Jackson
Audit Committee	12:33–1:30 p.m.	Johnson
SI Units and Metric Education Committee	12:33–1:30 p.m.	Jefferson
Governance Structure Committee	5:45–7 p.m.	Park Tower 8223
Science Education for the Public Committee	5:45–7 p.m.	Jackson
Research in Physics Education Committee	5:45–7 p.m.	Washington 1
Educational Technologies Committee	5:45–7 p.m.	Jefferson
Space Science and Astronomy Committee	5:45–7 p.m.	Johnson
Investment Advisory Committee	5:45–7 p.m.	Buchanon

Wednesday, February 17

Programs Committee II	7–8:30 a.m.	Harding
Nominating Committee II	7–8:30 a.m.	Washington 1
PERLOC	7–8:30 a.m.	Washington 5

Exhibitor Information

Booth #318, 320

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Booth #315

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Computing in Science & Engineering (CiSE) is the bimonthly magazine of computational tools and methods. APS and AAPT are the societies with the most CiSE subscribers, at least partly because computation is being introduced earlier in physics curricula. AAPT and APS members can subscribe to CiSE for 40% off the nonmember price; come by the booth for free review copies, and spin the wheel for prizes. CiSE is peer-reviewed and co-published by AIP and the IEEE Computer Society.

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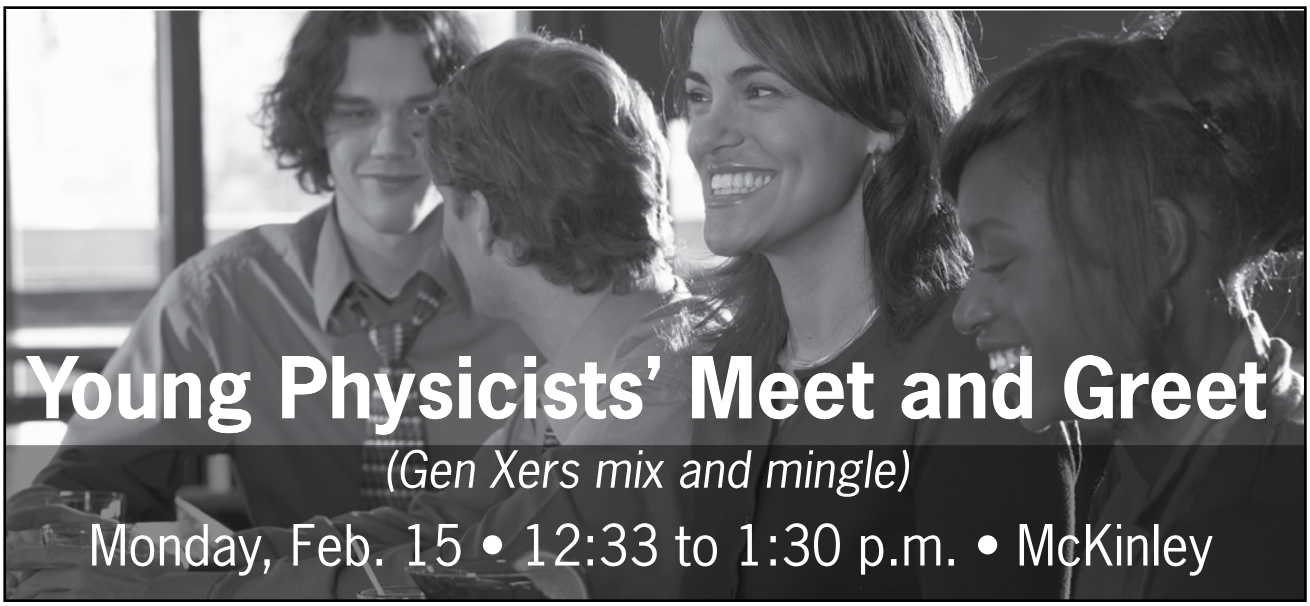

Commercial Workshops

CW01: And You Thought It Was About Homework

Sponsor: WebAssign
Date: Tuesday, Feb. 16
Time: 12:33–1:30 p.m.
Room: Washington 3

Leaders: John S. Risley, Eric Boyd, and Prabha Ramakrishnan, WebAssign

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CW02: Optics With Lights & Color: Bright Ideas

Sponsor: CPO Science
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.
Room: Nathan Hale

Leader: Erik Benton, CPO Science

CPO Science's new Optics with Light & Color kit comes with LED flashlights, a laser, convex and concave lenses, a prism, diffraction grating glasses, polarizing filters, and more. Mix colors of light, learn about human vision, measure angles of reflection and refraction, create interference patterns, calculate wavelengths of light, and experience total internal reflection with a laser and prism. We'll touch on current technological applications of these topics as we use hands-on equipment to study the time-honored properties of optics, light, and color in new ways.

CW03: Introductory Physics for the 21st Century

Sponsor: John Wiley & Sons
Date: Monday, Feb. 15
Time: 12:33–1:30 p.m.
Room: Park Tower 8210

Leader: Mark P. Haugan, John Wiley & Sons

John Wiley & Sons is pleased to announce the release of the third edition of *Matter & Interactions* by Ruth Chabay and Bruce Sherwood. This two-semester, calculus-based physics course offers students a remarkably coherent introduction to mechanics, thermal physics, and electricity and magnetism by integrating elements of contemporary physics, including the atomic structure of matter, and by emphasizing the use of fundamental physics principles to construct models of physical systems that predict or explain their structure or behavior. This workshop will discuss many of the most striking and effective features of this curriculum. It will also present the positive experiences of faculty at the growing number of large research universities that are using *Matter & Interactions* to teach introductory physics to all of their engineering and science students. The workshop leader is a professor of physics at Purdue University, one of the institutions using *Matter & Interactions* in this way.

CW04: Physics2000 Workshop

Sponsor: Physics2000.com
Date: Tuesday, Feb. 16
Time: 11:30 a.m.–1:30 p.m.
Room: Balcony D

Leader: Elisha Huggins, Physics2000.com

Come to the popular Physics2000 workshop where we show you how to teach special relativity in the first week of an introductory physics course, and then how to fit 20th and 21st century physics into your course. We also show you how to introduce Fourier analysis using the free MacScope audio oscilloscope program (that works on Macs and Windows), ending up with an intuitive explanation of the time-energy form of the uncertainty principle. This approach is followed in the new noncalculus version of the Physics2000 text, as well as the calculus version that we introduced in January 2000.

CW05: Physics for Everyday Thinking (PET) and Physical Science for Everyday Thinking (PSET)

Sponsor: It's About Time
Date: Monday, Feb. 15
Time: 12:33–1:30 p.m.
Room: Balcony D

Leader: Fred Goldberg, It's About Time

PET and PSET are one-semester guided inquiry courses for prospective and practicing elementary and middle school teachers and general education college students. These courses focus on the themes of interactions conservation of energy, Newton's law, and (for PSET) atomic-molecular theory. They include Learning About Learning activities where students either reflect on their own learning, the learning of younger children (using elementary videos), or the learning of scientists (the history of nature of science).

Meeting-at-a-Glance

Meeting-at-a-Glance includes sessions, workshops, committee meetings and other events, including luncheons, Exhibit Hall hours, plenary sessions, and receptions. All rooms will be at the Washington Marriott Wardman Park Hotel. Workshops will be held at the University of the District of Columbia.

FRIDAY, Feb. 12

6–8 p.m.		Pre-registration Pickup	Lobby Level

SATURDAY, Feb. 13

7 a.m.–5 p.m.		**REGISTRATION**	Lobby Level
7:30–11:15 a.m.	W07	Data Analysis Software, Astronomical Images, and Physics Concepts	UDC
7:30 a.m.–3:30 p.m.	W01	Physics Teaching and the Development of Reasoning	UDC
7:30 a.m.–3:30 p.m.	W02	Developing Physics Teacher Knowledge	UDC
7:30 a.m.–3:30 p.m.	W04	Physics by Design	UDC
7:30 a.m.–3:30 p.m.	W05	Household Electricity in the Physics Classroom	UDC
9 a.m.–3 p.m.	W06	Behind the Scenes at the Smithsonian	offsite
8–10:30 a.m.		Awards Committee meeting	Congressional
10:30 a.m.–4 p.m.		AAPT Executive Board	Congressional
11:45 a.m.–3:30 p.m.	W08	Activities-based Units for All Ages	UDC
11:45 a.m.–3:30 p.m.	W09	Ben Franklin as My Lab Partner	UDC
11:45 a.m.–3:30 p.m.	W10	Condensed Lecture Demonstration Workshop	UDC
11:45 a.m.–3:30 p.m.	W24	Live Photo Physics: Video-based Analysis Activities	UDC
1–3 p.m.	T01	Building Your Physics Course with ComPADRE	UDC
4–6 p.m.		**The Kavli Foundation Joint Plenary** – Re-Energizing America's Focus on STEM Education	Salon 1 and 2
6–7 p.m.		Teach For America: SPS Recruiting Session	Tyler

SUNDAY, Feb. 14

7 a.m.–4 p.m.		**REGISTRATION**	Lobby Level
8–10:30 a.m.		Publications Committee meeting	Taylor
8–10:30 a.m.		Meetings Committee meeting	Truman
8–11:45 a.m.	W14	Using the Wii for Fun and Physics	UDC
8–11:45 a.m.	W15	Ranking Tasks in Astronomy	UDC
8–11:45 a.m.	W16	Equity Education "Outside the Box": Exploring Issues of Race and Gender	UDC
8–11:45 a.m.	W17	A New Model of Instruction for the Urban Physics Classroom	UDC
8–11:45 a.m.	W18	Designing an Inquiry-based Physics Course for K-12 Teachers	UDC
8–11:45 a.m.	W19	Using Easy Java Simulations for Physics Teaching	UDC
8–11:45 a.m.	W20	Just-in-Time Teaching: Using the Web to Create Active Learning	UDC
8 a.m.–4:30 p.m.	W11	Research-based Alternative to Problem Solving	UDC
8 a.m.–4:30 p.m.	W12	Teaching Physics for the First Time	UDC
8 a.m.–4:30 p.m.	W13	Going Deep to Reach the Stars	UDC
8 a.m.–4:30 p.m.	W03	Using Research-based Curricula and Tools for Intro. Course	UDC
10:30 a.m.–12:30 p.m.		Mini Retreat for Area Chairs and Section Reps	Virginia B
11:30 a.m.–2:30 p.m.		Resource Letters Editorial Board	Jackson
12–6 p.m.		Exhibitors Setup	Exhibit Hall
12:30–1:30 p.m.		Mini Retreat Luncheon	Virginia C
12:45–2:45 p.m.	T02	Civic Engagement and Service Learning: SENCER project	UDC
12:45–2:45 p.m.	T03	Multimedia Modern Physics for High School Teachers	UDC
12:45–2:45 p.m.	T04	Monster in the Middle	UDC
12:45–4:30 p.m.	W21	Designing a Diagnostic Learning Environment	UDC
12:45–4:30 p.m.	W22	Following Students' Learning in the PET, PSET, and LEPS Courses	UDC
12:45–4:30 p.m.	W23	Tutorials in Intro. Physics: A Research-Validated Approach	UDC
12:45–4:30 p.m.	W25	Laboratories with Biomedical Applications	UDC
12:45–4:30 p.m.	W26	TA Preparations: Challenges and Successes	UDC
12:45–4:30 p.m.	W27	Nuclear Forensics	UDC

12:45–4:30 p.m.	W28	N-TIPERS: Research-based Conceptual Reasoning Tasks	UDC
1:30–4 p.m.		Mini Retreat for Area Chairs	McKinley
1:30–4 p.m.		Mini Retreat for Section Representatives	Balcony C
2–3:30 p.m.		A Module from the Algebra Project: Mathematical Sentences	Washington 2
4–5:30 p.m.		Programs Committee meeting – I	Washington 2
5–6:30 p.m.		AAPT Council Meeting	Washington 3
5–6:30 p.m.		Nominating Committee meeting – I	Jefferson
5–6:30 p.m.		Graduate Education in Physics Committee	Jackson
5–7 p.m.		High School Share-A-Thon	Washington 1
6–8 p.m.		**REGISTRATION**	Lobby Level
7–9 p.m.		APS/AAPT Welcome Reception/ SPS Poster Reception/ Exhibits Open	Exhibit Hall
9–10:30 p.m.		*Secrecy* Film, a film by Peter Galison and Robb Moss	Park Tower 8209

MONDAY, Feb. 15

7–8:30 a.m.		Teacher Preparation Committee meeting	Truman
7–8:30 a.m.		Interest of Senior Physicists Committee meeting	Jackson
7–8:30 a.m.		International Physics Education Committee meeting	Jefferson
7–8:30 a.m.		Physics in High School Committee meeting	Johnson
7–8:30 a.m.		Physics in Pre-High School Education Committee meeting	Buchanon
7–8:30 a.m.		PIRA business meeting	Park Tower 8217
7–8:30 a.m.		Physics Bowl Advisory Group meeting	Park Tower 8223
7 a.m.–4 p.m.		**REGISTRATION**	Lobby Level
7:30–8:30 a.m.		First Timers' Gathering	Virginia B
7:30–8:30 a.m.		Two-Year College Breakfast	McKinley
7:30–8:30 a.m.		Retirees' Breakfast	Thomas Paine
8:30–10:18 a.m.		**Joint Plenary with APS**	Salon 1 and 2
9–10 a.m.		Spouses' Gathering	Thomas Paine
10 a.m.–5 p.m.		APS/AAPT Job Fair	Exhibit Hall
10 a.m.–6 p.m.		Exhibit Show Open	Exhibit Hall
10:45 a.m.–12:21 p.m.	AB	Bridging the Gap in Physical Science: Teaming H.S. and K-8 Teachers	Virginia B
10:45 a.m.–12:33 p.m.	AA	Panel: International Issues in Physics Education	Balcony D
10:45 a.m.–12:33 p.m.	AC	Interactive Lecture Demonstrations: Physics Suite	Virginia C
10:45 a.m.–12:33 p.m.	AD	Astrophysics in the Classroom	Balcony A
10:45 a.m.–12:33 p.m.	AE	SPS Undergraduate Research & Outreach – I	Harding
10:45 a.m.–12:33 p.m.	AF	National Resources for Science Education	Balcony C
10:45 a.m.–12:33 p.m.	AG	Teaching with Technology – I	Washington 1
10:45 a.m.–12:33 p.m.	AH	Reforming Introductory Physics Courses for Life Science Majors – II	Washington 2
10:45 a.m.–12:33 p.m.	AI	PER: Topical Understanding and Attitudes	Washington 3
10:45 a.m.–12:33 p.m.	CW02	CPO Science, School Specialty Commercial Workshop	Nathan Hale
12:33–1:30 p.m.	BA	CRACKERBARREL: Advanced Laboratory Personnel	Virginia C
12:33–1:30 p.m.	BB	CRACKERBARREL: PER Graduate Student Concerns	Virginia B
12:33–1:30 p.m.	BC	CRACKERBARREL: Physics and Society	Johnson
12:33–1:30 p.m.	BD	CRACKERBARREL: Impact of NCLB and Changes in State Certification	Buchanon
12:33–1:30 p.m.		Young Physicists' Meet and Greet	McKinley
12:33–1:30 p.m.		Bauder Committee meeting	Jackson
12:33–1:30 p.m.		Review Board Committee meeting	Jefferson
12:33–1:30 p.m.		Venture Fund Committee meeting	Ethan Allen
12:33–1:30 p.m.		Finance Committee meeting	Park Tower 8217
12:33–1:30 p.m.		Barbara Lotze Scholarship Committee meeting	Park Tower 8223
12:33–1:30 p.m.	CW03	John Wiley and Sons, Inc. Commercial Workshop	Park Tower 8210
12:33–1:30 p.m.	CW05	It's About Time Commercial Workshop	Balcony D
1:30–3:18 p.m.		**AAPT's Phillips, Jackson, Distinguished Service Awards Ceremony**	Salon 3
3:30–4:18 p.m.	JB	Teaching with Technology – II	Salon 3
3:30–5:18 p.m.	CC	Teaching Training/Enhancement	Virginia C
3:30–5:30 p.m.	CE	SPS Physics Outreach	Harding

3:30–5:45 p.m.		Chesapeake Section meeting	Taft
3:30–5:54 p.m.	FF	How To Advocate for Science Locally, Regionally, and Nationally	Washington 1
3:30–5:54 p.m.	CA	Panel: Information Fluency and Physics Curriculum	Balcony D
3:30–5:54 p.m.	CB	Unconventional Laboratories	Virginia B
3:30–5:54 p.m.	CD	TA Training: Why It Is Important and How To Do It Effectively	Balcony A
3:30–5:54 p.m.	CF	The Things Accomplished Teachers Do in Their Classrooms	Balcony C
3:30–5:54 p.m.	CH	Progress in Modernizing the Large Physics Course for Engineers	Washington 2
3:30–5:54 p.m.	CI	Research on Student Learning in Upper-Division Courses	Washington 3
3:30–5:54 p.m.	CJ	Exploring the Nation's Attic	Jackson
4–5:30 p.m.		*Secrecy* Film, a film by Peter Galison and Robb Moss	Park Tower 8209

5–7 p.m.		Undergraduate Awards with Physics Jeopardy; Vera Rubin Recognition	Hoover
5:45–7 p.m.		Physics in Undergraduate Education Committee meeting	Truman
5:45–7 p.m.		Laboratories Committee meeting	Jackson
5:45–7 p.m.		Professional Concerns Committee meeting	Jefferson
5:45–7 p.m.		PERTG meeting	Buchanon
5:45–7 p.m.		History and Philosophy Committee meeting	Johnson
5:45–7 p.m.		Minorities in Physics Committee meeting	Nathan Hale
7–8:30 p.m.		**LaserFest Public Lecture:** Ted Hänsch	Salon 3
8:30–9:15 p.m.	PST1	Poster Session 1 (odd numbers)	Exhibit Hall A
9:15–10 p.m.	PST1	Poster Session 1 (even numbers)	Exhibit Hall A

TUESDAY, Feb. 16

7 a.m.–4 p.m.		**REGISTRATION**	Lobby Level
7–8:30 a.m.		Women in Physics Committee meeting	Jackson
7–8:30 a.m.		Physics in Two-Year Colleges Committee meeting	Johnson
7–8:30 a.m.		Apparatus Committee meeting	Buchanon
7–8:30 a.m.		PTRA Advisory Board meeting	Congressional
7:30–8:30 a.m.		Governance Review Committee meeting	Jefferson
8:30–10:18 a.m.		**Joint Plenary with APS**	Salon 1 and 2
9 a.m.–4 p.m.		APS/AAPT Job Fair	Exhibit Hall
10 a.m.– 4 p.m.		Exhibit Hall Open	Exhibit Hall

10:45–11:57 a.m.	DG	Physics Education Research Around the World – I	Washington 2
10:45 a.m.–12:33 p.m.	DF	Lecture/Classroom	Washington 3
10:45 a.m.–12:33 p.m.	CG	Panel: Selling Physics Education Research and Education to Congress	McKinley
10:45 a.m.–12:33 p.m.	DA	The Art and Science of Astronomy	Balcony C
10:45 a.m.–12:33 p.m.	DB	Computational Physics in the Undergraduate Curriculum	Virginia B
10:45 a.m.–12:33 p.m.	DC	Funding Opportunities for Informal Science Education and Outreach	Virginia C
10:45 a.m.–12:33 p.m.	DD	Classroom Activities in Particle Physics for the High School – I	Balcony A
10:45 a.m.–12:45 p.m.	DH	PER: Problem Solving	Balcony B
11:30 a.m.–1:30 p.m.	CW04	Physics2000.com Commercial Workshop	Balcony D

12:33–1:30 p.m.	EA	CRACKERBARREL: What Now?	Balcony A
12:33–1:30 p.m.	EB	CRACKERBARREL: PER Faculty Concerns	Virginia B
12:33–1:30 p.m.	EC	CRACKERBARREL: Apparatus	Virginia C
12:33–1:30 p.m.	ED	CRACKERBARREL: History of Physics	Buchanon
12:33–1:30 p.m.	CW01	WebAssign Commercial Workshop	Washington 3
12:33–1:30 p.m.		Membership and Benefits Committee meeting	Jackson
12:33–1:30 p.m.		Audit Committee meeting	Johnson
12:33–1:30 p.m.		SI Units and Metric Education Committee meeting	Jefferson
12:33–1:30 p.m.		Multi-Cultural Luncheon	Washington 1
1:30–3:18 p.m.		**AAPT Symposium:** Educating Physics Teachers: A Call to Action	Salon 3

3:30–4:30 p.m.	FC	Classroom Activities in Particle Physics for the High School	Virginia C
3:30–5:18 p.m.	FK	A Physics Teacher's Introduction to Research Frontiers	Jackson
3:30–5:30 p.m.	FI	How Educational Technologies Can Support Physics Teaching	Washington 2
3:30–5:42 p.m.	FG	NSF Course Curriculum and Laboratory Improvement	Balcony D
3:30–5:45 p.m.	DE	Panel: Preparing Graduate Students for Careers in College Physics	Balcony C
3:30–5:42 p.m.	FA	Art and Physics	McKinley

3:30–5:54 p.m.	FB	Instructional Resources for Physics Teacher Education Programs	Virginia B
3:30–5:54 p.m.	FE	Enriching Physics in the Classroom and Beyond	Balcony A
3:30–5:54 p.m.	FH	**Joint AAPT/APS Session** on Physics and Society	Washington 1
3:30–5:54 p.m.	FJ	Improving Physics Teaching by Studying, Thinking, and Learning	Washington 3
4:42–5:06 p.m.	FD	Physics Majors: High School	Virginia C
5:45–6:30 p.m.		Great Book Giveaway	Registration area
5:45–7 p.m.		Governance Structure Committee meeting	Park Tower 8223
5:45–7 p.m.		Science Education for the Public Committee meeting	Jackson
5:45–7 p.m.		Research in Physics Education Committee meeting	Washington 1
5:45–7 p.m.		Educational Technologies Committee meeting	Jefferson
5:45–7 p.m.		Space Science and Astronomy Committee meeting	Johnson
5:45–7 p.m.		Investment Advisory Committee meeting	Buchanon
7–7:48 p.m.	GA	Physics of Hobbies	McKinley
7–8:12 p.m.	GF	Teaching to Students with Special Needs	Balcony C
7–8:24 p.m.	GC	Using Undergraduate Students in Undergraduate Curriculum	Virginia C
7–8:30 p.m.		*Secrecy* Film, a film by Peter Galison and Robb Moss	Park Tower 8209
7–8:36 p.m.	GI	PER: Student Reasoning	Washington 3
7–8:48 p.m.	GB	Astrobiology: From the Frontiers to the Classroom	Virginia B
7–8:48 p.m.	GD	Panel: Vertical Alignment of Physics Conceptual Curriculum	Balcony A
7–8:48 p.m.	GE	Successes/Challenges with SPS in TYCs and Small Departments	Balcony B
7–8:48 p.m.	GG	Teaching with Technology – III	Washington 1
7–8:48 p.m.	GH	Teaching Physics Around the World – I	Washington 2
7–7:48 p.m.	GJ	Upper-Level Physics	Balcony D
9–9:45 p.m.	PST2	Poster Session 2 (odd numbers)	Exhibit Hall A
9:45–10:30 p.m.	PST2	Poster Session 2 (even numbers)	Exhibit Hall A

WEDNESDAY, Feb. 17

7–8:30 a.m.		Programs Committee – II	Harding
7–8:30 a.m.		Nominating Committee – II	Washington 1
7–8:30 a.m.		PERLOC meeting	Washington 5
8 a.m.–12 p.m.		**REGISTRATION**	Lobby Level
8:30-9:42 a.m.	HB	Teaching Physics Around the World – II	Washington 2
8:30-9:54 a.m.	HF	New Results in Astronomy Education Research	Washington 6
8:30-10:18 a.m.	HA	Upper Division and Graduate	Washington 1
8:30-10:18 a.m.	HC	Physics Education Research: Solved Problems and Open Questions	Washington 3
8:30-10:18 a.m.	HD	Physics Education Research in the High School	Washington 4
8:30-10:18 a.m.	HE	Policy and Women	Washington 5
8:30-10:18 a.m.	HG	Reflections on the Topical Conference on Advanced Labs	Maryland B
8:30–10:18 a.m.	HH	Pre-High School Reform Curriculum for Teacher Preparation	Maryland C
8:30–10:18 a.m.	HI	Panel: Science Learning in Informal Settings	Maryland A
10:30–11 a.m.		AAPT Presidential Transfer Ceremony	Washington 6
11 a.m.–12:33 p.m.	IA	Frontiers in Astrophysics	Washington 1
11 a.m.–12:36 p.m.	IB	Physics Education Around the World – II	Washington 6
11 a.m.–12:48 p.m.	IC	PER: Investigating Classroom Strategies	Washington 3
11 a.m.–12:48 p.m.	ID	Optics in the Upper-Level Curriculum	Washington 4
11 a.m.–12:48 p.m.	IE	Labs/Apparatus	Washington 5
11 a.m.–12:48 p.m.	IF	Technology for Teaching Advanced Physics	Washington 2
11 a.m.–12:48 p.m.	IG	Applications of Supercomputers in Astronomy	Maryland B
11 a.m.–12:36 p.m.	JA	H.S/ Introductory College	Maryland A
1:15–7 p.m.		AAPT Executive Board	Congressional

Monday, Feb. 15, 2010 – Session Schedule

Rooms are in the Marriott Wardman Park Hotel – Poster Session I is in Exhibit Hall, 8:30 to 10 p.m.

	Virginia B	Virginia C	Balcony A	Harding	Balcony C	Balcony D	Washington 1	Washington 2	Washington 3	Johnson	Buchanon	Jackson	Salon 3	Salon 1and 2
8:30 a.m.														*Joint Plenary with APS*
9:00 a.m.														
9:30 a.m.														
10:18 a.m.														
10:45 a.m.	**AB** Bridging the Gap in Physical Science: Teaming H.S. and K-8 Teachers	**AC** Interactive Lecture Demonstrations: Physics Suite	**AD** Astrophysics in the Classroom	**AE** SPS Undergrad Research & Outreach	**AF** National Resources for Science Education	**AA** *Panel* – International Issues in Physics Education	**AG** Teaching with Technology – I	**AH** Reforming Introductory Physics Courses for Life Science Majors – II	**AI** Physics Education Research: Topical Understanding & Attitudes					
11:00 a.m.														
11:30 a.m.														
12:00 p.m.														
12:33 p.m.	**BB** Crackerbarrel: PER Grad. Student Concerns	**BA** Crackerbarrel: Advanced Labs								**BC** Crackerbarrel: Physics & Society	**BD** Crackerbarrel: Impact of NCLB			
1:00 p.m.														
1:30 p.m.													***Awards:*** ***Phillips, Jackson, & DSC***	
2:00 p.m.														
2:30 p.m.														
3:18 p.m.														
3:30 p.m.	**CB** Unconventional Laboratories	**CC** Teacher Training/ Enhancement	**CD** TA Training: Why It Is Important and How To Do It Effectively	**CE** Physics Outreach	**CF** Things Accomplished Teachers Do in Their Classrooms	**CA** *Panel* – Information Fluency & Physics Curriculum	**FF** How To Advocate for Science	**CH** Progress in Modernizing the Large Physics Course for Engineers	**CI** Research on Student Learning in Upper-Division Courses			**CJ** Exploring the Nation's Attic	**JB** Teaching with Technology – II	
4:30 p.m.														
5:00 p.m.														
5:30 p.m.														
5:54 p.m.														
7:00 p.m.													***LaserFest Lecture:*** ***Theodore Hänsch***	
7:30 p.m.														
8:00 p.m.														
8:30 p.m.														

Tuesday, Feb. 16, 2010 – Session Schedule

Rooms are in the Marriott Wardman Park Hotel – Poster session II is in Exhibit Hall, 9 to 10:30 p.m.

	McKinley	Virginia B	Virginia C	Balcony A	Balcony B	Balcony C	Washington 1	Washington 2	Washington 3	Jackson	Buchanon	Balcony D	Salon 3	Salon 1 and 2
8:30 a.m.														*Joint Plenary with APS*
9:00 a.m.														
9:30 a.m.														
10:18 a.m.														
10:45 a.m.	**CG** *Panel* – Selling Physics Educ. Research & Education to Congress	**DB** Computational Physics in Undergrad. Curriculum	**DC** Funding Opportunities for Informal Science Education & Outreach	**DD** Classroom Activities in Particle Physics for H.S. – I	**DH** Physics Education Research (PER): Problem Solving	**DA** The Art and Science of Astronomy		**DG** Physics Education Research Around the World – I	**DF** Lecture/ Classroom					
11:00 a.m.														
11:30 a.m.														
12:00 p.m.														
12:33 p.m.		**EB** Crackerbarrel: PER Faculty Concerns	**EC** Crackerbarrel: Apparatus	**EA** Crackerbarrel: What Now?							**ED** Crackerbarrel: History of Physics			
1:00 p.m.														
1:30 p.m.													*AAPT's Teacher Education Symposium*	
2:00 p.m.														
2:30 p.m.														
3:18 p.m.														
3:30 p.m.	**FA** Art & Physics	**FB** Instructional Resources for Physics Teacher Education Programs	**FC** Particle Physics for H.S. – II	**FE** Enriching Physics in the Classroom & Beyond		**DE** *Panel* – Preparing Graduate Students for Careers in College Physics	**FH** *Joint AAPT/APS Session* on Physics & Society Education	**FI** Educational Technologies Support Physics Teaching	**FJ** Improving Physics Teaching by Studying, Thinking, & Learning in Scientific Domains	**FK** Physics Teacher's Intro to Research		**FG** NSF Course Curriculum & Laboratory Improvement		
4:30 p.m.														
5:00 p.m.			**FD** Physics Majors											
5:30 p.m.														
5:54 p.m.														
7:00 p.m.	**GA** Physics of Hobbies	**GB** Astrobiology: From Frontiers to Classroom	**GC** Using Undergrad. Students in Undergrad. Curriculum	**GD** *Panel*-Vertical Align. of Physics Conceptual Curriculum	**GE** SPS Success in TYCs & Small Departments	**GF** Teaching to Special Needs	**GG** Teaching with Technology – III	**GH** Teaching Physics Around the World – I	**GI** PER: Student Reasoning			**GJ** Upper-Level Physics		
7:30 p.m.														
8:00 p.m.														
8:48 p.m.														

Wednesday, Feb. 17, 2010 – Session Schedule

Rooms are in the Marriott Wardman Park Hotel

	Washington 1	Washington 2	Washington 3	Washington 4	Washington 5	Washington 6	Maryland B	Maryland C	Maryland A
8:00 a.m.									
8:30 a.m.	**HA** Upper Division & Graduate	**HB** Teaching Physics Around the World – II	**HC** PER: Solved Problems and Open Questions	**HD** PER in the High School	**HE** Policy and Women	**HF** New Results in Astronomy Education Research	**HG** Reflections on the Topical Conference on Advanced Laboratories	**HH** Pre-H.S Reform Curriculum for Teacher Preparation	**HI** *Panel:* Science Learning in Informal Settings
9:00 a.m.									
9:30 a.m.									
10:18 a.m.						AAPT Presidential Transfer			
11:00 a.m.	**IA** Frontiers in Astrophysics	**IF** Technology for Teaching Advanced Physics	**IC** PER: Investigating Classroom Strategies	**ID** Optics in the Upper-Level Curriculum	**IE** Labs/ Apparatus	**IB** PER Around the World – II	**IG** Applications of Supercomputers in Astronomy		**JA** H.S./ Intro. College
11:15 a.m.									
11:30 p.m.									
12:00 p.m.									
12:33 p.m.									

Workshop Abstracts

Saturday, Feb. 13 workshops

W01: Physics Teaching and the Development of Reasoning

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Research in Physics Education
Time: Saturday, 7:30 a.m.–3:30 p.m.
Member Price: $90 **Non Member Price:** $110
Location: University of the District of Columbia

Organizer: Dewey I. Dykstra, Jr., Physics Dept., MS 1570, Boise State University, Boise, ID 83725-1570; ddykstra@boisestate.edu

Co-Organizers: Robert G. Fuller, University of Nebraska-Lincoln

Tom C. Campbell, Illinois Central College

Scott M. Stevens, Carnegie Mellon University

Students come to high school and college physics with differing abilities to make sense of the phenomena of physics. Piaget and colleagues give a powerful description for this observation in terms of stages of the development of reasoning or cognitive abilities. This workshop, updated from the original AAPT 1975 workshop, will assist participants in identifying these stages of reasoning in the behavior of students in typical physics course activities. Participants will also experience and study the instructional design strategy called the learning cycle, developed by Robert Karplus, an original author of the 1975 workshop. This workshop in the late '70s was an important initial influence that ultimately resulted in the physics education research community. It is still valuable today to teachers and researchers. Participants will receive a copy of a new book, *College Teaching and the Development of Reasoning*. Lunch is included in the price of this workshop.

W02: Developing Physics Teacher Knowledge

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Apparatus
Time: Saturday, 7:30 a.m.–3:30 p.m.
Member Price: $80 **Non Member Price:** $105
Location: UDC

Organizer: Eugenia Etkina, Graduate School of Education, Rutgers University, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

Lee Shulman identified pedagogical content knowledge (PCK) as a necessary component of teacher knowledge—a blend of content and pedagogy that distinguishes the understanding of a pedagogue from that of a content expert. PCK is a very personal construct that is based on one's orientation toward teaching, which in turn shapes the knowledge and attitudes towards students' ideas, different ways to represent those ideas, assessment strategies, and effective instructional methods within a particular discipline. The combination of the objective and subjective aspects of pedagogical content knowledge makes is difficult to teach and even more difficult to evaluate. Lunch is included in the price of this workshop. What constitutes physics PCK and how can physics teachers construct and evaluate theirs? In this interactive workshop, participants will reflect on their own PCK and develop some strategies for its improvement. They will also learn about a teacher preparation program that specifically focuses on helping future teachers build their physics PCK.

W04: Physics by Design

CANCELED

Sponsor: Committee on Physics in Pre-High School Education
Time: Saturday, 7:30 a.m.–3:30 p.m.
Member Price: $95 **Non Member Price:** $120
Location: UDC

Organizer: Julia Olsen, Teaching Learning & Sociocultural Studies, University of Arizona, Tucson, AZ 85721; jkolsen@u.arizona.edu

Participants will connect their current teaching practice to a model utilizing "Understanding by Design" as a planning tool to facilitate understanding and engagement in physics/physical science classrooms. This strategy also aids in teaching classes with diverse learners. Lunch is included in the price of this workshop.

W05: Household Electricity in the Physics Classroom

Sponsor: Committee on Physics in High Schools
Time: Saturday, 7:30 a.m.–3:30 p.m.
Member Price: $115 **Non Member Price:** $140
Location: UDC

Organizer: John P. Lewis, 1420 Magnolia St., Glenview IL 60025; jlewis@glenbrook.k12.il.us

Everything you need to start a household electricity unit in your physics classroom. Participants will build a student station that will accommodate actual electrical components used in common household electric projects. The station includes a fused power supply, conduit-connected electric boxes that will simulate an actual house with actual electrical requirements. These include 2-way and 3-way switched overhead lamps, a common outlet, a complete bedroom, doorbells, thermostats and more! You'll actually bring home a brief-case-sized self-contained student station with all of the equipment to build the circuits above and plans to build similar kits for each of your lab stations. No experience necessary. We will build and assemble the stations during the morning and use them to perform the student experiments during the afternoon. The "final exam" will be building your own working lamp "from scratch." Come enjoy this totally hands-on approach to the world of household electricity. Lunch is included in the price of this workshop.

W06: Behind the Scenes at the Smithsonian

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Science Education for the Public
Time: Saturday, 9 a.m–3 p.m.
(bus leaves hotel at 8:30 a.m.)
Member Price: $45 **Non Member Price:** $70
Location: offsite

Organizer: John Roeder, The Calhoun School,433 West End Ave., New York, NY 10024212-497-6500; john.roeder@calhoun.org

Co-Organizer: William McNairy

A behind-the-scenes tour of the Air and Space Museum. See how exhibits are conceived, planned, researched, developed, and executed.

W07: Data Analysis Software, Astronomical Images and Physics Concepts

Sponsor: Committee on Space Science and Astronomy
Time: Saturday, 7:30–11:15 a.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Douglas A. Lombardi, 515 West Cheyenne, Suite D, North Las Vegas, NV 89030; dalombardi@interact.ccsd.net

Co-Organizers: Donna L Young, Pamela Perry

This workshop will use Chandra x-ray archived data of supernovae remnants, variable stars, pulsars and white dwarfs, and the Chandra ds9 image analysis software to investigate the physics of astronomical phenomena. Using ds9 analysis tools such as energy cuts, power spectra and light curves along with basic physics equations the following topics will be investigated: the distribution of elements in supernova remnants and the properties of the progenitor stars, determining if the core collapse resulted in a pulsar, magnetar or a black hole, calculation of the periodicity of two objects using centripetal acceleration and gravitational forces to determine if an object is a white dwarf or pulsar, using images and physics calculations to calculate the size, rate of expansion, and dates for supernova events. The ds9 software, tutorials, and download instructions, along with all activities are available on the Chandra education website (HTML and PDF) including pencil and paper versions.

W08: Activity-based Units for All Ages

Sponsor: Committee on Science Education for the Public
Co-sponsor: Committee on Physics in High Schools
Time: Saturday, 11:45 a.m.–3:30 p.m.
Member Price: $75 **Non Member Price:** $100
Location: UDC

Organizer: Richard Flarend, Penn State Altoona, 3000 Ivyside Park, Altoona, PA 16601; ref7@psu.edu

Co-Organizer: Alice Flarend

Looking for more activities with a solid educational content for your classroom or an outreach program? In this workshop, participants will work through sequences of hands-on connected activities covering each of the following topics: heat, sound, and electro-magnetism. Presenters have used these activities in a variety of settings including outreach programs with elementary and middle school students, high school physics classes, college physics courses for non-scientists and teacher in-services. Presenters strive to use inexpensive materials. Participants will receive sample materials for many activities and a resource CD.

W09: Ben Franklin as My Lab Partner

Sponsor: Committee on History and Philosophy in Physics
Co-sponsor: Committee on Apparatus
Time: Saturday, 11:45 a.m.–3:30 p.m.
Member Price: $50 **Non Member Price:** $75
Location: UDC

Organizer: Robert A. Morse, St. Albans School, Mount St. Albans, Washington, DC 20016; robert_morse@cathedral.org

Benjamin Franklin's experiments and observations on electricity established his reputation as a scientist, our electrical conventions and vocabulary, and the principle of charge conservation. In his letters, Franklin builds, tests, and defends his model with skill and eloquence, arguing from experiment, sharing both his wisdom and doubts, while conveying his fascination with electricity. As Franklin lacked formal schooling in mathematics, his theory was qualitative, and is an approachable example of hands-on and minds-on construction of a conceptual model with significant explanatory power. In this workshop (developed at the Wright Center for Science Teaching at Tufts University), working with Franklin's descriptions, we will recreate many of his experiments using modern, inexpensive materials. Participants will receive a kit of materials, selections from the workshop manual, and a CD-ROM containing the complete workshop manual, a collection of Franklin's letters relating to electricity, and movie clips illustrating the experiments.

W10: Condensed Lecture Demonstration Workshop

Sponsor: Committee on Apparatus, APS
Time: Saturday, 11:45 a.m.–3:30 p.m.
Member Price: $70 **Non Member Price:** $95
Location: UDC

Organizer: Dale Stille, Dept. of Physics and Astronomy, University of Iowa, Iowa City, IA 52242; dale-stille@uiowa.edu

Co-Organizer: Sam Sampere, Dept. of Physics, Syracuse University, Syracuse, NY 13244; smsamper@syr.edu

During this ½ day workshop, we will introduce you to the Physics Resource Instructional Association (PIRA and the PIRA 200. The PIRA 200 are the 200 most important and necessary demonstrations needed to teach an introductory physics course. Each demonstration has a catalog number according to the Demonstration Classification System (DCS); we will introduce you to the system used to classify these and the bibliography that details journal articles and demonstration manuals for construction and use in the classroom. We will also show subset of approximately 50 demonstrations explaining use, construction, acquisition of materials, and answer any questions in this highly interactive and dynamic environment. Ideas for organizing and building your demonstration collection will be presented. We especially invite faculty members teaching introductory physics to attend.

W24: Live Photo Physics: Video-Based Analysis Activities for the Classroom/Homework

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Physics in High Schools
Time: Saturday, 11:45 a.m.–3:30 p.m.
Member Price: $50 **Non Member Price:** $75
Location: UDC

Organizer: Priscilla W. Laws, Dickinson College, Dept. of Physics and Astronomy, Carlisle, PA 17013; lawsp@dickinson.edu

Co-Organizers: Robert Teese, Maxine Willis and Patrick Cooney

This workshop is for physics teachers who wish to explore the use of video-based motion analysis in a wide range of applications, including tutorial and collaborative problem-solving sessions, projects, and homework. Participants will learn how to make digital video clips for analysis, as well as how to use video analysis for homework problems and in the classroom. We will discuss educationally effective uses of video analysis being developed in the LivePhoto Physics project, the Workshop Physics project, and in other settings. Evaluation copies of selected digital video clips and homework assignments will be provided to the participants for their use after the workshop. The software used in this workshop is available for both Mac and Windows computers. Participants in this workshop may find that some prior, hands-on experience with basic video analysis using software such as VideoPoint or Logger Pro will be helpful but is not required. (Format: Mac/PC)

T01: Building Your Physics Course with ComPADRE

Sponsor: Committee on Educational Technologies
Time: Saturday, 1–3 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Bruce Mason, Homer L. Dodge Dept. of Physics & Astronomy, University of Oklahoma, Norman, OK 73019; bmason@ou.edu

The ComPADRE online collections of physics educational resources contain many different types of materials to enhance physics courses at all levels. They also include the tools to help members build their own personal course collections. These include personal, sharable, online filing cabinets, editorial recommendations and features, and advanced search of the library. This tutorial will explore these tools with the goal of having participants begin building their own personal collections for a course they teach. Participants wishing to engage in the online tutorial activities should bring a computer with wireless Internet capabilities. Those without computers will receive an overview of the ComPADRE collections, resources, and tools. ComPADRE, a collaboration of the AAPT, APS, and AIP, is supported by the NSF and is part of the National Science Digital Library.

W11: Research-based Alternatives to Problem Solving

Sponsor: Committee on Research in Physics Education
Time: Sunday, 8 a.m.–4:30 p.m.
Member Price: $60 **Non Member Price:** $85
Location: UDC

Organizer: Kathleen A. Harper, Dept. of Physics & Astronomy, Denison University, Granville, OH 43023; harperk@denison.edu

Co-Organizers: Thomas M. Foster and David P. Maloney

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 for use in their own classrooms.

W12: Teaching Physics for the First Time

Sponsor: Committee on Physics in High Schools
Time: Sunday, 8 a.m.–4:30 p.m.
Member Price: $90 **Non Member Price:** $115
Location: UDC

Organizer: Mary Winn, 2623 W Watrous Ave., Tampa, FL 33629; winnmmw@aol.com

Co-Organizer: Jan Mader

With the push for physics first, many middle school and high school instructors find themselves assigned to teach physical science and physics classes with little or no formal preparation in the content. *Teaching Physics for the First Time* is designed to provide a supply of lessons based on the learning cycle that are reliable and cost-effective. The labs, demonstrations, and activities emphasize the hands-on approach to learning physics concepts and include teaching strategies and address misconceptions students often have with respect to the concept. The workshop attendees will receive a copy of the book *Teaching Physics for the First Time.*

W13: Going Deep to Reach the Stars

Sponsor: Committee on Physics in High Schools
Co-sponsor: Committee on Educational Technologies
Time: Sunday, 8 a.m.–4:30 p.m.
Member Price: $80 **Non Member Price:** $105
Location: UDC

Organizer: Cathy Ezrailson, University of South Dakota, Vermillion, SD 57069; Cathy.Ezrailson@usd.edu

Co-Organizer: Peggy Norris, Sanford Underground Science Laboratory at Homestake Mine in Lead, SD; peggynorris@bhsu.edu

The Deep Underground Science and Engineering Lab, an NSF project being planned for the former Homestake gold mine in Lead, SD, will attempt to answer questions at the forefront of our knowledge of fundamental physics and the nature of the cosmos by putting large detectors a mile deep. In this workshop we will explore two of those questions: What is the nature of dark matter, and what is the nature of neutrinos? The workshop will consist of both classroom activities and material exploring these questions and how scientists hope to answer them.

W03: Using Research-based Curricula and Tools to Revitalize Your Introductory Courses

CANCELED

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Educational Technologies
Time: Sunday, 8 a.m.–4:30 p.m.
Member Price: $80 **Non Member Price:** $105
Location: UDC

Organizer: David R. Sokoloff, Dept. of Physics, University of Oregon, Eugene, OR 97403-1274; sokoloff@uoregon.edu

Co-Organizers: Ronald Thornton, Tufts University, and Priscilla Laws, Dickinson College

This hands-on workshop is designed for those who want to introduce active learning and computer tools into their introductory courses. We will introduce new approaches to teaching based on physics education research (PER) in lectures, labs, and recitations as well as studio and workshop environments. Among the approaches presented will be Interactive Lecture Demonstration (ILDs), Web-Based ILDs, RealTime Physics Labs, Activity Based Tutorials, Collaborative Problem-Solving Tutorials, Live Photo Assignments and Workshop Physics, as well as analytic modeling and video analysis tools. The computer tools used are available for both Macintosh and Windows computers. Results of studies on the effectiveness of these teaching strategies will also be presented. Current versions of the curricula, along with the book *Teaching Physics with the Physics Suite*, by E.F. Redish will be distributed. Partially supported by the National Science Foundation. Lunch is included in the price of this workshop.

W14: Using the Wii for Fun and Physics

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on Educational Technologies
Time: Sunday, 8–11:45 a.m.
Member Price: $50 **Non Member Price:** $75
Location: UDC

Organizer: Dwain Desbien, Estrella Mountain Community College, Avondale, AZ 85392; dwain.desbien@emcmail.maricopa.edu

Co-Organizer: David Weaver

More than 30 million Wii remotes have been sold and many of our students have or use them. You will learn how to use the Wiimote as a 3-axis accelerometer in the physics lab. Then, you will assemble an IR pen and use the Wiimote to create a fairly Smart Board for use in your classroom. Participants MUST bring their own Wiimote to the workshop.

W15: Ranking Tasks in Astronomy

Sponsor: Committee on Space Science and Astronomy
Time: Sunday, 8–11:45 a.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Kevin M. Lee, Dept. of Physics & Astronomy, University of Nebraska, Lincoln, NE 68588-0111; klee6@unl.edu

Co-Organizer: Edward E. Prather, University of Arizona

Ranking tasks are a powerful example of curricular materials for promoting active engagement. A ranking task provides the learner with a series of pictures or diagrams that describe several variations of a basic physical situation. The student is then asked to make a comparative judgment and rank the various situations based on some criteria. These novel and intellectually challenging tasks effectively probe student understanding at a deep conceptual level. This workshop focuses on two libraries of ranking tasks for use in introductory astronomy at either the college or high school level: 1) pencil-and-paper versions appropriate for group work in the classroom, and 2) computerized versions that contain extensive randomization and feedback.

Participants will work throughseveral ranking tasks and then discuss implementation in their own classrooms. Participants will be asked to download software and install it on a laptop which they will bring to the workshop.

W16: Equity Education "Outside the Box": Exploring Issues of Race and Gender in the Classroom Through the Lens of Privilege

CANCELED

Sponsor: Committee on Women in Physics
Co-sponsor: Committee on Minorities in Physics
Time: Sunday, 8–11:45 a.m.
Member Price: $50 **Non Member Price:** $75
Location: UDC

Organizer: Apri*el K. Hodari, 202-554-7789; hodaria@cna.org*

Co-Organizer: Melissa Dancy

Often discussions of race and gender center on the deficit model (why are "they" not succeeding, what are "they" lacking, etc.). This focus encourages solutions focused on changing "them" such as providing mentors or extra tutoring and experiences. Rarely do we examine aspects of our own privilege as educators, and how our privileges damage us and create unproductive environments in our classrooms. In this workshop we will challenge this traditional framing and consider issues of race and gender through the framing of privilege. Through activities and discussion we will explore the concept of privilege, how it plays out in the classroom, and how it can be used to rethink classroom practices. We will acknowledge and explore the emotional turbulence that the lens of privilege often creates, but focus on how we can redirect this emotional energy to empower ourselves and our students.

W17: A New Model of Instruction for the Urban Physics Classroom*

CANCELED

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Physics in Undergraduate Education
Time: Sunday, 8–11:45 a.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Mel S. Sabella, Dept. of Chemistry and Physics, Chicago State University, Chicago, IL 60628 msabella@csu.edu

Co-Organizers: Samuel Bowen, Kim Coble, Edmundo Garcia, Thomas Kuhn, Chicago State University

Anthony Escuadro, Jamie Millan, Daniel Russ, David Zoller, City Colleges of Chicago

Many PER-based materials are designed for institutions that serve largely traditional student populations in fairly rigid learning environments. The introductory physics course at the urban institution is often small, with students remaining in a single room for all components of the course (lecture, laboratory, problem-solving, etc.). Chicago State University and the City Colleges of Chicago are capitalizing on these features to create a learning environment where students continuously move back and forth between course components. To aid in the implementation of this environment, CSU is creating an Interactive Physics Workbook that provides a clear structure for the course. The workbook contains lecture notes, discussion questions, TIPERS, problem-solving tasks, and laboratories that are often broken up. The material in this workbook comes from a diverse group of collaborators. In this workshop, participants will be placed in this learning environment and will get a sense of how the various components cohere into one unit.
The workbook is a result of collaborations between New Mexico State University, California State University - Fullerton, Buffalo State University, and The Ohio State University.

*Supported by the NSF Course, Curriculum, and Laboratory Improvement Program (CCLI grants 0632563, 0618128, 410068)

W18: Designing and Implementing an Inquiry-based Physics Course for K-12 Teachers*

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Teacher Preparation
Time: Sunday, 8–11:45 a.m.
Member Price: $60 **Non Member Price:** $85
Location: UDC

Organizer: Lillian C. McDermott, University of Washington, Department of Physics, Seattle, WA 98195-1560; peg@phys.washington.edu

Laboratory-based, inquiry-oriented courses can help teachers develop the depth of understanding necessary to teach physics as a process of inquiry. For more than 30 years, the Physics Education Group at the University of Washington has been offering such courses using Physics by Inquiry, a research-validated curriculum.[1] This workshop is intended for faculty and others responsible for the preparation and professional development of K-12 teachers. Participants will have hands-on experience with the curriculum. By examining pre-test and post-test responses, participants will also gain insight into the impact of the curriculum on teacher understanding. Critical intellectual and practical issues associated with the development and implementation of such courses will be discussed.

1. *Physics by Inquiry*, L.C. McDermott and the Physics Education Group at the University of Washington, Wiley (1996).

* Supported in part by the National Science Foundation, most recently under DRK-12 grant #0733276.

W19: Using Easy Java Simulations for Physics Teaching

Sponsor: Committee on Educational Technologies
Co-sponsor: Committee on Physics in Undergraduate Education
Time: Sunday, 8–11:45 a.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Wolfgang Christian, Dept. of Physics, Davidson College, Davidson NC 28035-6926; wochristian@davidson.edu

Co-Organizer: Mario Belloni

This workshop shows how to use the open-source Easy Java Simulations (EJS) authoring and modeling tool for teaching. We will describe the simplified structure and extensive scaffolding provided by the tool to create interactive, dynamical, effective simulations and we will show how teachers can connect from EJS to national digital libraries to download hundreds of ready to use simulations. These simulations can be used for computer demonstrations or virtual laboratories in high school and undergraduate courses, or serve as programming examples and tasks for Computational Physics and higher-level students. These EJS simulations are ready to be distributed on a CD or published on a Web page as Java applets. Additional information is available at: http://www.compadre.org/osp.

Partial funding for this workshop was obtained through NSF grant DUE-0442581.

W20: Just-in-Time Teaching: Using the Web to Create an Active Learning Classroom

Sponsor: Committee on Educational Technologies
Time: Sunday, 8–11:45 a.m.
Member Price: $85 **Non Member Price:** $120
Location: UDC

Organizer: Andy Gavrin, Dept. of Physics, Indiana University Purdue University Indianapolis, Indianapolis, IN 46202; agavrin@iupui.edu

This workshop will introduce the Just-in-Time Teaching (JiTT) method, which promotes active learning in the classroom, improves student engagement and morale, and helps students stay caught up in the class. JiTT does this by establishing feedback between students' homework/study time and the time they spend in the classroom. The World Wide Web is used as a communications tool to establish this feedback. During the workshop, participants will learn what JiTT is, why it works, and how it can be implemented in a wide range of educational settings. Assessment data and techniques will also be discussed. There will be an emphasis on developing the resources to implement JiTT easily and effectively, and participants will leave the session with some material for their courses already complete. JiTT has been adopted by hundreds of faculty worldwide, in a wide range of classes in science, mathematics, and the humanities.

T02: Civic Engagement and Service Learning: The SENCER Project

CANCELED

Sponsor: Committee on Professional Concerns
Co-sponsor: Committee on Physics in Two-Year Colleges
Time: Sunday, 12:45–2:45 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Theo Koupelis, Edison State College, 8099 College Parkway SW, Fort Myers, FL 33919; tkoupelis@edison.edu

This tutorial is aimed at those interested in improving physics education within the context of civic engagement (including service learning). During the tutorial we will describe the national dissemination program SENCER—which connects science and civic engagement by teaching "through" complex, capacious, and unresolved public issues —and ways to participate in its activities. We will also discuss ways to include service learning in the physics curriculum using examples from across the country, and engage in group activities that will provide a springboard for making curricular changes that will make civic engagement an integral part of the physics curriculum.

T03: Multimedia Modern Physics for High School Teachers

Sponsor: Committee on Science Education for the Public
Time: Sunday, 12:45–2:45 p.m.
Member Price: $40 **Non Member Price:** $65
Location: UDC

Organizer: Michele McLeod, Annenberg Media, 1301 Pennsylvania Ave., NW, Suite 302, Washington, DC 20004; mmcleod@learner.org

Co-Organizer: Alex Griswold, Harvard Smithsonian Center for Astrophysics

Dark matter, string theory, and high energy particle accelerators. Do you need to be a Ph.D. from MIT to understand these things? Physics of the 21st Century, funded by Annenberg Media, is an upcoming, free, online resource covering the frontiers of physics research. Developed by the Harvard-Smithsonian Center for Astrophysics and designed by Harvard professor of astronomy and physics, Christopher Stubbs along with leading content experts, the multimedia course will connect the new ideas of contemporary physics with familiar ideas from classical physics. This workshop will introduce the course materials (to be released in fall 2010) including video profiles of research teams working on superconducting materials and the course web site. The goal of the materials is to help both teachers and the public better understand and appreciate the science behind the headlines of physics breakthroughs.

T04: Monster in the Middle

Sponsor: Committee on Space Science and Astronomy
Time: Sunday, 12:45–2:45 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Mandy Frantti, 108 W. Chocolay St., Munising, MI 49862; mpfrantti@hotmail.com

Students get excited about science when they hear "black holes." In this session we will consider different types of galaxies, the black holes at their centers, and what would happen if you "fell" into a black hole. Participants will receive materials about black holes, take part in hands-on activities, and learn interesting information that can be used in science classrooms (particularly physics and astronomy classes) to draw students into great physics topics using space as the stage. Materials are provided by NASA.

W21: Designing a Diagnostic Learning Environment: A Workshop for Teacher Educators

Sponsor: Committee on Teacher Preparation
Co-sponsor: Committee on Research in Physics Education
Time: Sunday, 12:45–4:30 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Eleanor W. Close, Dept. of Physics, Seattle Pacific University, 3307 3rd Ave., W., Ste. 307, Seattle, WA 98109; closee@spu.edu

Co-Organizers: Hunter Close, Lezlie DeWater

A diagnostic learning environment is one in which assessments are used for formative purposes. Formative assessment identifies the details of students' understanding and reasoning. This allows the teacher to address specific student ideas with targeted instruction. What does formative assessment look like and why do we think it is important? How do teacher-educators help pre-college teachers construct an understanding of what formative assessment is and how to implement it? In this workshop we will analyze video and written classroom data, diagnose student understanding of specific ideas using evidence from classrooms, and consider instructional implications. We will consider evidence of ways in which pre-college teachers understand and implement formative assessment in their classrooms. In addition, participants will learn about the Diagnoser Project's free instructional tools to help diagnose precollege student thinking and guide instructional decisions.

W22: Following Students' Learning in the PET, PSET, and LEPS Courses for Prospective Elementary Teachers*

Sponsor: Committee on Research in Physics Education
Co-sponsor: Committee on Teacher Preparation
Time: Sunday, 12:45–4:30 p.m.
Member Price: $40 **Non Member Price:** $65
Location: UDC

Organizer: Fred Goldberg, CRMSE, San Diego State University, 6475 Alvarado Rd., Ste. 206, San Diego, CA 92120619-405-5158; fgoldberg@sciences.sdsu.edu

Co-Organizers: Steve Robinson, Valerie Otero

Physics and Everyday Thinking (PET)** and Physical Science and Everyday Thinking (PSET)** are one-semester guided inquiry courses intended for prospective and practicing elementary teachers or students needing a general education science course (http://www.petpset.net). Both courses engage students in activities involving standards-based content, the nature of science, and learning about one's own learning and the learning of younger students. After providing a curricular overview, we will view video snippets of students engaged in various activities within the courses. The snippets will provide opportunities to analyze students' ideas and reasoning and discuss the roles of social interaction, laboratory experiments, computer simulations and the written curricula in promoting student learning. Finally, we will present recent work on a version of the course intended to meet similar goals in a large-enrollment format, called Learning Physical Science (LEPS).

*Supported by NSF Grants 0096856 and 0717791.

**Published by It's About Time, Herff-Jones Education Division.

W23: Tutorials in Introductory Physics*: A Research-Validated Approach to Improving Student Learning

Sponsor: Committee on Research in Physics Education
Time: Sunday, 12:45–4:30 p.m.
Member Price: $60 **Non Member Price:** $85
Location: UDC

Organizer: Lillian C. McDermott, Dept. of Physics, University of Washington, Seattle, WA 98195-1560; peg@phys.washington.edu

Tutorials in Introductory Physics[1] is a set of instructional materials intended to supplement the lecture, textbook, and laboratory of a standard calculus-based or algebra-based introductory course. The tutorials are designed to address specific conceptual and reasoning difficulties that have been identified through research. In addition to providing hands-on experience with the curriculum, the workshop will include discussions of instructional strategies and results from assessments of student learning. Important aspects related to implementation of the tutorials will be covered, including preparation of graduate teaching assistants, undergraduate peer instructors, and post-docs. Copies of *Tutorials in Introductory Physics* will be provided to participants.

1. *Tutorials in Introductory Physics*, First Ed., L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the University of Washington, Prentice Hall (2002).

* This work has been supported in part by a series of grants from the NSF, the most recent of which is CCLI grant #0618185.

W25: Laboratories with Biomedical Applications

Sponsor: Committee on Apparatus
Co-sponsor: Committee on Laboratories
Time: Sunday, 12:45–4:30 p.m.
Member Price: $55 **Non Member Price:** $80
Location: UDC

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

Co-Organizers: Dean Zollman, Sytil Murphy

There is a growing recognition of the need for laboratory activities that allow life science and biophysics students to explore and deepen their understanding of physics through such contexts as physiology, medical diagnostic and therapeutic devices, biomechanics, biological processes, and biological research techniques. Several individuals and groups who have been working independently on such laboratory activities will present examples of their labs. After an initial overview by all the presenters, participants will break into rotating groups for hands-on experience with different laboratory activities and more detailed discussion with each presenter about the pertinent pedagogy and apparatus. A flash drive with materials for all the laboratory activities will be given to the participants.

W26: TA Preparation: Challenges and Successes

CANCELED

Sponsor: Committee on Graduate Education, APS
Time: Sunday, 12:45–4:30 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Kenneth Heller, School of Physics and Astronomy, University of Minnesota, 116 Church St., SE, Minneapolis, MN 55455; heller@physics.umn.edu

Being a teaching assistant is often the first professional experience for physics students. Preparing students to be successful TAs gives them a positive attitude toward their graduate career. TA preparation and support influences how physics students interact within the department and colors their outlook towards teaching. Because TA duties usually comprise the largest single block of time for a physics student, whether graduate or undergraduate, adequate TA preparation assures that it is a productive part of their education. This workshop will explore how TA preparation programs help integrate the TA experience into the education of a physicist while facilitating the teaching of undergraduates in a physics department. Several examples of successful physics TA preparation programs will be presented and discussed. Participants will be able to discuss their goals, challenges, and constraints for TA preparation at their institution and compare with other institutions represented at the workshop.

W27: Nuclear Forensics

Sponsor: Committee on Physics in High Schools
Time: Sunday, 12:45–4:30 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: Daniel Crowe, 21326 Augusta Dr., Sterling, VA 20164; dan.crowe@loudoun.k12.va.us

Co-Organizers: Monica Plisch, Heide Doss, Cathy Mader, and Betsy Beise

Nuclear science meets CSI in this unit on nuclear forensics, intended for high school physics, chemistry, or forensics courses. A set of five lessons uses nuclear forensics scenarios to introduce nuclear science in a context that the students might find interesting. These lessons, which are flexible and designed to take up to 10 hours of class time, include background on nuclear science and case studies in which students analyze data from interdicted nuclear material. The workshop includes hands-on activities and mathematical modeling designed to develop students' critical thinking skills. The laboratory component includes detection of radiation from common materials and other sources, shielding experiments and more. Participants will be given both the student packets and teacher packets for the lessons.

W28: N-TIPERS: Research-based Conceptual Reasoning Tasks for Introductory Mechanics

Sponsor: Committee on Physics in Two-Year Colleges
Co-sponsor: Committee on Research in Physics Education
Time: Sunday, 12:45–4:30 p.m.
Member Price: $35 **Non Member Price:** $60
Location: UDC

Organizer: David Maloney, Dept. of Physics, Indiana University Purdue University -Fort Wayne, 2101 East Coliseum Blvd., Fort Wayne, IN 46805260-481-6292; maloney@ipfw.edu

Co-Organizers: Curtis Hieggelke, Joliet Junior College, and Steve Kanim, New Mexico State University

A common question instructors wrestle with is: How do I get my students to develop a strong understanding of physics? In this workshop, you will explore some new materials designed to get students to think about fundamental concepts in alternative and multiple ways to promote robust learning. Participants will work with a variety of tasks and task formats, including clickers, that require students to think about the basic physics in the domains of kinematics and dynamics, including rotational dynamics, in nonstandard ways. Participants will be given a CD with more than 400 tasks and other materials.

SUNDAY, February 14

High School Share-A-thon	5–7 p.m.	Washington 1
AAPT Council Meeting	5–6:30 p.m.	Washington 3
Opening Reception	7–9 p.m.	Exhibit Hall
"Secrecy," a film by Peter Galison & Robb Moss	9–10:30 p.m.	Park Tower 8209

Session SUN: Undergraduate Student Research and Outreach (Posters)

Location: Exhibit Hall C
Sponsor: Committee on Physics in Undergraduate Physics
Date: Sunday, Feb. 14
Time: 7–9 p.m.

Presider: Gary White

Undergraduates present posters on physics research and physics outreach efforts.

SUN01: 7–9 p.m. Hydrogen Clouds in the Galactic Plane: An Undergraduate Research Project

Kwok Cheng, Penn State University, Abington, Abington, PA 19001; ams@psu.edu*

Zuqun Li, Sarah Gearty, Ann Schmiedekamp, Penn State Abington

Sue Ann Heatherly, National Radio Astronomy Observatory, Greenbank, WV

We report on an undergraduate project to measure the velocity of hydrogen clouds in the plane of the Milky Way using the National Radio Astronomy's 40-ft. telescope in Greenbank, WV. Radiation of 21 cm wavelength was measured, and by tuning the frequency of the telescope's receiver from 1400 to 1427 MHz, Doppler shifts from the sources were obtained. At each galactic longitude measurement, several hydrogen clouds were detected. We measured 20 clouds of hydrogen gas at different Doppler velocities. Most of the clouds we detected were blue shifted, but weaker signals came from some red-shifted sources. We attempted to assign these clouds to known regions of gas in the Milky Way by using Kepler's third law and also considering the galactic rotation curve. We acknowledge the support of the National Radio Astronomy Observatory's campus in Greenbank, WV, which makes the 40-ft. radio telescope available for educational projects.

* Ann Schmiedekamp, sponsor

SUN02: 7–9 p.m. Hands-on Inquiry Science for Improving Teacher Quality and Student Achievement

Marja Copeland, Randolph College, Lynchburg, VA 24503; psheldon@randolphcollege.edu

Peggy Schimmoeller, Peter Sheldon, and Tatiana Gilstrap, Randolph College

We are creating K-8 lesson plans and content for hands-on and inquiry-based classrooms that will eliminate stereotypes that children hold about scientists and increase interest in studying science. We have been working with teachers to implement lessons in the classroom, and have been studying the effects on students' and teachers' attitudes. This ongoing research project includes a website, The new Science Teacher (http://tnst.randolphcollege.edu), that we are continuing to enhance with videos of children involved in discovery lessons that teachers can emulate in the classroom. This past summer, students involved in our week-long summer science camp were given the Draw a Scientist assessment pre- and post-test. Though there was no significant difference pre- and post-test when the drawings were analyzed, there were individual differences. Many of the children drew less stereotypical drawings at the end of the camp. In addition, the children were engaged in the activities and on-task.

SUN03: 7–9 p.m. Common Fungi Spores Investigated by Tapping Mode AFM

Brittany L. Ganther, Dept. Geology and Physics and Dept .of Biology, Lock Haven University of Pennsylvania, Lock Haven, PA 17745; bganther@lhup.edu

Ekaterina Yarunova, Barrie Overton, Indrajith C. Senevirathne

Biophysical study of biological specimens using Atomic Force Microscopy (AFM) attracts a great deal of attention due to the versatility, ability to extract diverse set of information and the image resolution acquired by the technique. Although structure, formation, and life cycle of fungal spores were deeply studied, the actual process of germination as breaking a spore's cover still remains unclear. This is tied to the spore structure and the environmental conditions. Detailed contact and taping mode Atomic Force Macroscopic (AFM) images describing the spore surface of the Phomopsis sp. (LHU15) and Hypocrea leucopus (LHU 26) species of fungi which are native to Pennsylvania are obtained. Further structural variations of spores leading to the germination will be discussed. Simple protocols to confine and observe Phomopsis sp. (LHU15) and Hypocrea leucopus (LHU26) will be also discussed. Study includes force curve measurements of the surfaces as well.

SUN04: 7–9 p.m. Angelo State SPS Outreach: West Texas Road Trip 2009

Logan Hancock, Angelo State University, San Angelo, TX 76909; bhancock@angelo.edu

Toni D. Sauncy

The Angelo State Society of Physics Students readily embraces the opportunity to give back to the community. For the past four years, the ASU Peer Pressure Team (PPT) has enhanced outreach efforts by presenting science demonstrations to elementary and junior high students in the West Texas area. The annual week-long trip involves college students seeking to inspire a younger generation about physics and science in general. The Road Trip 2009 took 14 undergraduate students on a nearly 900-mile round trip. This year, the PPT took on the issue of trying to do meaningful evaluation of the program. K-12 student participants were asked to answer two or three questions during the program by holding up "A,B,C,D" response cards; the questions were aimed at attitudes about science. Analysis of the responses has indicated that the presentation does have a desired effect on improving students' attitudes. Overall, other unsolicited responses from the students, teachers, and administrators have been overwhelmingly positive.

SUN05: 7–9 p.m. The Annual Pumpkin Drop at California State University, Chico

CANCELED

David T. Kagan, California State University, Chico, Chico, CA 95929-0202; dkagan@csuchico.edu

For more than 20 years, the Society of Physics Students at California State University, Chico have presented the Annual Pumpkin Drop to hundreds of members of the campus community and local school children. Legend has it that Galileo Galilei demonstrated his Law of Falling Bodies by climbing to the top of the Tower of Pisa so that he could drop a large ball and a small ball at the same time. Both balls hit the ground together, and his law was demonstrated. SPS members re-enact this great moment in the history of science, using pumpkins. The character of Albert Einstein is the master of ceremonies while Aristotle, Galileo and Sir Isaac Newton each explain their contribution to the theory of gravity. For a grand finale, the event presenters use Galileo's Law of Falling Bodies to drop pumpkins in time to the cannon blasts of Tchaikovsky's "1812 Overture."

http://phys.csuchico.edu/sps/activities/pumpkin_drop/

SUN06: 7–9 p.m. Through Time with Galileo: The 2009 SPS Outreach Catalyst Kit

Mary E. Mills, Miami University and the Society of Physics Students, Oxford, OH 45056; millsme2@muohio.edu

This is the eighth year for the Society of Physics Students Outreach Catalyst Kit (SOCK) Program. With 2009 being the International Year of Astronomy, this year's topic is Galileo and it celebrates not only his discoveries in astronomy, but also some of his other physics experiments. The SOCK features lessons on building a refracting telescope, racing household items down an incline plane, and fun with moon craters. Other demonstrations include day and night observations with a Galileoscope, instructions to build a water clock, and many other topics. If your chapter is interested in getting a SOCK, please contact me directly or the SPS National Office.

SUN07: 7–9 p.m. AFM of the Self-Assembled Ag Nanodots on Indoped Si(100)

Matthew A. Pautz, Dept. of Geology and Physics, Lock Haven University of Pennsylvania, Lock Haven, PA 17745; mpautz@lhup.edu

Jeffrey M. Parks, Bucknell University

Anura U. Goonewardene, Indrajith C. Senevirathne, Lock Haven University of Pennsylvania

Surface-bound nanostructures are getting increased attention due to a multitude of possible applications. Self assembly is an important bottom-up design approach in making epitaxial nanostructures, hence investigating dynamical formation and stability is very important. Structure and morphology of the self-assembled of Ag nano dots (having deformed spherical shape) via sputter deposition on the chemically cleaned ambient undoped Si(100) wafer at RT (about 300K) is observed via contact mode and tapping mode Atomic Force Microcopy (AFM). Formation and size effects of these nanodots are studied against varying coverage, varying deposition rate and finally against differing annealing temperatures (annealed up to 573K for 5 min). The structure and morphology at each case is studied revealing a new triangular phase, coexisting with the nanodot phase. System will be modeled considering surface free energies of the constituents. Force measurements are also carried out on the system which will be discussed.

SUN08: 7–9 p.m. STM of Self-Assembled Nano Layered Ag Structures on HOPG

Matthew A. Pautz, Dept. of Geology and Physics, Lock Haven University of Pennsylvania, Lock Haven, PA 17745; mpautz@lhup.edu

Jeffrey M. Parks, Bucknell University

Anura U. Goonewardene and Indrajith C. Senevirathne, Lock Haven University of Pennsylvania

Conductive and semi-conductive epitaxial nanostructures have various technological applications. Self assembly is an important bottom-up design approach in making epitaxial nanostructures, hence investigating dynamical formation and stability is very important. Structure and morphology of the novel self-assembled of layered Ag nano structures via sputter deposition on the clean, freshly cleaved HOPG (Highly Oriented Pyrolitic Graphite), at RT (about 300K) is observed via STM (Scanning Tunneling Microscopy). Formation and size effects of these layered nano structures are studied against varying coverage, varying deposition rate and finally against differing annealing temperatures (annealed up to 573K for 5 min). The structure/ morphology and surface band structure at each case is studied. System will be modeled considering surface free energies of the constituents. Conductive and semi-conductive epitaxial nanostructures have various technological applications. Self assembly is an important bottom-up design approach in making epitaxial nanostructures, hence investigating dynamical formation and stability is very important. Structure and morphology of the novel self-assembled of layered Ag nano structures via sputter deposition on the clean, freshly cleaved HOPG (Highly Oriented Pyrolitic Graphite), at RT (about 300K) is observed via STM (Scanning Tunneling Microscopy). Formation and size effects of these layered nano structures are studied against varying coverage, varying deposition rate and finally against differing annealing temperatures (annealed up to 573K for 5 min). The structure/ morphology and surface band structure at each case is studied. System will be modeled considering surface free energies of the constituents.

SUN09: 7–9 p.m. An Unconventional Way To Learn: The Physics Behind Rolling*

Erica P. Watkins, Chicago State University, Chicago, IL 60628; ericapwatkins87@yahoo.com

Mary M. Mills, Miami University

Scott A. Stacy, Texas Christian University

Gary White and Kendra Rand, SPS

Despite its scarcity in traditional physics texts, the science of rolling has a long history that dates back to 1602 when Galileo Galilei studied in Pisa, Tuscany.[1] Galileo rolled a sphere down an inclined plane to determine an object's acceleration due to gravity. The Society of Physics Students (SPS) has begun a major data-collection experiment to see if the theories of rolling objects actually match reality. Through an engaging competition where students race an assortment of household items, SPS has tested how concepts about rolling objects are formed amongst elementary school students. This unorthodox experiment has been used as a basis for a complete lesson plan that can be adjusted to accommodate grade levels from elementary to high school. The lesson concentrates on topics such as acceleration and its relationship to hollow and solid items, and rotational and translational energy, the work energy theorem, moments of inertia, and angular momentum.

Funded by Society of Physics Students

1. Groleau, Rick, "His Experiments;" Public Broadcasting Service (PBS). http://www.pbs.org/wgbh/nova/galileo/experiments.html. (2002).

SUN10: 7–9 p.m. Polar Light – Exploration and Revelation After the Course of the Introduction to Bilingual Physics

Heng Yang, Southeast University, Nanjing, China; ya_ya_hei90@126.com

Qianqian Chen, Sha Xia

The myths and legends were summarized along with a historical retrospect of the development of human beings' knowledge about aurora. Compared with neon lights, the formation of aurora was explored, the mystery of its beautiful color revealed, and the suitable sites for observation suggested. As the result, the high-energy electrons of aurora are meaningful for everyday life; hence the importance of further research.

SUN11: 7–9 p.m. Investigation of Ferromagnetism in Germanium Thin Film Structures

J.T. Mlack, Trinity College Dublin and Drexel University, Ashtabula, OH 44004; jerome.mlack@drexel.edu

Z. Diao, P. Stamenov, J. M. D. Coey

The realization of magnetic semiconductors, combining the properties of ferromagnetic and semiconductor materials, is important to fields such as spintronics. One reason for this is that such materials provide a greater compatibility with our silicon-based technology. Work has shown that germanium can be made ferromagnetic by forming it into a quantum dot lattice. [1] We present the results of experiments that attempted to reproduce the original work.

1. Y. Liou and Y. L. Shen, Adv. Mater., 20, 779 (2008)

SUN12: 7–9 p.m. Measurement of Faraday Effect in Flint Glass - SF-59

Luis Herrera, Chemistry and Physics Dept., University of Tennessee at Martin, Martin, TN 38238; mgetaneh@utm.edu

The effect of magnetic field in the propagation of red laser beam in flint glass is investigated. A plane polarized laser beam with wavelength of 650 nm is propagated along a 10-cm long flint glass (SF-59) rod which is placed along the axis of a solenoid. The beam is subjected to increasing axial magnetic field produced by externally controlled current in the solenoid. An analyzer and a detector system placed at the exit of the beam at the other end of the glass rod shows that the plane of polarization of the beam is rotated, confirming the well known Faraday Effect. The amount of rotation is directly proportional to the magnitude of the magnetic field. The Verdet constant for flint glass (SF-59) is determined from the measurements and it is in very good agreement with other reported values.

SUN13: 7–9 p.m. The Science Forest

Rebecca Orcutt, University of Northern Colorado, Greeley, CO 80639; Orcu4771@unco.edu

Sage Andorka

Traditionally science has been approached as the individual disciplines of Earth Science, Biology, Chemistry, and Physics. While this approach is acceptable for conveying fundamental concepts, problems arise in higher education because there is a lack of understating of how the disciplines overlap. The perception that the disciplines of science overlap and build off each other needs to be addressed in lower education. Our educational model proposes a new approach to science education from the elementary level through college. It begins with building a foundation of Science Inquiry and getting students to start asking why. In middle school, the individual disciplines are introduced. High school brings more depth to the individual disciplines, but introduces the idea that these individual disciplines relate to each other. College continues this push to greater interdisciplinary work.

MONDAY, February 15

First Timers' Gathering	7:30–8:30 a.m.	Virginia B
Spouses' Gathering	9–10 a.m.	Thomas Paine
Exhibit Show	10 a.m.–6 p.m.	Exhibit Hall
AAPT Awards	1:30 p.m.	Salon 3
APS/AAPT Job Fair	10 a.m.–5 p.m.	Exhibit Hall

Joint APS/AAPT Plenary

Location: Salon 1 and 2
Date: Monday, Feb. 15
Time: 8:30–10:18 a.m.

Session Chair: Barry C. Barish (Caltech)

Speakers:

A Space Program Worthy of a Great Nation: Norman R. Augustine (Retired Chairman and CEO, Lockheed Martin Corp.)

Nucleon Spin Puzzle: Naomi Makins (University of Illinois, Urbana-Champaign)

Surface Temperature Responses to Natural and Anthropogenic Influences: Past, Present and Future: Judith Lean (Naval Research Laboratory)

Session AA: Panel – International Issues in Physics Education

Location: Balcony D
Sponsor: Committee on International Physics Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Lei Bao

Panel speakers include:
Yuying Guo of Beijing Normal University,
Dewey Dykstra of Boise State University, and
Pratibha Jolly of the University of Delhi

Session AB: Bridging the Gap in Physical Science – Teaming H.S. Teachers and K-8 Teachers

Location: Virginia B
Sponsor: Committee on Physics in High Schools
Cosponsor: Committee on Physics in Pre-High School Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:21 p.m.

Presider: Jan Mader

With the push to evaluate science education in the elementary schools and produce vertically aligned curricula, more districts are teaming elementary through high school teachers. These teams are designed to increase content knowledge in the elementary grades and apply teaching strategies that work with all ages of children. This invited and contributed session will present strategies that work and areas of concern as districts and teachers strive to meet NCLB benchmarks and standards.

AB01: 10:45–11:21 a.m. Do You Have What It Takes?

Invited – Karen Jo Matsler, E. A. T. Inc., 3743 Hollow Creek, Arlington, TX 76001; kjmatsler@gmail.com

Participants of the Texas Tech Rural PTRA Institute were required to instruct mini-sessions to peers who had not experienced the week-long training. This enabled the participants to apply their newly acquired content knowledge and pedagogy with peers prior to instructing their students. The success of the collaboration of the National PTRA trainers, institute participants, and local educators impacted K-12 classroom instruction.

AB02: 11:21–11:57 a.m. Specially Designed Training for Texas Teachers: A Different Model

Invited – Tom O'Kuma, Lee College, Baytown, TX 77520; tokuma@lee.edu

Janie Head, Foster High School, Richmond, TX

To disseminate physics and physical science content knowledge and pedagogy to a diverse student population, Texas utilizes AAPT/PTRA in-service centers. This model has been used successfully for three years across the state. A description of this process and its evolvement will be presented.

AB03: 11:57 a.m.– 12:09 p.m. Taking PIE into Overdrive

Laura M. Akesson, Mills E. Godwin High School, Richmond, VA 23225; laura.akesson@gmail.com

Improving elementary science education through collaboration between elementary and secondary science teachers has been effective in the Physics is Elementary (PIE) program. Teachers worked together to develop hands-on and active learning lessons that met grades 4 and five physics-based SOL objectives. Secondary teachers brought activity ideas, a depth of knowledge, and passion for the content, while elementary teachers also shared activity ideas and contributed knowledge of age-appropriate and effective teaching methods for the elementary school classroom. Participants in the monthly workshops (complete program, five workshops) were provided classroom materials, recertification points, stipends, and a "vertical" network of support that included connections with local universities. This successful template has been expanded in Science Overdrive. This organization will include all elementary and middle school grades, as well as address SOL objectives related to mathematics, chemistry, and biology concepts. It is a model that works, is rewarding, and is necessary.

AB04: 12:09–12:21 p.m. Simplifying Physics for Elementary Teachers

Jeffrey S. Elmer, Oshkosh North High School, Oshkosh, WI 54901; delmer1@new.rr.com

Many elementary teachers feel ill prepared to teach physics-related topics in their curriculum as stipulated by state and local standards. The issue of lack of formal training in physics is further compounded by the fact that most elementary teachers are required to teach multiple subject areas each day, leaving little time to adequately research and prepare appropriate, inquiry-based, best practice, physics activities. To address this concern in the Oshkosh Area School District in Oshkosh, WI, a team of elementary teachers met with physics teachers to review content standards being taught, address the necessary content knowledge needed by teachers, and develop low-cost, hands on, inquiry-based activities. Four collaboration sessions were established in which elementary teachers would learn physics content, construct apparatus, and receive training in apparatus implementation. The collaboration process resulted in increased confidence of elementary teachers, while ensuring a consistent, district-wide approach to physics concepts.

Session AC: Interactive Lecture Demonstrations: Physics Suite Materials that Enhance Learning in Lecture

Location: Virginia C
Sponsor: Committee on Research in Physics Education
Cosponsors: Committee on Educational Technologies, APS Forum on Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Priscilla Laws

The results of physics education research and the availability of microcomputer-based tools have led to the development of the activity-based Physics Suite. 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). This session should be of special interest to teachers of large lecture classes as well as those who teach small classes where only one computer is available. This session will begin with an update on Interactive Lecture Demonstrations (ILDs), followed by contributed papers on their use at a variety of institutions.

AC01: 10:45–11:21 a.m. Interactive Lecture Demonstrations: Active Learning in Lecture

Invited – David R. Sokoloff, University of Oregon, 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 like 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] The demonstrations will be drawn from second-semester topics.

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).

AC02: 11:21–11:57 a.m. Interactive Lecture Demonstrations: Effectiveness in Teaching Concepts

Invited – Ronald K. Thornton, Center for Science and Math Teaching, Tufts University, Medford, MA 02155; csmt@tufts.edu

David R. Sokoloff, University of Oregon

The effectiveness of Interactive Lecture Demonstrations in teaching physics concepts has been studied using physics education research based, multiple choice conceptual evaluations.[1] Results of such studies will be presented. These results should be encouraging to those who wish to improve conceptual learning in lecture.

1. David R. Sokoloff and Ronald K. Thornton, "Using Interactive Lecture Demonstrations to Create an Active Learning Environment," *Phys. Teach.* **35** 6, 340 (1997).

AC03: 11:57 a.m.–12:33 p.m. Implementation of ILDs in an Engineering School in Chile

Olivier Espinosa, Universidad Tecnica Federico Santa Maria, Valparaiso, Chile; olivier.espinosa@usm.cl

Pedro Del Canto, Patricio Astorga

We report on the learning results obtained from the implementation of a subset of the Interactive Lecture Demonstrations, developed by Sokoloff and Thornton, to a group of about 150 first-year engineering students taking a standard introductory calculus-based mechanics course. The ILDs were used in four out of the 15 sections of the course. Additionally, about 200 students from all 15 sections participated in University of Washington Tutorials in Introductory Physics, which were carried out in recitation sessions outside class. The learning gain was measured through the FMCE, taken as pre- and post-test by about 540 students out of the 830 registered. The overall average score in the pretest was 49.9. The normalized gains in the FMCE were: 0.65 for students that did both ILD and Tutorials, 0.52 for students that did one but not the other, and 0.42 for students that did neither.

Session AD: Astrophysics in the Classroom

Location: Balcony A
Sponsor: Committee on Space Science and Astronomy
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: L. Todd Brown

This session will feature speakers relating their techniques, tools, and teaching methods used in engaging students in areas of astrophysics. The students' age groups can vary from elementary through undergraduate.

AD01: 10:45–11:21 a.m. Astrophysics in the Classroom Using CPEP Materials

Invited – Samuel Lightner, Contemporary Physics Education Project, 139 Cobbs Way, Aiken, SC 29803; lightner@westminster.edu

Since 1989 the Contemporary Physics Education Project (CPEP), a nonprofit volunteer organization of scientists and educators, has been developing materials for high school and college on contemporary topics such as particle physics, plasma and fusion science, nuclear science, and cosmology. (See www.cpepweb.org) This talk will highlight many of these materials and supplementary activities that relate directly and indirectly to astrophysics. Samples of CPEP posters and activities will be available to attendees.

AD02: 11:21–11:57 a.m. NASA's Space-Weather Action-Center: Educational Technology to Engage Teachers and Students

Invited – Troy Cline, Goddard Space Flight Center, Greenbelt, MD 20771; troy.cline@rcn.com

I will stress the importance of seeking-out and integrating current educational technology practices and resources that effectively enhance the abilities of students. I will show how basic problem solving and data-driven decision making can have a significant impact on how students collect, analyze, and communicate today's science. A wide range of suggested educational technology applications and successful classroom approaches will be shared including the Space Weather Action Center, the Sun-Earth Media Viewer, and NASA's International Sun-Earth Day program. The Space Weather Action Center is a cutting-edge program that teaches children and parents how to observe, collect, and analyze data on solar activity and its impact on Earth. With inexpensive and easily maintained equipment, they can communicate their ongoing results via written, audio and/or video reports and/or presentations. These reports and presentations can be shared locally, regionally and/or nationally as audio/video podcasts and distance learning broadcasts.

AD03: 11:57 a.m.–12:09 p.m. Remote Observing Telescopes for the Classroom and Student Projects

Mary Ann Kadooka, University of Hawaii Institute for Astronomy, Honolulu, HI 96822; kadooka@ifa.hawaii.edu

James D. Armstrong, Michael Nassir

Research in astronomy and astrobiology, the search for life in the universe, are both appealing and motivating fields and require the use of technology. The Internet has been a valuable resource for remote observing telescopes. Becoming increasingly popular in Hawaii, the 2.0-meter Faulkes Telescope has been used by students for their projects on extrasolar planets and asteroids. Located at Halealaka Observatories, Maui, this telescope is owned by Las Cumbres Observatory Global Telescope network. They are installing more educational telescopes throughout the world. The remote DeKalb Observatory telescope in Indiana has allowed Hawaiian students to do observing in the afternoon due to the time difference. Technology literacy has played a critical role in students' ability to learn remote observing and conduct research. Our international collaborations for joint projects and challenges such as school firewalls will be discussed.

AD04: 12:09–12:21 p.m. Decades of Dark Matter and Dark Energy in Intro Astronomy

Curt W. Foltz, Marshall University, Huntington, WV 25701; foltzc@marshall.edu

Dark Matter has been a topic in Introductory astronomy textbooks for several decades. Their treatment of the topic, contrasted with physically meaningful models, shows that most authors do not expect students to understand basic concepts (underlying orbital motion, for example). Alternate treatments will be suggested to illuminate these concepts with more realistic models. In contrast, Dark Energy has been a topic for only one decade, and its treatment shows much less uniformity among introductory textbook authors.

AD05: 12:21–12:33 p.m. Great Expectations, Great Results

Gillian Winters, Smithtown High School East, Smithtown, NY 11780; gillian_winters@yahoo.com

Helio Takai, Brookhaven National Laboratory

Faced with five weeks of school after the final AP Physics exam, a class of 12th-grade students learned enough of the R statistical package to analyze real-world radar data of meteors. This research-level project was simple enough for a class of physics students to complete at the end of their senior year, but complex enough to hold their attention. The students, most with no prior knowledge of computer programming, learned basics of the open sourced R statistical package, and then applied their newly learned programming skills to determine meteor signal duration, an indication of the type of meteor detected. They also derived a histogram of numbers of meteors per hour over a 24-hour period, finding a clearly cyclical relationship, and then discussed the significance of their findings.

Session AE: SPS Undergraduate Research and Outreach

Location: Harding
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Gary White

Undergraduates contribute oral presentations on physics research and physics outreach efforts.

AE01: 10:45–10:57 a.m. Data Acquisition System for Muon Detectors at CSU

Macario Cervantes, Dept. of Physics and Chemistry, Chicago State University, 9501 S. King Drive SCI 309, Chicago, IL 60628; mcervantes358@yahoo.com*

Melissa Rangel, Marianela Perales, Jamall Davis, Edmundo Garcia,

I am participating in research related to the flow measurement of cosmic rays. Cosmic rays are high-energy particles that arrive to the Earth from the Sun or from other objects in outer space. When the cosmic rays interact with the Earth's atmosphere, collisions occur, particle showers are created, and the surviving particles that reach the surface are mouns. There are many applications to the measurement of muons, from helping us to understand stellar events (Sun activity, galactic jets, and gamma-ray burst) to practical applications such as scanning international shipments for hidden heavy cargo. My participation in this research includes the development of a CAMAC data acquisition system (DAQ) based on LabView. The DAQ consists of discriminators, registers, an ADC, and a TDC. In this talk, I will present some of the moun measurements that we have made and a description of the CAMAC DAQ that I am developing.

*Sponsor: Mel Sabella & Edmundo Garcia

AE02: 10:57–11:09 a.m. Muon Detector Simulation

Marianela Perales, Department of Physics and Chemistry, Chicago State University, 9501 S. King Drive SCI 309, Chicago, IL 60628; mperales@csu.edu*

Melissa Rangel, Macario Cervantes, Jamall Davis, and Edmundo Garcia, Chicago State University

I am involved in the study of cosmic rays. Cosmic rays are energetic particles that are mainly composed of high-energy protons. These rays originate in outer space and reach the Earth's atmosphere. When they collide with the atmosphere's molecules, they produce "particle showers." The surviving particles that reach the Earth's surface are neutrinos and muons. These muons can be measured on the ground for different purposes. My main objective in this research is to study the absorption of muons in different materials, and to study the response of the muon detectors. I had to first learn how to use Unix and Ubuntu. Then I was able to use GEANT 4, a program that simulates the response of particles through matter, which required my proficiency in C++. In this talk we will present some of the muon measurements and the preliminary results from the simulations.

*Sponsor: Mel Sabella & Edmundo Garcia

AE03 11:09–11:21 a.m. Cathode Interface Studies of Polymer Light Emitting Devices

Stephen Swiontek, Lock Haven University of Pennsylvania, 104 W. Water Street, Lock Haven, PA 17745; sswionte@lhup.edu*

Marian B. Tzolov, Lock Haven University of Pennsylvania

Efficient injection of charge carriers is a key factor for successful operation of any electronic device and especially of devices with noncrystalline or wide band-gap active material. Our study concentrates on the cathode interface of light-emitting devices with a conjugated polymer as light emitter. We apply two principally different methods for the cathode deposition—physical and chemical—in order to fundamentally understand if in addition to the commonly accepted notion for the matching of the work functions also material modification takes place. The completed devices are studies by steady-state electrical measurements, impedance spectroscopy, current and emission lifetime measurements, and electroluminescence spectroscopy. The morphology of the cathodes is studied by Scanning Electron Microscopy and the formation of additional phases by Energy Dispersive X-ray Spectroscopy. The results help to define ways for more cost-efficient fabrication of light emitting devices with applications in displays, electronic newspapers, room illumination, etc.

*Sponsor: Marian Tzolov

AE04: 11:21–11:33 a.m. Titania Films for Dye Sensitized Solar Cells

Christopher Grablutz, Lock Haven University of Pennsylvania, Lock Haven, PA 17745; cgrablut@lhup.edu*

Marian B. Tzolov, Lock Haven University of Pennsylvania

Dye sensitized solar cells are a relatively new concept for photovoltaic conversion of solar energy — a very successful concept due to the commercialization that is ongoing in several countries around the world. Despite this, there are number of open technological and fundamental problems. Titanium dioxide paste has been used since the very inception of the idea and, although significantly improved, it is still not clear in detail how it successfully satisfies the contradictory requirements for good charge collection and for highly developed surface as a host for the sensitizing dye. We will present our results in a very reproducible and effective way of producing titania paste. The Scanning Electron Microscopy images show very homogeneous dispersion of the titania nanoparticles. The steady state electrical and photoelectrical measurements, together with impedance spectroscopy and photocurrent time response experiments, were correlated with the morphology of the titania films.

*Sponsor: Marian Tzolov

AE05: 11:33–11:45 a.m. Study of Structural, Electronic, and Magnetic Properties of Nanostructures Formed by Microbeads

Laxmidhar Senapati, Lock Haven University of Pennsylvania, Lock Haven, PA 17705; lsenapat@lhup.edu

Jacob Cox and Austin Mohney, Lock Haven University of Pennsylvania

The field of "nano electronics" offers one possible solution to the problems faced by silicon technology as device miniaturization continues into the nanoscale regime. Although still limited to laboratory experiments, some remarkable achievements have already been demonstrated. Most of these rely on the charge of the electron for their functionality. The charge of an electron is a robust property and can often be well described using the relatively simple equations of semi-classical physics and experiments. But the ability to manipulate the spin of the electron offers a new dimension to conventional charge-modulated electronics—from both fundamental and technological points of view. When magnetic structures are shrunk to nanoscale, quantum effects such as spin become very predominate. Study of such nanostructures and its quantum properties is of great interest from technological and fundamental point. We will present the study of metal nanostructures made using microbeads of polystyrene of various sizes.

AE06: 11:45–11:57 a.m. Spectroscopic Ellipsometry: Multilayer and Porous Structures

Steven R. Jackson, Angelo State University, San Angelo, TX 76909; sjackson@angelo.edu*

Kunal Bhatnagar and Toni D Sauncy, Angelo State University

Due to its non-destructive nature, spectroscopic ellipsometry has become commonplace in the semiconductor industry as a widely used thin film characterization technique. This model-dependent technique exploits polarization states of light to study the structures and compositions of thin films ranging in thickness from just a few angstroms to several microns. In this study, three multi-layered MBE-grown thin film stacks were characterized over a spectral range of 2.0-5.0eV along with the irregular structures of a series of stain-etched porous silicon thin film layers. By using a novel modeling technique, the pore size and distribution was determined and correlated with surface resistivity and Raman measurements of the same structures.

*Sponsor: Toni Sauncy

AE07: 11:57 a.m.–12:09 p.m. Stability of Long-Range Wave Propagation

Elizabeth Bernhardt, St. Catherine University, St. Paul, MN 55105; eabernhardt@stkate.edu*

Steven Tomsovic, Katherine Hegewisch, Erick Agrimson, St. Catherine University

We present an exploration of the stability of long-range wave propagation through random media. As a ray travels through a medium, it encounters variations that cause slight changes in velocity. Over long ranges, these variations cause the ray to become chaotic. In order to determine the behavior of the ray, the evolution of its stability matrix must be studied. Through creation of an adaptive step-size Runge-Kutta differential equations solver, the stability matrices of several thousand rays were examined to determine the transition time between stable propagation and chaos. Results suggest that the timing of the transition is dependent on the initial kinetic energy in proportion to the average maxima and minima of the randomized plane potential. We would like to understand if rays with larger initial momentum tend to chaos as fast as rays with lower initial momentum.

*Sponsor: Erick Agrimson

AE08: 12:09–12:21 p.m. Zinc Oxide Nanostructure Grown by Chemical Vapor Transport

Bradley D. Golder, Lock Haven University of Pennsylvania, Lock Haven, PA 17745; bgolder@lhup.edu*

Marian B. Tzolov, Lock Haven University of Pennsylvania

ZnO is a versatile platform thanks to the unique combination of optical, semiconducting, and piezoelectric properties of ZnO. We have grown zinc oxide nanostructures by chemical vapor transport. The formation of the nanoparticles was studied by Scanning Electron Microscopy and the incorporation of impurities by Energy Dispersive X-Ray Spectroscopy. The photoluminescence spectra were used to quantify the presence of electronic defects and this was related to the parameters of the deposition process. The electrical conductivity along the nanorods was investigated together with the sensitivity to different gas environment. This way the applicability of the synthesized nanostructures for gas detection was evaluated.

*Sponsor: Marian Tzolov

AE09: 12:21–12:33 p.m. ZnO Thin Films and Nano-Whiskers via Thermal Oxidation of Zinc

Mario R. Jones, Longwood University, Farmville, VA 23909; mario.jones@live.longwood.edu*

Scidney A. Morris and James C. Moore, Longwood University

We have grown thin layers of zinc oxide (ZnO) via thermal oxidation of dc sputtered Zn-metal films on glass. We found that variations in the annealing temperature result in differences in the visual appearance. Films appear metallic, translucent, or transparent when annealed for several hours at room temperature, 300 C, and 600 C, respectively. Atomic force microscopy (AFM) images show a uniform distribution of protrusions approximately 200 nm in diameter for the un-annealed Zn film. When annealed at 300 C for 1 hour, a similar morphology is seen, though a bunching of protrusions is observed. At 600 C, tall nano-scale "whiskers" are seen. X-ray diffraction spectra indicate that annealed Zn-films transform into polycrystalline ZnO with the Wurtzite structure. At low temperature, zinc remnants are still observed, whereas at high temperature they are not. Zinc oxide films and nanostructures have attracted interest as potential materials for optoelectronic devices operating in the blue-ultraviolet.

*Sponsor: James C. Moore.

Session AF: National Resources for Science Education

Location: Balcony C
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Patricia Sievert

This session will present resources available to science educators from the national level.

AF01: 10:45–11:21 a.m. Resources from the Koshland Science Museum of the NAS

Invited – Erika Shugart, Marian Koshland Science Museum of the National Academy of Sciences, Washignton, DC 20001; eshugart@nas.edu*

The Marian Koshland Science Museum of the National Academy of Sciences offers a unique, standards-based approach to learning. Whether you are planning to visit the museum or looking for activities to use in your classroom, the museum's activities will engage and challenge your students to think critically about scientific issues. Come on a tour of activities focused on topics such as energy use or global climate change. For more information visit: www.koshland-science.org.

*Sponsor: Julia Olsen

AF02: 11:21–11:57 a.m. High School Student Research at the Carnegie Institution of Washington

Invited – Stephen A. Gramsch, Geophysical Laboratory, Carnegie Institution of Washington, Washington, DC 20015; s.gramsch@gl.ciw.edu*

Hosting high school students from the Washington, D.C. area for an intensive summer research experience is an important part of the outreach program of the Carnegie Institution. Both the Geophysical Laboratory and the Department of Terrestrial Magnetism have been active in recent years in mentoring high school students. Students have participated substantively in ongoing projects such as the preparative chemistry of inorganic crystalline solids, high-pressure chemistry of hydrogen storage materials, elemental superconductivity, seismology, and astronomy, with several of the students completing work at Carnegie earning awards in national science competitions. Some of the results of recent student work will be discussed, along with the broader scientific mission and research directions of the Carnegie Institution.

*Sponsor: David Sokoloff

AF03: 11:57 a.m.–12:33 p.m. Support for Pre-Secondary STEM Education at the Smithsonian Institution's National Air and Space Museum

Invited – Steven H. Williams, National Air and Space Museum, Smithsonian Institution, Washington, DC 20013-7012; williamssh@si.edu*

Aviation and space-related education supplement topics/materials are among the most universally engaging ones available to pre-secondary educators and learners of all ages. The Smithsonian's National Air and Space Museum uses that attractive value to good advantage by offering a variety of in-museum and classroom learning opportunities. Outreach programming, such as our "Kites, Wings, and Flying Things" interactive videoconference program, leverages the overall educational benefit, and has proved quite popular with grades 3-5 and older school audiences; see: http://www.nasm.si.edu/education for program details and access/reservation information. From that website, teaching posters and similar materials are available for download, and online activities and archived electronic field trips are accessible. NASM also offers professional development workshops and materials for K-12 teachers.

*Sponsor: Julia Olsen

Session AG: Teaching with Technology – I

Location: Washington I
Sponsor: Committee on Educational Technologies
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Taha Mzoughi

As technology changes, we find new ways to implement it in our classrooms. Technologies can help improve learning, can help enliven the classroom and make it more relevant and engaging, and can help teachers facilitate learning or manage classroom tasks more efficiently.

AG01: 10:45–10:57 a.m. Using WebAssign To Enhance the Undergraduate Laboratory Experience

John Risley, North Carolina State Univ/WebAssign, Raleigh, NC 27606; risley@webassign.net

Prabha Ramakrishnan and Michelle Snyder, North Carolina State University

N.C. State has been using WebAssign for online homework delivery in the lecture courses, and recently has begun integrating WebAssign into the laboratory. By using pre-lab assignments to gauge student practical and conceptual understanding, we have been able to utilize more quality time to actually perform the experiment. We also use WebAssign's data analysis tools to collect and report data and a post-lab assignment to measure student knowledge. The results have been a more consistent lab experience for our many teaching assistants, a more standardized grading structure for the lab, and a more engaging experience for our students.

AG02: 10:57–11:09 a.m. Extending Just-in-Time Teaching by Way of Worked Examples

Gregor M. Novak, U.S. Air Force Academy, USAF Academy, CO 80840-6299; gnovak@iupui.edu

Robert H. Lee, U.S. Air Force Academy

Just-in-Time Teaching, JiTT, is a web-based pedagogy where pre-class assignments prepare students for follow-up classroom activities. At the Air Fore Academy we are experimenting with a substantial extension of JiTT, modeled on the worked-examples self-explanation approaches.[1,2] New material is introduced via carefully crafted worked examples. Students study examples, answer questions in writing, and prepare their own questions to ask in class. Student answers are discussed and extended in class, bringing into focus the underlying concepts. In this talk we describe the resources we have developed and report on some assessment results.

1. Atkinson, R.K., et al., "Learning from Examples: Instructional Principles from the Worked Examples Research," *Review of Educational Research* **70**(2), 181-214 (2000).

2. Chi, M. T. H., & Bassok, M., Learning from Examples via Self-explanations. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 251-282). (Hillsdale, NJ, Erlbaum, 1989)

AG03: 11:09–11:21 a.m. Enhancing Learning Through Easy Java Simulations (Ejs)

Andrew Duffy, Boston University, Boston, MA 02215; aduffy@bu.edu

Ejs (Easy java simulations) is a free program, created by Francisco Esquembre of the University of Murcia, in Spain. Ejs makes it easy for someone who knows physics, but who doesn't necessarily have to know computer programming, to construct simulations and animations that demonstrate physics concepts. With Ejs, I make simulations to show in class; animated GIFs that I embed in PowerPoint presentations; and simulations students can use outside of class, guided by worksheets.

These simulations are freely available on the web at http://physics.bu.edu/~duffy/classroom.html. I will also describe a course we run at Boston University for high school physics teachers, in which the teachers learn Ejs and create at least one simulation. That course is part of our 10-course ITOP program for physics teachers (see http://physics.bu.edu/teachers/), which is funded by the Massachusetts Board of Higher Education.

AG04: 11:21–11:33 a.m. Clicker Program Implementation at a Small Liberal Arts University

Heather Whitney, Cumberland University, Lebanon, TN 37087; hwhitney@cumberland.edu

Classroom response systems, or "clickers," are electronic devices used by students to respond in real-time to class questions posed by instructors. While many references are available for consultation on the use of these systems, the authors are often from very large institutions with significant technical and pedagogical resources and support. Cumberland University, an institution of approximately 1300 students, piloted clicker use in fall 2009 and we report our experience on all facets, particularly practical, of implementing the educational technology at a small, liberal arts school. We have found that their use greatly enhances the participation of students in nonmajor, general education physics courses and lab sections, especially for modeling good problem-solving techniques and promoting active learning. In this paper we present our experiences and recommendations for implementing the systems at very small institutions, focusing on collaboration, cost, and planning concerns, and preparing students for using these systems.

AG05: 11:33–11:45 a.m. The Use of WIKIs in 9th Grade Physics

Pete Lohstreter, The Hockaday School, Dallas, TX 75229; plohstreter@mail.hockaday.org

With the introduction of our laptop computer program several years ago, we have been charged with finding more ways to introduce technology into the classroom. It seemed only logical to incorporate the Wikipedia philosophy in our physics classes. Students are required to make entries to the Wiki on a regular basis. The documents become a storehouse of cumulative knowledge produced by all students and accessible to all students. Example Wikis will be shown and suggestions on how to incorporate a Wiki into your classroom will be given.

AG06: 11:45–11:57 a.m. Using a Student Response System To Increase Student Engagement

Joshua Ravenscraft, Vernon Hills High School, Vernon Hills, IL 60061; joshua.ravenscraft@d128.org

Jay Walgren and Jason Rush, Vernon Hills High School

The use of student-response systems in the classroom has increased in both high school and college physics classrooms. The response systems and their data management systems are evolving every year to advance the learning and comprehension of the subject by the student. This talk presents a variety of methods in which the student response system can increase the amount of time students are engaged and the level of engagement both during class and outside of class. It will focus on how to use the response system for homework, lectures, quizzes, tests, and data collection. All of these methods can provide immediate feedback to the student and to the instructor on the progress of each learner.

AG07: 11:57 a.m.–12:09 p.m. Students' Perceptions About MBL Usage in Optics

CANCELED

Fatma Caner, Fahrettin Kerim Gokay Cad. Nilufer Apt. D:12 No: 245 Goztepe, Istanbul, Turkey 34722; canerfatma@gmail.com

Feral Ogan Bekiroglu, Marmara University

Microcomputer Based Laboratory (MBL) technology supports students' opportunities for real-time data collection, displaying, retesting their predictions, analyzing and interpreting data. The ease of real-time data collection encourages students to be active during the learning process. The purpose of this study is to determine students' perceptions about MBL usage in optics. The study was performed in a 9th grade class in 2008 spring semester and lasted for five weeks. The activities were related to concepts of light, brightness, illumination, and polarization. Semi-structured interviews were conducted with randomly selected nine students among the students who participate MBL activities. The interview questions were about the participants' opinions about MBL applications and their thoughts about the effects of MBL technology on their learning. Results presented using real-time graphs provided by MBL leads students to understand variables and relationships between them. Through visuality, MBL supports comprehending of optics concepts and durable learning.

AG08: 12:09–12:21 p.m. Exploring Physical Phenomena with Dynamic Graphical Story Telling

Charlotte M .Trout, Washington County Board of Education, Hagerstown, MD 21740; troutcha@wcboe.k12.md.us

Scott Sinex, Prince Georges Community College

Mark Perry, Pine-Richland High School

Susan Ragan, Project Director Maryland Virtual High School

How do you get students to develop a conceptual understanding of physical phenomena, handle the mathematics, and not bore them? Computational science tools, such as Stella and Vensim, allow instructors to take a conceptual path with camouflaged mathematics through the use of interactive and dynamic graphs. In this presentation, we will discuss the use of systems models to develop a conceptual understanding of motion, force, and attraction. Students develop the multivariable models, while complex mathematical relationships are disguised in the background, to experiment in the virtual realm and interpret graphical results. Scientific and algebraic thinking are used as students are constantly engrossed in a predict-test-analyze and then explain cycle, the "story telling" of the graph. We have used this method in our classrooms and as part of high school teacher training with the Maryland Virtual High School and the Pittsburgh Supercomputing Center.

AG09: 12:21–12:33 p.m. Interactive Physics Illustrations Using Geometer's Sketchpad

Dale R. Yoder-Short, Iowa Mennonite School, Kalona, IA 52247; dyodershort@gmail.com

This shows the use of Geometer's Sketchpad to create interactive, dynamic physics illustrations and explorations to be run on PC or Mac computers. These sketches allow the user to change input parameters and instantly see output results of a physics situation. A clock can be constructed or points can move to allow for motion in a sketch. The user can see how a concept works from graphing motion to the Doppler effect to drawing ray diagrams for a lens or mirror. These sketches can be used as an illustration by the teacher or as a hands-on computer lab or simulation by the learner.

Session AH: Reforming Introductory Physics Courses for Life Science Majors – II

Location: Washington 2
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: APS Forum on Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Juan R. Burciaga

The physics community has been asked to reform and rethink the introductory physics sequence for the life sciences. The session will feature speakers who will speak on the need for reform from the perspective of these organizations and some of the responses being shaped by the physics community. In essence, the session will address the questions: What is wrong with the current approach? What is good about the current approach? How should we be thinking of the course? What are some of the alternate approaches? What are the expectations of the course by institutions outside of physics? What efforts are under way to reform the IPLS course?

NOTE: Part I of this session was held at the 2009 summer meeting; Part III will be held at the 2010 summer meeting.

AH01: 10:45–11:21 a.m. Findings of the AAMC-HHMI Scientific Foundations for Future Physicians Committee

Invited – William Galey, Howard Hughes Medical Institute, Chevy Chase, MD 20815; galeyw@hhmi.org*

The scientific knowledge important to the learning and practice of medicine has changed dramatically, while the approach to science education has remained essentially unchanged. A National Academies report concluded that the premedical course requirements and MCAT content fail to reflect the competencies needed by medical students and we have failed to move from teaching facts to preparing students to use scientific knowledge. Modern medical practice requires different scientific competencies than currently taught and curricula lack emphasis on the knowledge key to lifelong learning. The AAMC and HHMI convened scientists, physicians, and science educators to address these issues. The committee recommended that: 1) medical and premedical learning shift from "required courses" to competencies; 2) the number of requirements should not increase but be more relevant; 3) students be more evenly prepared; 4) premedical and medical curricula foster scholastic rigor, analytical thinking, quantitative assessment, and analysis of complex problems.

*Sponsor, Juan Burciaga

AH02: 11:21–11:57 a.m. Responses to the AAMC-HHMI Scientific Foundations for Future Physicians Report

Invited – Suzanne Amador Kane, Haverford College, Haverford, PA 19041; samador@haverford.edu

This talk will be a status report on many efforts under way to assess the impact of and respond to the June 2009 Association of American Medical Colleges-Howard Hughes Medical Institute report on new recommended standards for premedical students. In particular, we consider how IPLS curricula might evolve in response to the report's call for medical schools to require "competencies" (various skill sets and specifically life-science-oriented content) rather than requiring specific courses (such as a year of physics with lab or organic chemistry), and the concomitant M5 effort to reform the MCAT to reflect these shifts (e.g., likely focusing only on physical applications relevant to life sciences.) In addition to this AAPT Winter Meeting session, two workshops on this topic (one at George Washington University in October 2009 and the other at Centre College in January 2010) are slated to address various approaches to reforming IPLS, and other, larger conferences are in the planning stages. We will summarize the outcomes of these workshops, discuss resources set up at AAPT and elsewhere to collect and disseminate information on IPLS reform (such as the AAPT's IPLS listserv), and outline the schedule of upcoming events.

AH03: 11:57 a.m.–12:33 p.m. The Other Half of Western Civilization: An Experiment in Multidisciplinary Education

Invited – William Bialek, Joseph Henry Laboratories of Physics, Princeton University, Princeton, NJ 08540; wbialek@princeton.edu

Although we should beware of over-simplification, physical scientists are taught to approach the world in mathematical terms, while biological scientists are taught to rely on qualitative descriptions. For a variety of reasons, this divergence is unhealthy. My colleagues and I have been engaged in an experiment that tries to address this problem. What has come to be called "integrated science" is a year-long, double course that substitutes for introductory physics and chemistry, reaching toward biology whenever possible. We unify our discussion around the kinds of mathematical models we use in thinking about the world, and teach at the level of courses for physics majors. The course provides an alternative path into multiple majors: physics, chemistry, biology. I will describe the intellectual ingredients of the course, some of the administrative structures that helped make things work, and the results we have accumulated over the past five years.

Session AI: PER: Topical Understanding and Attitudes

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Date: Monday, Feb. 15
Time: 10:45 a.m.–12:33 p.m.

Presider: Paula Engelhardt

AI01: 10:45–10:57 a.m. Adaptation of Tutorial-style Instruction for Interactive Lectures: Entropy "Two-blocks" Tutorial

Warren M. Christensen, North Dakota State University, Fargo, ND 58108-6050; warren.christensen@ndsu.edu

Mila Kryjevskaia, North Dakota State University

As part of an ongoing investigation into student learning of thermodynamics, we've adapted research-validated curricular materials to fit the constraints of a large lecture classroom. The "Two-Blocks" Tutorial was developed to directly address student thinking about energy and entropy in the context of spontaneous processes using the heat transfer between two massive blocks. [1] The tutorial was originally designed for use among small student groups in an environment with a low student-to-teacher ratio. At North Dakota State University, a lack of support for Teaching Assistants constrains the introductory sequence to four 50-minute lectures per week without the benefit of recitation sections. Therefore, current adaptation efforts focus on tutorial use in an interactive lecture format. Student data on pre- and post-instruction questions will be presented, and analysis will focus on the outcomes of the entropy curriculum in two different formats.

1. Christensen, W. M., Meltzer, D. E., and Ogilvie, C. A., "Student ideas regarding entropy and the second law of thermodynamics in an introductory physics course," *Am. J. Phys.* **77**, 907-917 (2009).

AI02: 10:57–11:09 a.m. Adapting Research-based Instructional Materials To Meet Institutional Constraints

Mila Kryjevskaia, North Dakota State University, Fargo, ND 58108-6050; mila.kryjevskaia@ndsu.edu

Warren Christensen, North Dakota State University

A substantial number of studies have shown that Tutorials in Introductory Physics[1] developed by the Physics Education Group at the University of Washington are effective in improving student understanding in large introductory physics courses if implemented as intended—in a small-group discussion format. Currently, the Department of Physics at North Dakota State University does not have sufficient resources to adequately staff tutorial sessions with the department-funded graduate and undergraduate TAs. As a result, large- enrollment introductory physics courses at NDSU are offered in a fairly traditional format with lectures meeting four times a week. This situation is not unique to our institution. Therefore, we strive to investigate the extent to which Tutorials are effective if implemented and adapted for use in interactive lectures. Ongoing assessment of this instructional strategy will be discussed. Pre-test and post-test results will be presented.

1. L.C. McDermott, P.S. Shaffer and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics,* Prentice Hall (2002).

AI03: 11:09–11:21 a.m. Investigating Student Understanding of the Particulate Nature of Matter*

Amy D. Robertson, University of Washington, Seattle, WA 98195-1560; awrob@phys.washington.edu

Peter Shaffer, University of Washington

The Physics Education Group at the University of Washington is currently examining student and teacher understanding of the particulate nature of matter. The results are guiding the development of instructional materials for inclusion in *Physics by Inquiry.*[1] Examples of specific conceptual and reasoning difficulties with the laws of definite and multiple proportions, the gas laws, and the concept of substance will be presented, together with a preliminary assessment of the effectiveness of the effectiveness of the curriculum.

* This work has been supported under a National Science Foundation Graduate Research Fellowship.

1. L.C. McDermott and the Physics Education Group at the University of Washington, Physics by Inquiry, Wile, Inc. (1996).

AI04: 11:21–11:33 a.m. Use of Multimedia Learning Modules in Teaching Electricity and Magnetism

Homeyra R. Sadaghiani, California State Polytechnic University, Pomona, CA 91768; hrsadaghiani@csupomona.edu

Developed by Physics Education Research Group at University of Illinois, Multimedia Learning Modules (MLM) are combinations of various media (text, sound, graphics, simulation, and animation) within a single computer program streamed through the web. We are using this material at Cal Poly Pomona and are evaluating their effectiveness in student learning of introductory calculus-based electricity and magnetism. Analysis of results from Preflight's (ungraded quizzes), student feedback, and the Concept Survey of Electricity and Magnetism (CSEM) will be presented.

AI05: 11:33–11:45 a.m. Why Problems Related to Continuous Charge Distribution Are So Difficult for Students

Irina Struganova, Valencia Community College, Orlando, FL 32811; istruganova@valenciacc.edu

I am going to present the results of surveys and assessments administered in my calculus-based introductory physics courses. The goals of this research were to establish what makes problems related to continuous charge distribution so difficult for introductory physics students and how to help the students to overcome these difficulties.

AI06: 11:45–11:57 a.m. Concerning Longitudinal Wave Demonstration with Candle Flame and Loudspeaker

Zdeslav Hrepic, Dept. of Earth and Space Sciences, Columbus State University, Columbus, GA 31907; zdeslav_hrepic@colstate.edu

Chelsea Bonilla, Fort Hays State University

In order to reveal the longitudinal wave nature of sound phenomena to students, an experiment with a candle flame in front of a loudspeaker has been suggested as a clear demonstration. In this paper we describe the behavior of a flame under a range of frequencies and amplitudes of sound produced by a loudspeaker. The results show that desired effect can be demonstrated only within a relatively narrow frequency-amplitude (f-A) range. At the same time, for a variety of other ranges, the demonstration outcome might likely reinforce, rather than dismiss, the most common alternative conceptions and incorrect mental models related to sound propagation. This urges caution on the instructor's part when this demonstration is performed. The results are also relevant for researchers who use this experiment to study students' understanding of sound because questions related to outcomes of this experiment may not have single and unambiguous answers.

AI07: 11:57 a.m.–12:09 p.m. Looking at Teacher Content Misconceptions and a Successful Intervention Strategy

Mark D. Greenman, Einstein Fellow serving at NSF Department of Undergraduate Education and past K-12 Math and Science Curriculum Director at Marblehead Public Schools, Marblehead, MA, Arlington, VA 22203; mgreenma@nsf.gov

In this paper the author looks at pre- and post-test data from two cohorts of 25 teachers each who participated in a 60-hour Massachusetts Department of Elementary and Secondary Education (DESE) physics summer content institute during either the summer of 2008 or summer of 2009. The institute methodology modeled active learning using RealTime Physics Mechanics laboratory curricula and microcomputer-based Interactive Lecture Demonstrations. There is strong evidence that STEM degreed (but not physics/engineering degreed) teachers of physics have significant misconceptions concerning ideas in mechanics. The physics teachers with physics/engineering degrees did not exhibit these misconceptions. The STEM-degreed physics teachers performed nearly as well as their physics-degreed colleagues following participation in this DESE summer content institute.

AI08: 12:09–12:21 p.m. Student Attitudes Towards Using Physics in Biology

Kristi L. Hall, Dept. of Curriculum & Instruction, University of Maryland, College Park, MD 20742; khall@umd.edu

Todd J. Cooke and Edward F. Redish, University of Maryland

Heather D. Dobbins, University of Maryland and NIH

The University of Maryland Biology and Physics Education Research Groups are investigating students' views about the role of physics in introductory biology courses. The Bio 2010 report* emphasized the value of integrating physics, mathematics, and chemistry into the undergraduate biology curriculum. While mathematics and chemistry integration is progressing well, physics remains segregated. We are carrying out pre- and post-attitude surveys (using the new Maryland Biology Expectations survey, MBEX), individual interviews, and class observations in an introductory course that addresses the fundamental principles of organismal biology. Our observations indicate that these students have i) limited ability to apply their physics knowledge to biological problems, ii) strong feelings about the appropriateness of incorporating physical principles into biology courses, and iii) even antagonistic feelings toward physics in general. Developed utilizing the resource-framework model, active-learning exercises should help students learn to think scientifically— by developing reasoning skills, building conceptual models, and working in groups.

* National Research Council, Bio 2010: Transforming Undergraduate Education for Future Research Biologists (The National Academies Press, 2003).

AI09: 12:21–12:33 p.m. City of Physics – Exploring the Limits

A. Tabor-Morris, Georgian Court University, Lakewood, NJ 08701; tabormorris@georgian.edu

K. Froriep and T. Briles, Georgian Court University

C. McGuire, Dutchess Community College

Physics educators are concerned that students attain cognitive coherence, that is, that students understand and intra-connect the whole of their knowledge of the "field of physics." Using the metaphor "city of physics," which is laden with the implication of applying architectural concepts to the human acquisition of mental maps of physics subject material, we explore the seminal urban-planning research by architectural urban planner Kevin Lynch. He identified five elements of imageability that assist in forming the image of a city in a person's mind: landmarks, nodes, paths, edges, and districts. These elements applied to physics learning encourage students not to rely on route-knowledge (step-by-step instructions) but to seek survey-knowledge (including creating a mental map) to aid in navigational recall and wayfinding. Taking the concepts published in the journal article [*Phys. Educ*. **44** (2009) 195-198] by these authors, we discuss further research developments in this area.

Session BA: CRACKERBARREL: Advanced Laboratory Personnel

Location: Virginia C
Sponsor: Committee on Laboratories
Date: Monday, Feb. 15
Time: 12:33–1:30 p.m.

Presider: Gabriel Spalding

A moderated, open discussion about instructional laboratories beyond the introductory level (but including Modern Physics, Optics, Electronics, and other "Advanced Labs")

Session BB: CRACKERBARREL: PER Graduate Student Concerns

Location: Virginia B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Professional Concerns
Date: Monday, Feb. 15
Time: 12:33–1:30 p.m.

Presider: Renee-Michelle Goertzen

Meet graduate students from other universities engaged in physics education research. This crackerbarrel provides an informal opportunity for students to discuss concerns and share advice. We will go out to lunch as a group following the meeting.

Session BC: CRACKERBARREL: Physics and Society Crackerbarrel

Location: Johnson
Sponsor: Committee on Science Education for the Public
Date: Monday, Feb. 15
Time: 12:33–1:30 p.m.

Presider: Paul Williams

This Physics and Society Crackerbarrel will place special emphasis on courses in Energy and the Environment.

Session BD: CRACKERBARREL: Impact of NCLB and Changes in State Certification of Physics Teachers on the Quality of High School Physics Teaching

Location: Buchanon
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, Feb. 15
Time: 12:33 –1:30 p.m.

Presider: John Truedson

The rules for the licensing of physics teachers vary greatly from state to state. The 2001 NCLB legislation in particular has had a significant effect on state certification rules including Minnesota. The purpose of this session is to discuss the impact NCLB has had if any on undergraduate physics teacher programs across the country. Participants in the session are encouraged to present information on physics teaching rules in their own state and ideas on dealing with this issue.

AAPT Awards Ceremony

Location: Salon 3
Sponsor: Awards Committee
Date: Monday, Feb.15
Time: 1:30–3:18 p.m.

Presider: Lila Adair

Mary Beth Monroe

Melba Newell Phillips Medal

Mary Beth Monroe, Southwest Texas Junior College, Dept. of Physics, Uvalde, TX 78801; mbmonroe@swtjc.cc.tx.us

The Faces of AAPT

Melba Phillips was a very special colleague and friend to me, and to many others in the physics and physics education communities. She was responsible for me attending my first AAPT national meeting in 1977 and she took a personal interest in helping me to become an active member of the Association. I was an oddity, you see, at that time. I was a "woman in physics" and also a physics teacher at a two-year college. Melba believed that my involvement in AAPT was a win-win situation for both of us.

In the early planning stages of the AAPT initiative, "The Two Year College in the Twenty First Century (TYC21), Jack Hehn, then Associative Executive Officer of AAPT, asked me," Who is AAPT?" That question has come to mind often during the last fifteen years. During my presentation I will convey why it is important that we, individually and collectively as a community of physicists and physics teachers, answer that question.

Eugene Commins

J.D. Jackson Excellence in Graduate Education Award

Eugene D. Commins, Professor Emeritus, University of California–Berkeley, Dept. of Physics, Berkeley, CA 94720-7300; commins@berkeley.edu

Some Personal Reflections on Physics Graduate Education

I will try to give a picture of my life as a graduate student and then instructor in the Columbia University Physics Department of the 1950s, and how that influenced my subsequent experiences as a mentor of Berkeley physics graduate students during the last five decades.

AAPT Distinguished Service Citations

Karen Williams
professor of physics, East Central University Ada, OK

Patrick Whippey
physics professor emeritus, The University of Western Ontario

Trina Cannon
Highland Park High School, Dallas, TX

Diane Jacobs

SPS Outstanding Chapter Advisor Award

Diane Jacobs, Eastern Michigan University

A truly successful chapter of the Society of Physics Students requires leadership, organization, a broad spectrum of activities, and enthusiastic student participation. An outstanding Chapter Advisor provides the stimulus for such success. The award consists of a citation of the recipient's distinctive service, and $5,000, split among the winning advisor, his/her chapter and the physics department.

The award will be presented by Dr. Toni Sauncy of Angelo State University, SPS President.

Session CA: Panel: Information Fluency and Physics Curriculum

Location: Balcony D
Sponsor: Committee on Professional Concerns
Co-Sponsors: Committee on Physics in Undergraduate Education, APS Forum on Education
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Pat Viele

CA01: 3:30–5:54 p.m. Engaging Students, Involving Faculty, and Convincing the Audience

Panel – Jean-Francois S. Van Huele, Brigham Young University, Provo, UT 84602-4681; vanhuele@byu.edu

Effective science communication has always been a critical issue for individual physicists and for the field of physics as a whole. It should therefore be considered an item of very high priority by physics educators. The continuing expansion of knowledge coupled with the introduction of new technologies brings new opportunities but also adds considerable challenges to this formidable enterprise. We discuss the nature of these challenges and propose ways to address them at the individual and curricular level, based on personal experiences gathered in teaching situations ranging from freshman physical science to graduate research at Brigham Young University.

CA02: 3:30–5:54 p.m. Teaching Research Skills: Why Do It? Who Should Do It?

Panel – Adriana Popescu, Princeton University, Friend Center for Engineering Education, Princeton, NJ 08544; popescua@princeton.edu

It can be called information literacy, library research instruction, or bibliographic instruction; no matter what terminology is used, the bottom line is, are graduates of science and engineering programs prepared to find, acquire, evaluate, and use scientific information to achieve a specific goal? Program accreditation requirements are the driving force in engineering departments for altering the curriculum to introduce fundamentals of information literacy as a means of achieving lifelong learning. Writing requirements can also lead to elements of information literacy being introduced in the curriculum. While there are no set prescriptions, formulas, or methods to follow, research and practice has shown that faculty-driven initiatives for promoting and teaching information literacy within science and engineering curriculum have been most productive. Examples from several undergraduate and graduate programs at Princeton University will illustrate the impact that faculty involvement and action had on the success of course-integrated information literacy and research instruction initiatives.

CA03, CA04: 3:30–5:54 p.m. Developing Lifelong Learning Skills Through a Great Issues Course

Panel – Michael Fosmire, Purdue University, West Lafayette, IN 4790-2058; fosmire@purdue.edu

Panel – Andrew S. Hirsch, Purdue University, West Lafayette, IN 47907-2036; hirsch@purdue.edu

A physics education has traditionally focused on problem-solving and conceptual skills at a fairly abstract and mathematical level. However, upon graduation, most students will be asked to solve more applied problems in their careers. With that in mind, Purdue University's College of Science passed a "Great Issues" requirement for all students, asking them to integrate and apply their disciplinary knowledge to important global challenges and to consider the impact of science on society and that of society on science. In order to engage these issues robustly, students need to be able to efficiently and effectively determine their information and learning need, locate and evaluate that information, integrate the information into their existing knowledge-base, and use that information to help solve their problem. These skills are necessary in order for students to become effective self-directed lifelong learners. Several techniques will be described that targeted these skills in the pilot course offering.

Session CB: Unconventional Laboratories

Location: Virginia B
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, Feb. 15
Time: 3:30 –5:54 p.m.

Presider: TBA

Unconventional laboratories are not bound by the confines of the traditional lab exercises. Unconventional labs may happen in different times, manners, methods and locus of control. We will explore distinctive programs and curricula for labs in these different modes.

CB01: 3:30–4:06 p.m. Studying the Students: Critical Investigations into a Physics Laboratory Course

Invited – Jennifer W. Blue, Miami University, Oxford, OH 45056; bluejm@muohio.edu

At Miami University, we have been studying the effectiveness of an introductory laboratory course for several years. This is a fairly traditional course; students work through a workbook-style lab manual, four students per setup, and write up three of the 13 activities informal lab reports. Three different undergraduate students have chosen this course as the setting for their physics education research projects. Students have been surveyed about their understanding of the lab and what lab structure and lab report style they would prefer. In addition, instructors were surveyed about their preferred lab structure and lab report style. We found that students from the calculus-based physics class have more confidence in lab than students from the algebra-based class and students and instructors have very different ideas about the labs and lab reports.

CB02: 4:06–4:42 p.m. Doing Gender in the Physics Student Laboratory

Invited – Anna T. Danielsson, Dept. of Physics and Materials Science and Centre for Gender Research, Uppsala University, Uppsala, Sweden 75121; anna.danielsson@fysik.uu.se

In this talk I explore how physics majors, in the context of laboratory work, learn to become physicists. In particular, I focus on how this learning can be understood as gendered. In my research I have interviewed physics students about their experiences of working in laboratories, analyzing questions such as; what do physics students see as appropriate and inappropriate practices in the laboratory? Which approaches to laboratory work are seen as having/giving high status? What does it take for a physics student to identify as a physicist? The theoretical point of departure is a conceptualisation of both gender and learning as aspects of identity constitution, instead of viewing them as attributes of the individual. By using such a theoretical framing, I am able to provide new and deeper insights into issues of physics, learning and gender, which also will be discussed in relation to implications for teaching.

CB03: 4:42–5:18 p.m. Busting 'Mythconceptions' About Physics Concepts in the Introductory Laboratory

Invited – Stephen J. Van Hook, Penn State University, University Park, PA 16802; sjv11@psu.edu

Michael J. Cullin, Lock Haven University

Edgardo Ortiz Nieves and Daniel Costantino, Penn State University

The television show "Mythbusters" is popular with many of today's college students. We have used the basic Mythbusters approach of putting common "myths" to the test to create a series of introductory physics laboratories where students design and perform experimental tests of physics "mythconceptions" (myths based on common misconceptions about science). These mythconception-based laboratories were developed to engage students in exploring physics conceptions and scientific inquiry within the constraints of the laboratory component of a large university introductory physics course. We will give examples of the mythconception-based laboratories, show typical student work from the laboratories, and discuss results from surveys of the students and laboratory instructors about the mythconception-based laboratories. ("Mythbusters" is a registered trademark of Discovery Communications, LLC, Silver Spring, MD.)

CB04: 5:18–5:30 p.m. Exploring Crystallization – Low Cost, Hands-on Experiments with Candy Glass

William R. Heffner, Lehigh University, Bethlehem, PA 18015; wrh304@lehigh.edu

Sarah Horst, Lehigh University

Jung Hyun Noh, University of Notre Dame

Sucrose-based glass (a.k.a. hard candy) provides a perfect paradigm to explore many aspects of glass science, from synthesis to properties and performance. We have developed a collection of experiments around this interesting and accessible glass forming system.[1] In this paper, we present our experiments relating to nucleation and growth of crystallites in sugar glass. These experiments demonstrate surface crystallization at room temperature, the significant influence of moisture in mediating this process, as well as crystal nucleation and growth within the material at elevated temperatures. Most of the experiments can be assembled in a high school laboratory, or even in a home setting with minimal cost, and yet would also be appropriate for inclusion in an undergraduate materials lab. All apparatus including the humidity chamber and the temperature-controlled sample chamber were constructed from commonly available items, none costing more than $20.

1. For details on all of our candy glass related experiments see our website at http://www.lehigh.edu/imi/libraryglassedu.html

CB05: 5:30–5:42 p.m. The Application of Play Theory to Laboratory Pedagogy

Juan R. Burciaga, Denison University, Granville, OH 43023; burciagaj@denison.edu

The physics community is becoming increasingly aware of the complex learning environment of the introductory laboratory. In addition to the concepts of physics, the technology of the laboratory, and the techniques of error analysis, physics instructors are being asked to attend to the social construction of the lab groups, developing and sustaining a constructivist learning environment, and securing the engagement and motivation of a diverse student body. How can a physics instructor gain insight into, and coordinate the demands of, these varied expectations? Play theory provides a coherent framework for developing an appropriate perspective on designing and developing the learning environment of the laboratory.

CB06: 5:42–5:54 p.m. Examples of Research-Level Laboratory Experiments for High School Students

Sophia Gershman, Watchung Hills Regional High School, Warren, NJ 07059; sgershman@whrhs.org

Research experience has been gaining acceptance as an effective learning and teaching tool. Undergraduate research experience is almost expected and the number of research opportunities for high school students has been on the rise. Most of the opportunities for high school students exist through summer programs and collaborations with colleges and universities. Simple, relatively low-cost tabletop experiments described in this work make it possible for science teachers to provide their students with research opportunities right in their high school laboratories. Specific examples given here provide lists of materials, costs, and examples of possible experiments. Using this information, high school physics teachers can enjoy creating a research learning community right at their own high schools. Pre- and post-survey information addressing students' learning experience is discussed. Students report a dramatic increase in confidence in choosing science related careers following their research experience.

Session CC: Teacher Training/ Enhancement

Location: Virginia C
Sponsor: Committee on Physics in High Schools
Date: Monday, Feb. 15
Time: 3:30–5:18 p.m.

Presider: TBA

CC01: 3:30–3:42 p.m. Playing Inquiry-Based Science: Video Games for Science Teachers

Danielle B. Harlow, Dept. of Education, University of California, Santa Barbara, Santa Barbara, CA 93106-9490; dharlow@education.ucsb.edu

Phillip Conrad and Lauren H. Swanson, University of California, Santa Barbara

Engaging students in the practices of developing scientific models helps develop content knowledge, knowledge of the nature of science, and creative thinking skills. Unfortunately, such instruction rarely occurs in K-5 science. This is, in part, because teachers do not have the opportunity to develop sophisticated understandings of the process of modeling. A growing body of research shows that carefully designed video games can expose players to the problems and problem-solving approaches of a profession. We are drawing on this body of research to develop games for teachers based on video clips of classroom activities. These games allow pre-service teachers to experiment with model-based instructional practices. In these games, classroom events can be slowed down and replayed before making an instructional decision. Teachers can then observe how their ideas play out in the game without risking actual students' learning. Here, we report on initial development.

CC02: 3:42–3:54 p.m. Things I Learned from Teaching Astronomy to Teachers

Todd Brown, University of Pittsburgh at Greensburg, Greensburg, PA 15601; ltbrown@pitt.edu

Katrina Brown, University of Pittsburgh at Greensburg

In June 2009, the University of Pittsburgh at Greensburg hosted an inaugural workshop for teachers entitled "The Sun, the Solar System, and the Science Grade 8 Assessment Anchors." As part of its Institute for Continued Learning, this three-day class helped fulfill Pennsylvania professional educators who need to complete continuing education requirements.

Several concepts were presented from various directions, and the end result was that the teachers always thought they had complete mastery of the reasons behind such things as retrograde loops and problems inherent in space flight as shown on a solar system scale model. I will discuss the "tried and true" ways that I had taught such topics but found them to be extremely lacking as addressed by the teachers' confident, though wrong, understanding. I will also discuss the newer techniques that we introduced which greatly eliminated the confusion.

CC03: 3:54–4:06 p.m. Empowering Teachers with the Development of Representations of Physics Scenarios

Rachel E. Scherr, Physics Education Research Group, University of Maryland, College Park, MD 20742; rescherr@gmail.com

Hunter G. Close, Seattle Pacific University

The aim of professional development (PD) offered through the Physics Department at Seattle Pacific University is to empower teachers as intelligent and talented professionals by increasing their awareness of the potential intellectual life of the teacher. We have identified a new approach to PD that emphasizes the social construction of disciplinary knowledge, organized around the development of representations. As the teachers creatively invent representations of physics scenarios, they make their thinking visible to themselves, to one another, to the instructors, and to the video cameras with which we extensively document their experience. As the teachers' use of the representations grows more disciplined, they recognize the significance of their choices. The flexibility of the instructional approach allows the instructors to teach responsively while retaining fidelity to their learning goals. The approach is inspired by The Algebra Project, a community-organizing project centered on math literacy.

CC04: 4:06–4:18 p.m. Advocating a New Perspective on TA Professional Development

Renee Michelle Goertzen, University of Maryland, College Park, MD 20742; goertzen@gmail.com

Rachel E. Scherr and Andrew Elby, University of Maryland, College Park

Effective physics instruction benefits from respecting the physics ideas that introductory students bring into the classroom. We argue that it is similarly beneficial to respect the teaching ideas that novice physics instructors bring to their classrooms. We present a case study of a tutorial teaching assistant (TA), Alan. When we first examined Alan's teaching, we focused our attention on the mismatch of his actions and those advocated by the TA instructors. Further study showed us that Alan cared about helping his students and that his teaching was well integrated with his beliefs about how students learn physics and how teachers can best assist students. Learning about Alan's resources for teaching changed our thinking about what might constitute effective professional development for Alan and other TAs. We advocate a new perspective on TA training: one in which TAs' ideas about teaching are taken to be interesting, plausible, and worth understanding.

CC05: 4:18–4:30 p.m. The Development of Scientific Reasoning Abilities in Pre-service Teachers*

Kathleen M. Koenig, Wright State University, Dayton, OH 45435; kathy.koenig@wright.edu

Melissa Schen and Sachiko Tosa, Wright State University

Lei Bao, The Ohio State University

Student development of transferable general abilities is at least as important as certain acquired scientific knowledge. This emphasizes not only the need for K-12 students to develop a solid foundation of scientific reasoning skills along with appropriate content knowledge, but it implies that teachers must also be competent in both. Previous assessment of Wright State's teacher candidates indicated that they were developing specific content knowledge but not reasoning skills. This presentation describes the curriculum of an innovative "Foundations in Scientific Literacy and Problem Solving Course" now required of our middle childhood teachers to address this concern. The course employs direct scientific reasoning training and closely aligns with Ohio's Academic Content Standards for scientific inquiry and scientific ways of knowing. Evaluation of the curriculum indicates that student scientific reasoning ability and student understanding of the nature of science significantly improves as a result of this course (n= 135 students).

*Supported in part by NSF Grant DUE 0622466

CC06: 4:30–4:42 p.m. Developing Mathematical Reasoning within the Physics Curriculum

Suzanne White Brahmia, Rutgers, the State University of New Jersey, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Andrew Boudreaux, Western Washington University

Stephen Kanim, New Mexico State University

Mathematical reasoning skills are fundamental for understanding physics, and proportional reasoning is perhaps the most commonly used skill. Physicists reason about proportional relationships between physical quantities in almost all contexts and through use of a wide variety of representations (algebraic, graphical etc.). This type of reasoning is essential to the way we understand our discipline, yet we know our students often struggle with it. In this talk we describe materials and methods related to proportional reasoning created as part of an ongoing collaboration between Rutgers University, Western Washington University and New Mexico State University. The materials are intended to build these reasoning skills in the context of physics, and are currently being piloted in grades 6 through 16. We present sample activities, and describe their current impact on teachers who are implementing the associated curriculum. In addition, we suggest ways that these materials might fit into a typical curriculum.

CC07: 4:42–4:54 p.m. Preparing Instructors to Teach an Intensive STEM Course

Vincent Bonina, Johns Hopkins University Center for Talented Youth, Baltimore, MD 21209; vbonina@jhu.edu

Jocelyn C. Koller, Johns Hopkins University Center for Talented Youth

For the past 30 years, the Johns Hopkins University Center for Talented Youth has provided physics teachers the opportunity to teach STEM topics through our three-week summer programs for academically talented pre-collegiate students. During this presentation, we will discuss our teachers' experiences in the classroom, highlighting the support we provide to make a physics teacher an effective STEM instructor. Emphasis will be placed on the curricular support offered to instructors, including examples from our courses: "Principles of Engineering Design" and "Flight Science." We will provide an overview of the resources and preparation provided to new instructors throughout their participation in our program. Lastly, we will show how these types of resources could be implemented in the standard school setting to prepare teachers to implement STEM curriculum in their classrooms. Further materials will be available to instructors interested in this teaching opportunity.

CC08: 4:54–5:06 p.m. Preparing Pre-service Elementary Teachers for Inquiry-based Physics Teaching

Annmarie R. Ward, Penn State University, University Park, PA 16802; arw192@psu.edu

Milton W. Cole, Penn State University

This presentation describes a semester-long specialized physics course for pre-service elementary teachers emphasizing in-depth learning about sound and light, with a common underpinning: waves. The course addresses three learning strands: 1) science topics, 2) scientific inquiry, and 3) teaching science to children. Learning goals for these strands include: 1) generating deeply rooted understanding of relevant concepts of waves, sound and light which students can adaptively apply to future teaching, 2) enhancing understanding of the nature of scientific inquiry through first-hand experience with guided inquiry-based learning, and exploration of historical episodes, and 3) demonstrating the importance of depth of content knowledge for inquiry-based teaching. We discuss key aspects of the course contributing to these goals, including explicitly scaffolded content learning emphasizing conceptual interrelationships; incorporation of science notebooking to develop literacy skills and scaffold inquiry-based strategies emphasizing evidence and explanation; and Teaching Application assignments connecting content understanding to teaching strategies.

CC09: 5:06–5:18 p.m. Iowa Physics Teacher Instruction and Resources (IPTIR)

Lawrence T. Escalada, University of Northern Iowa, Cedar Falls, IA 50614-0150; Lawrence.Escalada@uni.edu

Jeffrey T. Morgan, University of Northern Iowa

The IPTIR program, a three-year professional development program, is the University of Northern Iowa's latest effort to address the critical shortage of high school physics teachers in the state of Iowa; prepare more high-quality high school physics teachers for Iowa schools; and improve the performance of their students.[1] IPTIR targets a cohort of 24 high school physics teachers providing the majority with a means of completing the requirements necessary for a physics teaching endorsement. The program provides professional development in physics content and pedagogy with the focus on interactive engagement methods using both PRISMS PLUS[2] and Modeling Instruction.[3] Teachers are provided classroom physics resources on loan during the implementation component of the program. The impact of the program on instructional practice and student/teacher learning is being investigated. A brief description of the program, how it has been structured based on insights gained from previous programs, and initial findings will be discussed.

1. The IPTIR program is funded by the Board of Regents, State of Iowa and Title IIA (of the No Child Left Behind Act).
2. Cooney, T., Escalada, L., & Unruh, R., *Physics Resources and Instructional Strategies for Motivating Students* (PRISMS) PLUS, University of Northern Iowa Department of Physics, Cedar Falls, IA (2005).
3. Hestenes, D., "Toward a modeling theory of physics instruction," *Am. J. Phys.* **55**(5), 440-454, (1987).

Session CD: TA Training: Why It Is Important and How To Do It Effectively

Session Dedicated to Cornelius Bennhold

Location: Balcony A
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Research in Physics Education, APS Forum on Education
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Raluca Teodorescu

Graduate students in physics are often employed as teaching assistants (TAs) for physics courses. The amount of training provided for graduate TAs to prepare them for their teaching assignments varies widely in different physics departments. In this session, speakers will explore why it is important to provide TA training and discuss strategies for preparing TAs effectively.

CD01: 3:30–4:06 p.m. Educating the TA: A Key to a Physicist's Professional Development

Invited – Kenneth Heller, University of Minnesota, Minneapolis, MN 55455; heller@physics.umn.edu

Being a teaching assistant (TA) is part of almost every physicist's PhD experience. This experience can and should provide more than financial support for graduate students. It is an educational opportunity to help them learn the communication and teamwork skills crucial to effective collaboration in research, become more focused and effective learners, make the transition from students to professionals, and start on the road to becoming effective teachers. At the University of Minnesota we have been purposefully engaged in this process for more than 25 years. Using various research techniques, we have evolved a system that is routinely operated by the physics faculty to support about 80 TAs per year. This system, described in this talk, emphasizes having TAs teach in an environment in which they will be successful, coordinating each course as if it were a research group, and providing support for new TAs with organized seminars and mentors.

CD02: 4:06–4:42 p.m. On the Front Lines: Graduate Student Insights on TA Training*

Invited – Amber L. Stuver, Caltech/LIGO Livingston Observatory, Baton Rouge, LA 70810; stuver@caltech.edu

Providing TA training to graduate students supported on teaching assistantships is considered a "best practice" to prepare them for their first teaching experience in higher education. Many programs incorporate the feedback of their students to improve this professional development at their institution. While many TA training programmers share experiences between institutions, the input of the graduate student population at large has not been available previously. The APS Forum on Graduate Student Affairs (FGSA) has conducted a survey of its membership (which is composed primarily of graduate students in all stages of matriculation and in programs nationwide) on their experiences with TA training. The collected results of this survey will be presented, contributing the broad graduate student perspective to the TA training dialog. General trends and opinions on which innovations work and which do not are offered, from the graduate student perspective, for the first time.

*This work is supported by the APS and the Forum on Graduate Student Affairs (FGSA).

CD03: 4:42–5:18 p.m. Professional Development of Graduate TAs: The Role of PER*

Invtited – MacKenzie R. Stetzer, University of Washington, Seattle, WA 98195-1560; stetzer@phys.washington.edu

For more than 15 years, the Physics Education Group at the University of Washington has been offering an academic-year teaching seminar that is required for all new graduate TAs in physics. The seminar, conducted in the context of Tutorials in Introductory Physics,[1] is designed to help prepare graduate students and junior faculty to teach introductory physics more effectively. In the seminar, TAs have an opportunity to learn (or relearn) basic concepts that they have likely not studied for many years, to reflect on student understanding of these concepts, and to gain experience with instructional strategies that have proved effective in helping students learn. The seminar represents an important step in developing a comprehensive, research-based TA-preparation program that deepens content understanding and fosters effective instructional practices. Examples from ongoing investigations will be used to illustrate the role of physics education research in informing the design and implementation of such programs.

*This work has been supported in part by the National Science Foundation.

1. L. C. McDermott, P. S. Shaffer, and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics*, Prentice Hall (2002).

CD04: 5:18–5:54 p.m. Helping TAs Learn To Teach in a Studio Setting

Invited – Mary Bridget Kustusch, North Carolina State University, Raleigh, NC 27695-8202; mbkustus@ncsu.edu

Jon D.H. Gaffney, North Carolina State University

Many graduate students have little to no teaching experience, and the training they undergo for their appointments wil l likely be the only instruction they receive on how to teach.

Knowing that they come from a variety of backgrounds and that they will be asked to teach in a variety of sections ranging from studio-style classrooms and laboratory sections to individual tutoring at office hours, we face a challenge: how to provide enough training to be effective while understanding and acknowledging limited resources—in terms of both time and money. We present several key principles that guided the revision of the TA training program at North Carolina State University and provide examples of how these principles have been enacted.

Session CE: Physics Outreach

Location: Harding
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, Feb. 15
Time: 3:30–5:18 p.m.

Presider: TBA

CE01: 3:30–3:42 p.m. The SPS Intern Experience: Preparing the 2009 SPS Outreach Catalyst Kit

Erica P. Watkins, Chicago State University, Chicago, IL 60628; ericapwatkins87@yahoo.com*

Mary E. Mills, Miami University

Scott A. Stacy, Texas Christian University

Gary White and Kendra Rand, Society of Physics Students

The Society of Physics Students' (SPS) Outreach Catalyst Kit—also known as the SOCK, is a collection of exploratory physics and science activities specifically designed for SPS Chapters and collegiate physics departments to use in outreach presentations to local elementary, middle and high school students.[1] New SOCKs have been prepared every year since 2001 by SPS national interns and office staff. This year's SOCK has a theme centered around Galileo Galilei and his experiments, in honor of 2009 being the International Year of Astronomy. The SOCK contains lessons, demonstration, and activities that span topics such as optics and the refracting telescope, inclined planes and the formation of moon craters. In this talk, I will highlight the procedure SPS uses in preparing and testing the SOCK activities at various pilot sites as well as discuss my overall experience as an SPS intern.

*Supported by Society of Physics Students

1. Science Outreach Catalyst Kit; Society of Physics Students. (2009) http://www.spsnational.org/programs/socks.

CE02: 3:42–3:54 p.m. After-School, Activity-based Physical Science in a Low-income, Rural County

Staci J. Small, Longwood University, Famville, VA 23909; staci.small@live.longwood.edu*

Ben Ryan, Nik Vann, and Christopher Moore, Longwood University

Longwood University's Society of Physics Students conducted a six-week, activity-based after-school program for middle-school students in partnership with a rural low-income school system. Hands-on learning activities were designed and implemented to improve content knowledge in typically low-scoring standardized testing areas in the physical sciences. For example, we used colored yarn of different lengths to help demonstrate visible light in the electromagnetic spectrum along with the relationship between wavelength and frequency. Other topics were explored, such as reflection, refraction, sound and inference. At the end of the six-week program, a science exposition was held where the students came to Longwood and participated in more sophisticated experiments, such as liquid nitrogen demonstrations. After the exposition, Longwood University held a small awards ceremony in which the parents were invited to watch their students receive an award congratulating them on completing the program and welcoming them into the Lancer Discovery Club.

*Sponsor: J. Christopher Moore.

CE03: 3:54–4:06 p.m. QuarkNet and Chicago State University

CANCELED

Jamall Davis, Chicago State University, Chicago, IL 60628; dvsshark@sbcglobal.net*

Melissa Rangel, Sharif Onihale, and Edmundo Garcia, Chicago State University

The purpose of our contribution to QuarkNet is involving high school teachers and students in the field of high-energy nuclear physics. Using detectors at the participating high schools, we are able to make measurements related to the muons that reach the Earth's surface from the outer atmosphere. Using the QuarkNet detectors, we measure lifetime, speed, and overall flux of the muons. Using computers connected to the detectors, we are able to analyze the data from the muons. Finally we are able to compare the data from other high schools and QuarkNet centers with the information from a GPS connected to the detector. In this talk we will present the measurements we have gathered with the detectors and we will review the QuarkNet program at CSU.

*Sponsors: Mel Sabella & Edmundo Garcia

CE04: 4:06–4:18 p.m. Using the Context of Modern Experimental Physics in the Undergraduate Curriculum

CANCELED

Sharif Onihale, Chicago State University, Chicago, IL 60628; onihalesharif1@yahoo.com

Melissa Rangel, Edmundo Garcia, and Mel Sabella, Chicago State University

The goal of this project is to improve student understanding of modern physics in the undergraduate curriculum by building stronger content knowledge, reasoning, and laboratory skills. This project is centered on the development of lab modules that help students move beyond theory and develop an appreciation of modern experimental physics. These modules will allow students to experimentally determine the existence of subatomic particles using detectors made of scintillating plastic that produce light as particles cross the devices. These instructional modules will permeate throughout the undergraduate curriculum forming a coherent conceptual thread. As students progress through the materials the level of content knowledge increases as the level of scaffolding decreases. As students complete the conceptual thread, they will become well versed in using NEM boxes and LabView. In this talk we introduce the project, the experimental techniques, and how education research will be used to guide the development of instructional materials.

*Sponsors: Mel Sabella & Edmundo Garcia

CE05: 4:18–4:30 p.m. Optics and Light Activities for Teachers of all Grade Levels from Easily Obtainable Supplies

Richard Lindgren, University of Virginia, Charlottesville, VA 22904; ral5q@virginia.edu

Curtis Hendricks and Stephen Thornton, University of Virginia

Lynn Lucatorto, James Madison University

Thomas McNeilus, Shenandoah Valley Academy

Several hands-on activities in light and optics covering selected topics will be discussed in the context of home labs and how such activities can be incorporated into a distance-learning or online web-based course utilizing the latest communication technologies and the Internet. The presentation will focus on activities that can be constructed from easy-to-obtain supplies as well as a commercially available kit that we are having made available. Activities for teachers at the elementary level will focus on understanding light rays, shadows, and reflection from plane surfaces; the middle school level will focus on curved mirrors and lenses, dispersion, and drawing ray diagrams; the high school level will focus on Snell's law, the lens equation, wave interference, polarization, Young's experiment, and diffraction. A distance-learning, web-based course based on these home labs will be described.

CE06: 4:30–4:42 p.m. Online Astronomy Resources from the American Museum of Natural History

Robert Steiner, American Museum of Natural History, Central Park West at 79th St., New York, NY 10024-5192; rsteiner@amnh.org

The American Museum of Natural History, one of the world's largest natural history museums, is the locus of a rich array of scientific research, exhibition, and educational resources through its Department of Astrophysics, its Rose Center for Earth and Space, and its Hall of Meteorites. For the past decade, the Museum's National Center for Science Literacy, Education, and Technology has leveraged these assets to create a panoply of web-based resources for students, teachers, and the general public. This session will review several of these resources, including the Digital Universe (a three-dimensional mapping of the Universe); The Solar System (an online graduate course for K-12 teachers); multimedia highlighting searches for exoplanets and ultra-high-energy cosmic rays; Journey to the Stars (a DVD version of the current planetarium show); and the astronomy section of Ology (a website for children ages 7 and up). A copy of the Journey to the Stars DVD will be provided to all attendees.

CE07: 4:42–4:54 p.m. Neutrinos and Dark Matter in the Black Hills

Margaret McMahan Norris, Black Hills State University, Spearfish, SD 57799; peggy.norris@bhsu.edu

Bentley Sayler, Black Hills State University

Where in the United States could you walk into a hardware store and be asked about neutrinos? It happens regularly in the Black Hills of South Dakota, where preliminary design is in progress for the Deep Underground Science and Engineering Laboratory (DUSEL), a planned NSF Major Research Experimental Facility Construction (MREFC) initiative to be located at the former Homestake gold mine in Lead, SD. DUSEL has physicists buzzing too, as the particle, astro-, and nuclear physics communities have all identified the need for a new laboratory deep beneath the Earth's surface to address some of the most compelling, transformational science at the frontiers of their disciplines. Elusive particles such as neutrinos and WIMPS (a possible candidate for dark matter)—though they spark the imagination—are equally elusive when trying to explain to students and the public. That will be the task of the Sanford Center for Science Education, planned to be the education arm of DUSEL. Early prototypes of future programs at the education center are now under development, ranging from professional development for teachers to classroom tours to working with Native American educators. These programs, which are building capacity for the future education center, will be discussed.

CE08: 4:54–5:06 p.m. Education and Outreach for Neutrino and Dark Matter Physics

Katherine Guenthner, MIT Laboratory for Nuclear Science, Cambridge, MA 02139; kguenthn@mit.edu

Science education and public outreach programs are designed to engage and excite the community in many fascinating fields, including Neutrino and Dark Matter physics. I will discuss a diverse program of education and outreach implemented by the physics faculty at the MIT Laboratory for Nuclear Science, and highlight some methods and strategies they employ to communicate recent advances in Neutrino and Dark Matter research to a wide audience.

CE09: 5:06– 5:18 p.m. Undergraduate Research in Experimental Granular Physics

Dustin Kimble, Loyola University Chicago, Elmhurst, IL 60126; dkimble@luc.edu

Jon Bougie, Loyola University Chicago

I will present an ongoing undergraduate experimental research project in granular physics. I am an active part in an undergraduate research team that is investigating the self-organization of granular media. Using a modified subwoofer, I have built an apparatus to fluidize grains so that granular phenomena can be examined. When shaken vertically and sinusoidally, grains self-organize into patterns such as squares, stripes, and hexagons. Future investigations of other granular phenomena will also be discussed. Finally, this project illustrates the importance of undergraduate research and of student initiative in establishing research opportunities.

Sponsor: Gordon P. Ramsey

CE10: 5:18–5:30 p.m. HEP Data in Education and Outreach Efforts

Matt Bellis, Stanford University, Palo Alto, CA 94305; bellis@slac.stanford.edu

The High Energy Physics (HEP) community has recognized that data preservation is an important part of our future and has organized an international working committee to address this. Beyond the continued data mining which can take place, there is a great opportunity to use these datasets as teaching tools, both for university students and an interested general public. The BaBar experiment at the SLAC National Accelerator Laboratory has a dedicated group working on the preservation effort; the education and outreach effort is a significant goal of this group. Retention of knowledge and conceptual understanding is enhanced by active participation in problem solving—a challenge that can be addressed with more involved projects than currently available to the general public from the HEP outreach centers. We are developing a framework that will make subsets of the BaBar dataset available to others, along with computing tools and tutorials, so that interested parties can work through either parts or the whole of a variety of analyses. With the proper framework, this may be used by other HEP experiments as a way to make their physics available and teachable beyond our community. The scope of this project may be extended to teach the next generation of particle physicists, who may lack immediate data, by providing them with datasets with which to prepare themselves for upcoming experiments.

Session CF: The Things Accomplished Teachers Do in Their Classrooms – Who Prepares Them?

Location: Balcony C
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Teacher Preparation
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Paul Hickman

CF01: 3:30–4:06 p.m. Tech Tool Savvy for Physics Teachers

Invited – Cathy M. Ezrailson, University of South Dakota, Vermillion, SD 57069; Cathy.Ezrailson@usd.edu

The complexion of physics classrooms today and tomorrow requires that teachers continue to acquire the skills needed to incorporate new and emerging technologies. There are a host of web-based teaching tools, easily learned, free to teachers, and immediately available that could enhance and augment physics learning. Technology takes many forms in today's high schools—from smart board, to data acquisition devices, to web-based lessons and resources. Using web tech tools such as Google Docs to organize, design, access, and assess lessons seamlessly is integral to teaching in the 21st century classroom. This paper illustrates use of and examples of these tools along with suggestions for applications.

*C. M. Ezrailson, "A Taste of Technology: Blogs, Wikis, Forums and more." AAPT Summer Meeting, Ann Arbor, MI (2009, July)

CF02: 4:06–4:42 p.m. Did Faraday and Hertz Do Hands-on: A Systematic Way To Approach Experimental Work in a Physics Classroom

Invited – Eugenia Etkina, Rutgers, New Brunswick, NJ 08901; eugenia.etkina@gse.rutgers.edu

Often we divide the experiments we use in the classroom into demos and labs. Sometimes we use the expression "hands-on" for quick experiments that do not require complicated data collection. Do demos, labs, or "hands-on" exist in the practice of physics? If we wish to help our students see a physics classroom as the place where physics is done, we might want to move away from the above classification and develop a new one to match the practice of physics. Consequently, we will need to prepare teachers who have a different view of experiments in the classroom. In this talk I will present a framework of classifying the majority of physics experiments into three broad categories,[1] describe how to apply this framework to the experiments performed by the students or the teacher, and finally, share a possible way of incorporating this framework into the program preparing physics teachers.

1.E. Etkina, A.Van Heuvelen, D. Brookes,& D. Mills, " Role of experiments in physics instruction-- A process approach," *Phys. Teach*. **40**(6), 351-355 (2002).

CF03: 4:42–4:54 p.m. How You Can Get More Time To Teach Your Curriculum

Tracey M. Means, CTE, P. O. Box 825, Mims, FL 32754; mzzmeans@yahoo.com

Every teacher knows the frustration of losing instruction time to discipline. For some teachers and some students, the amount of time lost is very great. Time To Teach is a program proven to restore that lost time to teachers and students in a way that is simple, fair, and mutually respectful. At the core of the nationally acclaimed Time To Teach! program is the strategy of REFOCUS?. This is unquestionably the most powerful solution to problem behavior ever developed for the classroom teacher. By effectively using REFOCUS?, participants will experience fewer disruptions to teaching, more Time To Teach and more energy and fun than ever before. Participants will leave this session with tools to help them as they begin to address behaviors early and consistently, without multiple requests or repeated warnings. Session participants will find that their classrooms will run smoother than they ever thought possible!

CF04: 4:54–5:06 p.m. Using Assessment Data To Inform Instruction

Kathleen A. Falconer, Buffalo State College, Buffalo, NY 14222; falconka@buffalostate.edu

David Abbott, Dan MacIsaac, Luanna S. Gomez, David Henry, Buffalo State College

The Physics Summer Teachers' Academy is part of the alternative certification and Master's program at Buffalo State College. Teachers attend intensive, short duration courses on physics content and pedagogy. Standardized multiple-choice measures of content understanding and attitudes toward science for the Academy over the past five years will be presented and trends examined with an eye toward reforming instructional practice.

CF05: 5:06–5:18 p.m. Preparing Accomplished Teachers through a Masters of Natural Science Program

Christina M. Keller, The University of South Dakota, Vermillion, SD 57069; tina.keller@usd.edu

Miles Koppang and Cathy Ezrailson, The University of South Dakota

School districts located in areas of low population density are typically able to hire one person, or in rare cases two, to teach science within their high schools. Teachers in these circumstances face many barriers to becoming excellent teachers — including being asked to teach outside of their areas of expertise, being asked to prepare five to six unique classes each day, and experiencing a sense of isolation with no science colleagues to share ideas and answer questions. The Masters of Natural Science program at The University of South Dakota is a graduate program for high school teachers who are currently teaching outside of their area of expertise. We will describe the program, which includes content instruction, interdisciplinary courses, and the opportunity to connect with teachers in similar circumstances and provide examples of successful teachers who have completed the program.

CF06: 5:18–5:30 p.m. Preparing Elementary Education Majors for all the Sciences*

Thomas M. Foster, Southern Illinois University Edwardsville, Edwardsville, IL 62026-1654; tfoster@siue.edu

Preparing elementary education majors to teach physical science is not a new idea. Great programs such as PiPS, PSET, PbI, and others already exist. However, elementary teachers will teach more than physical science. At Southern Illinois University Edwardsville, we have created a two-semester course to introduce students to the science they will need to teach, including biology and geoscience. Each topic selected matches to an Illinois state learning goal, and the topics are taught using the 5E inquiry framework borrowed from the BSCS. The students are also challenged with Design and Experimental capstone projects. This talk will share some details of the curriculum, our success, and our work with community college partners to improve science education in the region.

*Funded by NSF: DUE-0837417

CF07: 5:30–5:42 p.m. Bringing Inquiry to the Pre-college Classroom through Research-based Professional Development*

Donna L. Messina, Physics Education Group, University of Washington, Seattle, WA 98195-1560; messina@phys.washington.edu

MacKenzie R. Stetzer, Peter S. Shaffer, and Lillian C. McDermott, University of Washington

The Physics Education Group at the University of Washington conducts an intensive six-week Summer Institute for K-12 teachers. Physics by Inquiry,[1] a research-validated curriculum, is used to help teachers deepen their understanding of topics relevant to the K-12 curriculum. In addition, the teachers have an opportunity to experience the impact of inquiry instruction on their own learning. The pedagogical approach used in the Summer Institute serves as a model upon which teachers may draw in their own teaching practice. Pre- and post-test results as well as RTOP scores before, immediately after, and several years after participation in the Summer Institute will be presented in order to illustrate the effects of the Summer Institute on K-12 teachers' content understanding and classroom practice.

*This work has been supported in part by the National Science Foundation.

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry*, Wiley (1996).

CF08: 5:42–5:54 p.m. Challenging Learning Assistants with Development of Representations of Student Thinking*

Hunter G. Close, Seattle Pacific University, Seattle, WA 98119; hclose@spu.edu

Rachel E. Scherr, University of Maryland

The aim of teacher preparation (TP) offered through the Physics Department at Seattle Pacific University is to attract intelligent and talented people to teaching by increasing their awareness of the potential intellectual life of the teacher. We have identified a new approach to TP for Learning Assistants (LAs) that emphasizes the thoughtful investigation of student ideas, organized around conducting physics interviews with students and reflecting on those interview experiences. In a recent twist, physics LAs at SPU are now being challenged to create some models of the interviewee's thinking using one or more representations other than the usual sentences and paragraphs. This exercise encourages the LA to contemplate the interviewee's expressions of thought more deeply and carefully, reinforces the idea that student thinking can be taken sincerely as it is, and reveals more about how LAs think students think.

*This work is supported in part by the NSF grant DRL-0822342.

Session CH: Progress in Modernizing the Large Physics Course for Engineers

Location: Washington 2
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: APS Forum on Education
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Ernest Behringer

CH01: 3:30–4:06 p.m. The Evolution of Introductory Physics at Washington University

Invited – Rebecca Trousil, Washington University in St. Louis, St. Louis, MO 63130; trousil@wustl.edu

In 2004, we introduced a new calculus-based introductory physics sequence, based on the Six Ideas That Shaped Physics curriculum by Thomas Moore, that was explicitly designed to foster an active-learning environment, to emphasize conceptual reasoning along with quantitative problem solving, and to develop students' ability to see connections within physics and to the world around them. Positive instructor and student feedback and increasing student interest resulted in the enrollment climbing from 65 students in the first year to 320 students in fall 2009. Last spring, we launched a study to investigate the similarities and differences in attitudes and learning among students taking our traditional, lecture-based introductory sequence and those in our active-learning sequence. This talk will describe how we have incorporated active-learning into a large classroom and present preliminary data on student attitudes toward learning physics and their conceptual reasoning and quantitative problem-solving abilities.

CH02: 4:06–4:42 p.m. Implementing Curricular Reform in Introductory Physics Courses at Georgia Tech

Invited – Michael F. Schatz, Georgia Institute of Technology, Atlanta, GA 30332; michael.schatz@physics.gatech.edu

Marcos D. Caballero, Richard Catrambone, and Marcus J. Marr, Georgia Institute of Technology

Matthew Kohlmyer, North Carolina State University

The reform curriculum, Matter and Interactions (M&I), was first introduced into Georgia Tech engineering physics courses in summer 2006; today the curriculum is taught to approximately 1000 students each semester. We will discuss some key issues associated with implementing a new curriculum in large-enrollment introductory courses. We will also describe efforts to measure the new curriculum's impact using both standardized assessment tools (concept inventories) and in-depth student interviews (think-aloud protocol studies). Finally, we will discuss ongoing work to enhance students' understanding of numerical computation and visualization introduced in the M&I curriculum.

CH03: 4:42–5:18 p.m. Experiences in Teaching and Coordinating Matter & Interactions at Two Universities

Invited – Matthew A. Kohlmyer, North Carolina State University, Raleigh, NC 27695-8202; makohlmy@ncsu.edu

Implementing and coordinating large-enrollment introductory physics courses at research universities is a complex task, due to large numbers of students, multiple faculty involved in teaching, and numerous course components including homework, tests, and labs. Making changes in curriculum content in such courses adds an additional challenge. I will discuss my involvement at Georgia Tech (from 2006-2008) and at NC State (2008-present) in teaching and coordinating courses using Matter & Interactions, a contemporary intro physics curriculum that is noticeably different in its learning objectives, content, topic organization, and pedagogy from the standard course. Specific approaches to dealing with challenges in such areas as management of labs and TA training, testing and assessment, developing new pedagogical materials, and mentoring faculty new to the curriculum will be described.

CH04: 5:18–5:54 p.m. Bringing Introductory Physics into the 21st Century at Purdue

Invited – Mark P. Haugan, Purdue University, West Lafayette, IN 47907; haugan@purdue.edu

In the fall semester of 2006, Purdue University began using the Matter & Interactions[1] curriculum to teach the calculus-based introductory physics course sequence taken by science and engineering students. The curriculum presents a remarkably coherent introduction to mechanics, thermal physics, and electricity and magnetism by integrating elements of contemporary physics, including the atomic structure of matter, and by emphasizing the use of fundamental physics principles to construct models, including computational ones, that predict or explain the behavior of physical systems. This presentation reflects on events leading to our adoption of this new curriculum, on our process of implementing it in courses taken by thousands of students per year and on our assessment of students' performance in the new courses. The implementation process is getting easier and easier because of the availability of well-tested course materials for recitation, laboratory, and homework, as well as support from a growing number of Matter & Interactions users.

1. R. Chabay and B. Sherwood, *Matter & Interactions*, 3rd ed., (Wiley, 2010).

Session CI: Research on Student Learning in Upper-Division Courses

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Co-Sponsor: APS Forum on Education
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Paula Heron

CI01: 3:30–4:06 p.m. Using Research To Enhance Student Learning in Intermediate Mechanics*

Invited – Bradley S. Ambrose, Grand Valley State University, Allendale, MI 49401; ambroseb@gvsu.edu

For many undergraduate physics majors the sophomore/junior level course in intermediate mechanics represents their first step beyond the introductory sequence. Over the past several years, research has shown that intermediate mechanics students often encounter conceptual and reasoning difficulties similar to those that arise at the introductory level. Many difficulties suggest deeply seated alternate conceptions, while others suggest loosely or spontaneously connected intuitions. Furthermore, students often do not connect physics concepts to the more sophisticated mathematics they are expected to use. This presentation will highlight results from research conducted at Grand Valley State University, the University of Maine (by co-PI Michael Wittmann) and pilot sites in the Intermediate Mechanics Tutorials project. These results, taken from the analysis of pre-tests (ungraded quizzes), written exams, and classroom observations, will illustrate specific student difficulties as well as examples of guided-inquiry teaching strategies that appear to address these difficulties.

*Supported by NSF grants DUE-0441426 and DUE-0442388.

CI02: 4:06–4:42 p.m. Research on Student Learning of Upper-Level Thermal and Statistical Physics*

Invited – John R. Thompson, The University of Maine, Orono, ME 04469-5709; john.thompson@umit.maine.edu

It is only fairly recently that physics education researchers have begun to investigate student learning of thermal and statistical physics in the upper division. Much of the research in thermodynamics has focused on student ideas about the first and second laws and the associated concepts (e.g., work, heat, entropy). Some studies also probe broader ideas (e.g., state functions). Research in statistical physics has focused on the concepts underlying multiplicity and related ideas in probability. Research has identified a number of conceptual difficulties with varied degrees of persistence. Some investigations further probe connections between physics and relevant mathematics concepts in these areas. Results from research are guiding the development of curricular materials in order to address several known difficulties.

*Supported in part by NSF Grants REC-0633951, DUE-0817282, and DUE-0837214.

CI03: 4:42–5:18 p.m. Improving Students' Understanding of Quantum Mechanics*

Invited – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@Pitt.edu

Guangtian Zhu, University of Pittsburgh

Learning quantum mechanics is challenging. We are investigating the difficulties that upper-level students have in learning quantum mechanics. To help improve student understanding of quantum concepts, we are developing quantum interactive learning tutorials (QuILTs) and tools for peer-instruction. Many of the QuILTs employ computer simulations to help students visualize and develop better intuition about quantum phenomena. We are also developing tools to assess students' understanding of these concepts. We will discuss the common students' difficulties and research-based tools we are developing to bridge the gap between quantitative and conceptual aspects of quantum mechanics and help students develop a solid grasp of quantum concepts.

*This work is supported by the National Science Foundation (NSF-PHY-0653129 and 055434).

CI04: 5:18–5:54 p.m. A Research-based Approach To Transforming Upper-Division Electricity & Magnetism

Invited – Steven J. Pollock, CU Boulder, Boulder, CO 80309; steven.pollock@colorado.edu

Katherine Perkins and Stephanie V. Chasteen, CU Boulder

We are transforming an upper-division electricity and magnetism course using principles of active engagement and learning theory. We are guided by systematic investigation of student learning difficulties, with the goal of developing useful curricular materials and suggestions for effective teaching practices. We observe students in classroom, help-session, and interview settings, and analyze written work. To assess student learning, we have developed and validated a conceptual instrument, the CUE (Colorado Upper-division Electrostatics) diagnostic. We have collaborated with faculty to establish learning goals, and have constructed a bank of clicker questions, tutorials, homework, and classroom activities. We find that students in the transformed courses exhibit improved performance over the traditional course, as assessed by common exam questions and the CUE, but there is still much work to be done. Our work underlines the need for further research on the nature of student learning and appropriate instructional interventions at the upper division.

Session CJ: Exploring the Nation's Attic

Location: Jackson
Sponsor: Committee on History and Philosophy in Physics
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Thomas B. Greenslade, Jr.

Three curators from the Smithsonian Institution in Washington will discuss their current research.

CJ01: 3:30–4:06 p.m. The Overhead Projector – Glimpses from the Smithsonian Collections

Invited – Peggy A. Kidwell, National Museum of American History, Smithsonian Institution, Washington, DC 20013-7012; kidwellp@si.edu

Carefully examining Smithsonian collections reveals a wealth of stories. Some are about common teaching tools that physics teachers have taken for granted. The history of the overhead projector well illustrates this. It originated in 19th-century European lecture halls, and diffused to the United States. In the 20th century, it also found a place in the bowling alley and, during World War II, in military instruction rooms. During the 1960s, new materials for lenses, new manufacturers, and increased funding for education combined to make the overhead projector a common tool of physics instruction. Objects, advertisements, and other documents at the Smithsonian demonstrate this transformation.

CJ02: 4:06–4:42 p.m. Joseph Henry and His Electromagnets in the Classroom

Invited – Roger E. Sherman, National Museum of American History, Smithsonian Institution, Washington, DC 20013-7012; shermanr@si.edu

Steven Madewell, National Museum of American History

Joseph Henry (1797-1878) is best known today for his discoveries in electromagnetic induction (the unit of inductance is named for him) and for his efforts, as first Secretary of the Smithsonian Institution, to enhance the stature of science in the United States. Essential to his success in both these endeavors were his early experiences as a teacher of natural philosophy, first at the Albany Academy and then at Princeton College. Teaching students brought home to him the importance of impressive demonstrations. Henry's efforts to make effective didactic electromagnetic instruments led him directly to important discoveries that resulted in the construction of the most powerful electromagnets in the world. Using small-scale reproductions of Henry's famous Yale magnet, we show how his design principles can be effectively communicated to students today.

CJ03: 4:42–5:18 p.m. "The National Physics Course"

Invited – Steven Turner, Smithsonian Institution, Washington, DC 20013-7012; turners@si.edu

Between roughly 1890 and 1910, physics teaching in American schools was transformed. The old lecture/demonstration method was abandoned and replaced with the student laboratory method. Remarkably, this national revolution in science teaching was accomplished without the existence of a strong national organization—neither the NEA nor the federal Bureau of Education had significant power during this period. Instead, the story of this transformation emerges from a unique combination of high-minded reformers, historical forces, and economic collusion. It's a distinctly American story, illustrated with science teaching instruments, science textbooks, and scientific trade literature from the Smithsonian collections.

CJ04: 5:18–5:30 p.m. Interesting Things About Isaac Newton

Scott C. Beutlich, Crystal Lake South H.S., Crystal Lake, IL 60014; sbeutlich@d155.org

This talk will be a historical outline of some well-known and not so well-known pieces of information about Isaac Newton. Most physics teachers talk about the main person behind classical Mechanics. But Newton himself was more interested in other topics including Light, chemistry and religious chronology. This talk will share some of the little stories and tidbits not found in most classroom textbooks.

CJ05: 5:30–5:42 p.m. The Use of Causal Warrants in Physics

Luke D. Conlin, University of Maryland, College Park, MD 20707; luke.conlin@gmail.com

The practice of science seems to hinge upon causal notions, but the nature of causation and its precise role in science has proved difficult to pin down. So, while most working scientists take causation as a given, many philosophers have doubted the need for any causal talk in science. John Norton has argued for a middle ground in which causal talk amounts to folk science, giving scientists a useful but empirically empty heuristic for doing science. Here I argue for a more ambitious role for causation than Norton: even if causal notions do not appear explicitly in our dynamical equations, they do make real, empirical differences in our theories. I demonstrate how causal notions can and do factually constrain our theories—both as mathematical conditions that can be empirically tested, and as warrants for throwing out spurious solutions to mathematical equations.

CJ06: 5:42–5:54 p.m. Pivotal Ideas of Physics

Genrikh M. Golin, Touro College, 448 Neptune Ave. , # 5K, Brooklyn, NY 11224; genrikhgolin@yahoo.com

Among a vast number of physical ideas of the past and present, only few can be named as the ones that had played an important role in development of physics. On the one hand, an idea of this kind comprises the latest scientific achievements in a most focused and concise way; this allows us to consider it as the highest form of scientific knowledge. On the other hand, the idea appears to be a heuristic method of knowledge. Scholars investigate nature in the darkness; there is no "royal road" in science, and it is very important to have some landmarks along the way to the unknown, which show that the researcher has not chosen a totally wrong way in his or her efforts to reveal the secrets of nature. These pivotal ideas in physics include among others the ideas of simplicity, conservation, symmetry, correspondence, complementary, unity of the world picture. Thus, the idea of conservation "forced" Pauli to put forward a hypothesis of neutrino, the idea of symmetry "prompted" Maxwell's hypothesis of displacement current, idea of correspondence was as N.Bohr put it, a "magic wand" in the initial period of the atomic theory formation, etc.

Session FF: How To Advocate for Science Locally, Regionally, and Nationally

Location: Washington 1
Sponsor: Committee on Physics in Two-Year Colleges
Date: Monday, Feb. 15
Time: 3:30–5:54 p.m.

Presider: Pat Viele

FF01: 3:30–4:06 p.m. Advocating from the Classroom

Invited – Francis Slakey, Georgetown University, Washington, DC 20057; slakeyf@georgetown.edu

An effective means to teach students the connection between science and public policy is to have them think outside the textbook and directly engage in problem solving with experts in government, industry, and NGOs. This talk describes the development of this teaching concept at Georgetown University where students have had their ideas included in bills voted on by Congress and ultimately signed into law. This has led to a network, GlobalSolver.org, which allows science undergraduates from across the country to consult with experts and develop ideas.

FF02: 4:06–4:42 PM Science, Society, and Social Networking

Invited – Kasey White, AAAS (American Association for the Advancement of Science), Washington, DC 20005; kwhite@aaas.org

Tiffany Lohwater and Joanne Carney, AAAS

The American Association for the Advancement of Science (AAAS) uses a variety of online networks to engage its members and the broader scientific community. These tools allow scientists, educators, and others to become engaged in policy by providing information and methods of involvement. For example, members and the public can comment on policy-relevant stories from Science magazine's ScienceInsider blog, download a weekly policy podcast, receive a weekly email update of policy issues affecting the science community, or watch a congressional hearing from their computer. AAAS members and nonmembers can interact with AAAS staff and each other on AAAS sites on Facebook, YouTube, and Twitter, as well as blogs and forums on the AAAS website (www.aaas.org). AAAS resource websites and outreach programs, including Communicating Science (www.aaas.org/communicatingscience) and Science Careers (http://sciencecareers.sciencemag.org) also provide tools for scientists to become more personally engaged in communicating their findings and involved in the policy process.

FF03: 4:42–5:18 p.m. How To Advocate for Science Locally, Regionally, and Nationally.

Invited – Julie C. Benyo, WGBH Educational Foundation, Boston, MA 02135; julie_benyo@wgbh.org*

In the past five years more than 100 science café event series have popped up in the United States with the support of the public television program "NOVA scienceNOW." Featuring a conversation between a scientist and the public in a casual venue like a pub or restaurant, science cafés present the opportunity to reach beyond the traditional science enthusiasts to an audience that is not accustomed to science conversations. National evaluations of the café format show that it is effective at influencing attendees' attitudes toward current science research. Importantly, café events also have important impacts on the presenting scientists. The lessons learned from these public science conversations will be presented in the context of the panel topic.

*Invited by Patricia T. Viele

FF04: 5:18–5:54 p.m. Lessons Learned from Year of Science 2009 – Now What?

Invited – Jennifer A. Collins, Consortium for Ocean Leadership–Deep Earth Academy, Washington, DC 20005; jen@paleobio.org

A broad spectrum of the scientific, education, and business communities are concerned that science and our leadership in science are at risk. Cross-cutting this is an assault on the fundamental nature and role of science in society by groups with anti-science agendas. To help reverse these trends, a grass-roots effort has emerged—the Coalition on the Public Understanding of Science (COPUS)—and with it a cross-disciplinary national initiative to provide new opportunities for engaging the public in science—the Year of Science 2009 (YoS09). In this session we will share some of the results and lessons learned from the YoS09 efforts, highlight resources available to support science advocacy efforts, and discuss new and exciting ways to reach out to the public, teachers, and students—including the Understanding Science website and the USA Science Festival 2010.

Session JB: Teaching with Technology – II

Location: Salon 3
Sponsor: Committee on Apparatus
Date: Monday, Feb. 15
Time: 3:30–4:18 p.m.

Presider: TBA

JB01: 3:30–3:42 p.m. Verification of Malus Law of Light Polarization by Using a Data Acquisition System

Periasamy Ramalingam, American University of Nigeria, Yola, School of Arts & Sciences, Yola, Adamawa, Nigeria; periasamy.ramalingam@aun.edu.ng

Bamidele Ajide Adeolu, Federal University of Technology

The polarization of light is one of the most remarkable phenomena in nature and has led to numerous discoveries and applications.Polaroid filters absorb one component of polarization while transmitting the perpendicular components. A simple experimental arrangement based on computer-controlled data acquisition system was used to measure the light intensity transmitted through two coaxial polarizers and the angle theta of the axes of the polarizers. This optical setup helps our undergraduate students in the verification of Malus' law of light extinction as well as the transverse nature of light. The students get to have a real-time display of the experimental data, which facilitates the analysis and mathematical interpretation of the results. The excellent quantitative and qualitative results are to be presented

JB02: 3:42–3:54 p.m. Tablet Computers and Digital Ink for Efficient Intro. Physics Recitations

Cynthia J. Sisson, Louisiana State University in Shreveport, Shreveport, LA 71115; cynthia.sisson@lsus.edu

This talk discusses the use of the digital inking capability of tablet computers for recitations in introductory physics courses. Efficiency was especially important in these classes, as there was no scheduled recitation day; problem-solving days came at the expense of lecture and other class activities. Over the two years of this study, one day per week in three-day per week courses was replaced with a tablet-computer assisted recitation, with students working in collaborative groups on physics problems. The digital-ink capability of the tablet computers allowed students to draw diagrams, write out equations, and solve problems exactly as they would do on a piece of paper while simultaneously allowing the instructor to quickly evaluate student solutions and present exemplars to the class multiple times within the 50-minute class meetings. Student outcomes of this study (FCI post-test, final exam scores, and overall course performance) have been encouraging.

JB03: 3:54–4:06 p.m. Modeling Applied to Problem Solving

David E. Pritchard, Massachusetts Institute of Technology, Cambridge, MA 02139; dpritch@mit.edu

Andrew Pawl, Saif Rayyan, and Analia Barrantes, MIT

Modeling Applied to Problem Solving (MAPS) is a pedagogy that helps students transfer instruction to problem solving in an expert-like manner. Declarative and Procedural syllabus content is organized and learned (not discovered) as a hierarchy of General Models. Students solve problems using an explicit Problem Modeling Rubric that begins with System, Interactions and Model (S.I.M.). System and interactions are emphasized as the key to a strategic description of the system and the identification of the appropriate General Model to apply to the problem. We have employed the pedagogy in a semester-long freshman mechanics course plus two three-week review courses for students who received a D in mechanics in 2009 and in 2010, and we will present the results.

JB04: 4:06–4:18 p.m. Research on Student Model Formation and Development in Physics

Mark J. Lattery, University of Wisconsin Oshkosh, Oshkosh, WI 54902; lattery@uwosh.edu

Christopher Hathaway, University of Wisconsin Oshkosh

The research literature on modeling in science education is rapidly growing. This literature focuses on several related questions: How can scientific models and modeling be used to enhance K-16 science learning? How and why do student models change? What is the relationship between model development in the modern classroom and the history of science? This project examines student model formation and development in a university-level physical science course. The essence of my research method is to engage students in a modeling task involving a two-way trip of a fan cart (analogous to a vertical ball toss). Following classroom experiments and discussion, students attempt to render their models electronically using an interactive simulation program called Modeling Aid. Student thinking and reasoning are captured and studied using Techsmith Morae. Connections to history of physics are discussed. This research is supported by the Spencer Foundation (Grant #200800161) and the UW System Office of Professional and Instructional Development.

LaserFest Public Lecture

Location: Salon 3
Date: Monday, Feb. 15
Time: 7–8:30 p.m.

From Edible Lasers to the Search for Earth-like Planets – Five Decades of Laser Spectroscopy

Speaker: Theodor Hänsch, Director, Max-Plank-Institute für Quantenoptik, Professor, Ludwig-Maximilians Universität, München, Germany

Dr. Hänsch won the Nobel Prize in Physics (2005) with John L. Hall for developing laser-based precision spectroscopy.

Session PST1: Labs & Apparatus, Teacher Training & Lecture/Classroom

Location: Exhibit Hall A
Date: Monday, Feb. 15
Time: 8:30–10 p.m.

Authors should put up their posters at 8 a.m. Monday.
The authors should be present at the times listed on abstracts: odd numbers, 8:30–9:15 p.m.; even numbers, 9:15–10 p.m.

A) Labs & Apparatus

PST1A-1: 8:30–9:15 p.m. Optical Emission Spectroscopy of Microwave Induced Plasma

Brian H. Kim, Watchung Hills Regional High School, Warren, NJ 07059; kim.brian92@gmail.com

Sophia Gershman, Watchung Hills Regional High School

Microwave induced plasmas (MIP) are widely used in material processing and surface modification. The chemical processes in MIP and the results of the processing depend on the gas and plasma temperatures. In this work, a microwave induced plasma reactor was constructed using a household microwave oven. Atomic and molecular emission spectroscopy was used to determine the plasma temperature and the gas temperature in the chamber. The temperature was determined for various pressures, gas flow rates, and gas compositions. Optical emission spectroscopy used here provides a portable, noninvasive and fast plasma diagnostic method. It provides fast access to plasma temperature that is an important parameter for plasma applications.

PST1A-2: 9:15–10 p.m. Water Purification With Atmospheric Pressure Plasma

Jasmine K.Y. Lo, Watchung Hills Regional High School, Warren, NJ 07059; jl71894@hotmail.com

Manaswini Rajaram and Wesley Yiin, Watchung Hills Regional High School

A new way to decontaminate and disinfect water without the addition of chemicals is to use atmospheric pressure plasma. This project used pulsed electrical discharge to form plasma in gas bubbles in water. The plasma contains electrons, photons, and active radicals that disinfect and decontaminate the water. To increase the throughput and the efficiency of the process, we redesigned the reactor and constructed a power supply. The new power supply allows a greater pulse rate and therefore a greater spark rate in the reactor. The new power supply combined with the redesign of the reactor leads to more effective decontamination of water samples.

PST1A-3: 8:30–9:15 p.m. Improved Production of Hydrogen via Photo-Electrochemical Cells

Christopher A. Pang, Watchung Hills Regional High School, Warren, NJ 07059; pangster08@gmail.com

Michael J. Wu and Edbert K. Li, Watchung Hills Regional High School

Photo-electrochemical cells (PECs) can use the full solar spectrum not only for electrical power, but also for energy storage through hydrogen production. PECs are currently the cleanest method of hydrogen production. We designed and tested the PECs in conjunction with a broader study delving into the possible uses of local biofuel resources. Our research looked into the feasibility of certain new semiconductor materials well suited to water electrolysis, new techniques for energy control, the addition of certain catalysts, and the effect of environmental factors like pH, solution composition, etc. The performance of the PECs was analyzed in terms of charge separation and transfer, electron excitation, generation of voltage, and hydrogen produced. PEC technology promises to be a great source of future energy.

PST1A-4: 9:15–10 p.m. The Effect of Electromagnetic Fields on Rat Neural Cells

Dennis D. Xuan, Watchung Hills Regional High School, Warren, NJ 07059; dennisxuan1@optonline.net

Alex B. Hanna and Sophia Gershman, Watchung Hills Regional High School

Accumulation of the fragments of the APP protein in neural cells results in cell apoptosis that is associated with Alzheimer's disease. Exposure of neural cells to electromagnetic fields can affect protein production. In this experiment we exposed rat neurons to electromagnetic fields at varying frequencies and times. We analyzed the cells through microscopy and electrophoresis before and after the exposure to the fields. The study of the effects of electromagnetic fields on neurons may lead to a more complete understanding of the causes of Alzheimer's disease.

PST1A-5: 8:30–9:15 p.m. Effects of Ultraviolet Radiation on Dust Cloud in Glow Discharge

Brendan W. Wu, Watchung Hills Regional High School, Warren, NJ 07059; brendanwu92@gmail.com

Djohan M. Sutjiawan, Watchung Hills Regional High School

Plasma is used to etch circuit pathways in microchips, but microscopic dust particles are formed in the process, contaminating the chips. Manipulating the charge on dust particles may be used to control the behavior of the dust and possibly avoid contamination. Intense ultraviolet radiation was used in this experiment to change the dust charge. The plasma parameters were then determined using a Langmuir probe and optical emission spectroscopy. The dust behavior was observed and recorded using a laser-optics setup and a digital camera. This analysis yields a better understanding of individual and collective particle behavior in dust clouds, important for improving microchip manufacturing and for studying dusty plasma.

PST1A-6: 9:15–10 p.m. Comparing Data Analysis Techniques for the Undergraduate Lab

Joseph J. Trout, Drexel University, Philadelphia, PA 19104; st92l7c3@drexel.edu

Various data analysis techniques used in introductory physics labs are compared and contrasted. Error analysis methods are also discussed.

PST1A-7: 8:30–9:15 p.m. Looking into the Infrared

Helio Takai, Brookhaven National Laboratory, Upton, NY 11973; takai@bnl.gov

An inexpensive spectrometer and infrared camera are used to look at the emitted light from the IR to the UV. The spectrometer is tunable

and uses a piece of a CD-ROM as a diffraction grating. The spectrometer is surprisingly linear and can be combined with the IR camera, built from a webcam, to detect up to 1000 nm. Both can be built by students and used to explore many different physical phenomena such as light absorption, fluorescence, and so on. The camera as a stand-alone unit can be used to visualize objects under IR light.

PST1A-8: 9:15–10 p.m. On-line Simulations vs Traditional Experiments in the Introductory Physics Laboratory

Tatiana Stantcheva, Northern Virginia Community College, STB Division, Alexandria, VA 22311; tstantcheva@nvcc.edu

The laboratory component has proved to be a significant obstacle to teaching introductory physics courses in nontraditional formats. In attempt to investigate possible alternatives, we created a set of online simulations as a replacement to several of our laboratory experiments. Using the University of Colorado's PhET Interactive Simulations, we wrote up laboratory manuals for the selected simulations that closely follow the format and activities of the traditional experiments. Students were then asked to perform the experiments in both formats and supply feedback. The resulting surveys showed that students consistently ranked the online simulations equal or higher than the regular experiments on clarity and effectiveness. Yet, they also indicated that the real-life hands-on experience that a traditional laboratory provides was highly valued and expected it to remain a part of the physics class.

PST1A-9: 8:30–9:15 p.m. Quantitative Demonstrations of Lenz's Law

Joseph A Sinacore, Newfield High School, Selden, NY 11784; jsinacore@mccsd.net

Helio Takai, Brookhaven National Laboratory

In the typical high school physics classroom, teachers introduce Lenz's law by demonstrating the slow fall of a strong magnet through a copper pipe. The ensuing discussion is often limited to a qualitative description of the phenomenon, and the opportunity for further inquiry is missed. In this work, we have carried out a series of simple experiments based on the falling magnet demo, measuring the magnet velocity using two telephone pick-up coils, a software oscilloscope, and different pipe materials and dimensions. Each experiment yields quantitative results that provide reinforcement of basic concepts from both kinematics and electromagnetism.

PST1A-10: 9:15–10 p.m. Amusement Park Physics: Data-Collection Equipment

Peter Sheldon, Randolph College, Lynchburg, VA 24503; psheldon@randolphcollege.edu

Kacey Meaker, University of Califormia at Berkeley

A great way to motivate students to be excited about physics, and to show real-life applications, is to take students to an amusement park to study the physics of the rides. The physics of rides can be understood by first-year physics students in college, high school, or even earlier. Students can make qualitative observations or take data that they can analyze using basic mechanics. We have tested and compared the physics classroom standards of GPS, altimeter, and accelerometer to cheaper alternatives, to more expensive professional equipment, and to popular alternatives such as the iPhone. This is part of a larger project, a book on the physics of rollercoasters. We will share some of what we know about coasters, and we will discuss the best ways for students to take meaningful data, which equipment works, and which equipment works best for various applications.

PST1A-11: 8:30–9:15 p.m. USB Hall Probe B Field Measurements Along a Solenoid Axis

S. Clark Rowland, Andrews University, Berrien Springs, MI 49104-0380; rowland@andrews.edu

Mickey D. Kutzner, Andrews University

The magnetic field B, generated by the current in a solenoid, is fundamental to further understanding of Ampere's law. Since Hall probes are costly, it has been a challenge to develop a quantitative elementary physics experiment demonstrating this important relationship. We have used the new, low-cost USB-based Hall probe manufactured by Physics Enterprises to measure the field strength as a function of position along the axis of a solenoid of finite length. A plot of B vs z is consistent with predicted values of magnetic field for such a finite length solenoid.

PST1A-12: 9:15–10 p.m. Using Student-authored Lab Proposals in an Introductory Physics Course

Bruce Palmquist, Central Washington University, Ellensburg, WA 98926; palmquis@cwu.edu

The laboratory portion of a first-year calculus-based physics course was organized in two-week blocks. During the first week, students did a hands-on exploration of a topic selected by the instructor with the goal of developing a basic lab proposal to present to the class for a vote. Whichever proposal got the most votes would be the lab done the following week. The lab handout for week two would be the winning proposal from week one. The proposal format included: brief statement of purpose, specific hypothesis, five- to seven-step procedure, predicted result, and list of materials. A proposal evaluation rubric was developed. This instructional method effectively addressed the AAPT's four goals of the introductory physics laboratories (www.aapt.org/Policy/goaloflabs.cfm) as well giving students ownership of the concepts and procedures covered. The main detriment of this method is that students need significant practice to determine what makes an effective lab proposal.

PST1A-13: 8:30–9:15 p.m. High-Voltage Power Supply

Brian C. Merrill, 580 Mountain Ave., Gillette, NJ 07933; Rockclimberd07@aol.com*

Plasma sterilization and treatment of surfaces use low-temperature plasma sources. These plasma sources require usually expensive kilo-Hertz range high-voltage power supply. A new, inexpensive power supply was designed and constructed for the low-temperature plasma sources. This high-voltage power supply has been made using a transformer driven by a pulse modulating device. This power supply has regulated and reliable frequency, voltage, and current. The creation of the power supply has led to the ability to create cold plasma for sterilization and for the development of a plasma pen.

*Sponsor: Sophia Gershman

PST1A-14: 9:15–10 p.m. Another Lab on the Thermal Properties of Rubbers

Mark I. Liff, Philadelphia University, Philadelphia, PA 19144; liffm@philau.edu

Ileana Ionascu, Philadelphia University

We converted a demo on the thermal properties of rubber into a quantitative experiment that may serve as a base for a student lab. The apparatus—some elements of it were described earlier elsewhere—includes a wooden uniform bar with a stretched rubberband that is surrounding the bar. The band is hanging on a peg fixed in space. The bar is balanced initially in the horizontal direction approximately at its geometrical center. The right side of the band is heated while the other one is screened from heat. This causes the bar's counterclockwise (ccw) rotation. At a certain critical angle which is rather small—just a few degrees—the bar falls off and the assembly collapses. We discuss possible reasons for the existence of the critical angle.

PST1A-15: 8:30–9:15 p.m. Generating a Hysteresis Loop Using a USB Hall Probe

Mickey D. Kutzner, Andrews University, Berrien Springs, MI 49104-0380; kutzner@andrews.edu

S. Clark Rowland and Andrew R. Kutzner, Andrews Academy

Few activities teach the relationship between the magnetic induction, *B*, and the applied magnetic field intensity, *H*, as graphically as the generation of a hysteresis loop in ferromagnetic materials. In this experiment, we use an iron-core toroid with variable current and a small gap for insertion of a Hall probe. The new USB Hall probe manufactured by Physics Enterprises is used to measure *B* for a variety of current values both positive and negative and we plot *B* vs the current, *I*. For sufficiently large *H, B* reaches its saturation value, but by cycling the applied field with small amplitude, a minor hysteresis loop is formed. The energy loss per cycle of the applied field is determined from the area enclosed within the hysteresis loop.

PST1A-16: 9:15–10 p.m. Development of Modified Scanning Monochromator for Undergraduate Laboratory

Daehwan Kim, Seoul National University, Optics Lab, Seoul, Korea 151-748; kdh2707@snu.ac.kr

Sungmuk Lee, Seoul National University

We made Modified scanning Czerny-turner monochromator using self-developed Rotational flexure bearing. Especially, we realized a more detailed scanning monochromator by using siphon principle and distinguished doublet & triplet of Mercury lamp. Also, we could advance the ability of Modern Physics in undergraduate laboratory students by using Application of modified scanning monochromator system.

PST1A-17: 8:30–9:15 p.m. Experimental Method for Correcting Misconception on Light and Color

Bukyung Jhun, Gyeonggi Science High School, JanganGu SongjukDong 68-23, Suwon, Korea 440-800; jhunys@paran.com

Youngseok Jhun, Seoul National University of Education

There are two common myths on light and color. The one is that a red transparent sheet can only pass the red light and the other is that you can make yellow light by adding red to green. Quantitative experiment can be a way to examine your own thought to have a clue for the correction of it. While a spectroscope may be a strong tool to deal with the above-mentioned myths, existing commercial spectroscope is very expensive and a kind of black box to use in high school classes. We made a spectroscopic system precious enough to analyse the light spectrum from various light sources with reasonable cost. We had used the paper box in making a spectroscope and took pictures with digital camera to analyse the spectrum with new-made computer program. We acquired the transmittance of various colored transparent sheets with respect to the wavelength with the spectroscopic analysis system. We also compare the light spectrums from the yellow LED and spectrums of yellow light from LCD monitor.

PST1A-18: 9:15–10 p.m. Photon Quantum Mechanics in the Undergraduate Curriculum*

David P. Jackson, Dickinson College, Carlisle, PA 7013; jacksond@dickinson.edu

Brett J. Pearson

Armed with an NSF CCLI grant, the Department of Physics at Dickinson College is infusing various optics experiments throughout the physics curriculum. The ultimate goal is to bring students face to face with some of the fascinating and subtle aspects of quantum mechanics in a hands-on setting. Planned experiments include single-photon interference, the quantum eraser, and tests of Bell's theorem. This poster will provide an update on our progress and highlight some of our successes and difficulties thus far.

*Supported by NSF CCLI grant DUE-0737230

PST1A-19: 8:30–9:15 p.m. Current Efforts To Preserve the Nikola Tesla Laboratory at Wardencyffe

Richard Gearns, Sachem High School East, Farmingville, NY 11738; rgearns@sachem.edu

Carl Erickson, Sachem High School East

In Shoreham, NY, physicist and inventor, Nikola Tesla built his Wardenclyffe laboratory and tower for experiments on wireless communication and power transmission. The laboratory and tower were designed by renowned architect Stanford White. Tesla planned to develop a World Wireless System of free wireless power distribution and wireless communication from this location. After many years as an industrial site, the laboratory is for sale. The efforts of local residents and political leaders to acquire the site and turn it into a museum will be discussed. Recent and historical photographs will provide a glimpse into the future of the site as a science center specializing in physics programs.

PST1A-20: 9:15–10 p.m. WebLabs – A Way To Submit Lab Reports Online

Duane L. Deardorff, The University of North Carolina at Chapel Hill, Chapel Hill, NC 27599; duane.deardorff@unc.edu

Raj Saha, The University of North Carolina at Chapel Hill

For the past three years at UNC-Chapel Hill, we have been using a program called WebLabs that was developed by graduate student Raj Saha to facilitate the online submission and grading of student lab reports for our introductory physics labs. This system uses a database (MySQL) to store questions, student responses, and TA comments with points deducted for ensuring consistency when grading. Benefits and limitations of the system will be presented, along with a summary of student and TA feedback.

PST1A-21: 8:30–9:15 p.m. A Classroom Martian Rover

Todd Brown, University of Pittsburgh at Greensburg, Greensburg, PA 15601; ltbrown@pitt.edu

Katrina Brown and Christine McCreary, University of Pittsburgh at Greensburg

Simulating actual space missions would be exciting for students but is a challenge for school programs. One particularly current and successful mission, NASA's duo Mars Exploration Rovers, allows for an informative demonstration concerning the perils of extreme off-road navigation by remote control. We describe here an inexpensive, hands-on activity that simulates planetary exploration, such as that performed during the Rovers' mission, using easily obtainable materials.

PST1A-22: 9:15–10 p.m. Measuring the Acceleration Due to Gravity in a Sophomore Physics Lab

Charles Borener, Eastern Michigan University, Ypsilanti, MI 48197; cborenerj@emich.edu

Diane Jacobs, Eastern Michigan University

Many college students have difficulty observing that acceleration due to gravity is a constant when analyzing the motion of a cart down an inclined air track. They often cannot make the connection that it is gravity pulling the cart down the incline. This is unfortunate as the results of the measurement are usually excellent. We have written two different experiments in which the students drop an object and analyze its motion. Our goal was to not sacrifice accuracy while ensuring greater understanding of the physics. We gave the students a short quiz before and after the lab to assess comprehension of the concepts. As a control, the quiz was also given to several lab sections where the incline plane method is still used. We will discuss the outcomes of the assessments and correlate them with conceptual understanding exhibited in the laboratory reports.

PST1A-23: 8:30–9:15 p.m. Potential, Power, and Energy of Induced Pulse from Dropped Magnet

Joel C. Berlinghieri, The Citadel, Charleston, SC 29409; berlinghieri@citadel.edu

A magnetic pellet is released so that it drops through and along the axis of a coil. The drop-height above the coil is varied. The induced potential and resulting current are measured using a PASCO current/voltage sensor attached to an impedance connected across the coil. Potential and power are recorded as a function of the magnet's drop height above the coil's entry and exit points. Both entry and exit pulses can be used. A simple model is used to analyze the experiment and the data.[1] The rate of change of magnetic flux is proportional to the speed of the magnet entering or exiting the coil. The speed in turn is proportional to the square root of the height. The power is proportional to the square of the potential and thus directly proportional to the height. Total induced energy as a function of impedance can also be analyzed.

1. Joel C. Berlinghieri, *Physics Laboratory Manual for Scientists and Engineers*, Tavenner, 2009, ISBN 971-1-930208-35-3.

PST1A-24: 9:15–10 p.m. A Study of Training and Maintenance of Science and Laboratory Personnel

Solomon O. Aregbede, Lagos State University, Ojo, Lagos, Lago, Nigeria 234; areoye63@yahoo.co.uk

This study was a survey on the training and maintenance of laboratory personnel in secondary schools in Nigeria. A total of 285 questionnaires were administered and the results presented using percentages and mean. The results show that out of the three personnel that were expected to be in each school, only one was available. 70% of these attendants were holders of school certificates/ general certificate of education. The laboratory personnel needed to be trained on general laboratory procedures, identification, and remedying simple faults in laboratory equipment. The condition of service of the laboratory personnel was found to be very poor. 60% of the schools visited had no laboratory equipment; those that have were with insufficient, outmoded, and sometimes faulty equipment.

PST1A-25: 8:30–9:15 p.m. Using Arduino Microcontrollers as Inexpensive Dataloggers

Eric Ayars, California State University, Chico, Chico, CA 95929-0202; ayars@mailaps.org

The Arduino is an open-source microcontroller system that is relatively easy to use in a broad range of situations. I will be discussing some potential applications of the Arduino as a small (< 10 cm^3), lightweight (< 30 g), and cheap (< $100) datalogger. In addition to obvious uses of such a device in an undergraduate physics lab, there are numerous cross-disciplinary applications in fields such as biology, geology, and environmental science.

PST1A-26: 9:15–10 p.m. Development and Effect of Physics Toy Teaching-Learning Material for Motivation

Bongwoo Lee, Dankook University, Gyonggi-do, Republic of Korea 448-701; peak@dankook.ac.kr

Jeongwoo Son and Young Joon Shin, Gyeongsang National University

Heekyong Kim, Kangwon National University

We developed the physics toy teaching-learning material for improvement of learning motivation and investigated the effect of this material. We developed the physics toy teaching-learning model(SPEEE, Situation – Predication – Execution – Explanation – Expansion) followed by four principles. We applied these materials to middle school students. The results showed significant effect (p<0.05) on the learning motivation(relevance, satisfaction, confidence, attention). Especially, the attention factor showed a remarkable growth. Therefore, physics toy teaching-learning was effective in the development of students' physics learning motivation.

PST1A-27: 8:30–9:15 p.m. Service Learning Physics Labs with Elementary School Outreach

Carolyn D. Sealfon, West Chester University of Pennsylvania, West Chester, PA 19383; csealfon@wcupa.edu

Katalin Grubits, Marymount Manhattan College

We present two service-learning course models in which non-major physics students teach basic physics concepts to elementary-school students. In one model, college students visit and teach in an elementary school classroom; in the other, college students design and implement hands-on activities at an after-school program. Such course structures promote student understanding, motivation, and confidence in communicating scientific ideas, while also benefiting the community. We summarize the logistics, successes, and lessons learned from each pilot course.

PST1A-28: 9:15–10 p.m. Student-oriented Plasma Physics Projects at Eastern Michigan University

James Carroll, Eastern Michigan University, Ypsilanti, MI 48197; jcarroll@emich.edu

Plasma physics is an excellent research area for junior- and senior-level students as it integrates topics studied throughout the physics curriculum. The wide use of plasmas, from spacecraft propulsion and possible energy sources to the manufacturing of solar cells, is intriguing to many different students. Undergraduate students working in the Eastern Michigan University Plasma Physics Laboratory engaged in a series of laboratory projects constructing and operating plasma sources and diagnostics. Students constructed a radio-frequency plasma source, built and operated a spherical Langmuir probe, and performed spectroscopic measurements. In another set of projects, students constructed a hollow-anode plasma source, built a double Langmuir probe and are currently using a residual gas analyzer to characterize the plasma and sputtered material. In these laboratory projects, students learned vacuum techniques and operated all diagnostics using LabView. This poster highlights the student laboratory projects.

PST1A-29: 8:30–9:15 p.m. WiSTEM Summer: A Photovoltaics Module for Incoming STEM Undergraduates

Marta L. Dark, Spelman College, Atlanta, GA 30331; mldark@spelman.edu

Monica Y. Stephens, Spelman College

Women in Science Technology, Engineering and Mathematics (WiSTEM)* is a residential summer program for incoming first-year students at Spelman College. A module on renewable energy and photovoltaic cells was developed in the Physics Department. The module?s objectives were to introduce incoming STEM majors to physical phenomena, to develop quantitative and communication skills, and to increase the students? interest in physics. The students completed library and internet research on renewable energy sources and photovoltaics. Working in small-groups, they investigated the behavior of silicon semiconductors through experiments they designed, carried out and analyzed. Following this study, they fabricated and tested organic dye Grätzel cells. At the end of the program, students gave presentations and wrote scientific papers on their work. This poster describes the program, the solar cell module, and presents experimental results obtained by the students.

*The WiSTEM program is supported by a grant from the U.S. Department of Education Minority Science and Engineering Improvement Program.

B) Teacher Training

PST1B-1: 8:30–9:15 p.m. Physics Teaching Resource Agents (PTRA): The Past, Present, and Future

James Nelson, AAPT/PTRA, 3000 NW 83rd St., Gainesville, FL 32606-6200 ; nelsonjh@ix.netcom.com

George Amann, AAPT/PTRA

Jan Mader, Great Falls High School (AAPT/PTRA)

Karen Jo Matsler, Education, Assessment & Training Inc. (AAPT/PTRA)

Twenty-five years ago, NSF awarded its first grant in which the Principle Investigators were high school teachers, and the Physics Teaching Resource Agents, or PTRA, program became a reality. Through the years Jim Nelson, Larry Badar, and Robert Beck Clark fine-tuned the teacher and curriculum enhancement program to include a story line, an assessment program, and a unified curriculum. As a result of the PTRA PLUS, Urban PTRA, and finally the Rural PTRA grants, the AAPT/PTRA program has received recognition as a quality provider of physics and physical science teacher training and in-service. The curriculum and instructional strategies are now being disseminated via Math Science Partnership grants in several states on a contractual basis. The past, present, and future of the AAPT/PTRA program will be presented, along with information as to how the PTRA program can assist your state in reaching highly qualified status for its physics and physical science educators.

PST1B-2: 9:15–10 p.m. Teaching Physics and Engineering to Pre-service Elementary Teachers Using Robots

Stephen J. Van Hook, Penn State University, University Park, PA 16802; sjv11@psu.edu

Mark Merritt and Annmarie R. Ward, Penn State University

This presentation describes a semester-long specialized science/engineering course for pre-service elementary teachers that uses robots as a context for learning about energy, electricity, magnetism, forces, and motion. Lego Mindstorm NXT robots are used through the course to: 1) motivate topics in physics, 2) perform experiments about the topics being examined, and 3) provide a platform for students to engage in collaborative engineering design. We will discuss some of the robotic activities developed for the course, the reaction of pre-service teachers to programming and using the robots, and the challenges of embedding this technology for teaching physics concepts in the classroom.

PST1B-3: 8:30–9:15 p.m. Elementary Teachers' Constitution of Identities as Teachers of Physics

Anna T. Danielsson, Dept. of Physics and Materials Science and Centre for Gender Research, Uppsala University, Uppsala, Sweden 75121; anna.danielsson@fysik.uu.se

I discuss the initial development of a project aiming to explore how elementary school student teachers constitute identities as teachers of science by negotiating the multiple, possibly conflicting subject positions that are actualized in their teaching of physics. In particular, the project will focus on the intersections of gender and the teaching and learning of science. This can include, e.g. the tension between how elementary teaching is associated with women, care, and human relations, versus how physics is dominated by men and conceptualized as a "hard science," independent of human relations. Theoretically the project integrates situated learning theory and post-structural gender theory, conceptualizing both learning and gender as aspects of identity constitution. The aim of the project is to contribute to theoretical and empirical development in the area of critical studies of gender, science, and learning, but also to inform a more inclusive science education.

PST1B-4: 9:15–10 p.m. Enhancements to Physics Pathway: Web-based Assistance for Teachers of Physics*

Dean A. Zollman, Kansas State University, Manhattan, KS 66506-2601; dzollman@phys.ksu.edu

Sytil K. Murphy and Christopher M. Nakamura, Kansas State University

Scott Stevens and Michael Christel, Carnegie Mellon University

The Physics Teaching Web Advisory (Pathway) is continuing to demonstrate the ability to address pedagogical issues of many physics teachers via the Web and to evolve as a tool for teachers. Pathway's "Synthetic Interviews" which engage teachers in a natural language dialog about effective teaching of physics now can display additional information in the forms of graphics and videos. The interview database is a growing digital library that now contains about 6000 different recorded answers and over 10,000 question/answer pairs. A new component is a collection of videos that are related to the interview questions and can be used directly in the classroom. This collection includes both professional and teacher-produced videos. Pathway is available at www.physicspathway.org

*Supported by the US National Science Foundation under Grants 0455772 & 0455813.

PST1B-5: 8:30-9:15 p.m. Nondirective Instruction on Newtonian Thinking and Attitude Toward Science

Stanley J. Sobolewski, Indiana University of Pennsylvania, Indiana, PA 15705; sobolews@iup.edu

This study will examine the attitude toward, and understanding of physics in pre-service primary school teachers. A nature of science survey and the Force Concept Inventory will be administered to elementary education majors enrolled in a program-specific physics class before and after instruction to determine if there is a change in these measures. Classroom instruction will be nondirective in approach, similar to a constructivist approach.

PST1B-6: 9:15–10 p.m. ATE Program for Physics Faculty

Thomas L. O'Kuma, Lee College, Baytown, TX 77522-0818; tokuma@lee.edu

Dwain M. Desbien, Estrella Mountain Community College

The ATE Program for Physics Faculty is finishing its fourth year and its 14th workshop/conference. In this poster, we will display some of the materials from these various workshops/conference and illustrate some of the activities, sessions, and individuals involved—particularly from the New Faculty Conferences for TYC and the DVTS-MBL Workshop at Springfield Technical Community College (MA).

PST1B-7: 8:30–9:15 p.m. Ranking Tasks and Science Teacher Preparation*

Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101; scott.bonham@wku.edu

Rico Tyler, Western Kentucky University

Ranking tasks are powerful tools for modeling higher order teaching and assessment for new and current teachers. There is currently great interest in higher order teaching and assessment due to the Kentucky College Readiness initiative and SKyTeach, Western Kentucky University's replication of the UTeach program for math and science teacher preparation. SKyTeach teacher candidates are trained in the use of ranking tasks beginning with the initial courses as they are simple yet powerful techniques for the type of inquiry-oriented instruction fundamental to the UTeach model. Pre-service teachers in the previous program and in the alternative certification route also learn to use them. In-service teachers also learn to use them through a variety of professional development initiatives, including the Middle School Science Circle, the ASK-IT program for middle school inquiry teaching, and the Explorer program preparing students for pre-college curriculum.

*Support from the National Math and Science Initiative, the Kentucky Council on Post-secondary Education, U.S. Department of Education, and Western Kentucky University

PST1B-8: 9:15–10 p.m. The PER User's Guide: Bringing Physics Education Research to Educators

S. B. McKagan, American Association of Physics Teachers, 2436 S. Irving St., Seattle, WA 98144; sam.mckagan@gmail.com

Researchers in physics education have made many important discoveries about how to teach physics effectively. Unfortunately, the results of such research are often hidden in research journals or available only by word of mouth, and thus inaccessible to practicing educators who need them most. This poster will give an overview of a new project to designed address the gap between research and practice in physics education. The PER User's Guide will be a web resource that will help educators by summarizing, condensing, and translating the vast web of knowledge contained in the field of PER into a format that is easily accessible, enabling educators to quickly find and use the information they need. Content will include guides to PER-based curricula and techniques, summaries of research results, and how they apply to classroom teaching, videos of exemplary classrooms, and forums to speak with experts, curriculum developers, and educators using similar methods.

PST1B-9: 8:30–9:15 p.m. Physics Applied to Astrobiology

Mary Ann Kadooka, University of Hawaii Institute for Astronomy, Honolulu, HI 96822; kadooka@ifa.hawaii.edu

Karen J. Meech, University of Hawaii Institute for Astronomy

The growing field of astrobiology, search for life in the universe, serves as the perfect venue for teachers to learn other sciences. As one of 14 NASA Astrobiology Institute (NAI) teams, the University of Hawaii Institute for Astronomy has done this through their national ALI'I teacher workshops since 2004. The teachers learn about the integration of science concepts from physics, chemistry, geology, and biology. Physics principles serve as a foundation for the other sciences. Spectroscopy in physics is applied to composition of substances, asteroids, and rocks. Gravitational forces affect orbits of comets. Changes due to research results such as Pluto's "demotion" demonstrate the dynamic nature of science. This can be seen as an opportunity for physics concepts to be promoted in all science courses for all students. Students can learn about the importance of physics and be encouraged to enroll in a high school physics course.

PST1B-10: 9:15–10 p.m. A Course in Physics Pedagogical Content Knowledge for Urban Chicago In-Service Teachers*

Virginia L. Hayes, Chemistry and Physics Dept., Chicago State University, Chicago, IL 60628; virginialenisehayes@yahoo.com

Joel Hofslund, Stephanie A. Barr, and Mel S. Sabella, Chicago State University

The science programs at Chicago State University are involved in developing a series of courses on Pedagogical Content Knowledge (PCK) through funding from the Illinois Board of Higher Education. This past summer we offered a PCK course in physics geared toward urban in-service science teachers from the Chicago area. During the course, teachers engaged in Physics Education Research (PER)-based instructional materials (adapted from materials in our National Science Foundation-Course, Curriculum, and Laboratory Improvement Project), read journal articles on science education, developed inquiry-based activities for their students, discussed student learning, and developed assessment questions designed to diagnose their students' level of understanding. Examples of participant work and classroom discussion will be presented to show how participants in the program engaged in integrating content understanding with their pedagogical knowledge. In addition, we provide evidence that these two types of knowledge build upon and reinforce each other.

*Supported by the Illinois Board of Higher Education, the National Science Foundation CCLI Program (#0632563) and the National Science Foundation Noyce Scholarship Program (#0833251)

PST1B-11: 8:30–9:15 p.m. Advocating a New Perspective on TA Professional Development

Renee Michelle Goertzen, University of Maryland, College Park, MD 20742; goertzen@gmail.com

Rachel E. Scherr and Andrew Elby, University of Maryland, College Park

Effective physics instruction benefits from respecting the physics ideas that introductory students bring into the classroom. We argue that it is similarly beneficial to respect the teaching ideas that novice physics instructors bring to their classrooms. We present a case study of a tutorial teaching assistant (TA), Alan. When we first examined Alan's teaching, we focused our attention on the mismatch of his actions and those advocated by the TA instructors. Further study showed us that Alan cared about helping his students and that his teaching was well integrated with his beliefs about how students learn physics and how teachers can best assist students. Learning about Alan's resources for teaching changed our thinking about what might constitute effective professional development for Alan and other TAs. We advocate a new perspective on TA training: one in which TAs' ideas about teaching are taken to be interesting, plausible, and worth understanding.

PST1B-12: 9:15–10 p.m. Developing Relationships of Sharing and Collaboration Across Grade Levels

Pamella Ferris, Riverside Middle School, 1095 Fury's Ferry Road, Evans, GA 30809; PamellaFerris@comcast.net

Lisa Tarman, William Penn Sr. High

Bruce Boehne, Zion Dallas Lutheran School

Gary Stark, Estes Park High School

James Morgan, Princeton Plasma Physics Laboratory (PPPL)

From July 6 through Aug. 14, middle and high school science teachers from all parts of the country attended one of two programs offered at the Department of Energy (DOE) Princeton Plasma Physics Laboratory (PPPL) to learn about plasma, fusion and the science research process. Academies Creating Teacher Scientists (ACTS), a six-week program and Plasma Camp a one-week program both met during the summer of 2009. The friendships formed during those residential programs have developed into professional relationships of sharing and collaboration. High school physics teachers and middle school physical science teachers have shared teaching ideas and their students have interacted via the Internet.

PST1B-13: 8:30–9:15 p.m. Evaluation of a Physics by Inquiry Program for K-12 Teachers*

Robert J. Endorf, University of Cincinnati, Cincinnati, OH 45221-0011; Robert.Endorf@UC.edu

Don Axe, Amy Girkin, Jeffrey Radloff, University of Cincinnati

Kathleen M Koenig, Wright State University

We will describe and report on an evaluation of the Physics by Inquiry[1] professional development program for K-12 teachers at the University of Cincinnati. A four-week 120-hour graduate course in Physics by Inquiry has been conducted for teachers in grades 5-12 and a separate two-week 60-hour course has been held for teachers in grades K-5, each summer since 1996 with a total of 495 teachers completing one of the courses. Results will be presented from an evaluation of pre-tests, post-tests, journals, and surveys completed by the participants. The evaluation found large gains in the teachers' science content knowledge, science process skills, and in the teachers' confidence in preparing and teaching inquiry-based science lessons.

* Supported by The Improving Teacher Quality Program administered by the Ohio Board of Regents.

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry,* Wiley (1996).

PST1B-14: 9:15–10 p.m. Initial Professional Learning for Physics Teachers in Oranim College

Osnat Eldar, Oranim Acdemic College of Education Israel, Timrat, Israel 36576; eldar@oranim.ac.il

The program for teacher certificate in Oranim College consists of several courses that prepare the future teacher to perform demonstrations, to use media and technology tools, and to organize effective laboratory experiences. The program combines learning in the college classes, observing accomplished teachers in high school classes, and peers teaching in the college. This presentation will demonstrate the program and present examples of the course's outline and of the future teacher's outcome.

PST1B-15: 8:30–9:15 p.m. Physics Teacher Education Program – One Example from Finland

Ville Nivalainen, University of Joensuu, Joensuu, Finland 80100; ville.nivalainen@joensuu.fi

Mervi A. Asikainen and Pekka E. Hirvonen, University of Joensuu

The teacher education program in Joensuu is affected by European didactics and Anglo-Saxon influence. European didactics concentrates on questions what, why, and how to teach. It analyzes the content and the structure of physics in terms of phenomena, concepts, quantities, laws, and theories. The Anglo-Saxon tradition offers certain aspects of learning, e.g. preknowledge, and different viewpoints of modeling. Based on these traditions, we have developed our physics teacher education program. Almost all of our courses have been piloted before including in the program. Our Bachelor's degree contains the traditional physics courses, the same that future physicists take, and two laboratory courses aimed at student teachers. Master's degree consists mainly of special courses designed only for student teachers. The value of the program is evaluated by sending a questionnaire to graduated students working at schools. The last evaluation was done in 2002 and the next evaluation will be done in 2010.

PST1B-16: 9:15–10 p.m. Pre-service Teachers' Objectives and Attitudes to Laboratory Work

Ville Nivalainen, University of Joensuu, Joensuu, Finland 80100; ville.nivalainen@joensuu.fi

Mervi A. Asikainen and Pekka E. Hirvonen, University of Joensuu

There is a rising concern that pre-service teachers do not understand all the objectives of laboratory work that should be included in physics teaching at school. In this study, third-year preservice teachers' understanding of the objectives of laboratory work as part of physics teaching, as well as the background of their attitudes on using laboratories, were investigated. Data were collected by essays and interviews and content analysis was used for the analysis of the data. Results indicate that pre-service teachers can come up with only a few meanings for laboratory work based on their school history and conventional physics studies at university. In addition, they are not aware of some of the most central objectives that laboratory work should have in school teaching. Pre-service teachers' attitudes to laboratories form during their secondary level education. However, significant changes occur in students' attitudes during university studies.

PST1B-17: 8:30–9:15 p.m. Supporting STEM Teachers and Noyce Scholars via Online Social Networking

Gregory D. Phelan, Dept. of Chemistry, SUNY Cortland, Cortland, NY 13045; gregory.phelan@cortland.edu*

Seattle Pacific University created an online social networking tool to support the work of STEM teachers working in elementary and secondary education. Through the use of a social group created on Facebook, teachers were encouraged to interact with each other in an example of just-in-time mentoring. The group currently has more than 120 members from throughout the United States. The work being presented here is an examination of the efficacy of the use of social networking tools as a way to increase STEM teacher retention.

*Sponsor: Stamatis Vokos

PST1B-18: 9:15–10 p.m. Hands-On Research for High School Teachers and Students

Daniel A. O'Brien, Saint Peter's College, Jersey City, NJ 07306; dobrien@spc.edu

The newly formed Center for Microplasma Science and Technology at Saint Peter's College has been founded to be a national clearinghouse for research in microplasmas. Constitutive of this work is educational outreach. An extensive summer program, using money from several grants, is bringing promising young students to the college for summer research. This effort is now extending into research done during the school year. A division of the CMST, the PARSE Institute, is running a summer program for in-service and pre-service science teachers. The four-week program includes instruction on pedagogy, two weeks of hands-on research, and a week of synthesis. The program is unique in its mix of research, instruction, students, and teachers. The program is also interested in addressing the shortfall of physics majors by involving younger students and nontraditional students. Many students have just completed freshman year in a "physics first" high school. Almost all are from urban districts. Stipends are available for most students, so that those under economic pressure don't have to take a summer job. Teachers are given a stipend for the same reason. Early results have been encouraging.

PST1B-19: 8:30–9:15 p.m. New Faculty Training Experience – For Two-Year College Instructors

Todd R. Leif, Cloud County Community College, Concordia, KS 66901; tleif@cloud.edu

Scott Schultz, Delta College

Warren Hein, American Association of Physics Teachers

The American Association of Physics Teachers has received an NSF grant to provide a New Faculty Training Experience for Two-Year College Physics Instructors. Professor Scott Schultz, Delta College, and Dr. Todd R. Leif, Cloud County Community College, along with AAPT CEO Warren Hein, will be the principle investigators for the grant. This effort follows a successful pilot project run by a group of Two-Year College Physics Instructors. The poster will describe the new program.

PST1B-20: 9:15–10 p.m. A Photonics Workshop for Secondary School Teachers

Paul J. Marchese, Queensborough Community College, Bayside, NY 11364; pmarchese@qcc.cuny.edu

Rosalie Bautista, Queens High School of Teaching

George Tremberger and Cheryl Bluestone, Queensborough Community College

Caterina La Fata, Graduate Center City University of New York

The Laser Academy at Queensborough Community College informs high school science teachers and students about photonics, a multi-trillion-dollar industry with applications in medicine, defense, entertainment, communication, and manufacturing. Participants of the program learn general optics, fiber optics, lasers, electronics, and communications. Participants also learn about career opportunities in the field of optical science and technology in general. Science teachers participate in the academy at the beginning of summer where, in addition to the science and technology components, they also learn about the most effective methods to teach science and technology. At the end of the three-week project, the teachers put together and teach a photonics course to high school students. After the summer, teachers receive technical and pedagogical support during the school year. Both the teachers and students expressed an increased appreciation of technology and optics. The students demonstrated an increased mastery of optics-related material.

C) Lecture/Classroom

PST1C-1: 8:30–9:15 p.m. Physics Study Groups: Using Internal Funding for Effective Undergraduate Support

Suzanne White Brahmia, Rutgers, the State University of New Jersey, Math and Science Learning Center, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Mary Ann Cancio, Calvin Yu, and Kathleen Scott, Rutgers

Most universities have a variety of undergraduate support programs that are internally funded, often function independently of the faculty, and are too commonly under-utilized by the students. Coordinating these programs more closely with the courses that the students take has the potential to boost student success. At Rutgers we have undertaken coordination between the faculty of the large-enrollment introductory physics courses with the already-established student support programs to create Physics Study Groups. These groups are led by undergraduate physics majors who are advised regularly by the course faculty. The result is cyclic enlightenment: mentoring for the undergraduates by the physics majors, mentoring about teaching for the physics majors by the physics faculty, and finally feedback for the faculty who can then better tailor the course to their students' needs. Everyone wins. We report on the formation of this program, its costs, and some preliminary results.

PST1C-2: 9:15–10 p.m. Formula Recollection Made Easy!

Shannon A. Schunicht, Texas A&M University, College Station, TX 77845-3005; mnemonicmind@alpha1.net

Using this author's mnemonic formula recollection technique (Vowels: Mathematical operations), education will be "revolutionized." This will be illustrated through a mnemonic technique to be presented during this presentation. It was devised as a compensatory method to assist this author's disabled memory (19 days unconsciousness) in rehabilitation. So many times countless complicated formulas are presented during physics instruction, never to be used again following test recollection. Using this author's recollection technique (Vowels:Mathematical operations), complicated formulas may be algebraically manipulated into a word/series of words for recollection ease. ***Additional letters may be inserted to enhance a letter combination's intelligibility, but these additional letters need be consonants ONLY. Examples include(Arrhenius Gas/law equation): tHiS to tHat are ln kLoCkS +++CAPITAL LETTERS ARE ADDITIONAL CONSONANTS What about the quadratic equation? yeS, i buiLD rabbiTS 4 caTS oN 2 HaTS +++CAPITAL LETTERS ARE ADDITIONAL CONSONANTS remember Dr. Seuss? Once this mnemonic technique becomes propagated, untold acronyms will abound. Student's algebraic skills will become refined, and each letter combination will become more apropos to the actual formula it represents to be remembered indefinitely like: FOIL & My Dear Aunt Sally. Plan to attend with formulas to be submitted to illustrate the applicability of this mnemonic technique. It is most applicable to the science of physics due to the multitude of complex/unique formulas, but may be applied to ANY FORMULA. It's possibilities are limitless as Delta X => 0 .

PST1C-3: 8:30–9:15 p.m. Learn How Dr. Seuss Built Rabbits 4cats on 2hats

Shannon A. Schunicht, Texas A&M University, College Station, TX 77845-3005; mnemonicmind@alpha1.net

Using the following mnemonic technique, ANY formula may be algebraically manipulated into a word, or http://thefewsterfamily.blogspot.com/ series of words for ease of recollection. Come visit to learn how Dr. Seuss teaches students to: build rabbits 4cats on 2hats using this technique! While in the Army, Mr. Schunicht was in a mid-air collision rendering him unconscious for three weeks. Everything had to be relearned as nursing actions were reported having been displayed upon awakening from the extended unconsciousness (19 days). Studies in recovery brought about some pragmatic discoveries to compensate for the residual memory deficits. The most valuable was having each vowel represent a mathematical operation, i.e. "a" multiplication implying "@", "o" for division implying "over", "i" for subtraction implying "minus", "u" for addition implying "plus", and "e" implying "equals". Most constants and variables are indeed consonants, e.g. "c" = "speed of light" & "z" = "altitude." ***Note how additional letters may be added to enhance a letter combination's intelligibility, but these additional letters need be consonants only. Examples will be shown, as well as those submitted by attendees. The ramifications of this educational technique are limitless. Implementation into our education/texts/learning/school instruction will revolutionize education. It will encourage learning by simplification all the while refining algebraic skills. Continued use will become more refined and apropos to the actual formula an acronym represents, until some MBA compiles a dictionary of these refined acronyms assimilating to the complicated equations each acronym represents.

PST1C-4: 9:15–10 p.m. Special Relativity: A Classroom Tutorial Using Graph Paper

Roberto B. Salgado, Mount Holyoke College, South Hadley, MA 01075; rsalgado@mtholyoke.edu

We present a tutorial on drawing and interpreting spacetime diagrams in Special Relativity. Ordinary graph paper rotated by 45 degrees, representing light-cone coordinates, allows quantitative results to be read off the diagram by counting boxes. Radar methods and the Bondi k-calculus provide operational definitions and numerical computations of elapsed time, spatial separation, and relative velocity. The tutorial is being developed for a course in introductory physics.

PST1C-5: 8:30–9:15 p.m. A Lasers Course for Nontechnical Major Students

Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

It is vital to improve the technological skills and scientific understanding of students who are not pursuing scientific and technological degrees because they indirectly support science. Furthermore, they need to evaluate scientific information as portrayed by the media. LASERs hold a fascination for students. LASERs are used in a wide array of technological devices and procedures, and are widely available in office supply stores and ebay. To understand LASERs requires an understanding of light, of how light interacts with matter, with the structure of matter, and optics. Therefore, a course about LASERs can entice students who typically avoid science classes, in particular physics classes, into taking this course providing the opportunity for improving their understanding of science, their critical thinking skills, and developing their appreciation of basic physics.

PST1C-6: 9:15–10 p.m. Examining Student Identity in Large-Enrollment Introductory Calculus-based Physics

Sissi L. Li, Oregon State University, Corvallis, OR 97331; lisi@onid.orst.edu

Dedra N. Demaree, Oregon State University

At Oregon State University, we have redesigned our large-enrollment lecture classroom to facilitate learning in social interactions during class. In conjunction with our ISLE-based curriculum where social interactions are enhanced by Peer Instruction, we want to develop a community of practice (Wenger, 1998) where students participate in social interactions and make meaning of their experiences in class to build a shared repertoire of knowledge and become more central members of the community by engaging in some practices of authentic scientists. In the 2008-9 academic year, we observed and recorded student interactions in the introductory calculus-based physics sequence and invited a small subset of the students for individual interviews to discuss their experience. The aim of this study is to examine how student identity is shaped by acquiring and contributing to practices and knowledge of the community through interactions with the instructor and other students in the classroom.

PST1C-7: 8:30–9:15 p.m. Using an Innovative Skills-based Course To Improve First Year Retention*

Kathleen M. Koenig, Wright State University, Dayton, OH 45435; kathy.koenig@wright.edu

Michael Edwards, Wright State University

Douglas Bradley-Hutchison, Sinclair Community College

Lei Bao, The Ohio State University

At WSU we have observed poor first-to-second year retention in particularly those science-intent majors who lack competency-based scientific reasoning abilities and mathematical skills. As part of an NSF STEP grant, these students were targeted in an effort to address this leak in our STEM pipeline. Through an innovative course that involves direct scientific reasoning training and math skill development, we have seen improvements in our retention rates. This poster includes a thorough description of the course and the course manual developed under this project. Examples of several skills-based activities found within the course are provided. In addition, results of the effectiveness of the course in terms of increasing student first-to-second year retention along with student development of scientific reasoning skills will be shown. The course, including pilots, has been offered seven quarters across three academic years to roughly 330 students.

*Supported in part by NSF Grant DUE 0622466

PST1C-8: 9:15–10 p.m. Elementary School Physics: An Outreach Service Learning Project

J. Johanna Hopp, University of Wisconsin - Stout, Menomonie, WI 54751; hoppj@uwstout.edu

Gary Muir, St. Olaf College

Service learning projects in the college classroom are becoming more popular in a multitude of disciplines. There are many benefits to engaging students in service learning. Students gain an appreciation for community, develop a sense of social responsibility, and increase confidence in their ability to engage in their surrounding environment. This poster describes a service learning project that is done in collaboration with local elementary schools. The college students develop a highly interactive physics lesson to do with an elementary classroom. This project is well received by both college students and the teachers. In addition, the elementary kids are very excited about the classroom visitors. This has the added benefit of engaging young kids in physics.

PST1C-9: 8:30–9:15 p.m. Historical Documents for Classroom Use

Alan Gnospelius, Design and Technology Academy, San Antonio, TX 78218; agnosp@neisd.net

I'll be presenting some historical papers that I have used in class to motivate high school students. These papers include reflections, labs, and discussion documents from Galileo, Fermi, the Wright Brothers, Marie Curie, and other prominent scientists.

PST1C-10: 9:15–10 p.m. Small Whiteboards: Updating an Old Technology with New Pedagogies

Elizabeth Gire, Kansas State University, Manhattan, KS 66503; elizabeth.gire@gmail.com

Corinne Manogue, Oregon State University

Leonard Cerny, Philomath High School

Updating the old technology of classroom "slates," we will discuss how individual-sized whiteboards can be used to increase student interactivity in small-enrollment courses. These "small whiteboards" can be used to invite classroom participation from each student (like electronic classroom responses systems in large-enrollment courses), and they also allow for students to respond with multiple representations or even multistep calculations. Small whiteboards are particularly relevant for upper-division physics courses where small numbers of students wrestle with geometric reasoning, multiple representations, integrating new ideas with their lower-division understandings, and increased mathematical sophistication. We will discuss several techniques for using small whiteboards, including formative assessment, cuing, and immediate practice. We will also discuss how small whiteboards can be incorporated into lectures via a technique we call "adaptive instruction," and how small whiteboards can initiate conversations about sense-making techniques and issues with formalism.

PST1C-11: 8:30–9:15 p.m. A Multi-Institutional Effort To Develop Effective Learning Environments for the Urban Setting*

Anthony Escuadro, Harold Washington College, Chicago, IL 60601; aescuadro@ccc.edu

Jaime Millan, Harold Washington College

Daniel Russ and David Zoller, Olive Harvey College

Mel Sabella, Chicago State University

The physics faculty at Chicago State University, Harold Washington College, and Olive Harvey College are engaged in an NSF project to implement research-based instructional materials and assess student learning in the introductory physics classes at our urban institutions. The project utilizes an instructional approach that builds on the strengths of the diverse student populations we work with. In this poster, we report on the process through which we have been establishing flexible learning environments by sharing resources and experiences during three semesters of implementation. In particular, we present the physical, technological, and instructional resources that we use to generate greater student engagement and more effective student-student and student-instructor interactions, and we discuss our assessment of student content learning and attitudes at our institutions.

*Supported by the National Science Foundation CCLI Program (DUE-0632563).

PST1C-12: 9:15–10 p.m. Mock Mars Rover Mission: Increasing Interest in STEM Courses

Ransom Brown, Eastern Michigan University, Ypsilanti, MI 48197; rbrown35@emich.edu

Diane A. Jacobs and Beth Kubitskey, Eastern Michigan University

An alarming number of middle school students, especially girls, do not plan to take more than the minimum requirement of science credits in high school. The main thrust of our research was to determine whether a single, significant enrichment event in 8th grade could alter students' attitudes toward taking secondary science classes. We gave an 8th grade class a pre-experience survey to assess their attitudes toward science. We then worked with the students for eight weeks on
a project where they had to build a robot and
program it to navigate a mock Martian terrain that was created by the modeling team. The culmination event included Power Point presentations by the students. We then gave the class a post-experience survey to determine if their attitudes had changed. We will discuss our findings, including the beginnings of the longitudinal study where we track the students during their high school careers.

PST1C-13: 8:30–9:15 p.m. Teaching Quantum Physics without Paradoxes, as a Field Theory

Art Hobson, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

Quantum field theory (QFT) has long stated that electrons, photons, and other particles are quanta of various fields, and that a field quantum is a discrete and inseparable portion (or bundle) of a field, occupying an extended spatial region. Although quantum mechanics is the non-relativistic limit of QFT, and although QFT is entirely based on fields, the understanding of particles as field quanta has not seeped through to undergraduate teachers and textbook writers. Hence, there is still much perplexity about the supposed wave-particle paradox. But there is no paradox. Electrons are field quanta, extending spatially throughout the delta-*x* of the uncertainty principle, not particles. Each field quantum (each electron) comes through both slits, resolving the paradoxes. This poster presents a simple method of teaching these fundamentals, based on the double-slit experiment for light and for electrons using intense beams (demonstrating interference) and dim beams (demonstrating discrete interactions).

PST1C-14: 9:15–10 p.m. Modeling Applied to Problem Solving

Andrew Pawl, Massachusetts Institute of Technology, Cambridge, MA 02139; aepawl@mit.edu

Saif Rayyan, Analia Barrantes, and David E. Pritchard, MIT

Modeling Applied to Problem Solving (MAPS) is a pedagogy that helps students transfer instruction to problem solving in an expert-like manner. Declarative and procedural syllabus content is organized and learned (not discovered) as a hierarchy of General Models. Students solve problems using an explicit Problem Modeling Rubric that begins with System, Interactions, and Model (S.I.M.). System and interactions are emphasized as the key to a strategic description of the system and the identification of the appropriate General Model to apply to the problem. We have employed the pedagogy in a semester-long freshman mechanics course plus two three-week review courses for students who received a D in mechanics in 2009 and in 2010, and we will present the results.

PST1C-15: 8:30–9:15 p.m. Light as a Substance

Corrado E. Agnes, Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, Italy 10129; corrado.agnes@polito.it

The subject is an attempt to popularize physics with illustrations in the "comics" style and statements in the "slogan" style. The 14 pictures represent experiments carried out in thought, some more "gedanken" and unrealistic than others, and they want to show that the substance model for light completes the traditional description with rays, waves and particles. But my major hope is to demonstrate the possibility to build a substantial understanding of an important theme from natural sciences through narrative understanding, with no unnecessary simplification and no dumbing down.

PST1C-16: 9:15–10 p.m. Inquiry-based Learning in Physics 101 Lab

Jingrong Huang, Mercer County Community College, West Windsor, NJ 08550; huangj@mccc.edu

Inquiry-based learning exercises has been introduced to Physics 101 laboratory this year. Students spend a lot more time going over theory, using critical thinking, and solve problems creatively. Both instructor and students feel more accomplished. The presentation will share the methods and material in hope to get more feed back and suggestion from other conference participants.

PST1C-17: 8:30–9:15 p.m. Magnetic Forces Do No Work – Really!

Jonathan Mitschele, St. Joseph's College, Standish, ME 04084; jmitsche@sjcme.edu

Gene Mosca, U.S. Naval Academy

While virtually all introductory physics texts begin the discussion of magnetic forces by stating that because they are perpendicular to the velocity they can do no work. However, most then provide one or more examples in which it appears that a magnetic force does work. This apparent contradiction is potentially confusing to the novice reader. One of us (Gene Mosca) published a note[1] explaining this apparent contradiction. In this poster session we revisit the question of magnetic forces doing work in hope of persuading teachers and textbook authors to accompany their explanations with clarifying arguments.

1. E P. Mosca, "Magnetic Forces Doing Work?," *Am. J. Phys* **42**, 295-297 (1974).

PST1C-18: 9:15–10 p.m. Teachable Moment in Science Classrooms

Jeongrim Won, Seoul National Univ., Daehak-dong, Gwanak-gu, Seoul, Korea, 151-742; kikio20@snu.ac.kr

Gyoungho Lee, Seoul National Univ.

Science classrooms are filled with opportunities for students to learn science meaningfully. Thus, it is clearly important for teachers to recognize and manage these opportunities effectively in their classes. We call these opportunities "Teachable Moments." If a teacher could understand the right feature of teachable moments and use them effectively, the teacher would be able to help students learn science. The purpose of this study is to find features of teachable moments in science classroom in order to understand them. For this purpose, we conducted case studies. We observed six science lessons related to frictional electricity in a middle school and conducted nonstructured interviews with a science teacher who taught the six lessons. Through the analysis, we found that the teacher recognized teachable moments through three types of students' responses. Also, we found that teachable moments were changed when the teacher taught same content in another class.

TUESDAY, February 16

Exhibit Show	10 a.m.–4 p.m.	Exhibit Hall
AAPT Education Symposium	1:30–3:18 p.m.	Salon 3
Great Book Giveaway	5:45 p.m.	Registration
Multi-Cultural Luncheon	12:33 p.m.	Washington 1

Joint APS/AAPT Plenary

Location: Salon 1 and 2
Date: Tuesday, Feb. 16
Time: 8:30–10:18 a.m.

Session Chair: Michael Turner (University of Chicago)

Speakers:

Cosmology with the Cosmic Microwave Background, John Carlstrom (Kavli Institute, University of Chicago)

*Early Results from the Kepler Mission,*William Borucki (NASA Ames Research Center)

The Search for the Higgs Bosons and More at the Tevatron Collider, Rob Roser (Fermilab)

Session CG: Panel: Selling Physics Research & Education to Congress

Location: McKinley
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Professional Concerns, APS Forum on Physics and Society
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: Chandralekha Singh

CG01: 10:45 –11:12 a.m. Communicating Science Issues to Congress

Panel – Ronald L Kelley, Materials Research Society, 499 South Capitol St., SW, Suite 600, Washington, DC 20003; rkelley@livingstongroupdc.com

Direct advocacy of science issues of importance to Congress requires an understanding of the audience and the issues and legislation that are currently being considered by our representatives and their staff. Communicating effectively in a concise manner is important for any scientist who wants to engage in advocacy on behalf of their institution or professional society. The focus of the discussion in this session will be on the most important aspects of communicating with Congress and the practical aspects of increasing your chance of being heard and the potential for becoming a future resource.

CG02: 11:12–11:39 a.m. Selling Physics Research and Education to Congress

Panel – Dahlia L. Sokolov, U.S. House of Representatives, Committee on Science and Technology, Washington, DC 20515; dahlia.sokolov@mail.house.gov

Policies governing the scientific enterprise include not just how much money the federal government spends on science, but how that money is allocated, what role the government plays in technology transfer, and how we help ensure a diverse and well-prepared pipeline of students going into STEM fields. The development of these policies is influenced by a number of competing factors: lobbying by the various stakeholders, priorities of those in power at that moment (in both Congress and the Administration), and ongoing issues of national concern, including competitiveness, energy, health and national security. I will provide a broad overview of the budget and legislative cycles and key players in funding and policy decisions for scientific research and STEM education. In addition I will offer my thoughts on advocacy to Congress by the scientific community, including what not to do.

CG03: 11:39 a.m.–12:06 p.m. Supporting Research: A Scientist's View from Inside Congress

Panel – Elaine Ulrich, 1360 4th St., SW, Washington, DC 20024; optical.science@gmail.com

As the 2008-09 APS Congressional Science Policy Fellow, I had the opportunity to work with members of Congress for a year. After meeting with scientists, lobbyists, constituents, and lawmakers, I'll explain what it takes to effectively communicate with Congress, and what to avoid. I'll discuss my experience and the challenges I faced trying to reach the science community from the hill.

CG04: 12:06–12:33 p.m. Driving the Point Home – Science Must Be on America's Agenda

Panel – Michael S. Lubell, CCNY, New York, NY 10031; lubell@aps.org

Economic growth, jobs, competitiveness, national security, health care, energy, climate change—you can't find a high-profile issue on today's agenda that doesn't depend on scientific advances. It's no wonder that members of Congress are far more tuned into science now than they were a decade ago. Still, while they are apt to express strong support for science education and research, elected officials must always balance the needs of the R&D enterprise, which often provides only deferred gratification, against the pressure for supporting social and fiscal programs that can provide a payoff in time for the next election cycle. It is up the science community to maintain a steady drumbeat on Capitol Hill to remind elected officials that America's science and technology prowess once lost will be hard to rejuvenate. We will examine recent legislative science success and look for warning signs that might signal erosion in the future.

Session DA: The Art and Science of Astronomy

Location: Balcony C
Sponsor: Committee on Space Science and Astronomy
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: Jatila van der Veen

DA01: 10:45–11:21 a.m. Matter in Motion and the Art of Gravity

Invited – John Dubinski, Dept. of Astronomy and Astrophysics, University of Toronto, Toronto, ON M5S 3H4; dubinski@astro.utoronto.ca*

Modern physics originates in the decoding of the intricate motions of the heavenly bodies. From ancient to modern times, scientists and artists of the ages have built machines to emulate the motions of the Sun, Moon and planets as tools to illustrate the physical and mathematical ideas behind these motions to a wider audience. In recent times, computational astrophysics wedded with computer animation has permitted the construction of virtual worlds based on the laws of gravity where we can visually explore the dynamics of the galaxies and the universe as a whole. When presented this way, the result is an esthetically pleasing and more accessible description of the evolving universe. I'll present some work on visualizing the dynamics of galaxies and discuss some of the interesting stories that these animations can tell about the origins of the universe and our destiny.

*Sponsor: Jatila van der Veen

DA02: 11:21–11:57 a.m. A Voyage Through Art-Space

Invited – Donna L. Young, The Wright Center, 4 Colby St., Medford, MA 02155; donna.young@tufts.edu

People of prehistoric times and ancient cultures observed the daily motion of the stars, planets, and the moon and grouped them into patterns. They believed that human events and cycles were part of larger cosmic events and cycles. The night sky was part of that cycle. The steady progression of star patterns across the sky was their clock, calendar, and compass. They recorded these motions with writings and paintings on rocks, bones, antlers, and animal skins. Astronomical artwork has recorded observations since the first stirrings of human consciousness and still fires our imagination and helps maintain public interest in the exploration of space. Current scientific talks incorporate the creative artwork of illustrators and animators to help explain complex concepts and new discoveries. The historical perspective of the interdependence of art and space shows that "In all our explorations, art has always been our first vehicle" – B. E. Johnson, astronomical artist.

DA03: 11:57 a.m.–12:09 p.m. Catching Cosmic Rays with a DSLR Camera

Kendra J. Sibbernsen, Metropolitan Community College, Papillion, NE 68046; ksibb@cox.net

Cosmic rays are high-energy particles from outer space that continually strike particles in Earth's atmosphere and produce cascades of secondary particles that reach the surface of Earth, mainly in the form of muons. These can be detected with scintillators, Geiger counters, and cloud chambers, but can also be recorded with commonly available photographic equipment. Current digital single lens reflex (DSLR) cameras contain CCD or CMOS chips which are sensitive to these charged particles at long exposures and high ISO settings. Suggestions will be given on how to incorporate this capture and display technique as a teaching tool for physics. DSLR high-energy particle capture could be used as a classroom demonstration, as a laboratory experiment to accompany a high-energy particle physics discussion, or presented as an inquiry-based research project for advanced undergraduates.

Session DB: Computational Physics in the Undergraduate Curriculum

Location: Virginia B
Sponsor: Committee on Educational Technologies
Co-Sponsor: APS Forum on Education
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: Andy Gavrin

DB01: 10:45–11:21 a.m. OSP Modeling: Tools and Resources*

Invited – Wolfgang Christian, Davidson College, Davidson, NC 28035; wochristian@davidson.edu

Although computers and computer-based instruction pervade our society, computational physics remains absent from the typical undergraduate physics program. Students are bombarded with simulated reality by instructors, textbook publishers, and Hollywood directors, but few students are prepared to critically assess these simulations. A physics major might never study computational physics because it is not required for admission to graduate school and does not appear on the physics graduate record examination. This talk describes a pedagogy that limits the amount of programming when designing, implementing, distributing, and using computer models. It is based on the tripartite integration of Open Source Physics (OSP), the Easy Java Simulations modeling and authoring tool, and the ComPADRE OSP Collection. See: http://www.compadre.org/osp/.

*Partial funding from NSF grant DUE-0442581.

DB02: 11:21–11:57 a.m. Undergraduate Computational Physics at Penn State – Research Experiences and Coursework

Invited – Richard Robinett, Penn State University, University Park, PA 16802; rick@phys.psu.edu

I discuss the diversity of computational physics projects in which undergraduate physics majors at Penn State have participated in the last five years. Examples from gravitation wave data analysis, frustration in magnetic spin systems, simulations related to nanomaterials, atom trapping schemes, high-energy particle astrophysics detector design, and other examples will be presented. I will try to highlight the diversity of computational techniques, programming languages, platforms, and fundamental physics concepts and methods that our students have employed in their projects. I also discuss the development of an "Introduction to Mathematica in Physics" course, designed to help students incorporate symbolic manipulation and numerical methods into their junior and senior level courses.

DB03: 11:57 a.m.–12:33 p.m. Modeling Proteins – with Numbers and Toobers

Invited – Tim M. Herman, Milwaukee School of Engineering, Milwaukee, WI 53202; herman@msoe.edu*

It is important for students considering a career in the molecular biosciences to develop a deep understanding of protein structure and function. And so, educators can say that "Proteins are simply linear polymers of amino acids that spontaneously fold up into complex shapes following basic principles of chemistry and physics." But what are these basic principles, and how can we get students to appreciate them? The MSOE Center for BioMolecular Modeling has created a collection of hands-on instructional materials that introduce students to these basic principles that drive protein folding. These materials support a SMART (Students Modeling A Research Topic) Team modeling program in which students work with local research labs to create physical models of proteins, using 3D printing technologies.

*Invited by Andy Gavrin

Session DC: Funding Opportunities for Informal Science Education and Outreach

Location: Virginia C
Sponsor: Committee on Science Education for the Public
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: Stanley Micklavzina

Topics of planning and funding institutional outreach programs will be presented at this session.

DC01: 10:45–11:21 a.m. Materials Research at NSF: Educational and International Opportunities

Invited – Daniele Finotello, Division of Materials Research, National Science Foundation, Arlington, VA 22230; dfinotel@nsf.gov

The Office of Special Programs (OSP) of the Division of Materials Research (DMR) at the National Science Foundation (NSF) coordinates and supports crosscutting activities. These activities, some of which are in conjunction with NSF-wide programs, include enhanced international collaborations in materials research and education. OSP-supported programs range from the Materials World Network (MWN), to the International Materials Institutes (IMI), to Research Experiences for Undergraduates (REU) and for Teachers (RET). In this presentation, several examples will be given.

DC02: 11:21–11:57 a.m. Funding Opportunities for Informal Science Education and Outreach

Invited – Sylvia M. James, National Science Foundation, Arlington, VA 22230; sjames@nsf.gov

The National Science Foundation's Division of Research on Learning (DRL) invests in projects to enhance STEM learning for people of all ages. Its mission includes promoting innovative and transformative research, development, and evaluation of learning and teaching in all STEM disciplines in both formal and informal learning settings. This informative session will discuss funding opportunities in DRL while providing examples of projects supported by two relevant programs, Informal Science Education (ISE) and Innovative Technology Experiences for Students and Teachers (ITEST). ISE invests in projects that promote lifelong learning of STEM by the public through youth and community programs, exhibits, science education radio and television, and web-based projects. ITEST invests in projects designed to enhance participation in the future workforce through the design, implementation, scale-up, and testing of technology-intensive educational experiences for students and teachers. This session provides an overview of the programs and the application process.

DC03: 11:57 a.m.–12:33 p.m. Reaching Out for Outreach: The University/Science Center Connection

Invited – Steven L. Snyder, The Franklin Institute, Philadelphia, PA 19130; ssnyder@fi.edu

The funding and subsequent operation of a successful outreach program can be a stressful endeavor. However it is one that does not have to be undertaken in isolation. Science centers, universities, and research organizations have been developing collaborative outreach programs across the country. These partnerships have enormous potential to improve the connection between research organizations and the public through shared expertise, pooled resources, and collaborative funding strategies. This presentation will review models, examine pitfalls, and provide insight into developing fundable partnerships for science outreach.

Session DD: Classroom Activities in Particle Physics for the High School – I

Location: Balcony A
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Educational Technologies
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: Marla Glover

Activities to use in the classroom to help high school students learn fundamental concepts in particle physics will be shared. Also this session will be an opportunity to present curriculum connections to standard physics topics and how study of cutting-edge research is of benefit to high school students.

DD01: 10:45–11:21 a.m. Yes, Particle Physics! Now, What?

Invited – Michael Fetsko, Mills Godwin High School, Henrico, VA 23238; mr-fetsko@henrico.k12.va.us

So, you would like to add some activities to your particle physics unit, but you do not have a particle accelerator? It can be quite challenging to provide hands-on exercises to accompany your particle physics instruction. In this talk, I will present a few investigations that I have found to be successful for engaging my students with particle physics. All of these activities use cooperative learning and some may be modified into inquiry-type investigations. I will also highlight a variety of online resources that I have found useful over the years. Whether you are preparing your students for the upcoming Particle Physics Masterclasses or you simply want to bring 21st century physics into your classroom, you should find something in this talk that you can put to good use.

DD02: 11:21–11:57 a.m. Integrating Particle Physics into the High School Curriculum*

Invited – Deborah M. Roudebush, Oakton High School, Vienna, VA 22181; droudebush@cox.net

Particle physics is the arena for many of the most exciting research questions for physicists in the 21st century. This talk will focus on methods of introducing particle physics throughout the year to make current research questions more accessible to high school students. Two paths through the curriculum will be shared with guidance for where particle physics background and topics can be inserted. An inquiry activity developed by the Teaching and Learning Fellows in honor of the start-up of the Large Hadron Collider in November will also be shared.

*This work was supported by the QuarkNet Program which is funded through the National Science Foundation.

DD03: 11:57 a.m.–12:09 p.m. The Particle Physics Masterclass

Shane Wood, Irondale High School/QuarkNet, New Brighton, MN 55112; shane.wood@moundsviewschools.org*

The particle physics Masterclass is a program in which high school students analyze data from CERN's Large Electron-Positron Collider (LEP) experiments and CERN's Large Hadron Collider (LHC) experiments to better understand the world of quarks and leptons. This presentation will highlight some of the features of the Masterclass, some of the changes in place for 2010, and how high school teachers and students may become involved in this exciting collaboration.

*QuarkNet is funded in part by the National Science Foundation and the US Department of Energy.

DD04: 12:09–12:21 p.m. Particle Physics Masterclass: Possibility for Learning About the Nature of Science?

Michael J. Wadness, Medford High School/UMass Lowell/QuarkNet, Natick, MA 01760; mjwadness@verizon.net

This research addresses the problem of science literacy, focusing specifically on students' understanding of the nature of science. In February of 2009, research was conducted to determine if QuarkNet's Particle Physics Masterclass provided a fruitful context for students to learn about the nature of science. QuarkNet's Particle Physics Masterclass is a national program in which students come to a local area research institute and interact with particle physicists through lectures, informal discussions, and working together to analyze real particle physics data. This presentation highlights the results of this study.

DD05: 12:21–12:33 p.m. Introducing Elementary Particles in the Classroom

Helio Takai, Brookhaven National Laboratory, Upton, NY 11973; helio.takai@gmail.com

Gillian Winters, Smithtown High School East

We describe how a set of live demonstrations can be used to effectively introduce elementary particles in a secondary school classroom. We start by observing through a Brownian motion demonstration that there are particles too small to be observed visually. A photoelectric effect demonstration shows the particle nature of light. The final demonstration is done with a specially designed cloud chamber with a magnetic field to show tracks left by elementary particles. This set of demos has been successfully used in high school classrooms to kick off a unit on modern physics, and as an introduction to the successful QuarkNet MasterClass program.

Session DF: Lecture/Classroom

Location: Washington 3
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:33 p.m.

Presider: MacKenzie R. Stetzer

DF01: 10:45–10:57 a.m. Teaching a Course on Gender and Physics

Amy L. Bug, Swarthmore College, Swarthmore, PA 190891; abug1@swarthmore.edu

Bringing demographically underrepresented people into physics is a laudable goal. It has received the attention of physicists, physics educators, and the commercial and government sectors for decades. Yet, undergraduate-level courses on race, gender, and physics are hard to find--both in the standard physics curriculum and in the race/gender studies curriculum. Such a course can both reveal causes and suggest solutions. We discuss curricular ideas, based on courses that have been taught at Swarthmore and elsewhere.

DF02: 10:57–11:09 a.m. Toward Classroom Gender Equity: What Behavioral Science Can Teach Physicists

Kimberley Kreutzer, Clemson University, Newry, SC 29665; kreutzk@gmail.com

The behavioral sciences have been studying how to increase women's learning and participation in mathematics since the 1980s. There is much overlap in the barriers between women's learning in math and in physics. Physics thus may benefit substantially from incorporating some of these findings into physics education. In our study at WWU, we found that courses where many of the recommendations from the behavioral sciences were utilized the women consistently outgained women in similarly taught courses that did not utilise these recommendations. In one case women outgained and outscored the men on the post class diagnostic test.

DF03: 11:09–11:21 a.m. Science and Pseudoscience, A High School Course

Richard Taylor, The Hockaday School, Dallas, TX 75229; rtaylor@mail.hockaday.org

A new course at Hockaday, Science and Pseudoscience, examines what we know, how we know it, and why we get fooled so often and so easily. This is a course in which we measure things we thought we understood and use statistical analysis to test our understanding. We investigate extraordinary claims through the methods of science, asking what makes a good scientific theory, and what makes scientific evidence. We examine urban myths, legends, bad science, medical quackery, and plain old hoaxes. We analyze claims of UFOs, cold fusion, astrology, structure-altered water, apricot pit cures, phlogiston and N-rays, phrenology and orgonomy, ghosts, telekinesis, crop circles and the Bermuda Triangle—some may be true, some are plainly false, and some we're not really sure of. We develop equipment and scientific techniques to investigate extra-sensory perception, precognition, and EM disturbances.

DF04: 11:21–11:33 a.m. Implementing the SCALE-UP Pedagogy in an Algebra-Based Physics Course

Larry Medsker, The George Washington University, Washington, DC 20052; lrm@gwu.edu

Cornelius Bennhold, Gerald Feldman, Raluca Teodorescu, The George Washington University

Nawal Benmouna, Montgomery College

The SCALE-UP student-centered active learning approach has been utilized at GW in the calculus-based introductory physics class since spring 2008. We are now extending SCALE-UP to the algebra-based physics class in spring 2010. This effort is supported by an NSF CCLI grant to focus on the cognitive aspects of physics instruction in the framework of a structured problem-solving protocol. We will be incorporating this collaborative pedagogy into an already established "thinking skills" curriculum based on a taxonomy of cognitive skills. We are also partnering with Montgomery College (MC) to establish the SCALE-UP pedagogy there. SCALE-UP has been widely disseminated within the calculus-based curriculum, but few implementations of this collaborative approach at the algebra-based level exist. Our plans for algebra-based SCALE-UP will be outlined, and our current progress in the first semester implementation (both at GW and MC) will be discussed.

DF05: 11:33–11:45 a.m. Teaching Special Relativity: Correcting Misconceptions

Stuart Gluck, Johns Hopkins University Center for Talented Youth, McAuley Hall, Baltimore, MD 21209; stu@jhu.edu

Misconceptions about the Special Theory of Relativity (STR) are common; even the foundations of the theory are often misunderstood. There are two postulates of STR: the Principle of Relativity and the Light Postulate. Contemporary textbooks tend to interpret the "constancy of the speed of light" referenced in the Light Postulate differently than Einstein and his contemporaries. This misconception has led most people to misunderstand Einstein's thought process in discovering STR and to misjudge what experimental evidence was significant in confirming it, as well as to misplace the proper emphasis. This session will make clear why it's known as the Special Theory of Relativity rather than the Special Theory of the Light Postulate, and will provide some clarity necessary to effectively and accurately teach special relativity and to get students to think like Einstein.

DF06: 11:45–11:57 a.m. The Science of Sound: A General Education Course

Randy M. Carbo, Penn State University, University Park, PA 16802; rmc258@psu.edu

Most colleges and universities have general education programs that require coursework in the natural sciences. Typically, physics departments offer very few courses outside of the traditional introductory mechanics and electromagnetism that meet this requirement. The goals of these introductory courses are at odds with the philosophy of general education; namely, content knowledge by itself is not sufficient for a scientifically educated population. The broader context of science in society is rarely discussed. A qualitative measure for evaluating general education science courses will be provided and a brief discussion of prioritizing the affective and scientific literacy will provide grounds for developing new courses. A course entitled "The Science of Sound" will be proposed that is informed by educational theory and practice. The course will draw on various disciplines but organized around scientific principles.

DF07: 11:57 a.m.–12:09 p.m. Physics Applications from New York Times News

John P. Cise, Austin Community College, Austin, TX 78701; jpcise@austincc.edu

Over 350 one-page physics applications from recent *New York Times* (NYT) news articles are on the web at: http://CisePhysics.homestead.com/files/NYT.htm. These printable one-page edited recent physics news articles contain: pertinent physics questions, graphics, hints and answers. These single NYT web page questions have been used as: quiz questions, extra credit, and by this author as an introduction to new physics concepts by way of current physics applications in the news. The website is listed at ComPADRE as a resource.

DF08: 12:09 –12:21 p.m. Principles, Reasoning, Rules of Thumb and Mnemonics; Advantages and Disadvantages*

Mikhail M. Agrest, College of Charleston, Charleston, SC 29424; agrestm@cofc.edu

Alem Teklu, College of Charleston

In describing cognitive mental processes, Bertrand Russell stated: "We all start from naive realism, i.e., the doctrine that things are what they seem." Things are not always what they seem.[1,2] It is great when students learn via their own hands-on experience and process that experience in their brain creating their personal understanding of the principles of physics. However, there are reefs on the way to cognition. The pragmatic desire to have the skills and tools of "problem solving" often lead to inventions of rules of thumb. These shortcuts often lead to misconceptions and misinterpretations of how things work. The teacher's role here is to uncover to students the logical reasoning that leads them from the assumptions to proofs of the "rule of thumb." In this report, we discuss how students' rule of thumb misinterpreted the elegant Babinet's principle of diffraction and effectiveness of Huygens principle in recreating this legitimacy.

*Supported by the College of Charleston CFD Grant

1. Mikhail M. Agrest, *Misconception, Miscommunication, Misunderstanding. Studying and Teaching Introductory Physics,* SACS-AAPT, Fall 2007 Meeting. Lander University Greenwood, SC. Oct. 12-13, 2007.
2. Mikhail M. Agrest, *Rules of Thumb. Teaching and Studying Introductory Physics,* NCS-AAPT Fall 2007 Meeting. High Point University. High Point, NC, Oct.19–20, 2007.

DF09: 12:21–12:33 p.m. The Way Things Work – Project-based Electricity and Magnetism for Engineers

Rebecca J. Christianson, Franklin W. Olin College of Engineering, Needham, MA 02492; rebecca.christianson@olin.edu

This talk will describe the successes and failures of a project-based electricity and magnetism class for engineers. In this class, student learning is motivated by a semester-long student-chosen project to understand, explain, and demonstrate the basic physics behind the student's chosen electrical or magnetic device. Analytical order of magnitude calculation, simulation and a hands-on proof of concept and/or device deconstruction and reverse engineering are all required elements that combine to give the students a complete picture of the way that electric and magnetic fields are manipulated to achieve technology.

Session DG: Physics Education Research Around the World – I

Location: Washington 2
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Research in Physics Education
Date: Tuesday, Feb. 16
Time: 10:45–11:57 a.m.

Presider: Genaro Zavala

DG01: 10:45–11:21 a.m. Understanding and Addressing the Dilemmas of Physics Teaching: On Teaching Newton's First Law of Motion

Invited – Gyoungho Lee, Seoul National University, Kwanak-Gu, Seoul, Republic of Korea 151-748; ghlee@snu.ac.kr

Arie Leegwater, Calvin College

Numerous studies have analyzed student difficulties in the field of physics education. Research-based physics programs have been positively influenced by these studies and demonstrate the effectiveness of these approaches. Identifying and resolving these difficulties can enhance student learning and the research of physicists. In the history of physics, there are many examples of how great physicists, once having been confronted with controversial problems (or difficulties), developed a new theory overcoming those problems. From these cases of student learning and physicists' research, it is reasonable to assume that we need to better understand how to identify and to address physics teachers' difficulties in teaching physics, and thereby enhance our physics teaching. In our preliminary study and talk on this issue in physics education, we will introduce and discuss a dilemma creating episode[1] of a physics teacher who is confronted by student disbelief in Newton's first law of motion. There is a tension between the students' common-sense knowledge and the formal knowledge of science. In addition, we will compare/discuss how science education experts view these dilemmas differently and how to explore possible solutions.

1. John Wallace and William Louden, *Dilemmas of Science Teaching,* Routledge Falmer, (2002).

DG02: 11:21–11:57 a.m. Understanding of Physical Concepts Based on a Versatility of the Change in Physical and Mathematical Representations*

Invited – Sergio Flores, University of Juarez Mexico, 1424 Desierto Rico, El Paso, TX 79912; sflores17@utep.edu

Luis L. Alfaro, Karla Carmona, and Oscar Ruiz, University of Juarez

Most students enrolled in the introductory levels of physics and mathematics have difficulty in developing basic knowledge to succeed in engineering studies to the Bachelor degree level. Some find it difficult to understand and use cognitive tools during a formalization process of scientific knowledge. In addition, this academic situation yields lost attitudes toward the advanced courses. The research group physics and mathematics in context from the University of Juarez in Mexico has designed a didactic strategy based on the real representation of the knowledge object to transfer the possible understanding from a physical context to a mathematical reasoning frame. The transfer from one to another representation could be possible despite a discontinuity of the semiotic registers students use during the change in context. We will show evidence of students' understanding difficulties to interpret and change the representations during a flux of water process. We used recipients of constant surface to collect data through this implementation. Results suggest that students develop understanding difficulties trying to change a mathematical representation of physical concepts. However, it seems to be easier for them to change in representations inside the corresponding physical reasoning frame.

Session DH: PER: Problem Solving

Location: Balcony B
Sponsor: Committee on Research in Physics Education
Date: Tuesday, Feb. 16
Time: 10:45 a.m.–12:45 p.m.

Presider: Andrew Heckler

DH01: 10:45–10:57 a.m. Assessing Student's Ability To Solve Textbook-Style Problems: Update, Part I

Jeffrey Marx, McDaniel College, Westminster, MD 21157; jmarx@mcdaniel.edu

Karen Cummings, Southern Connecticut State University

Development of students' "problem solving ability" is commonly cited as one of the primary goals in introductory physics courses. However, there is no broadly agreed upon definition of what is meant by "problem solving." Most physicists ultimate want students to be able to successfully apply a logically yet flexible approach to solving real-world problems significantly different from any they have seen before. Still, many introductory instructors are first and foremost concerned with how successfully and thoughtfully students solve standard textbook-style problems. We have developed a 15-item survey to help assess students' abilities at solving textbook-style problems. In the fall of 2009, we beta-tested this instrument on introductory physics students (pre-instruction and post-instruction) at several institutes and on a pool of "experts." In this, the first of two talks, we will present details of the survey instrument, its administration, and some results from our first round of testing.

DH02: 10:57–11:09 a.m. Assessing Student's Ability To Solve Textbook-Style Problems: Update, Part II

Karen Cummings, Southern Connecticut State University, New Haven, CT 06511; cummingsk2@southernct.edu

Jeffrey D. Marx, McDaniel College

Most physicists ultimately want students to be able to successfully apply a logically yet flexible approach to solving real-world problems significantly different from any they have seen before. Still, many introductory instructors are first and foremost concerned with how successfully and thoughtfully students solve standard textbook-style problems. We have developed a 15-item survey to help assess students' abilities in solving textbook-style problems. In fall 2009, we beta-tested this instrument on introductory physics students (pre-instruction and post-instruction) at several institutes and on a pool of "experts." In this, the second of two talks, we will present additional results from our first round of testing and discuss our plans for future work.

DH03: 11:09–11:21 a.m. Building Problem-Solving Strategy for Algebra-based Undergraduate Students in UW-Stout

Yuanjia Hong, University of Wisconsin at Stout, Menomonie, WI 54751; toyuanjia@gmail.com

Helping students to develop their "problem solving strategy" is a common goal for introductory physics. At UW-Stout, we have a special discussion section to help students develop their solving skills with their instructor. In this talk, we will share our experiences on how our students trained to gain the right information to start their problem solving and how they build up a logical yet flexible structuralized approach to work it through.

DH04: 11:21–11:33 a.m. Using an ECR Framework To Characterize Problem Difficulty and Problem-Solving*

Elizabeth Gire, Kansas State University, Manhattan, KS 66506-2601; egire@phys.ksu.edu

N. Sanjay Rebello, Kansas State University

Estimating problem difficulty has traditionally been an art, relying on a teacher's or researcher's knowledge of students and personal intuition. We identify two aspects of problem difficulty: the intrinsic complexity of a problem and its situated difficulty. We adapt an ECR framework (Exposition, Complication, and Resolution) as a tool for characterizing the intrinsic complexity of physics problems and for exploring the situated difficulty of a problem for a particular solver. The ECR framework is used in the disciplines of literature and psychology to describe the structure of stories and for studying story comprehension among children and adults. We will discuss the validation of an ECR analysis rubric for characterizing textbook problems and discuss using an ECR rubric as a research tool for studying problem-solving.

*This work is supported in part by the National Science Foundation under grant 0816207.

DH05: 11:33–11:45 a.m. Applying a Framework for Assessing Efficiency and Innovation in Problem Solving*

N. Sanjay Rebello, Kansas State University, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

Elizabeth Gire, Kansas State University

Schwartz, Bransford and Sears[1] propose a two-dimensional conceptual framework that describes transfer of learning in terms of efficiency and innovation. Efficiency is the ability to apply prior knowledge to new, albeit familiar idealized situations quickly and accurately. Innovation is the ability to question assumptions and generate new ideas to solve problems in novel and realistic situations. We discuss the development of criteria to measure these constructs for problem solving tasks in science courses. We provide examples of problems and discuss how they align with the operational framework. Finally, we discuss how such a framework can serve as a lens to enable educators to develop assessments that optimize both efficiency and innovation.

*This work is supported in part by the U.S. National Science Foundation grant 0816207.

1. D. Schwartz, J. D. Bransford, and D. Sears, in *Transfer of Learning from a Modern Multidisciplinary Perspective,* edited by J.P. Mestre (Information Age Publishing, Greenwich, CT, 2005).

DH06: 11:45–11:57 a.m. Explaining Student Expertise with Mathematical Sense-Making

Eric Kuo, University of Maryland, College Park, MD 20842; erickuo@umd.edu

Mike Hull, Andrew Elby, and Ayush Gupta, University of Maryland

We are interested in different ways that engineering students in introductory physics courses connect mathematical formalism with physical processes. In clinical interviews, Alex and Pat solved a question requiring the use of a familiar equation, $v = v_0 + at$. Alex, following a procedure sanctioned by many textbooks and professors, methodically calculated the solution but was unable, afterwards, to find a shortcut to that result. Pat, by contrast, failed to employ "good" problem-solving skills such as drawing a diagram and organizing the given information. Yet she found an expert shortcut and followed up by fluidly switching among multiple alternative paths (describing what he might do if he got stuck). The key difference between Pat and Alex, we argue, is that Pat uses "symbolic forms,"[1] cognitive structures that combine an algebraic symbol template with a conceptual schema to produce a seamless blend of conceptual and symbolic reasoning.

1. B. Sherin,*Cognition and Instruction*, **19**(4), pp. 479-541 (2001).

*This work is partially supported by NSF-IEECI grant # 0835880.

DH07: 11:57 a.m.–12:09 p.m. I'm Doing What My Teacher Says, Why Aren't I Expert-Like?*

Michael M. Hull, University of Maryland, College Park, MD 20742-4111; mhull12@umd.edu

Eric Kuo, Andrew Elby, and Ayush Gupta, University of Maryland

We are investigating what facilitates or hinders students from connecting mathematical equations to causal relations and processes in the world. In clinical interviews, two students were asked to explain the hydrostatic pressure equation, $p = p_0 + rhogh$, an equation unfamiliar to both, and then use the equation to solve problems. The two students correctly solved the problems in markedly different ways. Alex diligently carried out conventional problem-solving procedures using the equation as a computational tool to generate the answer. Pat, in contrast, relates the math to physical processes, using mathematical relationships to reach conclusions about causal relationships that hold in the world. When Alex steps back to relate the math to everyday experiences, she does not see this connection between the equation and physical processes. Pat's reasoning can be described with Sherin's "symbolic forms,"[1] which are cognitive structures that blend an algebraic symbol template with a conceptual schema.

1. B. Sherin, *Cognition and Instruction,* 19(4), pgs 479-541, 2001.

*This work is partially supported by NSF-IEECI grant # 0835880.

DH08: 12:09–12:21 p.m. The Role of Affect in Stabilizing Wanda's Approach Toward Circuits*

Brian A. Danielak, University of Maryland, Curriculum and Instruction, College Park, MD 20742-1115; briandk@umd.edu

Ayush Guptaa and Andrew Elby, University of Maryland

Wanda, an electrical engineering major, expressed during a clinical interview that her circuits class focuses on ideal rather than real circuits. In her view, the conceptual reasoning tools needed to address ideal circuits simply don't apply to real circuits. Initially, this epistemological belief seems to explain much of her approach toward the course; particularly her strong preference for mathematical, as opposed to qualitative/conceptual, problems on homework and tests. Our analysis shows, however, that Wanda's belief is tied to a strong emotional response: her dislike of conceptual problems. For example, Wanda doesn't think about the ideal/real distinction when using idealized equations. We are formulating a fine-grained cognitive model to explain how Wanda's emotions, epistemological stances, and problem-solving views feed reflexively into one another, stabilizing her approach toward the course. We believe emotional responses are a key element of the model for understanding her ways of learning and knowing.

*This work is partially supported by NSF-EEC grant # 0835880 and NSF-DRL grant # 0733613.

DH09: 12:21–12:33 p.m. Affect and Identity in Engineering Students' Approaches to Learning, Problem-Solving

Ayush Gupta, University of Maryland, College Park, MD 20742; ayush@umd.edu

Brian A. Danielak and Andrew Elby, University of Maryland

In previous accounts of students' disciplinary identity formation in fields such as engineering and mathematics, classroom environments and departmental cultures shape the epistemologies, habits of mind, and aspects of students' emerging identities [Reed et al., Boaler & Greeno].[1] Our case of an engineering undergraduate, Michael, contrasts with these accounts: Michael's identity as an engineer is largely defined and reinforced in opposition to what he takes to be the prevailing "engineering student culture." Specifically, Michael positions himself apart from his fellow students in valuing conceptual reasoning as central to problem solving. ichael's stable adherence to this epistemological stance—even in the face of not getting the correct answer—derives in part from his positive emotional reaction to sense-making as part of his identity as an engineer, and his anger at school environments that discourage creativity in favor of conformist step-by-step problem solving.

1. R. Stevens, et. al. *Journal of Eng. Educ.* pp. 355-368. (2008). J Boaler, & J. G. Greeno, in J. Boaler (Ed.) *Multiple Perspectives in Mathematics Teaching and Learning.* Westport, CT: Ablex Pub. (2000).

*This work is partially supported by NSF-IEECI grant #0835880

DH10: 12:33–12:45 p.m. Toward an Inventory Assessing Expert Problem-Solving Skills

Andrew Pawl, Massachusetts Institute of Technology, Cambridge, MA 02139; aepawl@mit.edu

Analia Barrantes, Saif Rayyan, David E. Pritchard, MIT

We describe some of the challenges inherent in constructing standardized instrument assessing problem solving skills, and suggest ways to overcome these challenges. We present items from a conceptual multiple-choice instrument assessing problem solving skills relevant to freshman mechanics that we are developing. This instrument is inspired in part by Lawson's Classroom Test of Scientific Reasoning and Van Domelen's Problem Decomposition Diagnostic. We seek teachers who are interested in testing the preliminary version!

Session EA: CRACKERBARREL: What Now?

Location: Balcony A
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, Feb. 16
Time: 12:33–1:30 p.m.

Presider: David Weaver

Co-Presider: Bill Waggoner

We are planning a National Two-Year College Physics Meeting entitled: "Past Successes and Future Directions" on the Saturday before the AAPT Summer Meeting, 2010. Paul D'Alessandris and Dwain Desbien have led (probably more like herding cats) a small planning group to put together a rewarding meeting, so we will hear about the current state of the plans and solicit input. We've also talked about updating the TYC Guidelines document and that is worthy of further discussion (and decisions). Please re-read the Guidelines (http://tinyurl.com/tycguidelines) as homework and think deeply about the future of our organization.

Session EB: CRACKERBARREL: PER Faculty Concerns

Location: Virginia B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Professional Concerns
Date: Tuesday, Feb. 16
Time: 12:33–1:30 p.m.

Presider: Tom Foster

Physics Education Researchers are inherently interdisciplinary which means that where ever we work, at what ever level we work, no place is a perfect fit. Fortunately the issues, concerns, and solutions at one place can be informative for those elsewhere.

Session EC: CRACKERBARREL: Apparatus

Location: Virginia C
Sponsor: Committee on Apparatus
Date: Tuesday, Feb. 16
Time: 12:33–1:30 p.m.

Presider: David Sturm

An open Crackerbarrel session to discuss current trends in instructional apparatus for lecture demonstration, public outreach, and instructional laboratory. A panel of experienced Physics Instructional Resource Association (PIRA) specialists will be present to take questions and lead discussion.

Session ED: CRACKERBARREL: History of Physics

Location: Buchanon
Sponsor: Committee on History and Philosophy in Physics
Co-Sponsor: Committee on the Interests of Senior Physicists
Date: Tuesday, Feb. 16
Time: 12:33–1:30 p.m.

Presider: Cheryl Schaefer Wrinkle

This Crackerbarrel is intended for a discussion of using history, historical figures, and historical apparatus to teach physics. We plan to have actual cheese and crackers as long as they last. Come and discuss these and other topics of interest.

AAPT Membership Booth and Physics Store Inventory Reduction Sale

Visit our friendly membership staff to ask questions or discuss your membership benefits and take advantage of savings up to 75% on selected Physics Store titles. Take your treasures today...no waiting, no shipping fees.

Visit the AAPT Membership Booth

& Physics Store Clearance in the Atrium.

Sunday, noon - 6 p.m.

Monday & Tuesday, 9:30 a.m. - 6 p.m.

Wednesday 9:30 a.m. - 1 p.m.

AAPT Symposium on Physics Education

dedicated to the memory of Len Jossem

Location: Salon 3
Date: Tuesday, Feb. 16
Time: 1:30–3:18 p.m.

Presider: Philip (Bo) Hammer, American Association of Physics Teachers

Comments by James Stith, former Vice President of AIP Physics Resources Center

A strong STEM education starts in our schools and depends on a large supply of highly qualified teachers. Ensuring that we have a highly prepared and ready "workforce" of pre-college science and physics teachers requires the consistent and joint efforts of many sectors in our community: universities, school districts, corporations and foundations, and the federal, state and local governments.

Fourth Annual

SYMPOSIUM on Physics Education

Educating Physics Teachers: A Call to Action for Physics Departments

Len Jossem

Dr. E. Leonard (Len) Jossem died August 29, 2009. During World War II, Jossem was a member of the scientific staff at Los Alamos in the Advanced Developments Division. He received his master's degree in 1939 from Cornell University and earned his PhD there in 1950 for his research on experimental condensed matter physics. He spent nine years on the faculty at Cornell, and two years with the commission on College Physics. In 1956 he joined the physics faculty at The Ohio State University where he taught for 33 years, serving as the chairman of OSU's Physics Department from 1967-1989. He served as AAPT President from 1973-74. As an active member of AAPT since 1948, Jossem received the AAPT Distinguished Service Award in 1970, the Melba Newell Phillips Award in 1985, and the Oersted Medal in 1994.

Symposium Panel:

Mary Ann Rankin

"Teacher Preparation – UTeach"

Mary Ann Rankin, Dean of the College of Natural Sciences at the University of Texas at Austin

Dr. Rankin received her BS degree in Biology and Chemistry from Louisiana State University in New Orleans, served as a National Science Foundation pre-doctoral fellow at the University of Iowa and Imperial College Field Station, Ascot, England, and was awarded a PhD in physiology and behavior from the University of Iowa in 1972. Her research focuses on studies of the physiological relationships governing the evolution of insect life history strategies. As dean she has overseen, along with her administrative team, the development of numerous new interdisciplinary research initiatives, construction of five new science buildings, and the establishment of several successful programs for undergraduates including the UTeach program for math and science teacher preparation, the UT Discovery Learning initiative, the Texas Interdisciplinary Plan, and the UT Austin Freshman Research Initiative.

Sheila Tobias

"Science Teaching as a Profession. Why it isn't. How it could be"

Sheila Tobias, Author, *Science Teaching as a Profession*

Sheila Tobias has made a science and an art of being a curriculum outsider. Neither a mathematician nor a scientist, she has tackled the question of why intelligent and motivated college students have specific difficulties in certain disciplines, particularly mathematics and science. She has written seven books on math-science teaching and learning, three (*) commissioned by Research Corporation for Science Advancement: *Overcoming Math Anxiety, Succeed with Math, They're not dumb, they're different*. In 2007, together with high school science chair Anne Baffert, she wrote *Science Teaching as a Profession. Why it isn't. How it could be*, available on www.rescorp.org since May 1, 2009. It will be published in soft cover as an NSTA (National Science Teachers Association) book in winter 2010.

Stamatis Vokos

"Transforming the Professional Preparation of Physics Teachers in the United States: Findings and Recommendations of the T-TEP Report"

Stamatas Vokos, Professor of Physics, Seattle Pacific University

At Seattle Pacific University, Stamatas Vokos has directed several projects on the learning and teaching of physics and has contributed to local and national science reform efforts in grades K-20. He is currently PI of two NSF-funded projects, which strive to improve teacher diagnostic skills in physics and physical science. Before joining SPU in 2002, Vokos was a senior member of the Physics Education Group at the University of Washington and contributed extensively to the Group's efforts. Vokos has served as member and two-term chair of the AAPT Committee on Research in Physics Education, member of the AAPT Committee on Graduate Education, and chair of the AAPT Physics Education Research Elections Organizing Committee. He is member of the APS Executive Committee of the Forum on Education and chair of the National Task Force on Teacher Education in Physics (T-TEP), sponsored by APS, AAPT, and AIP.

Session DE: Panel: Preparing Graduate Students for Careers in College Physics Teaching

Location: Balcony C
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, Feb. 16
Time: 3:30–5:45 p.m.

Presider: MacKenzie R. Stetzer

Upon obtaining their degrees, many physics graduate students pursue faculty positions at two- and four-year colleges. Although graduate programs in physics typically provide extensive training in research, considerably less emphasis is placed on preparing graduate students for careers in teaching at the undergraduate level. This invited panel discussion will focus on the types of preparation and professional development experiences that seem to be most beneficial in helping graduate students succeed in careers in college physics teaching.

Speakers:

***Robert M. Dixon,** Grambling State University, Grambling, LA 71245; dixonr@gram.edu*

***Keith Clay,** Green River Community College, Auburn, WA 98092; kclay@greenriver.edu*

***Adam B. Clark,** Muhlenberg College, Allentown, PA 18104; aclark@muhlenberg.edu*

Session FA: Art and Physics

Location: McKinley
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Women in Physics
Date: Tuesday, Feb. 16
Time: 3:30–5:42 p.m.

Presider: Kathleen Falconer

Art and physics are often considered very different, maybe even disparate. However, art and physics intersect in multiple ways. This session is the initial exploration of the intersection between art and physics.

FA01: 3:30–4:06 p.m. Hidden Harmony: The Connected Worlds of Physics and Art

Invited – Jack R. Leibowitz, Professor Emeritus, Depts. of Physics and of Art, Catholic University of America, Washington, DC, PO Box 31761 Santa Fe, NM 87594-1761; JRLEIB@WILDBLUE.NET*

I want to share the uncommon idea that the ties between physics and art are not obscure metaphor or historical coincidence. It is more fascinating than that: the basic connections are at the conceptual level. While art and physics are not identical, at a fundamental level they express what I call hidden harmonies. In art, the contacts with physics are partly what art historians call formalism. Ultimately, to some extent this refers, in physics as well as in art, to the concepts of symmetry and broken symmetry. They are keys to what physicists mean by beauty, as brilliantly expressed by Poincare. These themes indicate how pioneer physicists and artists look at their worlds. And, as understood in physics and in art, each in its own terms, discovery is driven by a search for beauty and hunger to explore the unknown.

*Sponsor: Kathleen Falconer

FA02: 4:06–4:42 p.m. Physics in the Arts*

Invited – Pupa U.P.A. Gilbert, University of Wisconsin, Madison, WI 53706; pupa@physics.wisc.edu

We will discuss the physics of light and sound, and provide a synopsis of our recent book.[1] The book provides a deep yet accessible analysis of the physics of light and sound, with particular attention to color and music. Besides being exciting and interesting, this is useful to understand and interpret the world in which we live, its phenomena, and how we see and hear them. The physics of light and sound increases the appreciation for works of art, and inspires artistic creativity. This talk rapidly glances over light and light waves, reflection and refraction, lenses, the eye, and photography, and will focus more in depth on the physics of color, color vision, additive color mixing, subtractive color mixing, and color generating mechanisms.

1. P. U. P. A. Gilbert and W. Haeberli, *Physics in the Arts*, Elsevier-Academic Press, Amsterdam, (2008). ISBN 978-0-12-374150-9 (Price: less than $40). Review: *Physics Today,* (March 2009).

*Supported by NSF grant 0613972.

FA03: 4:42–5:18 p.m. Symmetry and Aesthetics in Contemporary Physics: An Interdisciplinary Arts-and-Physics Curriculum*

Invited – Jatila K. van der Veen, University of California, Santa Barbara, Santa Barbara, CA 93106; jatila@physics.ucsb.edu

Philip M. Lubin, University of California, Santa Barbara

Symmetry and the search for broken symmetries in nature motivate our understanding of the laws of physics and our explanations of new discoveries. Similarly, symmetry and asymmetry are at the heart of our aesthetic experiences in art, music, and dance. Although surveys suggest that approximately 60% of Americans who practice some form of recreational arts hold jobs in a 'STEM' field, the popular perception that arts are accessible but physics is intimidating prevails. Our course, Symmetry and Aesthetics in Contemporary Physics, integrates the artist's and scientist's ways of knowing, so as to make physics less intimidating to arts-based students, yet not sacrifice the mathematical rigor that makes physics attractive to physics students. In this paper we present research in support of our pedagogical model, our curriculum, examples of assignments, and students' work, students' reactions (anonymous evaluations and interviews), and implications of our study for K-12, undergraduate, and teacher education.

*This work has been supported by NASA, the Jet Propulsion Laboratory, and the Planck Mission.

FA04: 5:18–5:30 p.m. Teaching Physics to Animation Artists

CANCELED

Alejandro L. Garcia, San Jose State University, San Jose, CA 95126-0106; algarcia@algarcia.org

David Chai, School of Art and Design, San Jose State University

With the support of the National Science Foundation, the Department of Physics and the Animation/Illustration program in the School of Art and Design at San Jose State University have teamed up to develop curriculum materials to teach physics to art majors planning to work in the animation industry. Initially, these materials were embedded as special topic lectures within existing art courses, but this past fall semester we introduced a new course, Physics of Animation, jointly cross-listed with Art and Physics. The talk will describe the project, focusing on how elements can be adopted by programs at high schools, universities, and art schools.

FA05: 5:30–5:42 p.m. Using Keynote as an Artistic Medium

Jeffrey M. Wetherhold, Parkland High School, Allentown, PA 18104; wetherholdj@parklandsd.org

Apple's Keynote is a very user-friendly piece of software that allows one to artistically combine animation and video. Several examples will be shared with the participants.

Session FB: Instructional Resources for Physics Teacher Education Programs

Location: Virginia B
Sponsor: Committee on Teacher Preparation
Date: Tuesday, Feb. 16
Time: 3:30– 5:54 p.m.

Presider: Carl Wenning

Overviews of proven educational resources available for use in physics teacher preparation programs.

FB01: 3:30–4:06 p.m. Seeing the Growth of Physical Theory in Students' Minds

Invited – Dewey I. Dykstra, Jr., Boise State University, Boise, ID 83725-1570; ddykstra@boisestate.edu

A new course has been established as a requirement for the Physics, Secondary Education Option, B.S. at Boise State University. The course title is Conceptions in Physics, but it is co-listed under other names for teacher candidates in other sciences. The focus of the course is to engage teacher candidates in an examination of typical conceptions students hold about the phenomena of science. The central reference for the course is the bibliography: Students' and Teachers' Conceptions and Science Education. A description of the activity in the course and the rationale and strategy of offering it simultaneously for teacher candidates in other sciences will be described. Lessons learned so far will be shared. Because the course specifically addresses a standard for Idaho science teachers, how this standard came to be will also be described. Projected other changes to the degree program will be described briefly.

FB02: 4:06–4:42 p.m. Experiences from a Physics Professional Development Grant Program for Teachers

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

This presentation will share experiences and results from our university's professional development physics program for teachers and pre-service teachers. Our program, which centered on energy transfers as they apply to physics concepts in Force and Motion, Gravitational and Magnetic Interactions, Heat, Light, and Simple Machines, was funded for six consecutive years by Title II Improving Teacher Quality Grant (ITQG) state funds for public school teachers and, concurrently, for the past three years by a private source for diocesan school teachers. Pre-post data on in-service and pre-service teachers' content knowledge, pedagogical practice,s and student achievement were collected each year by project faculty and an external evaluator. The combination of a fabulous cohort of in-service science teachers and pre-service teachers, a strong, constructivist, inquiry-based curriculum, and instructors that had a passion for teaching physics and a strong belief in the pedagogy contributed to a rewarding professional development experience with positive results.

FB03: 4:42–5:18 p.m. Teacher Education and Professional Development Programs in MA

Invited – Esther L. Zirbel, 52 Salisbury Rd., Watertown, MA 02472; ezirbel@gmail.com

This paper reviews and evaluates a series of STEM teacher education and professional development programs that are offered in Massachusetts. It analyzes a few select STEM education projects and identifies criteria that make these programs exemplary. This paper also describes some of the activities of the MA STEM Initiative (http://www.massachusetts.edu/stem). Particular reference will be made to their annual meeting where they facilitate an exchange of ideas between different stakeholders (teachers, educators, administrators & policy-makers) to discuss emerging STEM issues. In addition, this paper discusses how these state-wide collaborative efforts contribute toward improving individual STEM programs and how this raises the bar for everybody. Participants will leave the presentation with resources and links to STEM education programs in Massachusetts.

FB04: 5:18–5:54 p.m. Restructuring Physics Teacher Preparation – Teacher Advisory Boards, Field Experience, Induction

Invited – Duane B. Merrell, Brigham Young University, Provo, UT 84602; duane_merrell@byu.edu

This talk will highlight the use of the local schools and the mentor teachers that are used as a resource in preparation of secondary physics teachers. (The field experience—Practicum's at each level of preparation and the teacher advisory board.) The talk will include efforts in restructuring physics teacher preparation by using Modeling Physics and CASTLE Electricity and the effects they have in the classroom when students become the teachers. (If you have never experienced "constructivism" can you teach using "constructivist" methods.) Finally the talk will highlight the induction efforts of Brigham Young University during the first years of the recently graduated student's teaching career. (Are we through with the student when they graduate?) We have been somewhat successful at Brigham Young and these are efforts that are helping our students when they become teachers.

Session FC: Classroom Activities in Particle Physics for High School – II

Location: Virginia C
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Educational Technologies
Date: Tuesday, Feb. 16
Time: 3:30–4:30 p.m.

Presider: TBA

Activities to use in the classroom to help high school students learn fundamental concepts in particle physics will be shared. Also this session would be an opportunity to present curriculm connections to standard physics topics and how study of cutting-edge research is of benefit to high school students.

FC01: 3:30–3:42 p.m. Starting Introductory Physics With a Bang!

Rachel A. Wyatt, The Hockaday School, Dallas, TX 75044; rwyatt@mail.hockaday.org

Richard Taylor and Pete Lohstreter, The Hockaday School

The advent of a new era in physics is being ushered in by the Large Hadron Collider, and the LHC provides a prime curricular opportunity to introduce students to physics in an exciting and relevant way. We decided to begin our freshman-level physics course this year with a focus on the LHC and several associated particle physics concepts. The unit included measurements and analysis of radioactive sources, observations of a cloud chamber, and discussions of current media concerning the LHC ranging from the "LHC Rap" on YouTube to blogs and editorials addressing the potential creation of black holes. This approach with first-time physics students helped them to view the subject as meaningful and contemporary. We will outline the curriculum in further detail and share compelling qualitative evidence that supports using the LHC as a focal point in beginning a physics course.

FC02: 3:42–3:54 p.m. Particle Physicists for a Day? How Students Collaboratively Analyze Cosmic Ray Data

Thomas Tomaszewski, Shoreham-Wading River High School, Shoreham, NY 11786; TTOMASZEWSKI@swr.k12.ny.us

Gillian Winters, Smithtown High School East

Helio Takai, Brookhaven National Laboratory

Classes of students in three high schools independently analyzed cosmic ray data looking for evidence of a weak solar flare, and then held a videoconference to discuss their results. The previous year, students from one school cooperatively analyzed cosmic ray data from the MARIACHI cosmic ray experiment. In 2009, students from three separate schools cooperatively analyzed similar data, and then got together via videoconference to discuss their results. The students learned advanced Excel manipulation, as well as how to critically examine real-world, non-perfect data and extrapolate conclusions for their analysis. The videoconference was a huge success—the students loved it and were forced to justify their conclusions to peers.

FC03: 3:54–4:06 p.m. Nuclear Forensics Unit for High School Students

Daniel M. Crowe, Loudoun Academy of Science, Sterling, VA 20164; dan.crowe@loudoun.k12.va.us

Duke Writer and Jennifer Flynn, Loudoun Academy of Science

Monica Plisch, American Physical Society

Nuclear science meets CSI in this unit on nuclear forensics, intended for high school physics, chemistry, or forensics courses. A set of five lessons uses nuclear forensics scenarios to introduce nuclear science in a context that the students might find interesting. These lessons, which are flexible and designed to take up to ten hours of class time, include background on nuclear science and case studies in which students analyze data from interdicted nuclear material. Mathematical modeling is used in the data analysis to develop critical thinking skills. The laboratory component includes radiation detection from common materials and other sources, shielding experiments and more.

FC04: 4:06–4:18 p.m. Pedagogical Strategy for Implementing an Inquiry-based Fusion Simulation*

Thad Zaleskiewicz, University of Pittsburg at Greensburg, Greensburg, PA 15601; zpt@pitt.edu

Vickilyn Barnot and Katrina Brown, Pitt-Greensburg

A human-powered, hand-held, model that simulates the deuterium-tritium fusion reaction will be demonstrated and discussed. This model is the centerpiece of an inquiry based activity appropriate for use in middle school or high school physical science classrooms. This activity, "Testing a Physical Model" is an adaptation of a successful activity originally developed by the Contemporary Physics Education Project[1] for use in introductory (high school and undergraduate) chemistry and physics classrooms.[2] Although the p-p chain and carbon cycle are the fusion processes occurring most commonly in stars, the deuterium-tritium reaction is employed here because it is conceptually much more straightforward, and hence easier to simulate. The "Testing a Physical Model" Activity is presented using the 5-E pedagogical strategy: Engage, Explore, Explain, Elaborate, and Evaluate. In addition to being pedagogically sound, the 5-E format makes the activity teacher-friendly and classroom-ready. Audience participation will be encouraged.

*Work supported by the U.S. Department of Energy Contract # DE-AC02-09CH11466.

1. Visit: www.cpepweb.org
2. Adapted from the activity "Simulating Fusion" originally authored by Robert Reiland, Shady Side Academy, Pittsburgh, PA G. Samuel Lightner, Professor Emeritus of Physics Westminster College (now available in English, French and Spanish)

Session FD: Physics Majors: High School through Doctorate

Location: Virginia C
Sponsor: Committee on Teacher Preparation
Date: Tuesday, Feb. 16
Time: 4:42–5:06 p.m.

Presider: TBA

FD01: 4:42–4:54 p.m. Accreditation, Recruitment, and Retention

Daryao S. Khatri, The University of the District of Columbia, Washington, DC 20008; dkhatri@udc.edu

Anne O. Hughes and Brenda Brown, The University of the District of Columbia

The declining enrollment of physics majors has not changed that much; it seems to be worsening according to some accounts. As a result, the physics departments in Historically Black Colleges and Universities could face elimination if meaningful interventions are not implemented. Accordingly, this paper has two purposes. The first is to examine key—and negative—factors that have contributed to the declining enrollment, such as lack of professional accreditation for physics programs, outdated techniques used in teaching physics courses, inadequate preparation of students in basic algebra, and the organization of content in textbooks that leads to teacher-comfortable deductive rather than effective inductive approaches to teaching. The second purpose is to present successful strategies for overcoming these key problems. The strategies being reported have been tested with extremely positive results with under-prepared minority students through four years of intensive summer programs. They are called the Gateway Academic Program (GAP). The Accuplacer, the recognized placement test of the College Board for freshman college students, has measured our success rate. The authors will also discuss the importance of accreditation for physics programs for recruiting and retaining physics majors.

FD02: 4:54–5:06 p.m. Understanding Doctoral Completion Time and Its Impact on Career Physicists

Geoff Potvin, Dept. of Engineering & Science Education, and Dept. of Mathematical Sciences, Clemson University, Clemson, SC 29634; gpotvin@clemson.edu

Robert H. Tai, Curry School of Education, University of Virginia

Using regression analysis to analyze survey data taken from PhD-holding professional physicists, we find that time-to-doctoral-degree is significantly influenced by institutional factors (such as field of research, length of required coursework, and graduate teaching load) rather than factors associated to students' academic performance, research experiences, proficiency, or the advisor-advisee relationship. Furthermore, longer times-to-degree are strongly correlated to lower salaries after graduation, even controlling for a number of job-related factors (field of research, type of position and institution, rank, and seniority). Taken together, these two results suggest that time-to-degree is often used as a proxy for scientific merit even though, in practice, it appears to be largely out of control of students.

Session FE: Enriching Physics in the Classroom and Beyond

Location: Balcony A
Sponsor: Committee on History and Philosophy in Physics
Co-Sponsor: Committee on the Interests of Senior Physicists, APS Forum on History of Physics
Date: Tuesday, Feb. 16
Time: 3:30–5:54 p.m.

Presider: John S. Rigden

Four speakers will expand on their papers that were published in "Physics in Perspective," placing them in a broad context that might be useful in the physics classroom and beyond.

FE01: 3:30–4:06 p.m. Julian Schwinger, Inventor of Renomalized Quantum Electrodynamics: Restoring His Rightful Place in Physics Educ.

Invited – Kimball A. Milton, University of Oklahoma, Norman, OK 73019-2061; milton@nhn.ou.edu*

Julian Schwinger defined theoretical physics in the United States between 1945 and 1960. He educated more than 80 PhD students at Harvard and UCLA, who became leaders in physics and other fields. His lectures at Harvard were legendary, packed with students and faculty, and always original, containing many unpublished results. Yet now he is nearly forgotten even in the physics world, eclipsed by the fame of Richard Feynman, with whom he shared the Nobel Prize for the renormalized theory of quantum electrodynamics. This talk will discuss Schwinger's profound contributions to physics education at all levels, and will attempt to explain why the education of young physicists has neglected the originator of many of the tools of theoretical physics. This gentle genius has much to teach us today, and his legacy lives on.
*Sponsor: Roger Stuewer

FE02: 4:06–4:42 p.m. New York Physics and Physicists: From the Five Boroughs to the Manhattan Project

Invited – Benjamin Bederson, New York University, New York, NY 10003; ben.bederson@nyu.edu

New York City has a long and proud record for both the physics and the physicists it has produced over the years. I will outline some of its notable achievements in both categories, and suggest a possible tour of important physics sites. There are many historic physics locations in New York, some of which are still standing (in keeping with an old New York tradition, many historic sites have been replaced by bigger and better buildings). But even more important, in my opinion, than New York's historic physics sites are the vast number of physicists who were nurtured here and who established the city as the most important breeding ground for American physicists, many of whom went on to notable achievements both here and elsewhere.

FE03: 4:42–5:18 p.m. Tales of Fermilab: Achieving Robert R. Wilson's Vision and Leon M. Lederman's Reality, 1967-1989

Invited – Adrienne W. Kolb, Fermilab History & Archives Project, Batavia, IL 60510; adrienne@fnal.gov*

Robert Rathbun Wilson's vision for Fermilab in 1967 deepened as the Main Ring accelerator turned on in 1972. Wilson's dreams for the beauty of science, nature, and aesthetics came true at Fermilab through his subsequent years as director and into the administration of his successor, Leon Max Lederman. Wilson planted the seeds for an environment where the international pursuit of high-energy physics could flourish. When Wilson resigned in 1978 over serious budgetary limitations that threatened the future operation of Fermilab, Lederman picked up Wilson's reins to continue not only Fermilab but also its pursuit of even higher energy accelerators, including the Energy Doubler (Tevatron) and the Superconducting Super Collider. As Lederman recognized the changed culture of physics research within the federal system he saw the public need for science literacy in order to understand an increasingly technical 21st century. By 1989 science education and outreach had become the key to Fermilab's future visions and their reality.
*Sponsor: APS Forum for the History of Physics

FE04: 5:18–5:54 p.m. I. I. Rabi: Science as the Center of Education

Invited – Michael A. Day, Lebanon Valley College, Annville, PA 17003; day@lvc.edu

In 1944, Rabi (1898-1988) won the Nobel Prize for Physics for "his resonance method for recording the magnetic properties of atomic nuclei." Though best known for his contributions to physics, Rabi was also an influential educator as well as science advisor. Using a phrase from John Rigden, Rabi was a "statesman of science." In this talk, Rabi's views on education as developed during the 1950s-60s will be explored. These views culminate with his recommendation of moving science to the center of education—a view resonating with his overall position of science as the center of culture. Connections are made between Rabi's views and other intellectuals, in particular, C. P. Snow and "The Two Cultures" as well as the views of Robert Oppenheimer and the sociologist Daniel Bell. The talk concludes by considering how Rabi's insights, and the spirit behind them, offer ways of enhancing physics teaching in the classroom.

Session FG: NSF Course Curriculum & Laboratory Improvement Grant Report

Location: Balcony D
Sponsor: Committee on Apparatus
Date: Tuesday, Feb. 16
Time: 3:30–5:42 p.m.

Presider: Greg Puskar

This session will review the operation of this NSF program, summarize recent grants in physics and astronomy and focus on program operation and review of proposals. Contributed papers will describe actual uses and results from recipients of these grants.

FG01: 3:30–4:06 p.m. NSF's Course, Curriculum, & Laboratory Improvement (CCLI) Program

Invited – Duncan E. McBride, National Science Foundation, Arlington, VA 22230; dmcbride@nsf.gov

The National Science Foundation's undergraduate Course, Curriculum, and Laboratory Improvement (CCLI) program has been modified slightly for 2010, and further modifications are likely the following year. I will describe the new structure, talk about what the program staff expect from the program, and discuss some aspects that I think will be particularly interesting to the physics community. In addition, I will describe some of the physics and astronomy projects currently funded by CCLI. Grants in physics and astronomy range from equipment for a single lab to comprehensive curriculum development and dissemination projects. There will be time for questions and discussion of the CCLI program with the audience.

FG02: 4:06–4:42 p.m. Writing a Competitive CCLI Proposal

Invited – John Mateja, National Science Foundation, Arlington, VA 22230; jmateja@nsf.gov

In this presentation, I will present tips on how to write more competitive CCLI proposals. While a good idea is important, a good idea in and of itself does not ensure funding success. What do reviewers cite as a proposal's most important strengths? What are the most common weaknesses? Should you call the NSF program officer and talk with him/her about your proposal? Should you include letters of support? Should you include results from previously funded projects? How important are the project's evaluation and dissemination components? These and other important proposal considerations will be discussed during the presentation.

FG03: 4:42–4:54 p.m. Integrating Laser Tweezers into the Introductory Physics Curriculum

Mark E. Reeves, George Washington University, Washington, DC 20052; reeveme@gwu.edu

Meriam Abisourour, Michal Chojnacky, Carl Pearson, and Benjamin Gamari, George Washington University

From stretching DNA, to pulling DNA from a viral capsid to measuring membrane stiffness, laser trapping has become an increasingly useful tool for probing single molecule interactions in biophysics. A number of papers have presented plans for making affordable ($2k-3k) versions of laser tweezers that are suitable for advanced undergraduate laboratories, but little work has been done at the introductory level. We will present the results of using laser tweezers in a SCALE-UP pedagogical environment to teach basic principles such as Hooke's law, conservation of momentum, Brownian Motion, Taylor series expansions, and the equipartition theorem in the first semester of an introductory calculus-based physics class. We will also discuss the potential to apply the same set-up to teach principles of electrostatics and optics in the second semester of the same course.

FG04: 4:54–5:06 p.m. Development and Validation of the Calculus Concept Inventory

Jerome Epstein, Polytechnic University, Jackson Heights, NY 11372; jerepst@att.net

We report on the development of the Calculus Concept Inventory, explicitly modeled on the Force Concept Inventory. Results will be shown from about 70 classes and 4000 students involving both traditional instruction and carefully defined Interactive-Engagement instruction. Outcomes appear to be the same as reported by Richard Hake in 1998 for the FCI—a dramatic improvement in normalized gain for Interactive Engagement. We consider possible alternative explanations for the effect, and we discuss where the process in mathematics will proceed from here. Interest in this instrument nationwide is already quite extensive.

FG05: 5:06–5:18 p.m. Single Photon Quantum Mechanics: An NSF CCLI Progress Report*

David P. Jackson, Dickinson College, Carlisle, PA 17013; jacksond@dickinson.edu

Brett J. Pearson, Dickinson College

Armed with an NSF CCLI grant, the Department of Physics at Dickinson College is infusing various optics experiments throughout the physics curriculum. The ultimate goal is to bring students face to face with some of the fascinating and subtle aspects of quantum mechanics in a hands-on setting. Planned experiments include single-photon interference, the quantum eraser, and tests of Bell's theorem. This talk will provide an update on our progress and highlight some of our successes and difficulties thus far.

*Supported by NSF CCLI grant DUE-0737230.

FG06: 5:18–5:30 p.m. Diode Lasers as a Platform for Updating the Advanced Laboratory*

Eric Wells, Augustana College, Sioux Falls, SD 57197; eric.wells@augie.edu

Nathan Jastram, Russ Averin, Ron Andersh, Brian Moore, Augustana College

Diode lasers have been used as a framework for making large-scale updates to the upper-level laboratory curriculum at a small liberal arts college. These lasers are relatively inexpensive and versatile enough to use in a number of settings. We have adapted from existing literature around 10 experiments using diode lasers. Several experiments are used in both the physics and physical chemistry laboratory. Initial experiments at the beginning of the intermediate laboratory course are simple (e.g. photoelectric effect) but evolve toward more complex experiments (e.g. multi-photon absorption, saturated absorption of rubidium) by the advanced laboratory course. We observe that early experiments with the lasers build a comfort level that encourages students to explore more advanced topics. This confidence extends beyond laser-based labs to other techniques and choices for senior projects. Our experience suggests that widespread introduction of diode lasers is a viable method for updating an advanced laboratory curriculum.

*This work supported by NSF CCLI award DUE-0536303.

FG07: 5:30–5:42 PM Multiple Representations of Buoyancy*

James Vesenka, University of New England, Biddeford, ME 04005; jvesenka@une.edu

Jessica Oliveira and Meredith Weglarz, University of New England

For many students the concept of buoyancy falls under a category that can be loosely described as "knowing it when they see it." Unfortunately some of the "knowing" preconceptions include ideas such as "objects-- because they are light" and "objects – because they are full of air."[1] Though the ideas can sometimes be true, these descriptions are vague at best, and frequently are incorrect. Part of these preconceptions may stem from incomplete immersion of the object in the fluid and the vector nature of forces. We describe a demonstration/lab activity to help students make sense about the relationship between the tension on, and weight of, an object immersed in water. The activity is rich in multiple representations. A simple four-question multiple-choice pre/post test survey has been developed to evaluate the effectiveness of the lab activity. A post-lab life science based deployment activity will also be presented.

*Supported by NSF DUE 0737458.

1. www.stmatthewsschool.com/deep/pdfs/DivingScience.pdf

Session FH: Joint AAPT/APS Session on Physics and Society Education

Location: Washington 1
Sponsor: Committee on Science Education for the Public
Date: Tuesday, Feb. 16
Time: 3:30–5:54 p.m.

Presider: Art Hobson

FH01: 3:30–4:06 PM Moving Toward Sustainable Energy

Invited – John L. Roeder, The Calhoun School, New York, NY 10024; JLRoeder@aol.com

British physicist David MacKay has distilled the energy consumed by each Briton into the number of kilowatt-hours per day per person for every energy-consuming activity and has stacked against this the number of kilowatt-hours per day per person that can be produced by renewable energy sources. MacKay proposes several models for achieving a state of supporting Britain's energy needs from sustainable sources; but, regardless of which one is chosen, he warns that BIG changes will be needed.

FH02: 4:06–4:42 p.m. Perspective from a Policy Physicist

Invited – Charles D. Ferguson, Council on Foreign Relations, Washington, DC 20006; charlesdferguson@yahoo.com*

I will discuss my experience as a physicist who has worked on public policy issues for more than 12 years and who has also worked to educate the next generation of policy analysts about technical issues relevant to their professions. In particular, I will focus my talk on my work to improve nuclear security through prevention of nuclear proliferation, nuclear terrorism, and radiological terrorism as well as to educate policymakers, teachers, and the public about nuclear energy issues.

*Sponsor: AAPT CSEP Committee.

FH03: 4:42–5:18 p.m. Can Science Help Counter Suspicion of the Consequences of Climate Change?

Invited – Gordon J. Aubrecht, II, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

Stewardship of the Earth is not only moral: it is necessary to preserve its richness. The public appears to believe that waiting is acceptable before a decision must be made. Recent research[1] suggests that carbon emissions must be cut enough by 2050 for levels to begin decreasing to avert disaster. Science acts by asking questions that can be answered, but policy has to deal with imponderables. Scientists must back all sorts of energy alternatives and hope that half will fail—because if we don't explore options that could fail, we're not looking hard enough. It is equally important to communicate to the public that this search for failure is necessitated by the threat of millennium-length consequences of the greenhouse gases we have already released. Part of that communication needs to be by teachers who can help students (and the wider public) explore how science informs policy.

1. Katherine Richardson, Hans Joachim Schellnhuber, Joseph Alcamo, Terry Barker, Daniel M. Kammen, H.B.J. Leemans, Diana Liverman, Mohan Munasinghe, Balgis Osman-Elasha, Nicholas Stern, and Ole Wæver, *Climate Change: Global Risks, Challenges & Decisions*" University of Copenhagen report, March 2009.

FH04: 5:18–5:30 p.m. Renewable Energy from the Science House: Smart Grid for 6-12*

Lisa L. Grable, NC State University, Raleigh, NC 27606; grable@ncsu.edu

Smart grid, green power, and renewable energy are intriguing real-life challenges for today's middle and high school students. The Science House at NC State University is a partner in a Gen-III Engineering Research Center researching these challenges, the FREEDM Systems Center. Activities for learning basic electricity, batteries, capacitors, and transformers are the building blocks for understanding wind and solar power generation. Lab activities, multimedia, tour ideas, assessments, and additional sources of materials and ideas will be presented. See http://www.science-house.org/freedm/ for information and resources.

* Sponsored in part by NSF Award #0812121, Division of Engineering Education and Centers.

FH05: 5:30–5:42 p.m. Hooking Kids with Haunted Physics*

Patricia A. Sievert, Northern Illinois University, Byron, IL 61010; psievert@niu.edu

Kids love Halloween and science. Put them together and you have a real hit. In six years NIU's Haunted Physics Lab has grown to attract more than 1700 people and be named one of the 10 best things to do for Halloween in the Chicago Land area. We use 100 interactive displays decorated in a haunted theme to get children interested in physics. I'll share photos and information on displays, publicity, and planning.

*www.niu.edu/stem

FH06: 5:42–5:54 p.m. Ethics Instruction in Undergraduate Physics and Astronomy*

A. D. Bacher, Indiana University Bloomington, Bloomington, IN 47405; bacher@indiana.edu

Catherine A. Pilachowski and L. vanZee, Indiana University Bloomington

Instruction in research ethics is now in the curriculum for our undergraduate physics and astronomy majors and summer REU students at IU. Traditionally, students absorb research ethics through informal mentoring by research advisors. We have developed a more formal ethics program based on a "case studies" approach, following *On Being a Scientist: A Guide to Responsible Conduct in Research* (2009, National Academies Press). Students discuss possible resolutions of ethical questions in scenarios involving real-life situations they are likely to encounter as undergraduates or beginning graduate students. For undergraduates, discussion topics include reporting data, credit for ideas, and professional behavior. For graduate students, scenarios involve ethical concerns more appropriate for their career stage including conflicts of interest, authorship, and collaboration. The answers are not clear-cut and the students must grapple with conflicting choices that help them define the limits of ethical behavior.

*Supported in part by the NSF-REU program.

Session FI: How Current and Emerging Educational Technologies Can Support Physics Teaching

Location: Washington 2
Sponsor: Committee on Educational Technologies
Date: Tuesday, Feb. 16
Time: 3:30–5:42 p.m.

Presider: Cathy Ezrailson

Creative uses of emerging technology tools are allowing innovation in teaching online and elsewhere. From blogs, wikis, forums, podcasts, cafes, web seminars and other collaborative venues to social networks, Twitter and many types of "instant communication tools," a new day for teaching and learning is dawning. Along with the demise of many types of print media—magazines, newspapers and even textbooks—multi-faceted communication networks precipitate alternative methods of teaching and learning. This session will examine particularly effective models as well as newly defined challenges for the physics teacher.

FI01: 3:30–4:06 p.m. The Physics Classroom Website as a Teacher and Student Resource

Invited – Tom Henderson, Glenbrook South High School, Glenview, IL 60026; THenderson@glenbrook.k12.il.us

The Physics Classroom website (www.physicsclassroom.com) has a long history as a student resource. The site provides an easy-to-understand tutorial on physics concepts, complemented by a collection of animated GIFs, interactive Shockwave files, and review sheets. A variety of materials have been added over the past year to improve its value as a teacher resource. The site now provides classroom-ready curriculum materials, laboratory ideas, and activity sheets that are integrated with the various online resources designed for teachers. The means by which the newest resources at the site can be used to support teaching and learning will be demonstrated.

FI02: 4:06–4:42 p.m. Data Collection Outside the Box

Invited – Paul Kuhlman, Avon High School, Avon, SD 57315; Paul.Kuhlman@k12.sd.us*

Data collection probes are relatively inexpensive and are becoming readily available at many high schools. For assistance with these probes, there are many resources with "cookbook" laboratory instructions. However, are pre-made labs really the best method for students to understand how to collect data? "Cookbook" labs are very appropriate to teach many concepts. Yet, how could we get our students to really think deeply about the data collection process, as well as choose the appropriate equipment? We can do this by extending the use of probes to more practical applications. These powerful tools can be used in many creative ways in order to collect data that is all around our students. In this session, we will discuss several student-designed experiments that were conducted in the physics, chemistry, and physical science classroom. It is also requested that members of the audience share their own unique experiences with data collection devices.

*Sponsor: Cathy Mariotti Ezrailson

FI03: 4:42–4:54 p.m. Using Recordings and Lecture Quizzes in an Introductory Physics Course

Taha Mzoughi, Dept. of Biology and Physics, Kennesaw State University, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

Since spring 2009, I have substituted lectures in an introductory algebra-based physics course by recordings and lecture quizzes. Before coming to class, students watch the recordings, complete the lecture quizzes, and formulate questions about the content being covered. Class time is used to discuss the questions they have formulated earlier and to answer new questions. In this presentation, I will provide details about the methods used, and how they have affected the class dynamics.

FI04: 4:54–5:06 p.m. Whole-class Laboratories with Google Docs

Scott W. Bonham, Western Kentucky University, Bowling Green, KY 42101; scott.bonham@wku.edu

Discovering physical laws through hands-on experimentation is a powerful teaching approach for nonscience students in general education physics courses. A common problem in doing this is significant measurement uncertainty due to inexperience, which can be compensated by collecting many data points, averaging errors out. In my Light, Color and Vision class we collectively "discover" Snell's law, the thin lens equation, and similar relationships this way. Students work in small groups making three to five measurements at different angles or distances, then the results from all groups are easily amalgamated using a Google Docs spread sheet and associated form. Then I show the data to the class, graph it, and perform simple analysis while they watch the projection of the instructor's computer. Through this process, students see a physical law emerge from their own data during a 55-minute class period.

FI05 5:06–5:18 p.m. A Calculus-based Introductory Physics Text Based on Symbolic Computation Software

Brad Trees, Ohio Wesleyan University, Delaware, OH 43015; brtrees@owu.edu

The computational and graphical abilities of modern computational software are impressive. I report on a physics e-text project, based on Mathematica notebooks, which attempts to take advantage of those abilities. The text's emphasis is on combining dynamic content such as animations along with graphs in order to emphasize a pictorial approach to learning fundamental physics concepts while also retaining mathematical rigor at the level of a gateway course for physical science and engineering majors. Examples of text content will be shared.

FI06: 5:18–5:30 p.m. Learning Physics with CALM (Computer Assisted Learning Method)

Jay D. Tasson, Indiana University, Bloomington, IN 47405; jtasson@indiana.edu

R. T. deSouza and A. D. Bacher, Indiana University

The Computer Assisted Learning Method (CALM)[1] is a web-based learning tool that presents students with algorithmically generated questions. Using the Socratic method, it guides students in addressing questions. Key features include the instant feedback it provides students about the correctness of their response and the feedback it provides instructors about the comprehension of their students. Developed by the Indiana University chemistry department in 1996, CALM is now used by colleges, universities, and high schools throughout the United States. An important characteristic of CALM is that it provides a database of questions available to the community as well as including a web interface that facilitates development of additional questions by instructors. They can then choose to share their questions with other instructors. I will outline the features of CALM, provide examples of physics questions being developed, and describe how we are moving toward building a freely available, community-owned learning system.

1. http://calm.indiana.edu

FI07: 5:30–5:42 p.m. Time Dependence of Students' Homework Habits

Peter Knipp, Greenwich High School, Greenwich, CT 06830; peterknipp@juno.com

I've performed data-mining on the submissions of many students (N=600) to an online homework system (WebAssign) in order to study temporal aspects of their work habits. I monitor the time-dependence of each student's grade [G(t)] on each weekly homework assignment, and I define the student's "work rate" to be the derivative (with respect to time) of G(t). In particular I calculate the first-, second-, third-, and fourth-moments of the students' work rates, and I study the correlations between these moments and students' rate of success in the course, as manifested by their final grades.

Session FJ: Improving Physics Teaching by Studying, Thinking, & Learning in Scientific Domains

A Session Honoring Fred Reif

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Co-Sponsor: APS Forum on Education
Date: Tuesday, Feb. 16
Time: 3:30–5:54 p.m.

Presider: Ken Heller

FJ01: 3:30–4:06 p.m. Striving for a Scientific Approach to Science Education

Invited – Frederick Reif, Carnegie Mellon University, Pittsburgh, PA 15215; freif@andrew.cmu.edu

Most professors teaching a science proceed empirically without much knowledge or thought about educational issues. A more scientific approach requires an understanding of the underlying thought processes and knowledge properties needed for good performance in the science. There arise then the following questions: 1) How can concepts be specified well enough to be clearly interpreted in any specific case? 2) What descriptions and organizations of relevant knowledge facilitate its use? 3) How can one solve problems by making judicious decisions able to identify and select useful options? 4) How does an understanding of these cognitive processes facilitate learning and teaching? The answers to these questions are different in scientific domains or in everyday life (and these differences cause difficulties for students trying to learn science.) The preceding questions overlap some examined in cognitive science. Indeed, recent advances in cognitive science and information technologies offer promising opportunities for improving education.

FJ02: 4:06–4:42 p.m. A Knowledge Integration Perspective on Learning and Teaching Physics

Invited – Bat-Sheva Eylon, Weizmann Institute of Science, Rehovot, Israel 76100; b.eylon@weizmann.ac.il

Esther Bagno, Weizmann Institute of Science

The importance of knowledge integration in learning and teaching is a major theme in Reif's work. Students tend to fragment their knowledge, a widespread phenomenon that severely reflects on recall, reasoning and further learning. Following Reif's pioneering work in this area we have been exploring for over a decade the nature of knowledge integration (KI), how to design instruction that promotes KI, and how to implement such instruction with teachers. We have identified four interrelated processes necessary for KI: eliciting current ideas, adding new ideas, developing criteria for evaluating ideas, and sorting out ideas.[1] This characterization leads to design principles of instructional strategies that promote knowledge integration. In this talk we will describe several such strategies and empirical studies of their implementation in physics classes. We will also describe an evidence-based methodology for working with teachers that led to effective implementation of these strategies in physics classes.

1. M.C. Linn, and B. Eylon, In P. A. Alexander and P. H. Winne, (Eds.), *Handbook of Educational Psychology,* 2nd Ed, 511-544 (LEA, 2006).

FJ03: 4:42–5:18 p.m. Implication of Memory Models for Physics Problem Solving

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

For decades, Fred Reif has stressed the importance of physics teaching in our understanding students' initial mental states, the organization of their knowledge, and how their minds function.[1] Viewing nearly three decades of research in PER through this lens raises interesting questions. i) Many students in introductory physics classes show robust misconceptions, sometimes about topics they have misinterpreted, but sometimes about topics with which they have little or no experience. How are misconceptions generated and how stable are they? ii) Students solving physics problems sometimes fail to access knowledge they know well. How does a student's perception of the task they are carrying out affect what knowledge they bring to bear? In this talk I will discuss recent relevant results from cognitive science and from three recent physics dissertations[2] along with their instructional implications.

1. F. Reif, *Physics Today* 48-54 (November, 1986); *Am. J. Phys.* **63,** 17-32 (1995); and *Applying Cognitive Science to Education* (MIT Press, 2008).

2. T. Bing, T. McCaskey, and B. Frank, PhD dissertations, U. of Md.

FJ04: 5:18–5:54 p.m. Making Problem Solving a Valuable Learning Opportunity – An Instructors' Perspective

Invited – Edit Yerushalmi, Weizmann Institute of Science, Rehovot, Israel 76100; edit.yerushalmi@weizmann.ac.il

Reif's research characterizes a strategic approach to problem-solving that turns the process into a valuable learning opportunity, and stresses an overlooked instructional goal: the need to develop such an approach in physics students. Reif, his students, and other physics educators developed instructional innovations that have been shown to promote such a strategic approach; however, these innovations conflict with deep-rooted traditional practices and are sparsely implemented. How can we bring instructors to adopt Reif's ideas? I will describe a long-term effort aimed at supporting teachers in changing perceptions and adapting innovative instruction. The questions we faced along the way were: How do instructors conceive problem solving, its learning, and teaching to begin with? What resources and professional development are needed to support teachers during the change process? How do teachers customize instructional innovations to their own classroom context? How effective are instructors' customized innovations in making problem solving a valuable learning opportunity?

Session FK: A Physics Teacher's Introduction to Research Frontiers at the National Institute for Standards and Technology

Location: Jackson
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, Feb. 16
Time: 3:30–5:18 p.m.

Presider: Andy Gavrin

FK01: 3:30–4:06 p.m. Research with Laser-Cooled Atoms at NIST

Invited – Paul D. Lett, National Institute of Standards and Technology, Gaithersburg, MD 20899-8424; paul.lett@nist.gov*

Cold atoms have many uses in current research and have potential for future real-world applications. Researchers at NIST investigate the applications of ultracold atoms to quantum information processing, precision measurements, and metrology. This research has led to two Nobel Prizes in physics in recent years. I will describe some of the research taking place at NIST involving laser-cooled neutral atoms, and their further cooling and manipulation. Atoms can be slowed and cooled by careful interactions with light. The velocities of atoms can be reduced, by optical or other means, to below the recoil velocity obtained from absorbing a single optical photon. In this regime some remarkable properties of cold gasses due to the atomic statistics (Fermions or Bosons) become evident. The most famous result of this nature is the Bose-Einstein condensate.

*Sponsor: Andrew D. Gavrin

FK02: 4:06–4:42 p.m. Neutrons at NIST

Invited – Dan Neumann, National Institute of Standards and Technology, Gaithersburg, MD 20899-6102; dan@nist.gov

Neutron scattering is an invaluable tool for studying the structure and dynamics of complex modern materials. This is because neutrons scatter via a nuclear interaction so that they "see" hydrogen and deuterium differently. This allows scientists to selectively label materials to highlight particular components. In addition, neutrons possess a magnetic moment providing an unmatched tool to study magnetic materials. In this presentation, we will describe several examples taken from materials research at the NIST Center for Neutron Research that exemplify these properties. In particular, we will discuss recent studies of superconductors, polymers, materials for energy, and magnetic storage materials.

FK03: 4:42–5:18 p.m. NIST's Center for Nanoscale Science and Technology: New Research Opportunities

Invited – Robert J. Celotta, Center for Nanoscale Science and Technology, NIST, Gaithersburg, MD 20899-6200; robert.celotta@nist.gov*

Nanotechnology is ubiquitous. It is so because we now realize that by changing the size and shape of matter on the nanometer scale we can change its properties. And, we now have the tools to make and measure nanoscale objects. Consequently, there is an explosion of research and development aimed at nanotechnology enabled phenomena and products. NIST created the Center for Nanoscale Science and Technology (CNST) in May of 2007 to further the development of nanotechnology, from discovery to production. I will describe research currently under way at the CNST as well as the operation and use of its national user facility, the NanoFab.

*Sponsor: Andrew D. Gavrin

Session GA: The Physics of Hobbies

Location: McKinley
Sponsor: Committee on Physics in Two-Year Colleges
Date: Tuesday, Feb. 16
Time: 7–7:48 p.m.

Presider: Todd Leif

Got a neat Hobby? Does it involve physics in any way? Believe it or not, it probably does. This session is designed for you to share your hobbies and the physics that is related to enjoying such interesting activities.

GA01: 7–7:12 p.m. Physics in Crosswords

William P. Hogan, Joliet Junior College, Joliet, IL 60431; whoganjjc@gmail.com

The names of famous physicists and physics terms often appear in crossword puzzles. This talk will discuss which names and terms appear the most often and also how the physics names and terms are clued. For example, in recent *New York Times* crosswords, “Force” has been clued as “The F in the equation F = ma” while “Speed” has been clued as “Velocity.”

GA02: 7:12–7:24 p.m. The Physics of High-Altitude Ballooning

Erick P. Agrimson, St. Catherine University, St. Paul, MN 55105; epagrimson@stkate.edu

High-altitude balloons have been used for many years as a platform to collect many types of data such as relative humidity, pressure, cosmic ray counts, and temperature. In addition, HD video cameras and still cameras can be instruments flown on a stack. The individual can become involved in areas of parachute construction, APRS, sensor design, stack setup as well as holding launches for kids of all ages and informing them about the near space environment. We look at one of the hobbies at St. Catherine University, the experience of flying high-altitude balloons!

GA03: 7:24–7:36 p.m. Physics of Running

Renee J. Lathrop, Dutchess Community College, Poughkeepsie, NY 12601; lathrop@sunydutchess.edu

Running is a great relaxing hobby for many people. Some of the physics that applies to the act of running will be discussed. Topics will include energy, momentum, center of mass, and torque.

GA04: 7:36–7:48 p.m. Why Jerry Jones Needs a Lesson on Projectile Motion

James C. Moore, Longwood University, Famville, VA 23909; moorejc@longwood.edu

During the first football game played in the Dallas Cowboys’ new stadium, an opposing player’s punter hit the center-hanging scoreboard. The Cowboys’ owner, Jerry Jones, stated that a kicker would have to intentionally try to hit the board and that in a normal game-day situation it would not be a factor. We have modeled the trajectory of NFL punts using literature-based estimates of drag coefficients, initial velocities and angles. When maximizing both range and hang time, we find an optimal punting angle between 55 and 60 degrees, which is consistent with measurements of average punting angles in the NFL. Furthermore, we find that a well-kicked punt has the potential to hit the center-field scoreboard no matter the field position and especially in situations between the 50-yard line and the opposing team’s 30-yard line. The physics suggests that Jerry Jones is wrong. The scoreboard has the potential to be hit often.

Session GB: Astrobiology: From the Frontiers to the Classroom

Location: Virginia B
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, Feb. 16
Time: 7–8:48 p.m.

Presider: Juan R. Burciaga

What is life? Will we find it elsewhere in the universe? How are we looking? How does this search fit in our curriculum? Astrobiology exists at the intersection of physics, chemistry, biology, astronomy, and geology. But what have we discovered so far? How are we exploring our solar system for life? How can we train the next generation of researchers in a field so inherently interdisciplinary?

GB01: 7–7:36 p.m. The Crowded Universe: The Search for Living Planets

Invited – Alan P. Boss, Carnegie Institution, Washington, DC 20015-1305; boss@dtm.ciw.edu*

More than 350 planets have been found outside our solar system, ranging from the familiar to the weirdly unexpected. The discovery of dozens of super-Earths, planets with masses of 5 to 20 times the mass of the Earth, implies that Earth-like planets are commonplace. NASA’s Kepler Mission, now under way, will determine the frequency of habitable, Earth-like planets in our neighborhood of the galaxy. Once that frequency is known, we will know how best to design specialized space telescopes that will be capable of weighing and imaging these new worlds, and telling us whether their atmospheres show evidence of the molecules necessary for life (e.g., water and carbon dioxide), and possibly even those created by life (e.g., oxygen and methane). We will then know if any nearby stars harbor planets that are habitable, and perhaps even inhabited. We will know just how crowded the universe really is.

*Sponsors: David Sokoloff, Juan Burciaga

GB02: 7:36–8:12 p.m. Mars Organic Molecule Analyzer (MOMA): Instrument Concept and Results

Invited – Luann Becker, Johns Hopkins University, Bloomberg Center, Baltimore, MD 21218; lbecker@pha.jhu.edu

T. Cornish and M. Antione, Johns Hopkins Applied Physics Laboratory

R. Cotter and T. Evans-Nugyen, Johns Hopkins School of Medicine

The Mars Organic Molecule Analyzer (MOMA) is a powerful multi-source mass spectrometer-based instrument suite for investigation of potential life on Mars. MOMA has been selected as a core element of the Pasteur payload on the ESA ExoMars mission that will launch in 2016. The MOMA instrument is the next generation design for in situ life detection instrumentation. The MOMA suite includes a gas chromatograph (GC) and a 266 nm Nd:Yag laser allowing for several methods of volatilizing and ionizing chemical compounds from intact samples over a broad mass range with little or no sample manipulation. Both the LD and GC share an ion-trap mass spectrometer for the detection of volatile (amino acids) and more “labile” or heavier (small peptides) up to 2000 amu. The Ion Trap Mass Spectrometer provides enhanced mass resolution over a broad dynamic range and detailed structural information on specific (single mass) organic molecules and compounds in a given sample substrate. In this paper, we present our current MOMA-LDMS prototype design and some preliminary results on organic compounds of interest including several Martian “analogue” samples.

GB03: 8:12–8:48 p.m. Oasis in the Desert of Space

Invited – Jason Maron, American Museum of Natural History, Dept. of Astrophysics, New York, NY 10024; jasonmaron@gmail.com

Though we lack any direct detections of extraterrestrial life, we enjoy a wealth of observations about possible habitats, such as from Earth-based extremophiles, explorations of the solar system, and from a rapidly expanding population of extrasolar planets. Putting it all together in the context of the Drake equation invokes a web of interdisciplinary connections, with a few examples highlighted here about how comprehensive this web can be.

Session GC: Using Undergraduate Students in Undergraduate Curriculum

Location: Virginia C
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Research in Physics Education
Date: Tuesday, Feb. 16
Time: 7–8:24 p.m.

Presider: Lili Cui

GC01: 7–7:36 p.m. Re-conceptualizing Undergraduate Education: LA Programs as an Experiential Learning Model

Invited – Valerie K. Otero, University of Colorado, Boulder, CO 80309; valerie.otero@colorado.edu

The Colorado Learning Assistant Model is a multi-disciplinary, experiential learning model that doubles as a low-cost and effective mechanism for transforming large-enrollment, undergraduate courses so they are aligned with research in science education. LA-supported courses show higher learning gains than those not transformed with LAs, and LAs' learning gains far exceed those of their peers. Since 2003, 694 LA positions have been filled in seven departments and approximately 35 courses have been transformed at CU-Boulder. Additionally, 12% of LAs have been recruited to K-12 teaching careers. Since the program's inception, the number of physics majors enrolling in teacher certification programs has tripled and LAs who become teachers show higher average RTOP scores in their K-12 classrooms than a matched sample of teachers. Several different funding, student recruiting, and faculty buy-in mechanisms have been used to support the program. Support mechanisms, data, and reconceptualizing the undergraduate learning experience will be discussed.

GC02: 7:36–8:12 p.m. Recruiting More Majors and Teachers: Undergraduates Are Key

Invited – Gay B. Stewart, University of Arkansas, Fayetteville, AR 72701; gstewart@uark.edu

When we embarked upon an NSF-supported curriculum project, it became clear that the greatest need for educational reform to be embraced and sustained was for our future faculty to be prepared to be as professional about their roles as educators as their roles as researchers. Employer complaints about those hired for research positions involve interpersonal skills. More researchers have to do outreach. Teaching and outreach activities develop these skills. Our focus at first was to add these kinds of activities to the graduate program, with the same sort of mentoring that accompanies the development of research skills, without extending time to degree. Our undergraduates going out into graduate school requesting some of this same support led us to pursue undergraduate involvement. The results of bringing these talented and highly motivated students into a teaching apprenticeship have been wonderful for the students and their students! We discuss our experiences and findings.

*NSF has supported this work through Course and Curriculum Development, Shaping the Preparation of Future Mathematics and Science Faculty, PhysTEC, and the Math Science Partnership programs.

GC03: 8:12–8:24 p.m. Evolution of Student Teaching Assistants in Calculus-based Introductory Physics Courses

Paul G. Ashcraft, Penn State Erie, The Behrend College, Erie, PA 16563; pga106@psu.edu

Jonathan Hall, Penn State Erie, The Behrend College

As the pedagogy for a calculus-based introductory physics course transformed from a traditional lecture and lab to a SCALE-UP format, the tasks of our student teaching assistants also changed from a teacher-centered to a student-centered role. Students who used to lead a two-hour lab with a small group of students became classroom facilitators assisting the instructor during five hours of mostly student activities. Benefits to both the student assistants and the classroom students will be discussed along with the problems of hiring student workers for larger commitments of time.

Session GD: Panel: Vertical Alignment of Physics Conceptual Curriculum

Location: Balcony A
Sponsor: Committee on Teacher Preparation
Date: Tuesday, Feb. 16
Time: 7–8:48 p.m.

Presider: Nancy Donaldson

This panel session will highlight the value of a vertical alignment of physics conceptual curriculum across grade levels to aid in teachers' and students' learning progressions. Implementation requires collaboration across grade levels and teachers that are strong in content, strong in pedagogical content, and knowledgeable of their students' spiraled curriculum. Benefits and barriers to implementation of a vertical conceptual physics curriculum will be discussed.

GD01: 7–7:36 p.m. Learning About Energy in K-8

Panel – Fred Goldberg, CRMSE, 6475 Alavarado Rd., San Diego, CA 92120; fgoldberg@sciences.sdsu.edu

In this talk I will first review some recent work related to students' developing understanding of energy ideas in grades K-8. Then I will briefly describe two projects that help students develop energy ideas. One is a one-semester college level course[1] intended for prospective elementary and middle school teachers, where energy is a common theme throughout. The other is a module being developed for use in 3rd-grade classrooms to help motivate and help students develop initial ideas about energy.[2]

1. *Physics and Everyday Thinking,* Published by It's About Time, Herff Jones Education Division.
2. Toy Car Module, being developed as part of NSF grant 0732233, Learning Progressions in Scientific Inquiry.

GD02: 7:36–8:12 p.m. Conceptual Alignment, the Spiral Approach and Development of Reasoning

Panel – Dean A. Zollman, Kansas State University, Manhattan, KS 66506-2601; dzollman@phys.ksu.edu

Vertical alignment of the concepts in physics has a long tradition at all levels of instruction. Even up through graduate study we return to topics that students have studied previously and develop them at an advanced level that builds on the students' previous knowledge of the topic under discussion. This "spiral" approach has also been developed as a way to teach introductory college-level physics.[1] This vertical alignment of the university curriculum should make it relatively easy for physicists who are involved in teacher education to prepare elementary and secondary teachers to be able to vertically align the study of physics. A critical part of the effort is to establish how the concepts can be learned at various grade levels based on our knowledge of the students' reasoning skills.

1. Albert V. Baez, *The New College Physics: A Spiral Approach,* W. H. Freeman and Co., San Francisco, (1967).

GD03: 8:12–8:48 p.m. Vertical Integration in a Secondary Science Curriculum

Panel – Kathy L. Malone, Shady Side Academy, Pittsburgh, PA 15238; kmalone@shadysideacademy.org

In secondary schools most science curricula from year to year are disjointed and have no connection, giving students the impression that there is no connection between physics, chemistry, and biology. I will be presenting the work at one high school to integrate secondary science curriculum via pedagogical content (i.e., modeling instruction) and energy concepts utilizing a physics-first science sequence. I will share the barriers the department overcame (and continues to overcome) and the benefits to the student population. Specifically, I will share data demonstrating the students' scientific reasoning progression from freshman to junior year.

Session GE: Successes/Challenges with SPS in TYCs and Small Departments

Location: Balcony B
Sponsor: Committee on Physics in Two-Year Colleges
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, Feb. 16
Time: 7–8:48 p.m.

Presider: Gary White

The Society of Physics Students supports chapters at TYCs and other small departments, but some might ask how the organization can be sustained without senior physics majors. This session will explore the motivations, barriers, and successes that some of the most successful chapter advisors and student officers have faced in maintaining an active SPS chapter in a TYC or small departmental setting.

GE01: 7–7:36 p.m. Maintaining an Active SPS Chapter in a TYC Setting

Invited – Jesse L. Cude, Hartnell Community College, Salinas, CA 93901; jcude@razzolink.com

Brooke Haag, Hartnell Community College

The presenters (one recently retired, the other recently hired) will describe how it is possible to promote the goals of an SPS chapter with a group that contains freshman and sophomore college students and only an occasional physics major. By focusing on several specific goals, the chapter has attracted a loyal following of students willing to dedicate the time and energy needed to ensure a successful program—one that has earned the Hartnell College SPS chapter national recognition and made it one of the best and most long-lived clubs on our campus. Several essential ingredients will be discussed that the authors believe are responsible for this success. Past mistakes, potential pitfalls, and anticipated future changes will also be addressed.

GE02: 7:36–8:12 p.m. Overcoming Challenges Facing SPS Chapters at Two-Year Colleges

Invited – Ajay M. Narayanan, Green River Community College, Auburn, WA 98092-3622; anarayanan@greenriver.edu

Community and Two Year Colleges (TYCs) are focused on delivering content effectively. However, most two-year colleges lack the resources to provide for a "community of students," such as the Society of Physics Students, once regular classes are done for the day. This presentation will focus on some of the challenges facing two-year colleges and some strategies, ideas, and resources to help you overcome them. The students, faculty, and staff at Green River Community College have worked together to sustain a robust chapter for a few years. Some of our experiences will be highlighted.

GE03: 8:12–8:48 p.m. SPS and the SWTJC Physics Program

Invited – Mary Beth Monroe, Southwest Texas Junior College, Uvalde, TX 78801; mbmonroe@swtjc.cc.tx.us

Southwest Texas Junior College is a typical rural two-year college with a single physics faculty member. Membership in SPS had been a valuable experience for me as both an undergraduate and graduate student at Sam Houston State University, and I wanted to provide my students with some of that same experience. Therefore, with the help of four students, I organized the SPS chapter at SWTJC in 1975. I will describe the role that SPS has had in my physics program and the benefits to my students and college, as well as some of the challenges that my chapter faces due to our academic and geographic isolation.

Session GF: Teaching Physics to Students with Special Needs

Location: Balcony C
Sponsor: Committee on Physics in High Schools
Date: Tuesday, Feb. 16
Time: 7–8:12 p.m.

Presider: Katya Denisova

The focus of this session is various differentiation and adaptation strategies used in physics classrooms that allow students with special needs equal access to physics concepts and experiences.

GF01: 7–7:12 p.m. Teaching Learning Disabled Students Taught Me About Inertia & Momentum

Mark I. Moverman, The Lab School of Washington, Washington, DC 20007; mmoverman@aol.com

For many years, the pedagogical canon of mechanics has started with kinematics, lip service to inertia, and then a launch into the second law. Essentially a historical perspective. Having taught in both "normal' and exclusively LD settings, I have come to recognize the difficulties students have starting with the abstract concept of acceleration. I took a few steps back and examined the subject of mechanics as a whole as well as what I believe to be the heart of the Force Concept Inventory. In this session, I'll report my results and describe the curriculum I've created.

GF02: 7:12–7:24 p.m. Does Physics First Include Special Needs Students?

Rose M. Young, Liberty High School, Eldersburg, MD 21797; rmyoung@carrollk12.org

With the growth of the Physics First movement in the United States, increasing numbers of 9th-grade students are placed in high school physics, and this includes those with special needs. As a teacher of 9th-grade physics for the past four years, I have had experience with inclusion classes as well as smaller classes for students with significant disabilities. My classes have included a blind student, students with severe social-emotional disorders and many who had very limited math and reading skills. I have developed scaffolding tools to address the lack of algebra and reading skills, and work closely with case managers and special educators. Nearly all my students have been successful. I believe it is important to provide access to learning about physics to all students through these teaching methods, as well as assessment techniques that maintain accountability for student learning in a standards-based assessment environment.

GF03: 7:24–7:36 p.m. Twice-Exceptional Students in the Physics Classroom

Karen Weeks, JHU Center for Talented Youth, McAuley Hall, Baltimore, MD 21209; karen.weeks@jhu.edu

For 30 years the Johns Hopkins University Center for Talented Youth (CTY) has offered physics and other courses to academically talented pre-collegiate students during the summer. By their design, CTY's courses include differentiated lessons based on background knowledge and ability. Many CTY classrooms contain students who are labeled as twice-exceptional. These students are academically gifted while also having learning disabilities or other disorders. The three most common exceptionalities seen in the program are students that have diagnosed learning differences, autism spectrum disorders, and attention deficit hyperactivity disorders. This presentation focuses on strategies and practices that have been successful at CTY in keeping these students engaged while also meeting their individual needs in the STEM classroom.

GF04: 7:36–7:48 p.m. Effectiveness of Physics Teaching Based on the Parallel Curriculum Model

Minjung Park, Seoul National University, Gwanakro 599, Gwanak-gu, Seoul, Korea 151-748; mj1017@snu.ac.kr

Dongryul Jeon, Seoul National University

The purpose of this study is to assess students' growth through 12 physics classes based on the Parallel Curriculum Model (PCM) for gifted science students of 6th grade. PCM is composed of four facets of qualitatively differentiated curricula, which are core, connections, practice and identity. We taught the subject of light based on PCM for the experimental group but for the control group the same subject was taught based on the ordinary curriculum. The students' growth was checked by performing tests about science-related attitude, integrated process skills, logical thinking, and scientific knowledge. The result showed that, compared to teaching based on the ordinary curriculum, integrated process skills could be much more improved by specifically designed lectures based on PCM. Furthermore, analyzing field notes and students' self reports showed that the component of curriculum such as teaching strategies, learning activities, and extension activities influenced students' growth.

GF05: 7:48–8 p.m. Process-Oriented Guided Inquiry Learning (POGIL) Approach in a Diverse Class

Criselda Belarmino, Maritime Industry Academy High/ Baltimore City Public School System, Baltimore, MD 21206; cgbelarmino@yahoo.com

The topic of this presentation is the Process Oriented Guided Inquiry Learning (POGIL) method in teaching physics in a diverse class. During each discovery session, there will be a four-person team seated around a table. All contribute to the learning progress of the team, but in the context of four different, important roles within the team namely; Manager/Spokesman, Whiteboard Scribe, Researcher/Investigator/Technician, and Recorder/Secretary. There will be assessments given for each specific role at the end of the period right after the white board meeting. This method encourages every diverse student's participation in learning. I will share Post-Activity Survey results and graphs to prove its effectiveness and some weaknesses in comparison with diverse learners learning.

GF06: 8–8:12 p.m. Formula Recollection Through a Wordly Recognized Mnemonic Technique

Shannon A. Schunicht, Texas A&M/mnemonic Writings, College Station, TX 77845.3005; mnemonicmind@alpha1.net

Physics may be made fun, and encourage further learning through ease of recollection of complicated formulas; all the while increasing a student's comfort with their algebraic skills. Examples will be shown of how ANY complicated formula will be made into a memorable acronym using this author's mnemonic technique, i.e. allowing each vowel to represent a mathematical operation: " a" multiplication implying "@"; "o"-division implying "over"; "I"- subtraction to imply "minus"; "u"-addition to imply "plus"; and "e" implying "equals". Most constants and variables are indeed consonants; "c" = "speed of light" & "z" = "altitude". With this mnemonic technique ANY formula may be algebraically manipulated into a word, or series of words for ease of recollection. Additional letters may be added to enhance the intelligibility of such a letter combination, but these additional letters need be consonants ONLY. This mnemonic technique was developed as a compensatory memory method when taking physics at Texas A&M University following a severe head injury (19 days unconsciousness!) suffered by this author.

Session GG: Teaching with Technology – III

Location: Washington I
Sponsor: Committee on Educational Technologies
Date: Tuesday, Feb. 16
Time: 7–8:48 p.m.

Presider: Bruce Mason

As technology changes, we find new ways to implement it in our classrooms. Technologies can help improve learning, can help enliven the classroom and make it more relevant and engaging, and can help teachers facilitate learning or manage classroom tasks more efficiently.

GG01: 7–7:12 p.m. Using Sound Recording To Teach Fourier Analysis and Wavelet Analysis

Joseph J. Trout, Drexel University, Philadelphia, PA 19104; st92l7c3@drexel.edu

An advanced lab is designed to teach students Fourier Analysis and Wavelet Analysis and filtering. Students perform Fourier Analysis and Wavelet Analysis on sound recordings. White noise is then added to the sound recordings and the students then complete the analysis a second time. The students then attempt to filter out the noise and compare the filtered signal to the original signal.

GG02: 7:12–7:24 p.m. An Evaluation of the Effectiveness of Using Turning Point Software in the Teaching of Modern Physics

R. Seth Smith, Francis Marion University, Florence, SC 29506; rsmith@fmarion.edu

Physics professors attempt to engage students in the learning of physics by teaching in a manner that students will perceive as relevant, interesting, fun, intriguing, and clear. Perhaps, the most valuable contribution that a professor can make to a student's education is to stimulate an interest in a particular discipline. To accomplish this, a professor has to be a performer. One doesn't necessarily have to entertain, but one must bring a certain level of enthusiasm and energy to a classroom in order to engage the students. If they are not engaged in the classroom, students will not learn effectively. Toward this end, Turning Point software was used to create new classroom presentations for FMU's Modern Physics class in the spring of 2009. Turning Point is essentially Power Point, but it provides one with the ability to embed interactive questions within a presentation. Students in the class responded to these questions by using radio frequency devices known as "clickers." An analysis of the effectiveness of this approach, including student assessments of it, will be presented.

GG03: 7:24–7:36 p.m. Using Computer Tutorials To Teach Important Lab Skills

David J. Groh, Gannon University, Erie, PA 16505; groh001@gannon.edu

Kelly Zophy, Gannon University

Important lab skills were identified by surveying course faculty: using balances properly and distinguishing g, kg, N; using metersticks and Vernier calipers; graphing in Excel; finding averages and stdevs in Excel; testing hypotheses using basic statistics. The old paper tutorials were used by two of the lab sections, while the other two used computer Toolbook tutorials written by the presenter. Comparisons between the sections will be presented.

GG04: 7:36–7:48 p.m. Computational Exercises in Introductory Mechanics

Marcos D. Caballero, Georgia Insitute of Technology, Atlanta, GA 30071; caballero@gatech.edu

Michael F. Schatz, Georgia Institute of Technology

Matthew A. Kohlmyer, North Carolina State University

Students taking introductory physics are rarely exposed to numerical computation, that is, using a computer to solve science and engineering problems. An introductory physics course at Georgia Tech, based on the "Matter and Interactions (M&I)" curriculum by Chabay and Sherwood, utilizes numerical computation as a tool for describing physical phenomenon not easily described using analytic methods. Students are taught to develop visual 3D models of a variety of physical phenomenon (e.g., the motion of a spring-mass system exposed to viscous drag in 3D). We present an overview of the computational component of this curriculum and the development of exercises to enhance students' understanding of numerical computation and visualization introduced in the M&I curriculum.

GG05: 7:48–8 p.m. Use of Rensselaer Mobile Studio IOBoard Hardware and Software in Introductory Physics*

Peter D. Persans, Rensselaer Polytechnic Institute, Troy, NY 12180; persap@rpi.edu

Kim Michelle Lewis, Gwo-Ching Wang, and Donald Millard, Rensselaer Polytechnic Institute

Timely connection between lecture and hands-on experiments is central to learning introductory physics. Ideally, every student should personally perform hands-on experiments. Unfortunately, the cost and size of conventional laboratory equipment precludes such individual use in many courses. We report on the use of the Rensselaer Mobile Studio IOBoard (www.mobilestudio.rpi.edu) and associated software in Physics II, an introductory electromagnetism and waves course at Rensselaer. The IOBoard connects to the user's PC via USB, providing an inexpensive multipurpose instrument. In fall 2008, a pilot section of 48 students performed significantly better than control sections on common examination questions that related to traveling waves. In fall 2009, IOBoard use has been expanded to every student in two sections of 48 students each. We will describe and demonstrate specific experimental activities, student response, and analysis of student performance on test questions that address mastery of associated topics.

*Funded in part by the NSF DUE 0633083.

GG06: 8–8:12 p.m. Wolfram Alpha in the Physics Classroom

David L. Morgan, Eugene Lang College, The New School, New York, NY 10011; morgand@newschool.edu

In 2009, Wolfram Research, makers of Mathematica, introduced a web-based calculation and data-analysis engine called Wolfram Alpha. In this presentation I will explore the physics features built into Wolfram Alpha and its potential to allow physics students to explore advanced concepts and solve physics problems using natural language input.

GG07: 8:12–8:24 p.m. Enhancing Student Learning: Using Tablet PCs in Modern Physics Class*

Marina Milner-Bolotin, Ryerson University, Toronto, ON M5B 2K3; mmilner@ryerson.ca

Tetyana Antimirova, Ryerson University

At Ryerson University science teaching is taken very seriously. As a result, we have experimented with various technologies such as Vernier sensors, clickers, SmartBoard, various computer simulations, and now tablet computers. Thanks to the generous HP Educational Technology Initiative grant, we were able to create HP Mobile Physics Lab for Science students. The tablet technology was extensively used in two upper-level courses: Modern Physics (25+ students) and Electricity and Magnetism (40+ students). In the Modern Physics course the tablets were used both inside and outside of class. Tablets open new possibilities for student in-class collaboration, for open-ended continuous feedback, and for creating short video clips answering students' questions. We will discuss the advantages and limitations of in-class tablets use, the challenges we have encountered and how we addressed them. We will describe the effect of tablet PCs on students' learning and course satisfaction.

*This work is being supported by HP Innovations in Education Initiative.

GG08: 8:24–8:36 p.m. Enhancing Students' Learning: Using Tablet PCs in Electricity and Magnetism*

Tetyana Antimirova, Ryerson Toronto, ON M5B 2K3; antimiro@ryerson.ca

Marina Milner-Bolotin, Ryerson University

At Ryerson University, we have experimented extensively with various technologies to support our pedagogy. Thanks to the generous HP Educational Technology Initiative grant, we were able to create HP Mobile Physics Lab for Science students. The students in the Electricity and Magnetism course joined the instructors's presentation, annotated lectures, collaborated on problem solving, and submitted their work using Tablet PCs and Classroom Presenter free academic software (by the University of Washington). We are no longer restricted by the limitations of multiple-choice format. In-class use of tablets offers the instructor an unparalleled opportunity to receive instant open-ended feedback on class understanding of the material and adjust the teaching accordingly. We will discuss the advantages and limitations of in-class tablets' use and the effect of tablet PCs on students' learning and course satisfaction.

*This work is being supported by HP Innovations in Education Initiative.

GG09: 8:36–8:48 p.m. Integration Can Explain Physical Laws with the Help of Technology

George E. Kontokostas, University of Athens, Parthenonos 14, Athens, Greece 17562; gakon67@hotmail.com

PURPOSE: The integration of physical concepts through the microcosm. Studying the behavior of electrons and photons, we can justify any visual phenomenon with the help of interactive technology. RESULTS: Understanding the physical concepts are easy for any student. SUGGESTIONS: 1) From the particle of matter and field to the material body and field. 2) From the density and distribution in space to the mechanical properties. 3) From the thermal motion and shock to the Temperature and Pressure. 4) From the motion of the particles to the electrical current and induction. 5) From the vibrations to the waves.

Session GH: Teaching Physics Around the World – I

Location: Washington 2
Sponsor: Committee on International Physics Education
Date: Tuesday, Feb. 16
Time: 7–8:48 p.m.

Presider: Lei Bao

GH01: 7–7:36 p.m. Sharing PER and Physics Teaching in Mexico and with Tibetan Buddhist Monks In-Exile

Invited – Dewey I. Dykstra, Jr., Boise State University, Boise, ID 83725-1570; ddykstra@boisestate.edu

Comparing physics learning in the United States, in Mexico, and with Tibetan Buddhist monks, finds many important similarities. The responses to cognitive disequilibrations introduced in a certain type of inquiry instruction are very similar. The indication is at a certain level experience with physical phenomena is the same in spite of cultural differences. Some of the differences observed may be attributable to culture. It is important to note that for the most part so far, what we find is that inquiry-based materials developed for studying by U.S. students as they develop deeper understanding seem also to work in other cultures. This suggests that PER by colleagues in other cultures has relevance to us here, as well as our PER can have relevance for our colleagues in other cultures. Examples will be shared.

GH02: 7:36–8:12 p.m. Developing a Nuclear Questioning Curriculum

Invited – Donald G. Franklin, Retired, 39 West Main St., Hampton, GA 30228; dgfrank1@aol.com

What levels should curriculum materials be used to develop students with knowledge of our modern world. As nuclear energy has become a major topic in our world as a danger and a salvation, many students never have educational experience with the history or the conflicts that nuclear has raised in our world today. It is very important that all physics teachers spend time on this topic. An informed voter can make intelligent decisions! Teacher kits will be available to help teachers add nuclear topics to their Energy Solutions has three DVDs available for the teacher and other sites will be included in the handouts.

GH03: 8:12–8:48 p.m. Conceptual Understanding of Entering University Students in Five Spanish-Speaking Countries*

Invited – Genaro Zavala, Tecnologico de Monterrey, E. Garza Sada 2501, Monterrey, NL Mexico 64849; genaro.zavala@itesm.mx

Julio Benegas, Universidad de San Luis, Argentina

Maria del Carmen Perez de Landazabal and Jose Otero, Universidad de Alcala, Spain

In this work we analyze the basic conceptual knowledge in physics that entering freshman university students have in seven universities in five Spanish-speaking countries. The conceptual diagnostic test used in this study measures some fundamental knowledge and basic concepts necessary to study science or engineering majors in the university that pre-university education should provide to students. The analysis proves that students from very different cultures and educational systems have similar difficulties in their conceptual understanding. This study is part of a broad project carried out by educational researchers from Argentina, Chile, Cuba, México, and Spain in which the objective is not only to measure the deficiencies but also to propose solutions. In this presentation we will describe the diagnostic test, describe student populations, and present the data results from seven universities. We will analyze the general results and some particular items that show the educational situation of these students.

*Additional authors: Ascencion Macias, Nora Nappa, Susana Spandiella, Sylvia Seballos, Juan Silvio Cabrera, Hugo Alarcon, Roberto Espejo.

Session GI: PER: Student Reasoning

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Date: Tuesday, Feb. 16
Time: 7–8:36 p.m.

Presider: Jeff Marx

GI01: 7–7:12 p.m. The Semantics of Math in Physics

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

Ayush Gupta, University of Maryland

Physics makes powerful use of mathematics, yet how this happens is often poorly understood. Professionals closely integrate their mathematical symbology with physical meaning, resulting in a powerful and productive knowledge structure. But because of the way the cognitive system builds expertise, instructors who are expert physicists may have difficulty in unpacking their well-integrated knowledge in order to understand the difficulties novice students have in learning their subject. Despite the fact that students may have previously been exposed to ideas in math classes, the addition of physical contexts can produce severe barriers to learning and sense-making. In order to better understand student difficulties and to unpack expert knowledge, we adopt and adapt ideas and methods from cognitive semantics, a sub-branch of linguistics devoted to understanding how meaning is associated with language.

GI02: 7:12–7:24 p.m. Students' Views of Data Collected from Physical and Virtual Manipulatives

Jacquelyn J. Chini, Kansas State University, Manhattan, KS 66502; jackiehaynicz@gmail.com

Elizabeth Gire, Adrian Carmichael, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin-Madison

We aimed to contribute to the ongoing debate about the advantages of physical vs. virtual manipulatives in physics experiments by capturing students' views of some issues related to these different types of experimentation. Approximately 100 students enrolled in a conceptual-based physics course collected data from both physical experiments (using real pulleys) and virtual experiments (using a computer simulation). After completing the activities, students completed an open-ended survey designed to explore their views about data collected from physical and virtual manipulatives. Students were presented with several situations (a class exam, an experiment, and a rental store) and asked which set of manipulatives they would use to choose which pulley setup that would require the least force to lift a load or would be the most beneficial. We will present the type of manipulatives students preferred and their reasoning for their preferences.

*This work is supported in part by U.S. National Science Foundation under the GK-12 Program (grant) (NSF DGE-0841414, P.I. Ferguson) and U.S. Department of Education, Institute of Education Sciences Award R305A080507.

GI03: 7:24–7:36 p.m. Identifying Conceptual Schema Adaptation Using Similarity Ratings in Algebra-based Physics

Frances Mateycik, Pennsylvania State University, Altoona, Altoona, PA 16602; fam13@psu.edu

N. Sanjay Rebello, Kansas State University

David Jonassen, University of Missouri

Students often extract the conceptual schema from previous cases and adapt them to new problems. Recognizing the deep structure differences and similarities between problems is essential for productive case reuse, or conceptual schema adaptation. Data were collected during a semester-long study with students participating in weekly focus group learning interviews designed to facilitate case reuse strategies. At the mid and end points of the study, students were interviewed individually and asked to rate the similarities between problem pairs. For the upcoming spring semester, we look to extend this study using wider variations in population and problem sets. For this talk, I report on previous results from the similarity ratings and lay out the theoretical background and intentions of the next step of this study for the 2010 spring semester.

GI04: 7:36–7:48 p.m. How Students Reason About Competing or Enhancing Effects

Andrew Boudreaux, Western Washington University, Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

Frances DeRook, Western Washington University

Multi-step reasoning is known by instructors to pose substantial challenges to the learning and teaching of physics. One example involves the analysis of situations in which two independent variables both influence the behavior of a system. Students must first recognize the effect that a change in each variable has individually, and then compare the size and sign of these effects in order to make a statement about how the system will behave. At WWU, we have probed student facility with this type of multi-step reasoning in contexts that include the mechanics of particles, fluid dynamics, and electrostatics. Results from written questions and interviews will be presented to illustrate specific aspects of student thinking.

GI05: 7:48–8 p.m. Exploring Students' Patterns of Reasoning*

Mojgan Matloob Haghanikar, Kansas State University, Manhattan, KS 66506; mojgan@phys.ksu.edu

Sytil Murphy and Dean Zollman, Kansas State University

As a part of a study of the science preparation of elementary school teachers students, we have adopted two different methods for analyzing students' reasoning skills in answering written extended responses to examination questions. First, using a method outlined by Nieswandt and Bellomo,[1] we analyzed concepts levels and their linkages as displayed in students' answers. In the second method we devised a rubric based on the hierarchies of knowledge and cognitive processes cited in a two dimensional revision of Bloom's taxonomy.[2] We categorized responses in terms of knowledge types and cognitive types that were employed in the answers.

*Supported by National Science Foundation grant ESI-055 4594

1 M. Nieswandt and K. Bellomo, *Journal of Research in Science Teaching*, **46**(3) p.333-356 (2009)

2 L.W. Anderson & D.R. Krathwohl, *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, New York: Longman (2001).

GI06: 8–8:12 p.m. Ebb and Flow of Student Knowledge in Introductory Physics

Jessica W. Clark, Rochester Institute of Technology, Rochester, NY 14623; jwc4518@rit.edu

Scott V. Franklin, Rochester Institute of Technology

We have extended an earlier study by Sayre et al.[1] on student learning, forgetting, and interference in introductory calculus-based physics. Rochester Institute of Technology, where our study took place, has the advantage of offering all three courses of introductory physics every quarter. In one quarter, we administered seven tasks covering vectors, kinematic,s and basic dynamics to six sections of intro physics I, covering mechanics, and eight sections of intro physics III, covering E&M (<40> students/section in each). We use a between-group analysis to compare student performance of one section on a given task with that of another section at a different time. Our study not only reproduces the earlier study on responses during the quarter in which the material is learned, but extends it longitudinally to determine how students apply concepts almost a year after the initial exposure.

1. E. C. Sayre and A. F. Heckler, *Physical Review Special Topics - Physics Education Research* **5** (2009).

GI07: 8:12–8:24 p.m. An Example of Material Influence on Student Behavior and Thinking*

Brian W. Frank, Physics Education Research Laboratory, University of Maine, Orono, ME 04469; brian.frank@umit.maine.edu

Collaborative learning activities are rich with material and social interactions that can be strongly coupled to the substance of student discussions.[1] In particular, the nature and location of artifacts available to individuals and groups can both constrain and provide opportunities for different behaviors and student interaction. In tutorial settings, students have access to various artifacts that they can manipulate, attend to, relocate, crowd around, etc. By carefully tracking the trajectories of particular artifacts in space, we are able to observe couplings between these objects and specific patterns of student behavior. I present an example from a tutorial about motion,[2] in which changes to the location and arrangement objects appear consequential to students' physical behavior and to the substance of their thinking. I discuss the extent to which these material and social interactions help to explain the local stability of students' thinking.

* This work is supported in part by NSF Grant No. REC-0440113

1. For example, R. Scherr, R. & D. Hammer, "Student behavior and epistemological framing: Examples from collaborative active-learning activities in physics," *Cognition and Instruction,* **27**(2), 147-174, (2009)

2. Adopted from L. C. McDermott, P. S. Shaffer, & the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics.* Upper Saddle River, NJ: Prentice-Hall (1998).

GI08: 8:24–8:36 p.m. Hunting for Questions: Developing Metacognitive Strategies in Science Education

CANCELED

Hani Dulli, Graduate School of Education, Rutgers University, New Brunswick, NJ 08901; hdulli@eden.rutgers.edu

Eugenia Etkina, Rutgers University

We have developed a query-based assessment and instruction method that was used in an undergraduate physics course. The students were asked to write questions about the concepts of force and motion in Newtonian mechanics. These questions were answered naively by the instructor and returned to the students who made comments on the instructor's answers. Both the students' questions and comments revealed rich information about the students' content knowledge and cognitive/metacognitive learning strategies. The findings were shared with the students to give them a chance to reflect on their experience and to evaluate the strengths and weaknesses of their own thinking processes. In this talk, we will discuss the method used and the students' responses as well as potential applications of our approach.

Session GJ: Upper-level Physics

Location: Balcony D
Sponsor: Committee on Physics in Undergraduate Education
Date: Tuesday, Feb. 16
Time: 7–7:48 p.m.

Presider: TBA

GJ01: 7–7:12 p.m. Refining our University's Computational Physics Program for 2010

Larry Engelhardt, Francis Marion University, Florence, SC 29505; lengelhardt@fmarion.edu

Our university offers a major in Computational Physics which—in additional to the typical physics courses—includes a sequence of courses dealing explicitly with the application of computational methods to the solution of physical problems. This sequence has consisted of a two-semester upper-level sequence, and we recently added an additional sophomore-level course. We are now in the process of refining this three-semester sequence to take advantage of the best computational resources (packages, libraries, and textbooks) that are currently available. This availability has recently matured to the point that any instructor teaching computational physics will have excellent support; it is now a matter of putting these pieces together. Our approach to this issue will be discussed, as will the related topics of how to best correlate the computational activities with the students' level of academic preparation and how to identify projects that are both meaningful and feasible.

GJ02: 7:12–7:24 p.m. Undergraduate Course on "The Last Ten Great Discoveries in Physics"

Fereydoon Family, Emory University, Emory University, Atlanta, GA 30322; phyff@emory.edu

There is an obvious need to introduce undergraduate students to the latest developments in physics. I propose a course that accomplishes this difficult task in a natural way. The goal of the course is to present 10 of the most significant recent developments in physics by discussing the discoveries for which the last 10 Nobel Prizes in physics were awarded. The overarching aim of the course is to give the students sufficient scientific knowledge about each topic so they can understand and appreciate the significance of each discovery. The presentations revolve around three basic questions: What is the puzzle? Why is it important? and How was the discovery made? Since considerable information is available about each topic both in print and on the web, the instructors have the freedom to design their course as broadly or narrowly as they wish, while keeping the course highly focused.

GJ03: 7:24–7:36 p.m. What Is "Environmental Physics?"

Kyle Forinash, Indiana University Southeast, School of Natural Sciences, New Albany, IN 47150; kforinas@ius.edu

For the past 12 years I have been teaching environmental physics both as a technical course for junior physics and science education majors and as a "science and technology" course for college freshmen. The junior level course is taught very much in the spirit of *Consider a Spherical Cow* by John Harte and *Physics of Societal Issues* by David Hafemeister but with a slightly different scope. As the result of this experience, I am in the process of writing a junior- level text on the application of physics to environmental problems. The talk will review topics appropriate for these types of courses as well as ideas for student projects. The challenges inherent in teaching a course where the latest research results change very rapidly will also be addressed.

GJ04: 7:36–7:48 p.m. Modeling Energy States of Lithium Dimers with the Born-Oppenheimer Approximation

Collin J. Lueck, University of Dallas, Irving, TX 75062; collin.lueck@gmail.com

To obtain energy eigenstates of a two-atom system, it is necessary to separate the wavefunction of the system into nuclear and electronic components. In an adiabatic approximation, the nuclear component is a function of internuclear distance, and the electronic component is a function of electron-nuclear distance. When this approximation is used with the Numerov numerical method for plotting wavefunctions and a Distributed Approximating Function for finding energy eigenstates, it allows for plotting the energies of uncoupled states. However, more elegant and accurate solutions exist. Using a diabatic approximation, in which the wavefunctions of the nuclei are functions of the nuclear separation as well as parametric functions of the electronic motion, much more accurate energy eigenvalues are obtained. This method, when combined with a function to prevent crossings of the energy eigenstates using Clebsch-Gordan coefficients, yields a much more realistic energy plot and a deeper understanding of the two-atom system.

Poster Session PST2: PER, Technologies, Astronomy & Energy and Environment Courses

Location: Exhibit Hall A
Date: Tuesday, Feb. 16
Time: 9–10:30 p.m.

Authors should put up their posters at 8 a.m. on Tuesday.
Authors will then be present at times listed on abstracts: odd numbers, 9–9:45 p.m.; even numbers, 9:45–10:30 p.m.

A) Physics Education Research

PST2A-1: 9–9:45 p.m. Diagnosing Course Diagnostics

Patricia E. Allen, Appalachian State University, Sugar Grove, NC 28608; allenpe@appstate.edu

John E .Cockman, Appalachian State University

Diagnostic tests provide a wide range of information on student performance. At Appalachian, the impact of a reformed laboratory approach in the algebra-based course was examined using an in-house diagnostic exam[1] and final exam questions. The Hake scores[2] for the exams were surprising because initial results indicated little to no difference of the reformed labs on overall student performance. In particular, many of the diagnostic questions with the largest gains, or losses, were linked to lab activities. However, when an item-by-item analysis was conducted, the lab activities could be viewed in a new light. This paper will focus on how the item-by-item analysis helped reveal subtle issues with select lab activities and how those issues are currently being resolved both in lab and lecture.

1. Twenty of the 34 questions of the in-house diagnostic are from the FCI (Force Concept Inventory).
2. R. R. Hake, *Am. J. Phys.* **66**, 64 (1998).

PST2A-2: 9:45–10:30 p.m. Influence of Meanings Mediation in Learning Mechanical Energy Concept

Hilda Ameneyro Ameneyro, CICATA IPN, Mazaquiahuac 306, Fraccionamiento Zaragoza, Apizaco, Tlaxcala, Mexico 90300; hildaameneyro@gmail.com

We found serious deficiencies in teaching the concept of energy, in spite of it being the most important concept in physics. In the current work, material student-centered for teaching the concept of mechanical energy was tested through the answer to the question: What effect does the mediation of meanings produce in student performance for solving problems involving mechanical energy? That response was given based on the theories of Ausubel and Vigotzky on meaningful learning, mediation learning, and knowledge construction; testing the strategy of the Karplus Learning Cycle, in which it is possible to develop abstract thinking at the same time knowledge is acquired. A quantitative study was developed through a pre- and post-test design, with control and experimental groups. The results of the instrument before and after treatment were compared and the statistical study with a student test, showed a significant difference between the mentioned groups.

PST2A-3: 9–9:45 p.m. Student Responses to a Multiple Representation Problem

Tara M. Bartiromo, Rutgers University, New Brunswick, NJ 08901; tmfinley1@yahoo.com

Eugenia Etkina, Rutgers University

During the field-testing year of the Physics Union Mathematics curriculum, students answered a conceptual test question that required them to use multiple representations to support their answer. The majority of the students answered the conceptual question incorrectly. Interestingly, the representations they drew were consistent with their answers. In this talk, we discuss the students' responses and how they compare to students' responses using the revised PUM curriculum. We focus on how their conceptual understanding has changed and how they use the representations to support their answers. The work was supported by NSF DRL-0733140.

PST2A-4: 9:45–10:30 p.m. Examining Proportional Reasoning Ability of Physics and Physical Science Students

Andrew Boudreaux, Western Washington University, Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

Suzanne W. Brahmia, Rutgers University

Stephen E. Kanim, New Mexico State University

Gary White, American Institute of Physics

Proportional reasoning has attracted substantial attention in mathematics and science education research over many years. Piaget treated facility with proportional reasoning as an indicator of formal scientific reasoning skills, and proposed a transition from concrete to formal reasoning at around age 15. Studies of physics students, however, have shown that a significant fraction of college-age students still struggle with proportional reasoning tasks. We have been investigating the ways that students of a variety of ages reason about ratios and proportions. Populations include pre-college science students, college students in general education science courses, college science majors, and teachers. In this poster, we present data from written questions involving concepts such as density and velocity in order to illustrate productive and problematic aspects of student reasoning, and to examine the effects of context, representation, and population on student performance.

PST2A-5: 9–9:45 p.m. Students' Views of Physical and Virtual Experiments with Pulleys*

Jacquelyn J. Chini, Kansas State University, Manhattan, KS 66502; jackiehaynicz@gmail.com

Elizabeth Gire, Adrian Carmichael, N. Sanjay Rebello, Kansas State University

Sadhana Puntambekar, University of Wisconsin, Madison

The debate about the advantages and disadvantages of using physical versus virtual manipulatives in physics laboratories is multi-faceted. In this study, we aimed to capture students' views of the issues related to physics and virtual experiments. Approximately 100 students enrolled in a conceptual-based physics course for future elementary school teachers learned about pulleys by performing experiments with physical (real) and virtual (computer simulated) pulleys. For each experiment, students made the same measurements and calculations and answered the same analysis questions. After completing the activities, students responded to an open-ended questionnaire designed to explore their views of the two types of experiments (physical and virtual). Specifically, students were asked to compare and contrast the physical and virtual pulley experiments, to describe the possible causes of any differences in their data, and to explain which experiment had more trustworthy data. We will present the analysis of students' responses to this questionnaire.

*This work is supported in part by U.S. National Science Foundation under the GK-12 Program (grant) (NSF DGE-0841414, P.I. Ferguson) and U.S. Department of Education, Institute of Education Sciences Award R305A080507.

PST2A-6: 9:45–10:30 p.m. Analyzing Student Attitudes After an Experimental Laboratory Using the CLASS

John E. Cockman, Appalachian State University, Boone, NC 28608; cockmanje@appstate.edu

Patricia E. Allen, Appalachian State University

The Colorado Learning Attitudes about Science Survey (CLASS) was administered as a pre- and post-test to measure student attitudes and beliefs in an introductory, algebra-based physics course. Of the six laboratory sections offered, four were taught using the same cookbook style as previous years. The remaining two, randomly selected laboratory sections, were given experimental, inquiry-based lab activities to perform. Although grades in the traditional lecture remained unaffected due to laboratory selection, an analysis of the CLASS data reveals that there is a marked difference between the traditional and experimental laboratory sections. After one semester of instruction, attitudes and beliefs about physics of students in the experimental laboratory sections were much better than those of students in the traditional sections. This analysis is supported by an additional survey written and administered by the researcher.

PST2A-7: 9–9:45 p.m. Which Sorts of Conflict Are Productive for Scientific Inquiry?

Luke D. Conlin, University of Maryland, College Park, MD 20912; luke.conlin@gmail.com

Ayush Gupta and David Hammer, University of Maryland, College Park

Productive scientific inquiry in physics tutorials should involve students evaluating their own ideas as well as those of their classmates in order to endorse or reject them. The rejection of each others' ideas can be a difficult task for a student group to manage, however, since the negative emotions associated with having an idea rejected can lead to a breakdown in the group's functioning. How do groups manage this complex social milieu? Which sorts of conflict, if any, can lead to productive inquiry discussions? In previous work (Conlin et al., 2007) we observed student groups transitioning into productive inquiry discussions. We suggested that such transitions were often precipitated by conflicts of various sorts, such as conflicting mechanistic explanations and epistemological stances. In this poster we build on this work by analyzing dozens of these transitions, analyzing the sorts of conflicts that lead to productive inquiry discussions.

PST2A-8: 9:45–10:30 p.m. Differentiating in the Physics Classroom for Academic Success.

Alice Cottaar, Eindhoven University of Technology, Postbus 513, Eindhoven, Netherlands 5611HZ; a.cottaar@tue.nl

The aim of this research is to determine how didactical aspects of physics teaching in secondary school influence the physics (national) exam grades and eventually academic success of the student in the Netherlands. Two sets of coupled survey data of 3230 and later 1870 Dutch university freshman students in science-related fields of study (2008-2009) have been obtained and analyzed. With dimension reduction techniques, components are extracted that characterize the typical physics student, teacher and classroom in high school, and the study mentality at university. The different variables influencing physics exam grades and academic success have been determined with linear regression techniques. Different kinds of students have different needs when aiming for (academic) success, so differentiating in the high school physics classroom seems necessary. Different options to optimize the effectiveness of high school physics lessons are proposed.

PST2A-9: 9–9:45 p.m. Comparing Traditional and Modeling Instruction Methods Using Item Response Curves*

Jorge de la Garza, Tecnologico de Monterrey, Av. E. Garza Sada 2501, Monterrey, Mexico 64849; jdelagarza@itesm.mx

Hugo Alarcon, Tecnologico de Monterrey

In a recent contribution we have reported on differences in conceptual learning of students between traditional and modeling instruction in an introductory course of mechanics.[1] In this study we use Item Response Curves (IRC) in order to visualize and understand these differences. "Testgraf," a friendly computational tool developed by Ramsay,[2] permits you to obtain a very complete item analysis. We have used this program to identify the main questions of the FCI that have shown great differences between these two instruction methods. The course that used modeling instruction was more effective in the Newton's third law dimension of the FCI.

1. H. Alarcon and J. de la Garza, *Influence of Scientific Reasoning on College Students' Physics Learning,* Physics Education Research Conference, Ann Arbor, MI, 2009.

2. J. Ramsay. http://www.psych.mcgill.ca/faculty/ramsay/ramsay.html

*This work has been supported by Tecnologico de Monterrey grant CAT-140.

PST2A-10: 9:45–10:30 p.m. Learning in a Physics Laboratory: Student Attitudes

Nilüfer Didis, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fak., OFMAE Bol., Ankara, Turkey 06531; dnilufer@metu.edu.tr

Ali Azar, Zonguldak Karaelmas University

Attitude is one of the affective factors that affect learning. This study aims to identify 11th- grade level science-mathematics division students' attitudes toward learning physics in the physics laboratory. An attitude scale was developed in the light of related literature, and validity and reliability issues are provided. The questionnaire was given to 63 students. Item level and total score analysis were conducted with SPSS. The results showed that students have mainly positive attitudes about learning in the physics laboratory. Also, these attitudes do not change due to gender, in other words, there is no significant mean difference in total attitude scores for males and females.

PST2A-11: 9–9:45 p.m. Factor Analysis and Question Categorization in the Force Concept Inventory

Richard D. Dietz, University of Northern Colorado, Physics Department, Greeley, CO 80639; rdietz@unco.edu

Matthew R. Semak and Courtney W. Willis, University of Northern Colorado

The application of factor analysis to the Force Concept Inventory (FCI) has proven to be problematic. Some studies have suggested that factor analysis of test results does serve as a helpful tool in assessing the recognition of Newtonian concepts by students. Other work has produced at best ambiguous results. One explanation for this may lie in the classification scheme of questions to which the results of the factor analysis are compared. We investigate some different categorizations of the questions on the FCI to see if we obtain better agreement between those categories and factors identified through factor analysis of student responses.

PST2A-12: 9:45–10:30 p.m. Describing Multiple Conceptual Stabilities During Collaborative Learning Activities*

Brian W. Frank, Physics Education Research Laboratory, University of Maine, Orono, ME 04469; brian.frank@umit.maine.edu

There is growing evidence against claims that students espouse singular frameworks for thinking about physics concepts and domains of physical phenomena.[1] Students, instead, may be understood to have multiple ways of perceiving, thinking, and talking about physical phenomena—understandings that may be locally generated and context dependent. Despite fragility, patterns of student thinking that arise in particular contexts exhibit varying degrees of local stability. Conceptualizing such stabilities as localized phenomena within dynamic systems has been generative for research in cognitive development[2] and may hold promise for physics education research as well.[3] I present analysis of video-data taken during a tutorial at the University of Maryland, in which participant groups settle into and shift among multiple conceptual understandings of tickertape representations of motion.[4] Patterns of student talk and behavior form the basis for speculating about the constituency of these local understandings and the mechanisms contributing to their local stability.

1. See, for example, A. Gupta, D. Hammer, & E. F Redish, (accepted), The Case For Dynamic Models of Learners? Ontologies in Physics, *Journal of the Learning Sciences*; or Frank, B. W., Kanim, S.E., & Gomez, L.S. (2008). Accounting for variability in student responses to motion questions, *Physical Review Special Topics - Physics Education Research*, **4**(2), 020102.

2. E. Thelen & L. B. Smith, *A dynamic systems approach to the development of cognition and action,* MIT Press Cambridge, MA (1994).
3. D. E. Brown & D. Hammer, "Conceptual change in physics," In S. Vosniadou (Ed.), *International Handbook of Research on Conceptual Change* (pp. 127-154), Routledge, New York, (2008).
4. Adopted from L C. McDermott, P. S. Shaffer, & the Physics Education Group at the University of Washington (1998), *Tutorials in Introductory Physics*, Prentice-Hall, Upper Saddle River, NJ (1998).
* This work is supported in part by NSF Grant No. REC-0440113.

PST2A-13: 9–9:45 p.m. Assessing the Impact of Diverse Instructional Techniques in the Introductory Physics Course*

Sean Gallardo, Chicago State University, Chicago, IL 60628; sean1g1@yahoo.com

Mel S. Sabella, Chicago State University

Over the past several years, the introductory mechanics class at Chicago State University has included several research-based instructional techniques aimed at improving student understanding of physics concepts. These techniques include pre-tests, Tasks Inspired by Physics Education Research (TIPERS), discussion questions, clicker question sequences, interactive PowerPoint lectures, and research-based laboratories. In addition, we have changed how we package our coursework by introducing a workbook that places these diverse pieces into a coherent unit. This year we introduced pre-lectures, developed by the University of Illinois Physics Education Research Group, into the course. A supplemental course designed to help students with their critical thinking skills was also implemented through a collaboration with Loyola Marymount University and the Mind Research Institute. In this poster, we discuss the details of our implementation and how these changes affect student performance.
*Supported by the National Science Foundation CCLI Program (#0632563) and the National Science Foundation Noyce Scholarship Program (#0833251).

PST2A-14: 9:45–10:30 p.m. Uncovering Middle School Students' Ideas About Energy

Cari F. Herrmann-Abell, AAAS Project 2061, 1200 New York Ave. NW, Washington, DC 20005; cabell@aaas.org

George E. DeBoer, AAAS Project 2061

This poster presents a summary of middle school students' understanding of the topic of energy. This work is part of a larger project to develop items that are precisely aligned with national content standards. The student data are a result of a field test of items aligned to ideas about forms of energy that was administered to 4761 middle school students in 35 states and a pilot test of items aligned to ideas of energy transformation, energy transfer, and the conservation of energy that was administered to 1806 middle school students in 30 states. Our results showed that middle school students had the most difficulty with ideas related to gravitational potential energy and conservation of energy. They were most successful with assessment items testing the ideas of elastic energy and motion energy. A cross-sectional analysis was performed to examine the progression of understanding of energy from middle to high school.

PST2A-15: 9–9:45 p.m. Concerning Longitudinal Wave Demonstration with Candle Flame and Loudspeaker

Zdeslav Hrepic, Dept. of Earth and Space Sciences, Columbus State University, Columbus, GA 31907; hrepic_zdeslav@colstate.edu

Chelsea Bonilla, Fort Hays State University

In order to reveal the longitudinal wave nature of sound phenomena to students, an experiment with a candle flame in front of a loudspeaker has been suggested as a clear demonstration. In this poster we describe the behavior of a flame under a range of frequencies and amplitudes of sound produced by a loudspeaker. The results show that desired effect can be demonstrated only within a relatively narrow frequency-amplitude (f-A) range. At the same time, for a variety of other ranges, the demonstration outcome might likely reinforce, rather than dismiss, the most common alternative conceptions and incorrect mental models related to sound propagation. This urges caution on the instructor's part when this demonstration is performed. The results are also relevant for researchers who use this experiment to study students' understanding of sound because questions related to outcomes of this experiment may not have single and unambiguous answers.

PST2A-16: 9:45–10:30 p.m. Assessing Expertise in Quantum Mechanics Using Categorization Task

Shih-Yin Lin, University of Pittsburgh, Pittsburgh, PA 15213; hellosilpn@gmail.com

Chandralekha Singh, University of Pittsburgh

We discuss the categorization of 20 quantum mechanics problems by physics professors and students in honors-level quantum mechanics course. Professors and students were asked to categorize the problems based upon similarity of solution. We find that while faculty members' categorization was overall better than students' categorization, the categories created by faculty members were more diverse compared to the uniformity of the categories they create when asked to categorize introductory mechanics problems. We will discuss the findings. We thank the National Science Foundation for financial support.

PST2A-17: 9–9:45 p.m. Lexical Availability for Measuring Growth in Conceptual Knowledge of Physics

Jesús Madrigal-Melchor, Unidad Académica de Física, Universidad Autónoma de Zacatecas, Zacatecas, Mexico 98060; jmadrigal.melchor@fisica.uaz.edu.mx

Agustín Enciso, Juan Manuel Rivera-Juárez, David Armando Contreras-Solorio, Juan López-Chavez, Universidad Autónoma de Zacatecas

Because different levels of education have been detected in the understanding of science, and particularly physics, we have done research to understand the causes of this behavior and propose models that will lead us to find solutions to improve the education and to enrich learning in physics. The Index of Lexical Availability (IDL), which arises from lexicometry, reflects a mental ordering of the vocabulary of a specific theme-interest center. We generated a database on the terminological dominion that had experts using the IDL, and then we did the same for novices. We realized the comparisons of individual orderings in which it's observed that they have a low correlation among them. The previous results give foundation to the conical model of education in physics.

PST2A-18: 9:45–10:30 p.m. Proposal of Education with Base in the Correlation of Groupings of Terms Marked by the IDL

Jesús Madrigal-Melchor, Unidad Académica de Física, Universidad Autónoma de Zacatecas, Zacatecas, Mexico 98060; jmadrigal.melchor@fisica.uaz.edu.mx

Agustín Enciso, David Armando Contreras-Solorio, Juan Manuel Rivera-Juárez, Juan López-Chavez, Universidad Autónoma de Zacatecas

We noted that if in the teaching of physics concepts are presented as separate concepts that are strongly related, it results in a slow and sometimes wrong comprehension of terms. The Index of Lexical Availability (IDL) exhibits the existing correlation between the words of an interest field, which has allowed us to design a lesson that, instead of leaving separated or loose terms, they are grouped according to the parameters thrown by the IDL, which improves the integral learning of the concepts. In addition, we showed the different curves from correlation of words as much related and not related.

PST2A-19: 9–9:45 p.m. Reflection and Self-Monitoring in Quantum Mechanics*

Andrew Mason, University of Pittsburgh/University of Minnesota, Twin Cities, Tate Laboratory of Physics, Minneapolis, MN 55454; ajmason@umn.edu

Chandralekha Singh, University of Pittsburgh

An assumed attribute of expert physicists is that they learn readily from their own mistakes. Here, we discuss a case study in which 14 advanced undergraduate physics students taking an honors-level quantum mechanics course were given the same four problems in both a midterm and final exam. The solutions to the midterm problems were provided to students. The performance on the final exam shows that while some advanced students performed equally well or improved compared to their performance on the midterm exam on the questions administered a second time, a comparable number performed less well on the final exam than on the midterm exam. The wide distribution of students' performance on problems administered a second time suggests that most advanced students do not automatically exploit their mistakes as an opportunity for learning, and for repairing, extending, and organizing their knowledge structure. Interviews with a subset of students revealed attitudes toward problem-solving and gave insight into their approach to learning.

*Supported by NSF awards PHY-0653129 and 055434.

PST2A-20: 9:45–10:30 p.m. Student Ideas Regarding Entropy*

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Warren M. Christensen, North Dakota State University

Craig A. Ogilvie, Iowa State University

We have probed student ideas regarding entropy and the second law of thermodynamics in several introductory physics courses enrolling more than 1000 students during a three-year period. We found distinct patterns of student thinking before instruction, including a strong tendency to apply conservation reasoning inappropriately as well as confusion regarding the meaning of "system" and "surroundings." We found little change in these patterns after instruction. However, targeted instruction using research-based tutorials showed promise of improving student understanding of these and related concepts.

*Supported in part by NSF PHY-0406724, PHY-0604703, and DUE-0817282

PST2A-21: 9–9:45 p.m. Assessing the Efficacy of an Online Interactive Tutoring System*

Chris M. Nakamura, Kansas State University, Manhattan, KS 66506; cnakamur@phys.ksu.edu

Sytil K. Murphy, Nasser M. Juma, and Dean Zollman, Kansas State University

Mike Christel, Entertainment Technology Center, Carnegie Mellon University

The online synthetic tutoring system, in development as part of the Pathway Active Learning Environment, has the capability to look at the efficacy of multiple types of multimedia instructional elements combined in parallel. The system is composed of an interactive tutoring interface that allows students to get video responses to typed questions about physics, multimedia support materials that are linked to the video responses through a digital multimedia library, and lessons designed using a three-stage learning cycle to provide students with a context in which to ask questions. Also of importance is a data logging system that allows students' interactions to be stored and analyzed. Assessing the efficacy of a teaching tool, including this one, requires systematic assessment of how the various components work together. Here we present schemes for examining how the components of our tutoring system interact and progress on the assessment of its efficacy.

*This work is supported in part by the National Science Foundation under grant numbers REC-0632587 and REC-0632657.

PST2A-22: 9:45–10:30 p.m. Resources: A Theoretical Framework for Physics Education

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

Eleanor C. Sayre, Wabash College

The Resources Framework (RF) is a structure for creating phenomenological models of high-level thinking. It is based on a combination of core stable results selected from educational research phenomenology, cognitive neuroscience, and behavioral science. As a framework (as opposed to a theory), it provides ontologies—classes of structural elements and their behaviors—rather than providing specific structures. These ontologies permit the creation of models that bridge existing models of knowledge and learning, such as the alternative conceptions theory and the knowledge in pieces approach, or cognitive modeling and the socio-cultural approach. Structurally, the RF is an associative network model with control structure and dynamic binding. As a phenomenological and descriptive framework, it does not (yet) create mathematical models from low-level elements. This poster outlines the RF and shows how it gives new ways of looking at traditional issues such as transfer, concepts, ontologies, and epistemology.

PST2A-23: 9–9:45 p.m. Differences in the Evolution of Student Understanding

Eleanor C. Sayre, Wabash College, Crawfordsville, IN 47933; le@zaposa.com

Scott V. Franklin, Rochester Institute of Technology

A classic method in PER is to pre-test students before instruction, teach them, then post-test afterwards to see how much they've gained. However, this method cannot capture the dynamics of student learning. By testing students more frequently, we can observe rapid learning and forgetting, as well as destructive interference patterns; a between-students design avoids test/retest effects. We measure learning differences for different demographics of students, as well as differing sensitivity to question format in both traditional and reformed classes for approximately 2000 students at The Ohio State University and Rochester Institute of Technology.

PST2A-24: 9:45–10:30 p.m. Innovation and Efficiency: How They Affect Student Discourse?

Gregory H. Suran, Rutgers University, Hillsborough, NJ 08844; hsuran@raritanval.edu

Anna Karelina, Maria Ruibal-Villasenor, and Eugenia Etkina, Rutgers

"Preparation for future learning" is a strand of transfer theory that recommends that students "invent" a concept before they are exposed to the normative knowledge about it. We investigate the application of this theoretical framework to the introductory physics labs. We focus on the changes in student writing about a scientific concept before they were exposed to the normative physics discourse about it and after such exposure. Specifically, we compared the reports that students wrote after a lab where they explored thermal conductivity without any theoretical knowledge of it (writing outside of normative discourse), and their written responses to the questions related to thermal conductivity after they read the text explaining the concept and connecting it to the flow of water and the flow of electric charge (writing in normative discourse). We developed a coding scheme and used it to score written work of 18 students participating in the study.

PST2A-25: 9–9:45 p.m. A Tutorial-Type Activity To Overcome Difficulties in Understanding Graphics in Kinematics

Santa Tejeda, Tecnologico de Monterrey, Eugenio Garza Sada # 2501, Monterrey, NL Mexico 64830; santa.tejeda@itesm.mx

Hugo Alarcon, Tecnologico de Monterrey

Understanding graphics in kinematics is one of the basic skills expected from engineering and science students. However, after administering the Test of Understanding Graphs in Kinematics (TUG-K), it is found that students have many misconceptions and learning difficulties.[1] To overcome some of these difficulties, we created a tutorial-type activity that was designed with the inspiration of the *Tutorials in Introductory Physics*.[2] In this work, we show the results obtained after the implementation of our activity with students in Introduction to Physics, a remedial-type physics course for entering engineering students. Using the TUG-K as a pre- and post-test, the implementation of this first version of the activity proves to have helped students. However, it also shows that the activity could be improved so ideas for the second version of the activity will be discussed.

1. R. J. Beichner, "Testing student interpretation of kinematics graphs," *Am. J. of Phys.* **62**, 750-762 (1994).
2. L. C. McDermott and P. S. Schaffer, *Tutorials in Introductory Physics,* Prentice Hall (2002).

PST2A-26: 9:45–10:30 p.m. A Standards-based Learning Progression of Ideas About Energy

Ted Willard, AAAS Project 2061, Washington, DC 20005; twillard@aaas.org*

This poster will feature the Energy Transformations strand map developed for the *Atlas of Science Literacy*, Volume 2. Strand maps display the relationships between learning goals for a particular topic, with goals for elementary students near the bottom of the page and goals for high school students at the top. Arrows connecting the learning goals indicate how knowing one idea can be helpful in learning another and are drawn based on the available research on student learning. While Benchmarks for Science Literacy focuses on energy transformations and the National Science Education Standards focuses on the transfer of energy, the research-based progression of understanding described on the map incorporates both approaches and also attempts to reconcile the different ways that energy is considered in different science disciplines. We are also developing assessments aligned to the goals on the map and testing students in an attempt to validate the learning progression.

*Sponsor: Cari Hermann-Abell

PST2A-27: 9–9:45 p.m. Embodied Physics: Gesture and Language as Signs of Emergent Meaning

Michael C. Wittmann, University of Maine, Orono, ME 04469-5709; wittmann@umit.maine.edu

Katrina E. Black, University of Maine

We often talk about the physics concepts students must learn, their misconceptions when they make mistakes, and the resources they activate when they use intuitions to guide their reasoning—different kinds of pre-existing ideas to be learned, understood better, or activated. We can also make fewer assumptions about pre-existing ideas and consider responses created dynamically, in immediate response to a question. In this poster, we use gesture and language to look at what students are doing while solving a problem. We present two examples, one from interviews of wave propagation and the other from videotaped groups involved in the algebraic manipulation of separable differential equations. We suggest that co-incident shifts in language use and gesture are signs of the emergence of newly constructed ideas.

PST2A-28: 9:45–10:30 p.m. Students' Understanding of Stern Gerlach Experiment*

Guangtian Zhu, University of Pittsburgh, Pittsburgh, PA 15260; guz11@pitt.edu

Chandralekha Singh, University of Pittsburgh

To improve students' understanding of quantum mechanics by helping them develop a good grasp of the Stern Gerlach experiments, we are developing quantum interactive learning tutorials (QuILTs) and tools for Peer Instruction. We will discuss the common students' difficulties with issues related to the Stern Gerlach experiment, and discuss ways to bridge the gap between quantitative and conceptual aspects of quantum mechanics using this topic as a tool.

*Supported by the National Science Foundation (NSF-PHY-0653129 and 055434).

PST2A-29: 9–9:45 p.m. Korean College Students' Concepts of Fluid Pressure and Force

Heekyong Kim, Division of Science Education, Kangwon National University, Gangwon-do, Chuncheon, Korea 200-701; heekyong@kangwon.ac.kr

This study investigated college students' concepts of fluid pressure and force. For this purpose, I administered open questionnaires to 45 senior students who majored in science education, comprising four tasks for fluid pressure. Individual interviews and group discussions followed to identify participants' reasoning and concepts. The results shows some serious conceptual and reasoning difficulties for understanding the pressure. Results from this study suggest some implications in the design of a curriculum that could help improve students' understanding of fluid.

PST2A-30: 9:45–10:30 p.m. Interference Between Concepts of Electric and Magnetic Forces

Thomas M. Scaife, The Ohio State University, Columbus, OH 43028; scaife.7@osu.edu

Andrew F. Heckler, The Ohio State University

We report results from a series of experiments that investigates how concepts of electricity and magnetism interfere with one another during instruction. Students were questioned at various times throughout an introductory sequence about the direction of force on a positively charged particle moving through either an electric or a magnetic field. Previous to instruction in magnetism, students answered magnetic force questions as though they were electric force questions, implying that electric force concepts were interfering with those of magnetic force. Following instruction in magnetism, however, interference reversed direction so that magnetic force concepts interfered with those of electric force. Students not only correctly answered that magnetic forces on charged particles were perpendicular to the magnetic fields, but also answered incorrectly that electric forces were perpendicular to electric fields.

PST2A-31: 9–9:45 p.m. Gain Dependence on Pre-test Score in Conceptual Change

Jungsook Lee, Korea National University of Education, Cheongwon, Chungbuk, Korea 363-791; lydia102@hanmail.net

Jung Bog Kim, Korea National University of Education

We have found differences in gain of conceptual change according to pre-test scores. Tutorials for conceptual change in electricity, which were developed for teachers, have been delivered to two groups. They are all teachers and enrolled in graduated school. This graduate school is a sort of retraining course. One group is in a course for teaching gifted students, and the other group is in a course for elementary science education. We found a statistically meaningful difference between the two groups. Even though the teacher group for gifted students got higher scores than the general teacher group, normalized gain in conceptual change of teachers for gifted students was less than teachers for general students. Because teachers for gifted students have had much more experiences in teaching, experiments, and scientific activities than others, they should get more points. The reason for the results may be due to too much self-confidence. Self-confidence might be an obstacle for learning and conceptual change.

PST2A-32: 9:45–10:30 p.m. Conceptual Understanding Process of Elementary Science-Gifted Students Using Dynamic Science Assessment

Hyun-Ju Hong, Korea National Univ. of Education, Cheongwon, Chungbuk, Korea 363-791; redcarrot_4ever@hanmail.net

Jung Bog Kim and Byung-Soon Choi, Korea National Univ. of Education

We have investigated characteristics of conceptual change about electric circuits by analyzing qualitatively scaffolding aspects obtained with Dynamic Science Assessment (DSA) of 12 elementary science-gifted students. Since DSA pursues two goals of both teaching and assessment, conceptual changing progress in problem setting of the zone of proximal development (ZPD) can be continuously monitored. The number of scaffolding for DSA was observed differently according to actual developmental level and potential developmental level. For subjects or problems that are not easy to conceptually formulate, explaining and intentional-induced-questioning scaffoldings were supplied many times. In addition, useful or weak points for conceptual changes in electric circuits were found.

B) Technologies

PST2B-1: 9–9:45 p.m. LivePhoto – Active Learning with Video Analysis – Workshops and Assessment*

Priscilla W. Laws, Dickinson College, Carlisle, PA 17013; lawsp@dickinson.edu

Robert B. Teese, Rochester Institute of Technology

Maxine C. Willis, Dickinson College

Patrick J. Cooney, Millersville University

The LivePhoto Physics Project team has been creating video clips and classroom-tested video analysis activities that can be used for interactive lecture demos, in-class exercises, labs, and homework. A preliminary study showed learning gains when video-analysis materials were added to an introductory physics course at Dickinson College. During the next two summers, the project team will offer two more five-day workshops for college and university physics instructors. Participants will learn about various ways to use video analysis in teaching and about action research and findings from physics education research related to video analysis. In addition, workshop participants will be invited to join a multi-year controlled study of the effectiveness of selected video-analysis curricular materials at diverse institutions. Preliminary results of this research study will be presented.

*Supported by NSF grants 0424063, 0717699 and 0717720 <http://livephoto.rit.edu/>

PST2B-2: 9:45–10:30 p.m. Exploring Physical Phenomena with Dynamic Graphical Story Telling

Charlotte M. Trout, Washington County Board of Education, Hagerstown, MD 21740; troutcha@wcboe.k12.md.us

Scott Sinex, Prince Georges Community College

Mark Perry, Pine-Richland High School

Susan Ragan, Maryland Virtual High School

How do you get students to develop a conceptual understanding of physical phenomena, handle the mathematics, and not bore them? Computational science tools, such as Stella and Vensim, allow instructors to take a conceptual path with camouflaged mathematics through the use of interactive and dynamic graphs. In this presentation, we will discuss the use of systems models to develop a conceptual understanding of motion, force, and attraction. Students develop the multivariable models, while complex mathematical relationships are disguised in the background, to experiment in the virtual realm and interpret graphical results. Scientific and algebraic thinking are used as students are constantly engrossed in a predict-test-analyze and then explain cycle, the "story telling" of the graph. We have used this method in our classrooms and as part of high school teacher training with the Maryland Virtual High School and the Pittsburgh Supercomputing Center.

PST2B-3: 9–9:45 p.m. The Physics Source: A ComPADRE Resource for Introductory Physics

Taha Mzoughi, Dept. of Biology and Physics, Kennesaw State University, Kennesaw, GA 30144-5591; tmzoughi@kennesaw.edu

The Physics Source (http://www.physicssource.org/), a component of ComPADRE, is designed to help faculty teaching introductory physics easily find and share relevant teaching resources. Content is not included in the Physics Source library until verified by the editors. It is grouped by topics and by resource type. Additionally, items are "linked" to similar and related items. The combination of all these features makes it easier for the user to find the resource they need in teaching introductory physics. Furthermore, the Source enables the users to organize the content they like, and to store it in virtual filing cabinets that they can maintain and share with students. Users are also encouraged to suggest resources for inclusion in the library. The Source and ComPADRE are a joint project of the AAPT, AAS, APS, and SPS. The Physics Source and ComPADRE are sponsored in part by the National Science Foundation (DUE 0532798).

PST2B-4: 9:45–10:30 p.m. The Mental Maps in the Active Learning of Physics

CANCELED

Melvin R. Melendez, Maria Alvarado Lima High School, Av. 28 de Julio 249, Lima, Peru 2144; mmelendez@pucp.edu.pe

This poster will present the results of innovative experiments in teaching physics in high school. These experiments were able to develop active learning for students through collaborative work dynamics such as the mind maps of Tony Buzan, concept maps from the software CmapTools, appreciation critical or social questioning related with the contents. It was noted that students, including those with lower academic performance, got a meaningful understanding of physics topics. For example, in a first phase, each student draws images with many colors that relate the concepts studied; in a second phase, working groups discuss and find consensus to represent the topic using a big image; the final phase involves the exposure of mental maps in groups. All team members participated, and everyone speaks in defense of their group.

PST2B-5: 9–9:45 p.m. Captivate Videos To Facilitate Astronomy Simulation Usage*

Kevin M. Lee, University of Nebraska, Lincoln, NE 68588-0111; klee6@unl.edu

Chrisopher M. Siedell, University of Nebraska

Edward E. Prather, University of Arizona

The Nebraska Astronomy Applet Project (NAAP) is developing high-quality astrophysical simulations accompanied by a variety of supporting resources. NAAP materials are appropriate for both college and high school introductory astronomy courses and could be used in computer-based laboratories, homework projects, and classroom demonstrations. This poster will describe a suite of training videos designed to guide instructors using the simulations interactively in the classroom. The videos are created in Captivate—an Adobe product that allows one to capture screen animation into a video and easily add captions and narration.

*Supported by the NSF under Grant No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

PST2B-6: 9:45–10:30 p.m. Physics to Go: Online Mini-Magazine and Resource Collection

Raina M. Khatri, American Physical Society, College Park, MD 20740; raina.khatri@hope.edu

Edward Lee, American Physical Society

Physics to Go is an outreach website, an informal collection of resources intended for readers who want to explore physics on their own. The homepage is also a magazine, updated every two weeks to focus on a different topic in physics by featuring outstanding websites in the Physics to Go collection. Physics to Go is part of the ComPADRE Digital Library, funded by the National Science Foundation, and is maintained by the American Physical Society.

PST2B-7: 9–9:45 p.m. Now Even Middle School Teachers Can Teach Spectroscopy!

Pamella Ferris, Riverside Middle School, 1095 Fury's Ferry, Evans, GA 30809; PamellaFerris@comcast.net

James Morgan and John DeLooper, Princeton Plasma Physics Laboratory

Bruce Boehne, Zion Lutheran School Dallas

With low-cost spectrometers now available, even middle school teachers can use cutting- edge technology in their classrooms. Peak students' interest in multiple areas of physical science using technology that shows students how scientists conduct research. Using Inquiry- based strategies, students will observe the emission spectra of various light sources, first by using only the naked eye and diffraction gratings. Then using inexpensive spectroscopes, students gather data and compare those measurements to measurements of the same wavelengths made with a low-cost, but fully functional spectrometer. Never before have middle schools been able to afford such cutting-edge technology. Students can now become "real" scientists and collect "real" data. This will undoubtedly spark many middle school students' interest in science and may even encourage them to become scientists in the future.

PST2B-8: 9:45–10:30 p.m. Using Clickers in Upper-Division Physics Courses: What Do Students Think?*

Katherine Perkins, University of Colorado, Boulder, CO 80309; Katherine.Perkins@colorado.edu

Chandra Turpen and Steve Pollock, University of Colorado

A growing number of faculty are using clicker questions and peer instruction in introductory physics courses at institutions across the United States; however, this approach is rarely used in upper-division physics courses. At the University of Colorado at Boulder, an increasing number of faculty are incorporating clicker questions in upper-division courses—clickers have been used 24 times in 10 different upper-division courses by 14 different faculty. Here, we report on the results of a survey administered to students in 16 classes. We find that 77% of the students recommend using clickers in upper-division courses. In all classes a majority of students favor clickers and there are few negative responses. We also analyze students' responses to why and how clickers do or do not support their learning, and report on how students recommend that faculty implement clickers in their courses (e.g. 2-5 questions interspersed with lecture).

*For upper-division clicker questions see http://www.colorado.edu/physics/EducationIssues/cts/index.htm. This work was funded the University of Colorado's Science Education Initiative and the National Science Foundation Grant No. 0737118.

PST2B-9: 9–9:45 p.m. Particle Physics Research with Undergraduates: Studying Multi-Higgs Models

Deva A. O'Neil, College of Wooster, Wooster, OH 44691; doneil@wooster.edu

Raymond M. Winters, College of Wooster

Doing original research in particle physics with undergraduate students is challenging, but also rewarding. In this presentation, I display the results of a theoretical particle physics project done with an undergraduate at a small liberal arts college. We analyzed the Two-Higgs Doublet in order to compare its predictions to experimental results from LEP and the Tevatron. Our results are displayed in visual and aural form.

C) Astronomy

PST2C-1: 9–9:45 p.m. Planck Visualization Project: Seeing and Hearing the Cosmic Microwave Background

Jatila van der Veen, University of California, Santa Barbara, Lubin Experimental Cosmology Lab, Santa Barbara, CA 93106; jatila@physics.ucsb.edu

John Moreland and Gerald Dekker, Purdue University-Calumet

Philip Lubin, University of California, Santa Barbara

Charles R. Lawrence, NASA/Jet Propulsion Laboratory

The Planck Mission, launched May 14, 2009, will measure the sky over nine frequency channels, with temperature sensitivity of a few 10^-6 K, and angular resolution of up to 5 arc minutes. Planck is expected to provide the data needed to set tight constraints on cosmological parameters, study the ionization history of the universe, probe the dynamics of the inflationary era, and test fundamental physics. The Planck Visualization Project consists of two parts: The first is a Virtual Reality simulation of the mission, in which viewers can follow the satellite on its orbit around the second Lagrange point as it maps the CMB, and peer inside the instruments, following the path of a photon. In the second part, starting with the CMB power spectrum, we model processes in the very early universe using multi-dimensional visualization and sonification techniques, thus allowing the viewer to "observe" the earliest moments of the universe.

*This work was sponsored by NASA/JPL and the Planck Mission.

PST2C-2: 9:45–10:30 p.m. A Progress Report – Reforming the Introductory Astronomy Lab Experience

Jon M. Saken, Appalachian State University, Boone, NC 28608; sakenjm@appstate.edu

Appalachian State University has recently completed construction of a new state-of-the-art introductory astronomy lab, featuring 15 GoTo telescopes, equipped with CCDs and permanently mounted under a roll-off roof. To go along with the enhanced capabilities of this facility, the curriculum for the laboratory portion of the course is being completely reformed to give the students an authentic research experience. This paper will discuss the results and progress from the first full year of operation under the new curriculum. Because the approach we have taken is not strictly dependent on a particular type of facility, we will also discuss how a similar curriculum could be adapted to other observing situations.

PST2C-3: 9–9:45 p.m. Meteorite or Meteor Wrong?

Elizabeth Fosse, St. Catherine University, St. Paul, MN 55105; ekfosse@stkate.edu

Terrence F. Flower, St. Catherine University

We share processes and conclusions of analysis of the alleged Swift County (Minnesota) Meteorite. We show individual straightforward physical tests one can use to confirm the nature of bodies suspected of being meteorites.

PST2C-4: 9:45–10:30 p.m. Creative Writing and Learning in a Conceptual Astrophysics Course

Rhoda Berenson, New York University, New York, NY 10003; rb143@nyu.edu

I often offer an optional assignment to the liberal arts students in my History of the Universe course that requires them to write a story incorporating specific scientific vocabulary. My goal has been to lessen student anxiety by providing a creative at-home contribution to exams. I have recently discovered that opting to write these stories also can affect student performance on the in-class exam. This presentation will include samples of assignments, student stories, and a statistical analysis of the effect that writing these stories has on in-class exams grades.

PST2C-5: 9–9:45 p.m. Long-term Sun Observations in Middle School

Gordon J. Aubrecht, II, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

During the 2008-09 school year, Ohio State University at Marion collaborated with Grant Middle School (Marion) science faculty to improve science teaching and learning systemically. Part of the effort involved developing an astronomy unit that would address major parts of Ohio standards by instituting an investigation that would occur over the entire school year. In these investigations students observed, predicted, and inferred changes in the motions of the Sun and Moon without being told what was expected. Only part of what we planned was implemented because few Moon observations were made. Sun shadows were observed roughly each month by students; a daub of paint on a wood platform indicated the tip of the shadow. We present the results of the year-long investigation and consider whether this is a useful way to address the pedagogical concern that students often make the experiments come out the way the teacher wants.

PST2C-6: 9:45–10:30 p.m. Extraordinary Matter: Visualizing Space Plasmas and Particles

Shirley B. Barbier, NASA GSFC / SP Systems, Inc., Greenbelt, MD 20771; Beth.Barbier@nasa.gov

Lindsay Bartolone, Adler Planetarium & Astronomy Museum

Eric Christian and James Thieman, NASA GSFC

Elaine Lewis, NASA GSFC / Honeywell International

We present a searchable online NASA multimedia library now in development called Extraordinary Matter: Visualizing Space Plasmas and Particles, which is designed to assist educators in explaining these concepts that cannot be easily demonstrated in the everyday world. Such resources are currently few in number and/or difficult to locate, and most do not provide suitable context. On our site, each ready-to-use product will be accompanied by a supporting explanation at a reading level matching the educational level of the concept. The site will target primarily grades 9-14 and the equivalent in informal education and public outreach. Products are intended to stand alone, making them adaptable to the widest range of uses, including scientist presentations, museum displays, teacher professional development, and classroom use. Our space science and education specialists are in the process of determining specific needs, gaps, and priorities by surveying the potential user community, and participation will be offered to visitors.

PST2C-7: 9–9:45 p.m. Group Work in Beginning Astronomy Classes

Shashi M. Kanbur, State University of New York at Oswego, Oswego, NY 13126; shashi.kanbur@oswego.edu

We report on a novel method to increase class engagement and participation in beginning astronomy classes for nonscientists. During a normal lecture period of 55 minutes, only about 20-25 minutes is spent on lecturing: the remaining time is spent by students working in groups on instructor assigned problems associated with a previous lecture. This approach has a number of benefits: firstly students are engaged for the whole period, students are actively participating their learning, students are learning from their peers and students are applying the material they have just heard about. Some of the problems the students work on emphasize the more mathematical aspects of the material such as the time dilation formula in Special Relativity and the Stefan-Boltzmann formula. Preliminary results indicate that a majority of the 29 students increased their score from the previous exam, a significant number improved their score by over 10 percent and virtually all the students answered the more mathematical questions correctly. We discuss this in more detail and present some suggestions for possible scale up to larger sections.

PST2C-8: 9:45–10:30 p.m. A Novel Intermediate-Level Astronomy Course Centered Around Hubble's Law

Shashi M. Kanbur, State University of New York at Oswego, Oswego, NY 13126; shashi.kanbur@oswego.edu

We present a novel intermediate level astrophysics course centered around Hubble's law: v = H x d. eWe concentrate on different aspects of this equation and in so doing cover a number of topics in astrophysics. For example, in studying the right hand side of Hubble's law, we examine the extra-galactic distance scale: radar ranging, parallax, main sequence fitting, the Cepheid PL relation and the Tully Fisher relation. While doing this we add associated topics such as variable stars, non-radial oscillations and stellar evolution. The "right hand side" enables us to examine how velocities are measured and leads us naturally into atomic physics and spectroscopy. We end the course with the middle part "H": that is a few lectures on cosmology and the Big Bang theory. Throughout the course, lecturing is kept to a minimum: students work on week-long projects that are meant to increase active learning and class participation.

PST2C-9: 9–9:45 p.m. Using Telescope Data To Support Understanding of the Electromagnetic Spectrum

Susan Kelly, Blind Brook High School, Rye Brook, NY 10573; susankelly.ct@gmail.com

Christopher Martin, Howenstine High School

The majority of wavelengths in the electromagnetic spectrum go unnoticed by the human eye, for our optical system evolved to see but a small range. Studying wavelengths of light beyond those that we can see helps us better understand astronomical objects and phenomena. In a one month course, a collaboration of eight teams of students from across the country gathered visible light data via remote-access telescopes of a galaxy with a super massive black hole. Infrared images of this galaxy were obtained during the same period via the Spitzer Space Telescope. This astronomy research project provided an engaging, authentic context from which students can develop and expand their understanding of light. We will distribute space and ground-based images and software in order to help teachers replicate the experience in their schools. Suggested activities will facilitate student understanding of the value of multi-wavelength research campaigns.

PST2C-10: 9:45–10:30 p.m. Teaching Astronomy with Stellarium

Mark Winslow, Southern Nazarene University, Bethany, OK 73034; mwinslow@snu.edu

Stellarium is a freeware planetarium program and useful tool to engage students in learning astronomy. Not only is Stellarium effective in demonstrating principles in a multimedia classroom setting, students can use the program to explore concepts and reinforce learning at home by participating in directed exercises. A set of activities has been developed for Stellarium and is free for use in your classroom. Activities include exploring coordinate systems, investigating the motion of constellations and the Sun, and recreating historical events such as Eratosthenes' determination of the Earth's diameter and Galileo's discovery of Jupiter's satellites. Student feedback through classroom surveys is positive and many students indicate they use Stellarium to investigate the night sky independent of assigned exercises. Activities are available for your use and adaptation to any astronomy classroom.

D) Energy and Environment Courses

PST2D-1: 9–9:45 p.m. Experiments in Wind and Solar Power for Middle School Students

Stephen Luzader, Frostburg State University, Frostburg, MD 21532; sluzader@frostburg.edu

Hang Deng-Luzader, Frostburg State University

During the summers of 2008 and 2009, we have offered at Frostburg State University the Summer Center for the Physics of Solar and Wind Power in the Maryland Summer Centers for Gifted and Talented Students program. In our Center, a group of 24 middle school students spends five days studying the science and economics of residential-scale solar and wind installations. Part of the curriculum includes experiments with small solar cells and wind turbines to learn how the power produced depends on light intensity and wind speed, respectively. The experiments for the middle school students will be described, and suggestions for more advanced activities suitable for college students will be given. These include finding the current-voltage characteristic for solar cells, demonstrating that the maximum power from a wind turbine depends on the cube of the wind speed, and determining the maximum electrical efficiency of the devices.

PST2D-2: 9:45–10:30 p.m. Is Writing Letters to the Editor Effective?

Gordon J. Aubrecht, II, Ohio State University at Marion, Marion, OH 43302; aubrecht@mps.ohio-state.edu

My personal experience writing letters to the editor of my local paper is shared.

PST2D-3: 9–9:45 p.m. Using Friedman's "Hot, Flat, and Crowded" in a Course Module on Energy and the Environment

Heather M. Whitney, Cumberland University, Lebanon, TN 37087; hwhitney@cumberland.edu

Cumberland University offers students the course Principles of Physical Science to satisfy a general education science requirement. It focuses on a wide variety of topics, including conceptual physics and basic astronomy. Beginning in spring 2009, we have included a module on the book *Hot, Flat, and Crowded* by Thomas L. Friedman as a vehicle for discussion on energy and the environment. The module implements a wide variety of active learning and peer-instruction tools, such as jigsaw techniques for book readings, peer interviews on the role of energy in student lives, discussions guided by the use of classroom response systems ("clickers"), and a research project in which the students locate recent media articles on climate change and describe their relation to the information presented in the focus book. We present our experiences in implementing this module in the class, including promising results from student surveys and formative and summative assessments.

PST2D-4: 9:45–10:30 p.m. Electrical Characteristics of Photovoltaic Cells

Mehmet I. Goksu, Millersville University, Millersville, PA 17551; mehmet.goksu@millersville.edu

Kevin Dougherty, Millersville University

Michael Oellig

Renewable energy production is one of the most important topics in energy today due to increasing global energy needs and global warming. An increase use of photovoltaic (PV) cells, which directly convert sunlight into electricity, is essential for meeting this need since sunlight is clean, abundant and effectively limitless. The main goal of this research is to determine the electrical characteristics of a PV cell by a variety of measurements including: Current-Voltage (I-V) characteristic curve, fill factor, and temperature response. Measuring the electrical characterization of a PV cell is critical for determining the cell's output performance and efficiency.

PST2D-5: 9–9:45 p.m. A Multidisciplinary Course on Energy, Society, and the Environment

Monica Halka, Georgia Institute of Technology, Roswell, GA 30075; monica.halka@gatech.edu

Kim Cobb, Georgia Institute of Technology

Anthropogenic global warming linked to society's energy consumption has made the search for affordable alternative energies a matter of local, national, and international importance. The path toward alternative energy infrastructures for the 21st century requires careful consideration of economic, environmental, technological, and political factors. This interdisciplinary course blends current events, guest speakers, lively discussion, and a diverse array of literature to separate fact from fiction in the heated debate concerning our nation's climate and energy future. Speakers include experts in climate change, energy technology, alternative energy, energy policy, and environmental economics as well as community stakeholders such as environmental advocacy groups, energy companies, and decision-makers. The culminating project is a carbon reduction challenge: The team whose work results in the largest actual CO2 reduction wins.

PST2D-6: 9:45–10:30 p.m. Using New Energy To Save Our World

Seyed Hamzeh Hosseini, Emam Pre-unversity High School, Moalem High school-Emem bolvar, kangan, Iran 7553144115; sh_hosseini1@yahoo.co.uk

Tahere Bahrani, Zahra High School

Our poster explains new energies and modern methods to use it.

E) Presentations with a Theme

PST2E-1: 9–9:45 p.m. Evaluation of Learning in Residential Science and Engineering Camps

Patricia A. Sievert, Northern Illinois University, Byron, IL 61010; psievert@niu.edu

Corry Cummings, Northern Illinios University

During the summer of 2009 NIU began the process of formally evaluating its summer residential science and engineering camps. Camper attitudes towards camp and STEM fields in general were evaluated throughout the week and a concept post test administered. The evaluation instruments were designed following the six strands of science learning referenced in the National Academies Press's *Learning Science in Informal Environments: People, Places, and Pursuits*. Results of this initial study will be shared along with samples of the evaluations.

PST2E-2: 9:45–10:30 p.m. Secrets of Science Toys and Gadgets Revealed

Christine L. McCreary, University of Pittsburgh at Greensburg, Greensburg, PA 15601; gwiz2@verizon.net

Todd Brown, Vickilyn Barnot, Thad Zaleskiewicz, and Katrina Brown, University of Pittsburgh at Greensburg

During the summer of 2009, a novel program entitled Summer Science and Math Experience (SSME) was offered at the University of Pittsburgh at Greensburg. Twelve 9th-grade students attended this intensive week-long program funded by the McFeely-Rogers Foundation, featuring a different workshop session each day taught by Pitt-Greensburg faculty. This poster focuses on one of the sessions, entitled Secrets of Science Toys and Gadgets Revealed. As children, toys were among our first experiences with learning about the physical world. As adults, toys still invite us to touch and explore. This inquiry-based workshop capitalized on this fascination with play by using active learning techniques featuring toys to teach basic scientific principles and promote problem-solving and critical-thinking skills. Working in small groups, the students investigated an array of devices that illustrated one or more fundamental scientific principles and then were challenged to determine the science of the apparatus.

AAPT Presidential Transfer Ceremony: 10:30–11 a.m. Washington 6

Session HA: Upper Division & Graduate

Location: Washington 1
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Graduate Education in Physics
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: TBA

HA01: 8:30–8:42 a.m. Implementing JiTT-based Worked Examples in Intermediate Physics Courses

Brian M. Patterson, U.S. Air Force Academy, USAF Academy, CO 80840; brian.patterson@usafa.edu

Robert H. Lee and Gregor M. Novak, U.S. Air Force Academy

We have adapted a previously developed extension of Just-in-Time Teaching (JiTT) to two intermediate physics courses, classical mechanics and electromagnetism. JiTT encourages the students to examine their prior knowledge and to get informed about the upcoming topic before coming to class. Our extension is modeled on our approach in introductory physics courses at USAFA, extending JiTT with worked-examples/self-explanation techniques, where new material is introduced via carefully crafted worked examples. We ask students to study examples, answer questions about them, and prepare questions to ask in class. During class, the examples are discussed and extended to reveal broader concepts. In this talk we will describe the resources we have developed for intermediate classes and report on some assessment results.

HA02: 8:42–8:54 a.m. Emphasizing Written and Oral Presentation in Graduate Astrophysics Courses

Eric Gawiser, Rutgers University, Piscataway, NJ 08854-8019; gawiser@physics.rutgers.edu

Graduate courses often feature lectures heavy on derivations and problem sets laden with algebra. Students emerge unprepared to face the primary career demands of reading the literature, designing research projects to extend on it, and clearly communicating their results in scientific papers and talks. I will describe a novel approach to the teaching of graduate astrophysics that has been implemented successfully in the Physics and Astronomy department at Rutgers University. It features 1) a simplified curriculum focused on concepts rather than derivations, 2) problem sets written in the style of refereed articles that place equal emphasis on calculation and explanation, 3) reading published papers from the literature, both historical and modern, 4) design, research, and writing of individual term papers in the style of a publishable article with a draft refereed by the instructor, and 5) oral presentations of the literature papers and term projects.

HA03: 8:54–9:06 a.m. Qualitative Understanding of Magnetism at Three Levels of Expertise

Jill A. Marshall, University of Texas, Austin, TX 78712-0382; marshall@mail.utexas.edu

Francesco Stefani, University of Texas

We report on an investigation of qualitative understanding and approaches to problem-solving in magnetism across a spectrum of expertise: 10 novices, 10 experts-in-training, and 11 experts. Data collection involved structured interviews during which participants solved a series of nonstandard problems designed to test for conceptual understanding of magnetism. No novices and few experts-in-training showed a strong understanding of inductance, magnetic energy, and magnetic pressure. They tended not to approach problems visually. Novices frequently described gist memories of demonstrations, textbook problems, and heuristics. These fragmentary mental models were not complete enough to allow them to reason productively. Experts-in-training were able to solve problems that novices were not, often simply because they had greater recall of the material. Much of their thinking was concrete, based on mentally manipulating objects. Experts solved most of the problems in ways that were effective and efficient, partly due to visualizing and reasoning in terms of field lines.

HA04: 9:06–9:18 a.m. Visualizing Tensors with VPython

Roberto B. Salgado, Mount Holyoke College, South Hadley, MA 01075; rsalgado@mtholyoke.edu

We visualize the tensor algebra of vectors, differential forms, and metric tensors using VPython. Our visualizations are based on illustrations found in the literature on Relativity and on Tensor Calculus (Schouten [1924], Misner-Thorne-Wheeler [1972], and Burke [1985]). These may be useful in the teaching of tensors and visualization of tensor fields in advanced physics courses. We provide some physical examples from electrodynamics and relativity. We mention other applications in analytical mechanics, optics, and thermodynamics.

HA05: 9:18–9:30 a.m. Nano-Bio-Med-Comp – It's All Physics!

CANCELED

Michael J. Schillaci, Northeastern State University, Tahlequah, OK 74464; mjs@evsis.org

I will present an overview of a course in applied/computational physics that attempts to bridge the gap between the many (sub) disciplines of physics popular today. I will stress cross-disciplinary skills needed to work in areas such as imaging and will suggest a suite of software that may be accessed freely. Examples of projects and how the course (or courses) may be accommodated in a traditional physics program will also be presented.

HA06: 9:30–9:42 a.m. A New Curriculum for Physics Graduate Students

Harald W. Griesshammer, George Washington University, Washington, DC 20052; hgrie@gwu.edu

Effective fall 2008, GW Physics implemented a new graduate curriculum addressing nation-wide problems: 1) wide gap between 50-year-old curricula and the proficiencies expected to start research; 2) high attrition rates and long times to degree; 3) limited resources in small departments to cover all topics deemed essential. The new curriculum: 1) extends each course to four hours weekly for better in-depth coverage and cautious additions; 2) decreases the number of core-courses per semester to two, with less "parallel-processing" of only loosely correlated lectures; 3) increases synergies by stricter logical ordering and synchronisation of courses; 4) frees faculty to regularly offer advanced courses; 5) integrates examples tied to ongoing research in our department; 6) integrates computational methods into core lectures; 7) encourages focusing on concepts and "meta-cognitive skills" in studio-like settings. The new curriculum and qualifying exam, its rationale and assessment criteria will be discussed. This concept is tailored to the needs of small departments with only a few research fields and a close student-teacher relationship.

HA07: 9:42–9:54 a.m. Lessons in Physics from a Study of Hexapedal Entomometry*

Saami J. Shaibani, Instruction Methods, Academics & Advanced Scholarship, Lynchburg, VA 24506; shaibani@imaas.org

Empirical evidence shows that houseflies and their ilk can avoid many of the standard attempts by humans to terminate their existence by planar instrument. The ability to evade such demise was in turn counteracted by a much more successful approach devised some time ago by this author. However, it had not been possible until recently to establish the exact scientific basis for his large increase in efficacy because values for key kinematic parameters were not available. Experimental data from contemporaneous research[1] have now enabled computations to be performed here, and the results explain both the survival rate against old techniques and the less favorable outcome for housefly-like insects against the new strategy. The methodology involved provides an excellent tool for student learning of physics, and elements of this are presented to demonstrate the applicability of many concepts in a pedagogical setting that is interestingly different from those in traditional textbooks.

* The final word in the title, and the associated adjective "entomometric," have been constructed by the author from the prefix and suffix for insect and measuring, respectively.

1. *J. Exp. Biol.* **211**, 341-353 (2008)

HA08: 9:54–10:06 a.m. Geometric Algebra and the Fundamental Theorem of Calculus

Gene E. McClellan, 2209 N Lincoln St., Arlington, VA 22207; GeneMc2@aol.com

This presentation describes how geometric algebra generalizes the fundamental theorem of calculus as taught in univariate, introductory-level calculus to multivariate, vector calculus in spaces with an arbitrary number of dimensions. Because geometric quantities are ubiquitous in physics, geometric algebra and geometric calculus provide powerful mathematical methods for solving problems in physics. The truth of this statement has been amply demonstrated by David Hestenes, Terje Vold, Chris Doran, Anthony Lasenby, and others. This presentation focuses on an elegant method for deriving conserved quantities for the electromagnetic field from the Maxwell equations using geometric calculus and the fundamental theorem of calculus. Currently, the method invoked may best be appreciated at the graduate level; however, geometric algebra is sufficiently straightforward to be taught at the high school level, which should lead to a full grasp and application of geometric calculus at the undergraduate level.

HA09: 10:06–10:18 a.m. Understanding of Inductance at Three Levels of Expertise

CANCELED

Francesco Stefani, University of Texas at Austin, Austin, TX 78759; stefani@iat.utexas.edu

Jill Marshall, University of Texas at Austin

This work compares how undergraduates, graduate students, and experts think about inductance. Data collection involved interviews during which participants solved non-standard problems designed to test for conceptual understanding. Of the novices, eight out of 10 described correctly some aspect of inductance, however, none provided accurate or complete definitions of inductance. Their mental models were variants on "something that wants to oppose current," and "like mutual inductance or Faraday's law." Of the experts in training (EITs), Faraday's law was the most common framework for conceptualizing inductance. This appeared in some form or another in eight responses. Two EITs conceptualized inductance in terms of magnetic energy, and two as a relationship between flux and current. Finally the expert mental models were more general and cognitively simpler than those of the other groups. Eight out of the 11 experts tended to think of inductance as the capacity to produce magnetic flux.

Session HB: Teaching Physics Around the World – II

Location: Washington 2
Sponsor: Committee on International Physics Education
Date: Wednesday, Feb. 17
Time: 8:30–9:42 a.m.

Presider: TBA

HB01: 8:30–8:42 a.m. Space Science Initiatives for STEM Education Betterment

CANCELED

Norma T. O. Reis, Ministerio Da Educao - MEC BL, L, ED. Sedes, Brasilia/DF, Brazil; normareis@mec.gov.br

We explore pedagogical benefits of two pre-college enterprises in space science education: the Space Weather Action Center, from NASA, and the Brazilian Olympics of Astronomy and Astronautics — OBA. SWAC is a nationwide program that helps engage students in space sciences, and promotes STEM learning in a meaningful approach. Students work like real scientists, monitoring space weather by accessing NASA databases. In teams, they collect, record, analyze, and communicate results using educational technologies such as video and broadcasting. Basic technology required is computer with Internet access, and low-cost broadcasting software. The program helps students develop confidence and intellectual autonomy. OBA is a long-established Brazilian competition held annually connecting students and teachers in space studies, trainings, and events. OBA involves all students, not only gifted ones. Students nationwide receive medals, trips to space-related events, low-cost telescopes, and other resources to encourage them keep exploring and learning STEM through the excitement of space.

HB02: 8:42–8:54 a.m. Analogy and Structure in the Karlsruhe Physics Course

Corrado E. Agnes, Politecnico, corso Duca degli Abruzzi 24, Torino, Italy 10129; corrado.agnes@polito.it

What do electrically charged bodies in contact and completely inelastic collisions have in common? A waterfall and a thermal machine? I'll give a short review of the basic ideas underlying The Karlsruhe Physics Course, focusing on the exemplar role played by extensive and intensive physical quantities. I'll show that the direct metrization approach leads both to the deep analogies between the different areas of physics and to a straightforward and integral approach to the teaching.

http://www.physikdidaktik.uni-karlsruhe.de/ and http://corradoagnes.com

HB03: 8:54–9:06 a.m. Potential Calculation for Generally Symmetrical Body Electrified by Superposition Principle

Chengjin Li, School of Physical Science and Technology, Soochow University, Suzhou, China, Jiangsu 215006; lichengjin@suda.edu.cn

In this paper, the electric potential for several generally symmetrical Bodies Electrified has been computed by means of superposition principle, and some limitations have been calculated. As a result, the limitations agree with the physical model.

HB04: 9:06–9:18 a.m. A Learner-Centered Approach to Teaching of Physics

CANCELED

Oleg Vorobyev, 608-460 Eglinton Ave., E, Toronto, Canada M4P 1M3; olegbvorobyev@gmail.com

Every kind of study may be enriched by active methods of students' involvement. For example, teachers could model problem situations that challenge knowledge acquired by students with unforeseen sides of study phenomena. Integrating optional parts of lectures, tutorials, and laboratory classes in a core curriculum, educators give students an opportunity to choose study questions that they are interested in the most, and, as a result, to be more responsible and engaged. At the same time, analysis of student choices provides feedback that allows adjustment of level of difficulty, content and a pace of studies to satisfy interests of an individual student and student groups. Seminars and students' research give a special opportunity to choose an individual educational trajectory for every student. From one side, it serves for individualization of study, as students are deeply engaged in a specific problem. From the other side, presentations made by a student for a group and followed by group discussion and problem solving creates an environment of reciprocal teaching and motivation.

HB05: 9:18–9:30 a.m. Teaching Physics Learning Through Researching at High School Level

Que Xuan Pham, Ha Noi University of Education, Ha Noi, Vietnam 10 000; quepx@hnue.edu.vn

Khamsoulin Chanthavong, Polytechnic College of Vien Chan, Laos

This talk deals with how to teach physics at high schools effectively and what will be needed to do it. Physics learning as physics researching will bring the best effectiveness. By researching, students are active, self-reliant, and creative. During the researching process, natural phenomena are studied to discover their essential characteristics. Based on them, theoretical models as hypotheses are put forward. Logical consequences are deduced from these hypotheses and must be experimentally verified. In order to teach physics learning through researching, there is often a lack of new experiments, especially computer assisted real experiments and interactive screen experiments. Therefore, we have developed some experiments (including teaching materials) as follow: – computer assisted real experiment on diagrammatizing experimental graph of self-inducted current during switching on and off; on displaying a rotating magnetic field of a three-phase system. – interactive screen experiment, which supports in researching mechanical moves of one or two bodies.

HB06: 9:30–9:42 a.m. A Master´s Degree Program for High School Teachers in Mexico

Jorge Barojas, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Ciudad Universitaria, Coyoacan, Mexico City, Mexico DF 04510; jorgebarojas@yahoo.com

A description of the main characteristics and results of a graduate education in physics teaching is presented. The program started in 2004, and its curriculum structure contains subjects related to education and to the teaching of physics as well as to practical teaching activities in high schools. The program has been recognized by the National Council of Science and Technology as a graduate program of excellence in the stage of consolidation. Some examples of representative dissertation works are considered and several possibilities of extension and international collaboration are discussed.

HB07: 9:42–9:54 a.m. Evaluating the Effectiveness of Physics Simulations on Students' Understanding of Physics in Nigeria

Banji K. Lawal, American University of Nigeria, 3201 New Mexico Ave., Suite 258, Washington, DC 20016; banji.lawal@aun.edu.ng

Ramalingam Periasamy, Faiza Babakano, Omasiri Udeinya, and Wisdom Omuaya, American University of Nigeria

One of the difficulties that physics teachers in Nigeria face is that there are not enough labs and equipment that can be used in giving students a practical, hands-on understanding of various topics. Also as the costs of education keep rising, we have been researching methods of providing quality lab experience to students who might be learning physics via distance learning. As part of our research on this topic we evaluated a Jimeta, which is a tool developed at American University of for simulating concepts in undergraduate physics. The tools developed were evaluated in the classroom. As part of our evaluation of Jimeta was exposed to a physics class that had no prior knowledge of the concepts the software teaches about. We then compared the understanding that this class had of the concepts with their peers who had a similar physics background but had not used the software. In our presentation we demonstrate the tool and share the preliminary results of the evaluation.

Session HC: Physics Education Research: Solved Problems and Open Questions

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Co-Sponsor: APS Forum on Education
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: Peter Shaffer

Research on the learning and teaching of physics over the past several decades has led to significant insights into what students learn (and do not learn) in physics courses and how to improve instruction. This session will focus on the questions of what has been learned; to what extent is it generalizable; and what gaps in our knowledge remain to be filled?

HC01: 8:30–9:06 a.m. Surveying the Conceptual and Temporal Landscape of Physics Education Research*

Invited – David E. Meltzer, College of Teacher Education and Leadership, Polytechnic Campus, Arizona State University, Mesa, AZ 85212; david.meltzer@asu.edu

I will discuss the evolution of physics education research within an historical perspective that focuses on origins in the post-World War II period and which extends towards diverse future pathways. PER has incorporated a broad array of themes that resonate with past developments in science education, but it also provides unique perspectives that offer promise of potential breakthroughs in areas previously underexplored. Nonetheless, there is a long road from promise to realization, and I will try to identify key aspects both of past accomplishments and of future challenges.

*Supported in part by NSF PHY-0108787 and DUE-0817282.

HC02: 9:06–9:42 a.m. Physics Education Research: Responses to Changing Course Goals and Demographics

Invited – Stephen Kanim, New Mexico State University, Las Cruces, NM 88003; skanim@nmsu.edu

This session offers an opportunity to reflect on the trajectory of physics education research, and to try to place research conducted today in a larger context. In this talk I will describe physics instruction before PER became a strong influence, and I will try to make inferences based on this description about the goals of this instruction. I will then compare these methods with those that have resulted from PER-influenced curricular changes, and (where goal statements are absent) again make inferences about changes to the goals of our instruction. In addition, I would like to discuss the demographics of physics instruction: who are students were, who they are today, and the implications for physics education researchers of existing changes in demographics and of the changes we are likely to see in the near future.

HC03: 9:42–10:18 a.m. Can Implicit Learning Help Students To Learn Scientific Concepts?

Invited – Andrew F. Heckler, Ohio State University, Columbus, OH 43210; heckler.6@osu.edu

Virtually all science education researchers agree on one thing: the empirical finding that students often answer questions about simple physical phenomena in ways that are not only specific and contrary to the scientific view, but also remarkably similar to answers of other students. The reason why these patterns in answering exist and how to address them is where the disagreements begin. Most efforts address student difficulties by using explicit reasoning activities to help students construct more accurate scientific concepts. However, it still remains an open question to what extent implicit, automatic learning processes such as associative learning can be utilized to help students to learn scientific concepts. We provide evidence that student difficulties with understanding some scientific concepts may be strongly influenced by fundamental learning mechanisms driving attention to salient variables rather than predictive ones, and this framework can be used to help overcome student difficulties with learning scientific concepts.

Session HD: Physics Education Research in the High School

Location: Washington 4
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Research in Physics Education
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: Dan Crowe

The purposes of this session are 1) to allow physics education researchers to present the results of research they have already conducted involving high school students, and 2) to provide a forum for establishing collaborations between physics education researchers and high school physics teachers to conduct future research.

HD01: 8:30–8:42 a.m. Using a Synthetic Tutor To Build and Assess Knowledge*

Chris M. Nakamura, Kansas State University, Manhattan, KS 66506; cnakamur@phys.ksu.edu

Sytil K. Murphy, Nasser M. Juma, and Dean Zollman, Kansas State University

Mike Christel, Entertainment Technology Center, Carnegie-Mellon University

The Pathway Active Learning Environment focuses on developing an online interactive synthetic tutoring system targeted at high school physics students and college students in concept-based or algebra-based physics classes. The system allows students to obtain expert responses to natural language questions about physics content. Combining this interactive technology with an online implementation of lesson materials developed using the three-stage learning cycle may produce a system that can provide students with real-time feedback on their understanding while collecting information that instructors or researchers can use to assess their understanding more deeply, but on a longer time-scale. The system may aid students in their knowledge construction, providing benefits similar to those provided by a real human tutor. Qualitative and quantitative assessment is needed to determine the efficacy of the system and to determine if students really reap benefits similar to human tutoring. The most recent progress will be presented.

*Supported in part by the U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657

HD02: 8:42–8:54 a.m. Preliminary Results of a Physics First Program Evaluation

Elissaveta R. Bachvarova, Mergenthaler Vocational/Technical High School, Baltimore, MD 21218; elissaveta@comcast.net

Ekaterina Denisova, Baltimore City Public School System

The Physics First model reverses the order of the science courses taught in high school, placing physics before chemistry and biology. There are sound theoretical arguments in support of Physics First but no actual evidence of the effectiveness of this model. Nevertheless, the movement is gaining momentum, and several public schools in Baltimore are implementing a Physics First course for ninth-grade students for the first time. This paper presents the early results of a study designed to evaluate the implementation and effectiveness of the ninth-grade physics course. In this mixed-methods study we compare the conceptual understanding and attitudes toward science of ninth- and 12th-grade students. The qualitative component of the study includes data collected through in-depth interviews with teachers and focuses on their experiences in the ninth-grade physics classes.

HD03: 8:54–9:06 a.m. Comparing Backgrounds and Physics Experiences of Minority and Non-Minority Students

Charity N. Watson, Clemson University, Clemson, SC 29634; charitw@clemson.edu*

Zahra Hazari, Clemson University

Philip M. Sadler and Gerhard Sonnert, Harvard Smithsonian Center for Astrophysics

In an effort to understand underrepresentation in physics and what can be done to increase participation, this talk examines how the backgrounds and physics experiences of under-represented minorities are different from other students. The data is drawn from the Persistence Research in Science & Engineering (PRiSE) project, which surveyed a nationally representative sample of college English students about their backgrounds, high school science experiences, and science attitudes. The sample includes 3829 students at 34 colleges and universities who had taken high school physics. We compared the responses of 737 underrepresented minority students (308 African American and 429 Hispanic) and 2546 white students. The results indicate significant differences in preparation, family support, physics classroom environments, and approaches to learning physics. Suggestions will be made as to how we can better engage underrepresented minorities in high school physics.

*Sponsor: Zahra Hazari

HD04: 9:06–9:18 a.m. Measuring Up: Assessing Student Learning in Physics Union Mathematics Curriculum*

James Finley, Rutgers University, Berkeley Heights, NJ 07922; james.finley125@gmail.com

Tara Bartiromo, Joseph Santonacita, and Eugenia Etkina, Rutgers University

Physics Union Mathematics (PUM) is a research-based curriculum that is grounded in the ISLE framework. Over the past three years, the curriculum has been piloted and field-tested in more than 20 schools across New Jersey. Findings from field-testing led to further developments and improvements to the curriculum modules. Student learning was captured through formative and summative assessments specifically designed for PUM. In an effort to compare learning outcomes of PUM students to the learning outcomes of students nationally, we redesigned PUM assessments to incorporate questions from both the FMCE and FCI. We will present the findings based on these new assessments and specifically compare performance of middle school students and high school students on the same questions.

*Sponsored by the National Science Foundation grant # DRL-0733140.

HD05: 9:18–9:30 a.m. Student Responses to a Multiple Representation Problem*

Tara M. Bartiromo, Rutgers University, New Brunswick, NJ 08901; tmfinley1@yahoo.com

Eugenia Etkina, Rutgers University

During the field-testing year of the Physics Union Mathematics curriculum, students answered a conceptual test question that required them to use multiple representations to support their answer. The majority of the students answered the conceptual question incorrectly. Interestingly, the representations they drew were consistent with their answers. In this talk, we discuss these students' responses and how they compare to students' responses using the revised PUM curriculum. We focus on how their conceptual understanding has changed and how they use the representations to support their answers.

*This work was supported by NSF DRL-0733140.

HD06: 9:30–9:42 a.m. Uncovering High School Students' Ideas About Energy

Cari F. Herrmann-Abell, AAAS Project 2061, 1200 New York Ave., NW, Washington, DC 20005; cabell@aaas.org

George E. DeBoer, AAAS Project 2061

This paper presents a summary of high school students' understanding of the topic of energy. This work is part of a larger project to develop items that are precisely aligned with national content standards. The student data are a result of a field test of items aligned to ideas about forms of energy that was administered to 3464 high school students in 35 states and a pilot test of items aligned to ideas of energy transformation, energy transfer, and conservation of energy that was administered to 1432 high school students in 30 states. Our results showed that high school students had the most difficulty with ideas related to thermal energy and conservation of energy. They were most successful with assessment items testing the ideas of elastic energy, energy transfer, and energy transformations. A cross-sectional analysis was performed to examine the progression of understanding of energy from middle to high school.

HD07: 9:54–10:06 a.m. Identifying Student Models of Collisions

Nattakit Sawadthaisong, Institute for Innovative Learning, Mahidol University, Phayatai, Bangkok, Thailand 10400; nsawad@hotmail.com

Ratchapak Chitaree, Department of Physics Faculty of Science

The aim of this study is to identify students' mental models underlying the difficulties that were affected by the student's naïve understanding of collisions. A number of techniques were used to elicit Thai students' understanding in high school after one week of current teaching on the topic of collisions. The results of the study show that students used three different mental models of reasoning in using physical models to solve all questions that are related to a single concept. If the student consistently uses one of the physical models that are not necessarily correct, the mental model is called "pure model." If the student uses several different physical models at the same time and is inconsistent in using them, this case is called "mixed model." If the student uses correct information to predict situations of collisions but their explanations are based on force reasoning, we called it "hybrid model."

HD08: 10:06–10:18 a.m. Examining Physics Career Interests: Recruitment and Persistence Prior to College

Zahra Hazari, Clemson University, Clemson, SC 29634; zahra@clemson.edu

Philip M. Sadler and Gerhard Sonnert, Harvard Smithsonian Center for Astrophysics

Much of the work examining the migration in and out of physics career trajectories has focused on attrition during college and at transition periods (high school to college, undergraduate to graduate). However, research indicates that career interests at the pre-college level are important for long-term persistence. We approach this issue by examining how physics career trajectories fluctuate for students at four different times from middle school to the beginning of college. The data is drawn from the Persistence Research in Science & Engineering (PRiSE) project, which surveyed a nationally representative sample of college English students about their backgrounds, high school science experiences, and science attitudes. The sample includes data from 6860 students at 34 colleges and universities across the United States. In this talk, we focus on understanding when students became interested in physics careers and what careers students switched into and out of when they changed their physics career interests.

Session HE: Policy and Women

Location: Washington 5
Sponsor: Committee on Women in Physics
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: TBA

HE01: 8:30–9:06 a.m. Women Into Physics: Why So Slow?

Invited – Shirley Malcom, AAAS, 1200 New York Ave., NW, Washington, DC 20005; smohamed@aaas.org*

As we consider Virginia Valian's question regarding women in science, we may need to focus in on the especially challenging fields. There have been advances in many science disciplines over the years since Title IX. Women have moved into the biological sciences so that their PhD numbers are at or near parity. Numbers within the broad category of physical sciences are showing upward trends, but these are largely driven by increases in chemistry, though advancement remains a problem. Other fields subsumed under the broad heading of physical sciences also show a growing presence of women (e.g., astronomy and astrophysics). I will explore the ecology of the physics community, raising research questions that might lead to interventions to address the stagnant situation for women in physics.

*Invited by Jill Marshall on behalf of the Committee on Women in Physics.

HE02: 9:06–9:42 a.m. Policy and Women

Invited – Judy Franz, American Physical Society, retired, Washington, DC 20037; franz@aps.org

Most of the policies that guide us as physicists in our research and teaching activities don't depend on gender, but can at times have gender-sensitive implications. Having both women and men involved in formulating these policies can be essential, and having both women and men involved in administering the policies can be just as important. I will give some examples of policies from the American Physical Society, the International Union of Pure and Applied Physics, and Physics Departments, which make this case.

HE03: 9:42–10:18 a.m. Science Policy: Its Creation and Execution

Invited – Patricia M. Dehmer, U.S. Department of Energy, Washington, DC 20585; demetrice.moody@science.doe.gov

Often scientists—both recent PhDs and established researchers—come to Washington with the hope and desire to engage in "science policy." What does it mean to create and execute science policy; how can individuals participate; and is this a fun and rewarding career experience? I discuss this from the perspective of a mid-career scientist from the Midwest who came to Washington nearly 15 years ago with little knowledge of the Washington science establishment—and what was learned during the ensuing odyssey.

Session HF: New Results in Astronomy Education Research

Location: Washington 6
Sponsor: Committee on Space Science and Astronomy
Date: Wednesday, Feb. 17
Time: 8:30–9:54 a.m.

Presider: Myra West

HF01: 8:30–8:42 a.m. Reforming Introductory Astronomy Using SCALE-UP Pedagogy and Principles of Learning

Carol L. O'Donnell, George Washington University, Washington, DC 20052; codonnel@gwu.edu*

Cornelius Bennhold, Gerald Feldman, Peter Hahn, and William Parke, George Washington University

Students' understanding of astronomy can be significantly enhanced when they take responsibility for their own learning, collaborate with others, receive immediate feedback, conceptualize scientific abstractions from concrete experiences, and are challenged to think deeply. These principles of learning were used to revise an introductory astronomy course at GW based on the SCALE-UP collaborative pedagogy. Instructional methods rooted in the learning cycle included assessing students' prior knowledge, addressing misconceptions, eliciting predictions, engaging students with real and simulated phenomena through inquiry, and having students reflect on findings and reason from evidence. Pre- and post-assessments were used to determine gain and included the Astronomy Diagnostic Test and the Survey of Attitudes Toward Astronomy. Examples of how traditional teaching materials were adapted to be more student-centered will be provided. Lessons learned about resistance to active learning, selection of a conceptually sequenced textbook and lab manual, and determination of material coverage will also be addressed.

*Sponsor: Gerald Feldman

HF02: 8:42–8:54 a.m. How Old Is Your Universe? Bridges and Barricades for Learning

Richard Gelderman, Western Kentucky University, Bowling Green, KY 42101-1077; richard.gelderman@wku.edu

The Creation Museum opened near Cincinnati in May 2007 as a $27 million, 70,000-square-foot, state-of-the-art, high-tech facility with the goal of presenting a "young Earth" account of the origins of the universe and life on Earth according to a literal reading of the Book of Genesis. The founders proudly claim that the 720,000 visitors in the museum's first two years (100,00 in two weeks) are "exposed to the bankruptcy of evolutionary ideas." We report on interviews and open-response surveys collected before and after a tour of the museum with a group of middle-school science teachers. The results provide some reassurance but also suggest cautionary warnings for those who wish to help their students appreciate the vast distances and ages that comprise our majestic cosmos.

HF03: 8:54–9:06 a.m. Student Understanding of and Attitudes Toward Pluto's Reclassification

Joseph Kozminski, Lewis University, Romeoville, IL 60446; kozminjo@lewisu.edu

When Pluto was reclassified in 2006, I developed a comparative planetology project for my introductory astronomy class. The students have to gather data such as size, composition, and orbital eccentricity on solar system objects. From these data, they must decide whether or not Pluto should be considered a planet. In this talk, I will give an overview of the comparative planetology project, discuss student understanding of Pluto's reclassification and the new definition of a planet, and highlight student attitudes toward Pluto's reclassification.

HF04: 9:06–9:18 a.m. The Galaxy Zoo Phenomena: Exploring Why People Are Engaging

Trent Mankowski, University of Wyoming CAPER Team, Laramie, WY 82071; avatar@uwyo.edu

Stephanie J. Slater, University of Wyoming CAPER Team

Pamela L. Gay, Southern Illinois University Edwardsville / Astronomy Cast

Jordan Raddick, Johns Hopkins University

As the Web 2.0 world lurches forward, so do intellectual opportunities for students, and the general public, to meaningfully engage in the scientific enterprise. One of the citizen scientist projects is GalaxyZoo, which provides direct access to the Sloan Digital Sky Survey. In the first generation of GalaxyZoo, participants first classify 15 galaxies as merger or single galaxy, then elliptical or spiral, and finally as spinning clockwise or anticlockwise. In the second generation of GalaxyZoo, participants are able to quickly analyze galaxies' roundedness as well as the nature of any arms or central bulge. In an effort to assess the intrinsic motivation afforded by participation in GalaxyZoo, we have inductively analyzed more than 1000 contributions in the GalaxyZooForum and coded posts thematically. We find that participants overwhelmingly want to meaningfully contribute to a larger scientific enterprise as well as have seemingly unique access to high quality, professional astronomical data.

HF05: 9:18–9:30 a.m. Astronomy On-Line – Boon or Boondoggle?

Terrence F. Flower, St. Catherine University, St. Paul, MN 55105; tfflower@stkate.edu

Online courses have been criticized for lack of interaction between professor and student. Sychronous presentations allow for interactivity with both content (lecture) and activity (laboratory) aspects of the course. A comparison of conventional vs. online class results shows relative effectiveness of both.

HF06: 9:30–9:42 a.m. Exploring Metacognitive Visual Literacy Tasks in Learning Astronomy

William Dwyer, University of Wyoming CAPER Team, Laramie, WY 82071; wdwyer@uwyo.edu

Stephanie J. Slater and Timothy F. Slater, University of Wyoming CAPER Team

How well students learn science concepts depends, perhaps to a large extent, on their use of metacognitive strategies, including self-monitoring, self-regulation, and self-awareness. However, the astronomy teaching and learning community has yet to give sufficient attention to students' metacognitive abilities in the classroom. Perhaps one of the more of these skills is that of visual literacy, achieving a deeper conceptual understanding through imagery. The Conceptual Astronomy, Physics and Earth sciences Research (CAPER) Team at the University of Wyoming is developing and pilot-testing metacognitive tasks for astronomy, focusing on visual literacy of astronomical phenomena. In initial versions, students are presented visual representations (photos, diagrams, charts, graphs) of phenomena, along with scientifically inaccurate descriptions (in the form of narrative prompts), and asked to do peer evaluations, assessing and correcting the descriptions. The students are provided with a scaffolded series of multiple-choice questions highlighting conceptual aspects of the prompt to guide their thinking.

HF07: 9:42–9:54 a.m. The Impact of Stereo Display on Student Understanding of Phases of the Moon

Ramon U. Lopez, University of Texas at Arlington, Arlington, TX 76019; relopez@uta.edu

Ximena Cid, University of Texas at Arlington

Understanding lunar phases requires a 3-D understanding of the relative positions of the Moon, Earth, and Sun. To investigate the effect of a stereo display on student understanding, we conducted a lab (15 sections) on phases of the Moon in introductory astronomy at the University of Texas at Arlington. Half of the labs were taught with passive stereo, while the other half used identical visuals rendered in 2-D. We assessed student comprehension using the Lunar Phases Concept Inventory (LPCI). Both sets of labs showed a statistically significant gain in the LPCI, but that there was no statistical difference between the stereo labs and the non-stereo labs. We conclude that there is no advantage to using a stereo display in teaching about lunar phases compared to a well-designed lab that uses perspective to illustrate the positions of the Earth, Moon, and Sun and the relationship to lunar phase.

Session HG: Reflections on and Outcomes of the Topical Conference on Advanced Laboratories

Location: Maryland B
Sponsor: Committee on Laboratories
Co-Sponsor: Committee on Apparatus, APS Forum on Education
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: TBA

HG01: 8:30–9:06 a.m. A Growing Quest: Open-Ended Projects in Advanced Labs*

Invited – Richard W. Peterson, Bethel University, St. Paul, MN 55112; petric@bethel.edu

Chad W. Hoyt and Keith R. Stein, Bethel University, St. Paul

The Advanced Lab Topical Conference affirmed the importance of traditional labs that repeat a challenging, beautiful and significant experiment. Yet there is also strength in less constrained and more open-ended experiments where instructor and student may both be unsure of the optimal approach or anticipated result. These sometime risky and creative ventures play an especially important role in reinforcing the advanced lab and undergraduate research interface, and they may also encourage the development of more versatile and flexible apparatus. We review some practical approaches that facilitate this extension of the growing open-inquiry goal of introductory labs to at least a portion of our advanced labs for upper-division courses. Examples are cited in areas of AMO physics, optics, fluids, and acoustics. Colleges that have dual-degree engineering and applied physics programs may especially profit from open-ended projects that utilize optical, electromagnetic, and acoustical measurements in conjunction with computational physics and simulation.

*Work supported in part by the Carlsen-Lewis endowment of Bethel University Physics/Engineering and the MN NASA Space Grant.

HG02: 9:06–9:42 a.m. Striking Responses from Advanced Lab Instructors – and New Initiatives

Invited – Gabriel Spalding, Illinois Wesleyan University, Bloomington, IL 61702-2900; gspalding@iwu.edu

A survey regarding the status of laboratory instruction beyond the first-year courses is being conducted by ALPhA (the Advanced Laboratory Physics Association). Preliminary results presented at the Advanced Lab Topical Conference, along with the input of other presenters, makes a clear case for revisiting this portion of the curriculum. At many institutions, advanced lab instruction is very far from being a "shared" responsibility, with only one or two instructors ever participating, with minimal ongoing investment, and with far too much of the burden for laboratory instruction for majors lumped into one (or two) courses. The formal (nonlaboratory) part of the physics course sequence for majors has often been described as a "spiral curriculum," which revisits, reinforces, and refines key concepts. Yet, for an experimental discipline, it seems that few undergraduate programs can claim to "co-value" the experimental and theoretical parts of the curriculum, suggesting that a major overhaul may be in order in some cases. I would argue that at too many programs it is possible to graduate with a physics major with very little experimental work. So, there is, I think, a need to consider the four-year "arc" of development, and how to construct a "spiral" curriculum of experimental instruction, with intentional selection of which topics deserve to be revisited, reinforced, and refined. In this context, I will provide my own perspectives on some of the notable take-away messages from this past summer's Topical Conference on Advanced Laboratories, (including a few notes from the more specialized breakout discussion of the curricular role of experiments in condensed matter and materials physics) ... as well as how all of this has led to a series of new initiatives that are either currently under way or in the planning stages.

HG03: 9:42–10:18 a.m. The State of the Traditional Advanced Lab Course

Invited – Randolph S. Peterson, The University of the South, Sewanee, TN 37383; rpeterso@sewanee.edu

The "traditional" advanced lab course is probably thought of as that collection of experiments that emulate or duplicate some historically significant or elegant experiments. The Millikan oil-drop, spectroscopy in various wavelength ranges, course-related labs in electronics or optics, and a variety of nuclear experiments come to mind. Although the advanced lab experiences reported at this conference did include many of these experiments, there is a strong effort to include more modern experiments with interconnecting themes. Today's labs emphasize more than the usual experiences in experimental technologies and data analysis. Advanced lab programs in many colleges emphasize development of scientific speaking skills, provide intensive writing instruction, and more advanced hardware/software interfacing solutions for the assigned labs. Many advanced lab courses are independent of the upper-level lecture courses and require extensive work by the students. The "traditional" advanced lab courses still emphasize important experiments and integrate those experiments into courses that provide a great physics education and skills development.

Session HH: Pre-High School Reform Curricula for Teacher Preparation

Location: Maryland C
Sponsor: Committee on Physics in Pre-High School Education
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: Tom Foster

If you teach classes for future K-8 teachers, you need to hear the latest and greatest from these PER supported curricula.

HH01: 8:30–9:06 a.m. Physics and Everyday Thinking and Physical Science and Everyday Thinking*

Invited – Steve Robinson, Tennessee Technological University, Cookeville, TN 38505; sjrobinson@tntech.edu

Physics and Everyday Thinking (PET) and Physical Science and Everyday Thinking (PSET) are curricula for one-semester college courses designed for prospective and practicing elementary teachers and non-science majors.[2] PET focuses on the themes of interactions, conservation of energy and Newton's laws. PSET also focuses on conservation of mass and atomic molecular theory. Both curricula include a substantive Learning about Learning component, focusing on the learning of scientists (NOS), young children and the students' themselves. Both curricula were designed around principles based on research on learning: learning builds on prior knowledge; knowledge construction is a gradual process; interaction with tools facilitates learning; social interactions aid in learning; and norms (evidence, responsibility, respect) can structure student interactions, discourse and learning. Pre-/post- conceptual tests and the Colorado Learning Attitudes about Science Survey[3] administered at many sites show growth in students' understanding of content and the nature of science and learning.

*Supported by NSF grant.

1. *Physics and Everyday Thinking and Physical Science and Everyday Thinking* are both published by It's About Time, Herff Jones Education Division.
2. W. Adams, K. Perkins, N. Podolefsky, M. Dubson, N. Finkelstein and C. Wieman, *Phys. Rev ST: Phys. Educ. Res.* **2**(1) 010101, 2006.

HH02: 9:06–9:42 a.m. Facilitating Inquiry by Using Powerful Ideas in Physical Science (PIPS)

Invited – Patsy Ann Johnson, Slippery Rock University of Pennsylvania, Butler, PA 16001-1190; profpaj@peoplepc.com

In the National Science Education Standards, scientific inquiry abilities and understandings are included in content standards for kindergarten through high school. Students preparing to teach grades K-8 need substantial experiences engaging in inquiry if they are to be ready to guide others in inquiry. An efficient and effective way to provide these experiences is to design a college or university course using Powerful Ideas in Physical Science (PIPS) published by the AAPT. PIPS was developed and field tested by faculty, usually in small sections of physics courses. The four original modules are Light and Color, Electricity, Nature of Matter, and Heat and the Conservation of Energy. Two additional modules are Force and Motion. Most of the PIPS activities use inexpensive and readily available materials. Students record their prior knowledge, consider what their classmates think, observe discrepant events, take measurements, record data, make inferences, and reconstruct their understandings about natural phenomena.

HH03: 9:42–10:18 a.m. Physics by Inquiry: Research-based Approach To Prepare K-12 Teachers To Teach Science as Inquiry Process

Invited – Paula R.L. Heron, University of Washington, Seattle, WA 98195-1560; pheron@phys.washington.edu

Lillian C. McDermott, Peter S. Shaffer, MacKenzie R. Stetzer, and Donna L. Messina, University of Washington

The Physics Education Group at the University of Washington (UW) has been helping prepare pre-service and in-service teachers to teach physics and physical science for more than 30 years. Based on this experience, and on systematic research, Physics by Inquiry (Wiley, 1996) has been developed to help college and university faculty conduct courses, workshops, and Institutes for K-12 teachers. This talk will address the development and use of PbI at the UW and elsewhere. Evidence of its effectiveness at helping teachers master important concepts and scientific reasoning skills will be presented.

Session HI: Panel: Science Learning in Informal Settings

Location: Maryland A
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Science Education for the Public
Date: Wednesday, Feb. 17
Time: 8:30–10:18 a.m.

Presider: Richard Gelderman

Each year, tens of millions of Americans, young and old, explore and learn about science via informal paths, such as visits to museums and aquariums, attending after-school programs, pursuing personal hobbies, and/or watching documentaries. The 2009 National Research Council report, "Learning Science in Informal Environments: People, Places, & Pursuits," documents that these programs and settings, and even everyday experiences such as a walk in the park, contribute to people's knowledge and interest in science. In this panel session, members of the NRC committee summarize the report's six strands of science learning that can happen in informal settings. Among the topics to be discussed are how the experiences in informal settings can promote learning outcomes for individuals from groups that are historically underrepresented in science; how to align evaluation procedures with the outcomes informal settings are designed to nurture beyond narrow factual recall; as well as how media can support science learning.

Speakers:

Michael Feder, National Research Council, Board on Science Education, Washington, D.C.
Sue Allen, National Science Foundation, Arlington, VA
Gil Noam, Harvard Medical School, Cambridge, MA
Brian K. Smith, Penn State University, University Park, PA

Session IA: Frontiers in Astrophysics

Location: Washington 1
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Space Science and Astronomy
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:33 p.m.

Presider: Kathleen Falconer

Astrophysics is the study of the physics of the universe. Now is a very exciting time in the study of astrophysics, with the exploration of frontiers and the pushing of boundaries of our knowledge. Please join us for a look at the terrific world of the models, theories, data and instruments, which are at the frontier.

IA01: 11–11:36 a.m. Hubble's Diamonds: Searching for the Oldest Stars in the Galaxy

Invited – Jason S. Kalirai, Space Telescope Science Institute, Baltimore, MD 21218; jkalirai@stsci.edu

The stars that we see every night lighting up our skies are balls of gas with nuclear furnaces in their cores. These brilliant objects have been gazed upon by mankind for centuries, and much of astronomy has historically represented a quest to understand the nature of these shining beacons. It is now well understood that, over time, all stars slowly deplete their fuel by converting the hydrogen in their cores into helium, and therefore cease nuclear burning. The first generation stars that formed in the universe completed this process billions of years ago, and are now invisible to our eyes as burnt out stellar cinders. The newly furbished Hubble Space Telescope will soon undertake an unprecedented imaging study to uncover and study these faintest, coolest, and oldest stars in our galaxy.

IA02: 11:36 a.m.–12:12 p.m. X-rays from Galaxies Teeming with Black Holes and Neutron Stars

Invited – Ann E. Hornschemeier, NASA GSFC, Code 662, Building 34, Room S264, Greenbelt, MD 20771; Ann.Hornschemeier@nasa.gov

Thanks to more than 40 years of investment in space-based technology capable of observing the universe in the X-ray band (0.5 - 100 keV), we have learned quite a bit about the X-ray universe. It has become clear that most of the glow of the X-ray sky is attributed to accretion onto supermassive black holes. However, as we push ever fainter in our detection methods, we find an interesting population of very faint sources arising. These are normal "Milky-Way-type" galaxies that also glow in X-rays. The X-ray emission from these galaxies arises from populations of accreting black holes and neutron stars contained in binary systems. This talk will describe our understanding of this population, including some strange regularity in the production of such accreting binary systems. The future, including new technology planned for the next 5-10 years and anticipated theoretical advancements, will also be discussed.

IA03: 12:12–12:33 p.m. Why Should We Care About Dark Energy in Our Universe?

Invited – Stephon Alexander, Haverford College, Haverford, PA 19041; stephonalexander@me.com

The field of cosmology has matured into a precision science due to new technological advances in probing the universe as well Einstein's theory of space-time. Recently, observations of exploding stars (Supernovae) reveal the remarkable fact that more than 70% of the substance in the universe is made from a strange substance that cosmologists call Dark Energy. In this talk I will walk the audience through the edges of the cosmos to reveal the nature of Dark Energy and its properties. I will conclude with a shocking new picture (developed by the author) as to the culprit behind Dark Energy.

Session IB: Physics Education Research Around the World – II

Location: Washington 6
Sponsor: Committee on International Physics Education
Co-Sponsor: Committee on Research in Physics Education
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:36 p.m.

Presider: TBA

IB01: 11–11:12 a.m. Peer Instruction: What Group Structure Works Best?

Nathaniel Lasry, John Abbott College, Montreal, QC H9X3L9; lasry@johnabbott.qc.ca

Elizabeth Charles and Chris Whittaker, Dawson College

In Peer Instruction, students are typically polled individually on a ConcepTest before discussing with a peer and re-voting. In the early days of Peer Instruction, students were sometimes polled on ConcepTests not individually but in groups because there were not enough clickers for each student. Currently, some instructors use ConcepTests to poll students without allowing for subsequent peer discussions, in a sense, taking the "peer" out of Peer Instruction. We report findings comparing learning and attitude data for different implementations of Peer Instruction. Our results suggest which group structure is best suited for optimizing learning and attitudinal changes.

IB02: 11:12–11:24 a.m. Comparison of Undergraduate Physics Education in U.S., Spain, and India

Nandini Banerji, Minnesota State Fergus Falls, Fergus Falls, MN 56537; nandin.banerji@minnesota.edu

This work presents a comparative study based on my personal teaching experiences of undergraduate physics courses in three widely different teaching environments: India, Spain and the United States. While the general course outlines for the standard college/Engineering Physics courses are broadly similar, student competencies may vary broadly due to multiple factors such as: educational goals of students, classroom and laboratory environment, assessment methods, class size and heterogeneity, availability of technology, and general life philosophy and aspirations etc. The results of my analysis indicate that while many Indian students demonstrate greater mathematical skill, they often also succumb to memory-based rote learning due to the competitive pressures of a larger student population. Spanish students may often not attend class but be skillful in passing exams. However, the teaching environment often also breeds some passionate learners. U.S. students demonstrate better conceptual and application-based understanding of physics but have a harder time with mathematics.

IB03: 11:24–11:36 a.m. How do the Junior Secondary Students Develop Scientific Research Questions in Open-Inquiry Activity?

Jongsook Kim, Seoul National University, The Dept. of Physics Education, Seoul, Korea; ggong11@snu.ac.kr

Junehee Yoo, Seoul National University

The eighth national curriculum that will be started in 2010 requires secondary students to do six hours open-inquiry activity in Korea. By the national curriculum, students are expected to function autonomously in open-inquiry activity. Studies reported that students had difficulties to develop the scientific research questions in the open-inquiry. This study investigates students' developing process of scientific research questions in open-inquiry activity by using formative monitoring tools which we developed.

IB04: 11:36–11:48 a.m. Web-based Collaborative Teaching of Astrobiology in the EU Project CoReflect

Andreas Redfors, Kristianstad University, SE-291 88 Kristianstad, Sweden; Andreas.Redfors@hkr.se

Lena Hansson and Maria Rosberg, Kristianstad University

Groups in Cyprus, Israel, Germany, The Netherlands, Greece, England, and Sweden have developed, implemented, and evaluated teaching sequences using the web-based platform STOCHASMOS in a EU-project — www.coreflect.org. The interactive web-based inquiry materials support collaborative and reflective work. The sequences have been tested as pilot projects and revised for a second local implementation. They will be culturally adopted for a third enactment in a partner country. The Swedish learning environment is Astrobiology for secondary students (ninth grade, 16 years). Scientific, social, economical and ethical perspectives are taken on the driving question: Should we look for, and try to contact, extraterrestrial life? Empirical data from the final enactment, including students' worldviews and their use of scientific arguments, will be discussed at the conference. Preliminary results from the pilot show that students appreciate the teaching, and we see an increase in students' motivation.

IB05: 11:48 a.m.–12 p.m. Recent Trends in Physics Education Research in Japan

Roy Lang, (formerly Tokyo University of Agriculture and Technology), 4-5-16 Egota, Nakano-ku, Tokyo, Japan 165-0022; rlang2@cc.tuat.ac.jp

Hidetoshi Yuguchi, Ohmiya High School

Hideo Nitta, Tokyo Gakugei University

For more than a half a century, there has been considerable effort among Japanese teachers toward student-centered science education, and various active learning methods have been developed and practiced, for example, the "Hypothesis-experiment-instruction" method proposed by K. Itakura in 1963. The 1986 ICPE Tokyo International Conference on Trends in Physics Education significantly stimulated interest in international exchange on physics education research (PER). However, Japanese involvement in the exchange thereafter remained modest, probably because of the social environment surrounding Japanese education, such as the constraints by national curriculum guidelines and the pressure exerted on pre-college education by fiercely competitive college entrance examinations. The International Conference on Physics Education 2006, held in Tokyo, appears to have rekindled the interest in physics education reform based on PER. This paper will review some of the recent activities among Japanese educators to develop and test PER-based active engagement learning methods with intensified international exchange.

IB06: 12–12:12 p.m. Beliefs About Physics in Saudi Arabia Before and After Instruction

Hisham A. Alhadlaq, The Excellence Center of Science and Mathematics Education/King Saud University, Riyadh, SA 11451; h.alhadlaq@gmail.com

Kathy and Carl E. Perkins/Wieman, University of Colorado, Boulder/University of British Columbia, Vancouver, BC Canada

Wendy Adams, University of Colorado, Boulder

Fahad Alshaya and Saleh Alabdulkareem, The Excellence Center of Science and Mathematics Education/ King Saud University

The Colorado Learning Attitudes about Science Survey (CLASS) is an instrument that was designed to measure student attitudes and beliefs about physics. Recently, an Arabic version of the CLASS was developed and validated to measure students' beliefs about physics at King Saud University (KSU) in Riyadh, Saudi Arabia. We have administered the Arabic CLASS to undergraduate students at KSU's men's and women's campuses before (pre-) and after (post-) instruction in introductory physics classes in the winter and fall semester of 2009. We will present a summary of students' beliefs about physics at KSU pre- and post-instruction as well as an analysis of the shift in student beliefs from pre to post. The change in attitudes toward learning physics over a semester will be compared to similar results from the United States.

IB07: 12:12–12:24 p.m. Physics Teaching by Concept Mapping

Nilüfer Didis, Middle East Technical University, Orta Dogu Teknik Universitesi, Egitim Fak., Ankara, Turkey 06531; dnilufer@metu.edu.tr

Ali Azar, Zonguldak Karaelmas University

Concept maps are graphical tools that connect the concepts meaningfully and systematically. This study aims to investigate pre-service physics teachers' theoretical knowledge on concept mapping, their opinion about implementation of concept mapping in physics instruction, and also the relation between them. Four participants of this qualitative study are pre-service physics teachers who completed "methods of science/mathematics teaching" courses in a physics teacher training program at Middle East Technical University (METU). In order to collect data, semi-structured interviews were conducted with each student. The results of this study are important for teacher training programs of universities in order to develop teacher candidates' opinions positively.

IB08: 12:24–12:36 p.m. Solving Problems in Physics with Critical Thinking Development

Ignacio Laiton, Escuela Tecnológica Instituto Técnico Central Bogotá, Bogotá, Colombia ,11001000; ilaiton@gmail.com

The development of critical thinking has in recent years been considered one of the most important aspects of education in different countries. However, in Colombia there is little that has been advanced in this respect, despite its undeniable usefulness in the training of learners by providing learning tools, learning to learn, question and evaluate information, so important in the globalized world. In the field of physics, very little, if any, work has been developed along these lines. We want to present results of research performed with students from the Escuela Tecnológica Instituto Técnico Central in Bogota, Colombia, about the teaching of critical thinking in the area of physics in first semester university students. The research was based on the basic parameters set by Professor Robert Ennis of the University of Illinois in the definition of critical thinking, and as regards the implementation of the pedagogical intervention with parameters of Professor Jacques Boisvert, University Quebec.

Session IC: PER: Investigating Classroom Strategies

Location: Washington 3
Sponsor: Committee on Research in Physics Education
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:48 p.m.

Presider: Mel Sabella

IC01: 11–11:12 a.m. Developing Scientific Reasoning Abilities Through General Education Courses

Sachiko Tosa, Wright State University, Dayton, OH 45435-0001; sachiko.tosa@wright.edu

Kathy Koenig, Wright State University

Educational reforms stress the need for a prepared 21st century workforce, which translates into students learning not only science content, but also acquiring advanced transferable reasoning skills. Scientific reasoning is a general ability and methodology, critical in enabling the successful management of real-world situations in professions beyond the classroom, even in nonscience related careers. Although typical large lecture college science courses have been shown to have no impact on reasoning skill development, this presentation describes instructional strategies implemented during a large lecture general education astronomy course with the purpose of developing such skills. The key element of the instructional strategies was to incorporate the training of solving problems that involve multiple reasoning steps. The problems were worked out throughout the course from a lower level (single step) to a higher level (up to three steps). Pre- and post-test results will be presented (n=114).

IC02: 11:12–11:24 a.m. Faculty and Student Views on Collaboration in the Science Course*

Geraldine Cochran, Chicago State University, Chicago, IL 60628; moniegeraldine@gmail.com

Mel Sabella, Chicago State University

In previous talks at AAPT meetings, our research group has presented findings from a survey we designed to reveal student feelings about the guided inquiry approach to instruction and we have discussed our analysis of classroom videos using a rubric to characterize group interactions. Our use of the rubric in analyzing the effectiveness of collaboration in classroom videos, yielded results contrary to what we expected and revealed a need to revise the rubric to be more consistent with our expectations about collaboration. To gauge consensus among faculty members, we have interviewed faculty from the chemistry and physics department at Chicago State University (CSU) to determine more precisely what they feel constitutes effective collaboration. In addition, we have conducted student interviews and recorded student analysis of their own collaboration during laboratory activities. In this talk we present our initial findings and discuss how these findings relate to our goal of promoting and encouraging effective collaboration at CSU.

*Funding provided by New York City Alliance Bridge Program and the National Science Foundation CCLI Program (Award # DUE 0632563).

IC03: 11:24–11:36 a.m. Students' Mathematical Difficulties in the Physics Lab

Maria R. Ruibal Villasenor, Rutgers University, New Brunswick, NJ 08901; mruibal@eden.rutgers.edu

Eugenia Etkina, Anna Karelina, and Gregory Suran, Rutgers University

Some basic knowledge of mathematics is essential to work productively even in instructional introductory physics labs. But do students possess the necessary mathematical knowledge to complete inquiry tasks where they have to develop the mathematical procedure without guidance or scaffolding? What types of math difficulties might hamper the investigations of students taking an algebra-based introductory physics course for science majors? We analyzed the lab reports of several groups of students working on a design lab where they needed to invent a quantity to describe the thermal conductivity of different materials, we examined, as well, as the written individual answers to questions in relation with the property of thermal conductivity. Finally, we contrasted the results with the video-recordings of other groups of students working on the same problem. Our findings are surprising and might have a value in the design of instructional tasks and their scaffolding.

IC04: 11:36–11:48 a.m. Reassessing Hake's Gain

David R. Dellwo, U.S. Merchant Marine Academy, Kings Point, NY 11024; dellwod@usmma.edu

This note proposes two new indices that, unlike Hake's gain, are direct measures of knowledge acquisition and knowledge retention. The paper derives the relationship between the three indices and demonstrates that practitioners using Hake's gain make assessment decisions based on less information than practitioners using the new indices. An application of the new indices invalidates a central assumption underlying the utility of Hake's gain.

IC05: 11:48 a.m.–12 p.m. An Analysis of Physics Classrooms Using the Edu Grid

Ricardo J. Rademacher, Futur-E-Scape, LLC, 503 McAlpin Ave., Cincinnati, OH 45220; ricardo@futur-e-scape.com

At previous AAPT meetings (Rademacher, 2009a; 2009b), Dr. Ricardo Rademacher explored the different types of physics classrooms in use today. In this presentation, I will continue this review by applying two educational theories to the analysis of three distinct physics classrooms. Combining Anderson and Krathwohl's (2001) revision of Blooms Taxonomy (1956) with Howard Gardner's (1983) theory of Multiple Intelligences, he will create the EDU Grid (Rademacher, 2009c; Rademacher, in press), a visual synthesis of these theories. Using this synthesis, he will analyze three physics classrooms: Traditional, Interactive, and Pure Online. He will show how the Interactive classroom is the epitome of offline physics education combining technology with PER results. As well, he will show how the Pure Online classroom shows several deficiencies related to current Learning Management Systems and course logistics. The audience will gain a high-level understanding of the educational merits of all three classrooms.

IC06: 12–12:12 p.m. Evaluation of Effective Instructional Methods and Strategies in Science Courses

Fariba Ansari, El Paso Community College, El Paso, TX 79915; fansari@epcc.edu

Implementation of tailored rubrics and students' surveys to track and analyze students' performance to improve teaching methods and instructional strategies in future physics courses. Through the use of collaborating teams, students will model physical concepts to demonstrate their newly acquired knowledge and expanding beyond theory and book work.

IC07: 12:12–12:24 p.m. Studying Group Formation and Engagement During Peer Instruction

Sissi L Li, Oregon State University, Corvallis, OR 97331; lisi@onid.orst.edu

Dedra N. Demaree, Oregon State University

Beginning in fall term of 2008 at Oregon State University, we have undergone curriculum reform in our large-enrollment introductory calculus-based physics sequence. As part of this reform, we have remodeled our large lecture hall to promote instructor/student and student/student interactions. To assess the classroom in its effectiveness in motivating and facilitating student discussions in small groups during class, we will examine the group size formed and level of student participation during group work. Additionally, survey results will provide student perception of the classroom features that aid or inhibit their learning in social interactions. This talk will showcase our analysis methods for the audiovisual recordings of classroom interactions. As we refine the analysis, this study will serve to inform future decisions to improve physical features of classrooms to enhance learning.

IC08: 12:24–12:36 p.m. Implementing Group Quizzes for Introductory Physics

Sylvester Ekpenuma, School of Natural Sciences & Mathematics, Claflin University, Orangeburg, SC 29115; ekpenuma@claflin.edu

An extension of group work to include group quizzes is being implemented in an introductory physics class in an effort to know how this will impact students' attitudes towards group work, students' learning and achievement. (Similar studies have been done in other areas).[1,2] Group details and preliminary data will be presented.

1. M. Weimer, Effective Group Work Strategies for the College Classroom, www.facultyFocus.com (2009).
2. S. R. Slusser and R. J. Erickson, *Group Quizzes: An extension of the collaborative learning process.* Teaching Sociology 34:249-62 (2006).

IC09: 12:36–12:48 p.m. Using Tutorials in Introductory Physics, with Matter and Interactions

Beth A. Lindsey, Georgetown University, Washington, DC 20057; blindsey@physics.georgetown.edu

The Georgetown physics department has recently adopted the "Matter and Interactions"[1] (M&I) curriculum, an introductory curriculum that emphasizes fundamental principles and microscopic models of matter. Our implementation of the curriculum includes a one-hour weekly interactive-engagement component focused on the development of conceptual understanding in which we use "Tutorials in Introductory Physics."[2] The Tutorials have been adapted somewhat to bring them into alignment with M&I. We will discuss the successes and challenges of the first semester of our implementation of the curriculum. We will also present data from pre-tests, post-tests, and interviews that have been used to evaluate the effectiveness of the tutorials in this context.

1. Ruth Chabay and Bruce Sherwood, *Matter and Interactions*, 2nd edition, Wiley (2007).
2. L.C. McDermott, P.S. Shaffer and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics,* Prentice Hall (2002).

Session ID: Optics in the Upper-Level Curriculum

Location: Washington 4
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: APS Forum on Education
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:48 p.m.

Presider: Ernest Behringer

ID01: 11–11:36 a.m. Integrating Undergraduate Optics Research with the Traditional Teaching Curriculum

Invited – Janice Hudgings, Mount Holyoke College, South Hadley, MA 01075; jhudging@mtholyoke.edu*

Undergraduate participation in scientific research provides invaluable opportunities for one-on-one teaching and mentoring. However, undergraduate research is often treated in isolation from the traditional curriculum. In this talk, we present a model for integrating both the preparation for and practice of undergraduate research with the traditional teaching curriculum. Basic research skills are woven into traditional class and lab work, and the sophomore-level optics lab is redesigned to more closely model the practice of scientific research, including emphasis on engagement with the literature, independent thought, and communication skills. All physics majors are required to participate in substantive independent research and are encouraged to join research groups as early in their education as possible, complementing traditional coursework. Likewise, undergraduate research is treated as an intensive teaching endeavor, complete with course syllabi, weekly group meetings, formal student presentations in campus-wide symposia, term papers, and, ideally, journal papers and presentations at national meetings.

*Sponsor: Ernest Behringer

ID02: 11:36 a.m.–12:12 p.m. Engaging Students in Optics*

Invited – Mark F. Masters, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

Timothy T. Grove, Indiana University Purdue University Fort Wayne

We began to revise our optics curriculum because our students displayed limited optical understanding and laboratory independence. They were employing "answer making" and going through the motions of doing optics without understanding the physics. Rather than adding the "latest and greatest" experimental investigations, we decided to focus on foundational basics. The laboratory methodology we developed relies upon peer interaction, confrontation of misconceptions, and skill building. The laboratory sequence helps students understand optics while fostering independence. Active learning in the laboratory is hindered if the students are not consistently and actively engaged in the classroom setting as well. This can be difficult in an intermediate class due to mathematical rigor, and the need to develop physical insights and conceptual understanding. To assist in this endeavor we developed a series of tutorials that help guide the students to develop "sense making," and facilitate the vital in-class discussions.

*Supported by NSF CCLI Grant #0410760.

ID03: 12:12–12:48 p.m. Beyond Rays and Waves: Expanding the Reach of Optics

Invited – Thomas G. Brown, The Institute of Optics, University of Rochester, River Campus, Rochester, NY 14627; brown@optics.rochester.edu

Once considered a subfield of physics, optics has emerged as an important area of study in its own right, and now spans from the very fundamental to the very applied. The latter includes lasers, medical diagnosis and treatment, energy-efficient lighting, and information technologies. An understanding of the basic physics of light can encourage students toward a wide range of productive and satisfying technical careers. This talk will discuss how optics instruction can extend well beyond the traditional optics courses in an undergraduate physics curriculum and how optics experiments can shed light on other, more esoteric areas of physics.

Session IE: Labs/Apparatus

Location: Washington 5
Sponsor: Committee on Apparatus
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:48 p.m.

Presider: TBA

IE01: 11–11:12 a.m. AMS Pressure Blocks (Why Is the Air Heavy Today?)*

CANCELED

Sarah A.Wendel, Parkdale High School/Maury Project, Riverdale, MD 20737; sarah.wendel@pgcps.org

The American Meteorological Society pressure blocks enable the learner to develop hands-on understanding about pressure. The activities presented apply those understandings to atmospheric and oceanic pressure. Motion in the Earth's atmosphere is initiated by differences. Since pressure is the amount of force acting on a unit surface area, then defining pressure becomes necessary. This is followed by five activities that explain these concepts.

*The Maury Project is a joint effort of AMS and the U.S. Naval Academy. It is a program that has existed for 16 years and developed a number of units involving STEM applications. There are over 300 teachers trained to teach other teachers in these concepts.

IE02: 11:12–11:24 a.m. Physics on the Cheap – Build with Your Students

Sean P. Lally, Park School of Baltimore, Brooklandville, MD 21022; slally@parkschool.net

This is a talk for teachers in need of cheap and fun ideas for lab work. Just starting out in physics education? Teaching with a limited budget? Looking for some new ideas to have students active in your classrooms? Well look no further. In this talk, I will present simple laboratory gear that your students can build together as part of their total physics experience. Microphones, motors, speakers, guitar pickups, wave machines, capacitors, telescopes and more. Some are classic, and some may be new to you, but all are helpful when teaching physics and you have a limited budget. The talk will be long on demonstration, if short on the descriptive physics — that is left as an exercise to the reader.

IE03: 11:24–11:36 a.m. What You Can Learn From a Discarded Microwave Oven

William W. McNairy, Duke University, Durham, NC 27708; mcnairy@phy.duke.edu

In my walks about town I often come across discarded microwave ovens lying by the curb — most are surprisingly in good working order. From several past discussion threads on TAP-L,[1] I have found that a number of interesting demonstrations can be created using either the microwave oven or its separate components. My presentation of some of my favorites will include: relative motion, thermal expansion, wavelengths of EM waves, plasmas, the sparkling glow of everyday objects, and energy stored in a capacitor.

1. TAP-L is a listserve hosted by NC State (http://physicslearning.colorado.edu/PiraHome/tapl/PIRATapL.html) under the auspices of the Physics Instructional Resource Association (http://physicslearning.colorado.edu/PiraHome/About%20us/About%20Us.htm).

IE04: 11:36–11:48 a.m. An Interesting Optical Illusion with Diffraction Glasses

Robert Schwartz, Harriton High School, Rosemont, PA 19010; bobschwartz314@comcast.net

Using an ordinary pen red laser and diffraction grating glasses that produce a visible image, the image is projected onto a screen when the laser is shone through the grating. When the image is observed by a person at various distances from the screen, an interesting illusion occurs with respect to the apparent size of the image. The effect can be observed by a class of students simultaneously.

IE05: 11:48 a.m.–12 p.m. Rolling to a Value for the Acceleration of Gravity

Bruce A. Weber, Montgomery College/Takoma Park Campus, Takoma Park, MD 20912; bruce.weber@montgomerycollege.edu

The measurement of the acceleration of gravity, "g", presents an opportunity to teach students to be careful and thoughtful observers of the physical world. But instead of simply dropping a mass and measuring "g" directly, we propose rolling a sphere down an inclined plane. Linear motion is generally taught before rotational so the students can first analyze the experiment without considering rotational motion. This will produce a value for "g" which will be too small requiring the student to discuss probable causes. After forces, kinetic energy and their rotational analogs are covered and reanalysis will yield a considerably better value for "g". Our presentation will consider both dynamical and kinematic solutions and point out how such an experimental setup can also be used to obtain a value for the coefficient of rolling friction for many surfaces and spheres.

IE06: 12–12:12 p.m. Pre-lab Videos: Digital-Age Solution to an Ancient Problem

Mickey D. Kutzner, Andrews University, Berrien Springs, MI 49104-0380; kutzner@andrews.edu

Andrew R. Kutzner, Andrews Academy

During the course of a term, it is not uncommon for elementary physics labs to engage concepts not yet encountered in the lecture portion of the course. Traditionally, this has been handled with lab lectures given by the lab instructor. We have attacked this problem with a series of pre-lab videos combining voice-over slides outlining the principles, still images of the apparatus and video clips with lab hints when motion is helpful. Since the videos are posted to YouTube.com, they must be concise with a 10-minute limit each. Students working through labs may replay key instructions from the video as needed. Sample clips will be shown.

IE07: 12:12–12:24 p.m. USB Hall Probe Straight Wire B Field Measurements

S. Clark Rowland, Andrews University, Berrien Springs, MI 49104-0380; rowland@andrews.edu

Mickey D. Kutzner, Andrews University

The magnetic field, B, generated by a current in a long straight wire is fundamental to an understanding of Ampere's Law. Since the magnitude of the B field is weak and Hall probes are costly, it has been a challenge to develop a quantitative elementary physics experiment demonstrating this important relationship. We have used the new, low-cost USB-based Hall probe manufactured by Physics Enterprises to measure the field strength as a function of the radial distance, r, of the probe from the center of the wire. A plot of B vs. r clearly shows the inverse relationship. Comparing a curve fit to the measured data with Ampere's law yields a good determination of the permeability of free space. Results obtained with various Hall probes are compared and contrasted.

IE08: 12:24–12:36 p.m. Laboratory Development for Physics of Living Matter Course

Vanalet Rusuriye, Texas Tech University, Lubbock, TX 79401; vanalet.rusuri@ttu.edu*

Beth Thacker, Texas Tech University

We discuss the development of the laboratory part of a physics course for nonscience majors with biological and health science applications. The lab is designed to convey an understanding of basic concepts in physics with applications in biology and the health sciences. It includes topics such as biological applications of motion, fluids, hearing, vision, bioelectricity, and the use of medical equipment. We will discuss our methods of development including techniques and instrumentation.

*Sponsor: Beth Thacker

IE09: 12:36–12:48 p.m. Experimental Proof of Malus' Law Using Photoelectric Current

Karen A. Williams, East Central University, Ada, OK 74820; kwillims@mac.com

Morgan Sennett, East Central University/OK State University

This presentation describes a lower-level research project based upon a revised upper-level lab done with a sophomore Engineering Physics II student. My idea to alter the lab came from an AAPT workshop on advanced labs. Malus' law deals with the intensity of light after the light passes through polarizers. This paper will show that it is possible to reduce the intensity of the light striking the metal in the photoelectric effect with two polarizers. Reducing the intensity of the light reduces the photoelectric current measured while leaving the stopping potential unchanged. This is directly observed in the plots of photocurrent versus stopping potential for various intensities of light. However, by plotting the photoelectric current versus the original intensity of the light (as obtained from the photocurrent when the transmission axes of the polarizers are parallel), students can demonstrate Malus' law quite accurately without using a light meter. It would be easy to do two experiments with only one "data taking" event.

Session IF: Technology for Teaching Advanced Physics

Location: Washington 2
Sponsor: Committee on Educational Technologies
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:48 p.m.

Presider: Bruce Mason

This session will explore the use of technology in upper-level physics classes. Both the technology use and its pedagogical foundations will be explored. The session will consist of two invited speakers and presentations of contributed posters.

IF01: 11–11:36 a.m. Computation in the Lawrence Undergraduate Physics Curriculum*

Invited – David M. Cook, Lawrence University, Appleton, WI 54911; david.m.cook@lawrence.edu

During the last two decades, computation has become increasingly prominent throughout the Lawrence physics curriculum. Data analysis and curve fitting are addressed in introductory laboratories. Algorithms and tools for solving ordinary differential equations, evaluating integrals, visualizing solutions graphically, and preparing documents comprise about 50% of the required, winter-term sophomore course Computational Mechanics. Thereafter, students have 24/7 access to our Computational Laboratory for required assignments in later courses, and we encourage students always to exploit computation on their own initiative. Finite-difference methods appear in a required, spring-term sophomore course in electromagnetism, and approaches to the eigenvalue problem are included in a required, fall-term junior course in quantum mechanics. In the elective, junior-senior course Computational Physics, students learn about finite-element methods. Currently, we are successfully confronting the challenge of assuring that the computational dimensions of our curriculum survive the retirement of the faculty member who guided the original development.

*Curricular development at Lawrence has been supported by the W. M. Keck Foundation, the National Science Foundation, and Lawrence University.

IF02: 11:36 a.m.–12:12 p.m. Reforming, Not Weakening the Physics Curriculum

Invited – Harvey Gould, Clark University, Worcester, MA 01610; hgould@clarku.edu

Jan Tobochnik, Kalamazoo College

The potential applications of accessible and powerful computer technologies give us a rare opportunity to rethink and enhance the physics curriculum. I will discuss some of the changes that have been made in upper-division courses, with an emphasis on the role of computers in statistical and thermal physics. I will also emphasize that reforms of the physics curriculum should emphasize the strengths of physics — the development of simple models and new measurement and theoretical tools, and the interplay between experiment and theory.

IF03: 11 a.m.–12:48 p.m. A Flexible Platform for Teaching Astronomy and Astrophysics*

Poster – Todd Timberlake, Berry College, Mount Berry, GA 30149-5004; ttimberlake@berry.edu

Mario Belloni, Davidson College

Two of the most popular courses in physics are that of astronomy and astrophysics. However, the topics taught require visualizations that are not familiar to the typical students in these courses. To address this issue, we have created a set of flexible resources for the teaching of introductory astronomy and advanced astrophysics based on two- and three-dimensional simulations. These simulations either use Open Source Physics programs or are created with Easy Java Simulations, EJS, which is a free and open source tool for creating Java simulations. Because EJS allows teachers to easily change simulations, existing simulations can be customized to the type of astronomy course one is teaching. This poster will show astronomy examples including the celestial sphere, Ptolemaic and Copernican models, and Keplerian orbits, and more advanced examples from colliding galaxies and general relativity. All of these materials are available on the OSP Collection on the ComPADRE digital library.

*The Open Source Physics Project is generously supported by the National Science Foundation (DUE-0442581).

IF04: 11 a.m.–12:48 p.m. Peer Instruction for Quantum Mechanics*

Poster – Chandralekha Singh, University of Pittsburgh, Pittsburgh, PA 15260; clsingh@pitt.edu

Guangtian Zhu, University of Pittsburgh

We are developing and evaluating resource material for "Peer Instruction" in quantum mechanics. A central component of the resource material is research-based concept tests that can be used by instructors as a formative assessment tool. The instructors can use these tools for bridging the gap between the abstract quantitative formalism of quantum mechanics and the qualitative understanding necessary to explain and predict diverse physical phenomena. Asking questions during the lecture and asking students to discuss it with each other before polling the class has already been shown to be effective at the introductory level. This method provides a mechanism to convey the goals of the course and the level of understanding that is desired of students and also helps students monitor their learning. We will discuss the development and assessment of these tools.

*This work is supported by the National Science Foundation (NSF-PHY-0653129).

IF05: 11 a.m.–12:48 p.m. Teaching Physics Using Virtual Reality

Poster – Craig M. Savage, Australian National University, Centre for Learning and Teaching in the Physical Sciences, Canberra, Australia, ACT 0200; craig.savage@anu.edu.au

Dominic McGrath and Margaret Wegener, The University of Queensland

Michael Williamson, The Australian National University

We present an investigation of three-dimensional, first person, game-like simulations for physics teaching. We report on the effectiveness of the "Real Time Relativity" simulation for learning special relativity. Through its use, students have become more confident, judged relativity as less abstract, performed better on relevant subsequent assessment, and act more like experts in the field. Many of the difficulties in learning special relativity arise from its disconnectedness from everyday experience — not only do students have no direct experience of special relativity, but it conflicts with deeply held everyday beliefs about space and time. Real Time Relativity connects students to special relativity through a virtual reality experience. We argue that the simulation not only enhances traditional learning, but also enables new types of learning that challenge the traditional curriculum. The lessons drawn from this work are being applied to the development of a simulation for enhancing learning of quantum mechanics. Teaching physics using virtual reality, project website: http://www.anu.edu.au/Physics/vrproject.

IF06: 11 a.m.–12:48 p.m. Use of SIMION Code To Teach the Basis of Implanters

Poster – Fabian U. Naab, University of Michigan, Ann Arbor, MI 48109; funaab@umich.edu

Ion implantation is a material engineering process by which ions of a material can be implanted into another solid, thereby changing the physical properties of the solid. Ion implantation is used in semiconductor device fabrication, metal finishing, medical applications, materials science research, etc. Ion implanters are the systems used to do ion implantation. The implanters produce, accelerate, focus, and raster the ions to be implanted into the materials. Using SIMION, each electromagnetic component of the implanter can be drawn and then the electric and magnetic fields are calculated. The trajectories of charged particles in those fields are simulated when given particle initial conditions. In this work, SIMION is proposed as a tool to teach undergraduate and graduate students the principle of operation of implanters, how to operate implanters, and how to predict each of the implanter's component parameters versus the energy, charge, and mass of the implanted ion.

IF07: 11 a.m.–12:48 p.m. Using ComPADRE for the Upper-Division Curriculum

Poster – Bruce Mason, University of Oklahoma, Norman, OK 73019; bmason@ou.edu

Lyle Barbato and Matt Riggsbee, AAPT

The ComPADRE digital library is designed to support all levels of physics and astronomy education, from middle school through graduate school and informal education. This poster will focus on the resources available in the library for the upper-division curriculum, including specific resource collections for upper-level classes, the portal to upper division materials, collaborations with curriculum developers, and personal collections.

*ComPADRE is supported, in part, by the NSF through grants DUE-0226192, DUE-0532798, and DUE-0937836.

IF08: 11 a.m.–12:48 p.m. Using Technology To Assess and Disseminate Curricular Innovation

Poster – Tevian Dray, Department of Mathematics, Oregon State University, Corvallis, OR 97330; tevian@math.oregonstate.edu*

Corinne A. Manogue and Emily van Zee, Oregon State University

The web provides a flexible new mechanism for assessing and disseminating curricular innovations. Wikis add to this structure a mechanism for encouraging and quickly incorporating feedback from students, instructors, and the public. The Paradigms in Physics project at Oregon State University uses wikis in all of the following ways. Our text materials exploit the connectedness of the web to provide multiple paths through curricular material that address the needs of courses with different content (or structure) as well as the needs of students of different abilities. We have developed a framework that permits the generation of both online and printed text materials, containing extensive mathematics, from a single source. Our wikis also provide an open-source mechanism, which includes video analysis, for disseminating specific active engagement materials and pedagogical strategies. These materials are easily linked to national electronic libraries such as NSDL and ComPADRE.

*Sponsor: Corinne Manogue. This work was supported in part by NSF grant DUE-0618877. The Paradigms in Physics wiki can be found at http://physics.oregonstate.edu/portfolioswiki.

IF09: 11 a.m.–12:48 p.m. A Learning Platform for Physics Teaching

Poster – Wolfgang Christian, Davidson College, Davidson, NC 28035; wochristian@davidson.edu

The combination of a computational modeling tool with Internet technologies allows teachers to easily incorporate computer-based modeling into their courses by providing an open and extensible solution for the creation and distribution of curricular material and software. This poster describes the integration of the Easy Java Simulations (EJS) modeling tool with the ComPADRE National Science Digital Library to produce a learning platform for the teaching of physics from introductory through advanced topics. EJS can connect to the digital library to download models onto a personal computer so that teachers can adapt these model for use in their classrooms. Curricular material with simulations from middle and high school through Lagrangian and quantum dynamics are available.

IF10: 11 a.m.–12:48 p.m. A Student's Guide To Searching the Literature via Online Databases

Poster – Michelle D. Chabot, University of South Florida, Tampa, FL 33620; mchabot@cas.usf.edu

Casey W. Miller, University of South Florida

Troy C. Messina, Centenary College of Louisiana

A method is described and demonstrated to empower students with the ability to efficiently perform general and specific literature searches using online resources.

Session IG: Applications of Supercomputers in Astronomy

Location: Maryland B
Sponsor: Committee on Space Science and Astronomy
Co-Sponsor: Committee on Educational Technologies
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:48 p.m.

Presider: Kevin Lee

This session will focus on fundamental problems in astrophysics where substantial progress has recently been made with the aid of supercomputers.

IG01: 11–11:36 a.m. Supercomputer Simulations of Dust In Extrasolar Planetary Systems

Invited – Marc J. Kuchner, NASA Goddard Space Flight Center, Greenbelt, MD 20771; Marc.Kuchner@nasa.gov

Images of dusty disks from the Hubble Space Telescope and other telescopes show rings and warps and other patterns that suggest the gravitational signatures of planets embedded in the dust. I will describe new models of these dusty disks run on NASA's supercomputers that help us to decode the images of these disks and read the signatures of the planets they contain.

IG02: 11:36–12:12 p.m. Rotational Breakup as the Origin of Small Binary Asteroids

Invited – Derek C. Richardson, Department of Astronomy, University of Maryland, College Park, MD 20742; dcr@astro.umd.edu

Kevin J. Walsh and Patrick Michel, University of Nice-Sophia Antipolis, CNRS, Côte d'Azur Observatory

About 15% of near-Earth and small inner Main Belt asteroids are binaries or multiples. Lightcurve measurements and radar observations indicate that the primaries of many of these systems are oblate and rapidly rotating, near the breakup limit for unconsolidated material. We show that gradual spin-up of small asteroids with little to no cohesion can account for the physical characteristics of many of the observed systems. The so-called "YORP effect," which causes a small body's spin rate and axis orientation to change as a result of solar illumination, may provide the required spin-up mechanism. (Tidal disruption, though a viable means of binary formation, cannot explain the small binaries in the inner main belt nor the tendency toward rounded, fast-spinning primaries.) We present numerical simulations demonstrating the spin-up, break-up, and reshaping of a progenitor leading to binary formation.

IG03: 12:12–12:48 p.m. Merging Black Holes*

Invited – Joan Centrella, NASA/Goddard Space Flight Center, Gravitational Astrophysics Lab, Greenbelt, MD 20771; Joan.Centrella@nasa.giv

The final merger of two black holes is expected to be the strongest gravitational wave source for ground-based interferometers such as LIGO, VIRGO, and GEO600, as well as the space-based LISA. Observing these sources with gravitational wave detectors requires that we know the radiation waveforms they emit. And, when the black holes merge in the presence of gas and magnetic fields, various types of electromagnetic signals may also be produced. Sincethese mergers take place in regions of extreme gravity, we need to solve Einstein's equations of general relativity on a computer. For more than 30 years, scientists have tried to compute black hole mergers using the methods of numerical relativity. The resulting computer codes have been plagued by instabilities, causing them to crash well before the black holes in the binary could complete even a single orbit. Within the past few years, however, this situation has changed dramatically, with a series of remarkable breakthroughs. This talk will focus on new simulations that are revealing the dynamics and waveforms of binary black hole mergers,and their applications in gravitational wave detection, testing general relativity, and astrophysics.

*Reasearch supported in part by NASA grant 06-BEFS06-19. Calculations performed on Discover at NASA/GSFC and Pleiades at NASA/AMES.

Session JA: HS/Introductory College

Location: Maryland A
Sponsor: Committee on Physics in Undergraduate Education
Date: Wednesday, Feb. 17
Time: 11 a.m.–12:36 p.m.

Presider: TBA

JA01: 11–11:12 a.m. Faculty Experiences with Research-based Instructional Strategies: Preliminary Interview Findings

Melissa H. Dancy, Dept. of Natural Sciences, JC Smith University, Charlotte, NC 28216; mhdancy@jcsu.edu

Charles Henderson, Western Michigan University

Chandra Turpen, University of Colorado - Boulder

During the fall of 2009, we conducted interviews with more than 70 physics faculty across the United States. Interviewees were from a group of over 700 faculty who had previously answered an online survey. Interviewees were selected to represent a range of institution types (two- year colleges, bachelor degree granting institutions, and graduate degree granting institutions) and reported knowledge and use of research based-instructional strategies. Questions focused on their experiences with research-based instructional strategies. We report preliminary findings from these interviews.

JA02: 11:12–11:24 a.m. Freshmen at the Forefront of Research Through an Integrative Quantitative Science Program

Mirela S. Fetea, University of Richmond, Richmond, VA 23173; mfetea@richmond.edu

Important questions at the forefront of 21st century science lie at the nexus of traditional disciplinary boundaries. Exploring this uncharted intellectual territory requires a new type of scientist who is familiar with the various ways of thinking and conversant in the language used by each of today's scientific disciplines. Our Integrative Quantitative Science program (IQS) for first-year students addresses this need. Ten faculty from five departments team teach the two-semester course (beginning with fall of 2009) that was developed as part of a year-long faculty seminar. IQS integrates the introductory courses in biology, chemistry, computer science, calculus, and physics and includes an entirely new set of discovery-oriented laboratory experiences in the context of antibiotic resistance and cell signaling. Seventy-eight students applied for the 20 available slots. Details on the progress of this course, cornerstone in our recent HHMI grant will be presented.

JA03: 11:24–11:36 a.m. The Implementation of a Global Laboratory at SUNY Oswego

Shashi M. Kanbur, State University of New York at Oswego, Oswego, NY 13126; shashi.kanbur@oswego.edu

Deborah Stanley, Lorrie Clemo, Mary Canale, and Cleane Medeiros, SUNY Oswego

SUNY Oswego, the largest comprehensive liberal arts college in the SUNY system is instigating a global laboratory experience for its undergraduates: students, mainly from underrepresented groups in the

STEM fields will be able to undertake a meaningful research experience of six to eight working at research-driven institutions on one of any number of continents outside the United States. This will give the students a significant research and cultural experience. This experience will be privately funded and intended for bright students from financially disadvantaged backgrounds who might not otherwise have considered a college education as a viable option. Some of the laboratory experiences could include robotic telescope software development in Brazil, wetlands ecology in Brazil, Molecular Biophysics at the Indian Institute of Science, diabetes research in the Congo, Astrophysics in Taiwan, and biofuel research in Brazil. In this talk, we describe these scholarships in greater detail.

JA04: 11:36–11:48 a.m. Integrating Lecture and Laboratory in Introductory Physics

Ntungwa Maasha, College of Coastal Georgia, Brunswick, GA 31520-3644; nmaasha@ccga.edu

Educational research indicates that effective learning of introductory physics is enhanced by active engagement of the learner. To implement some of the best practices in teaching introductory physics at the College of Coastal Georgia, it was decided to integrate lecture and laboratory activities. In this paper I discuss the steps we took to transition from teaching the introductory calculus-based physics course where the laboratory and lecture sessions were done separately to teaching the course by integrating lecture and laboratory.

JA05: 11:48 a.m.–12 p.m. Service-Learning Outreach Activities as a Tool for Enhancing Undergraduate Learning

Alice M. Hawthorne Allen, Concord University, Athens, WV 24712-1000; amhallen@concord.edu

Outreach opportunities serve to enhance undergraduate learning in multiple ways. These include: 1) low-stress, high-impact opportunities to share student content knowledge; 2) a chance to gain confidence communicating their excitement about science, and 3) a method of increasing awareness in current and future students about the availability of undergraduate research opportunities. Short, single-day outreach programs are open ended in their possibilities. In fall 2009, students in my Introductory Astronomy course offered several outreach workshops for small groups of children between the ages of 3 and 17, as part of an internal grant to incorporate a service-learning opportunity into introductory courses. The success and short-term impact of these opportunities will be presented.

JA06: 12–12:12 p.m. Service-Learning Physics Labs with Elementary-School Outreach

CANCELED

Carolyn D. Sealfon, West Chester University of Pennsylvania, West Chester, PA 19383; csealfon@wcupa.edu

Katalin Grubits, Marymount Manhattan College

We present two service-learning course models in which non-major physics students teach basic physics concepts to elementary-school students. In one model, college students visit and teach in an elementary school classroom; in the other, college students design and implement hands-on activities at an after-school program. Such course structures promote student understanding, motivation, and confidence in communicating scientific ideas, while also benefiting the community. We summarize the logistics, successes, and lessons learned from each pilot course.

JA07: 12:12–12:24 p.m. Putting Energy and the Environment into Physics

S. Hakan Armagan, Burke High of Omaha Public Schools, Omaha, NE 68154; hakan.armagan@ops.org

As our country and the world face an energy crisis and greenhouse gas effects, I have developed a course called Energy and Nuclear Science to educate our youth on the importance of knowing all energy resources. The course fills the gap between the physical sciences and real world problems and issues. The course begins with energy basics, thermodynamics, and electricity. We delve into population growth and energy demand. Students then learn about current energy resources, both renewable and nonrenewable. Afterward, the students learn about nuclear science and its various applications ranging from nuclear power to nuclear medicine. Throughout the course, pros and cons of all the energy resources and their impacts on the environment are examined. It is hoped that, after exposure to this course, students will make more informed decisions about our country's energy future. I will share my experiences of teaching this course for the past three years.

JA08: 12:24–12:36 p.m. Inquiry-based Front Ends for Conventional Textbook Topic Treatments

David Schuster, Western Michigan University, Kalamazoo, MI 49008; david.schuster@wmich.edu

Science is not just a body of knowledge to be learned. Yet students would be forgiven for thinking it was, going by most mainstream physics textbooks. Topics are typically presented as a "rhetoric of conclusions,." The end-product physics facts, principles, and formulas are provided up front, to be applied to end-of-chapter problems. We illustrate with a topic treatment from a high-adoption physics textbook. Such approaches do not reflect the nature of scientific inquiry nor the intellectual achievement of discovering the principles. Note that National Science Education Standards advocate inquiry-based science instruction throughout K-12 education, while at the college level the curriculum reforms of the 1960s and beyond take an inquiry approach. But little of this is reflected in conventional textbooks. What to do, other than writing your own? One way to go is to devise inquiry-based front-ends for each topic in a prescribed textbook. We illustrate by showing how to rescue the epistemologically and pedagogically challenged treatment of refraction in Serway.

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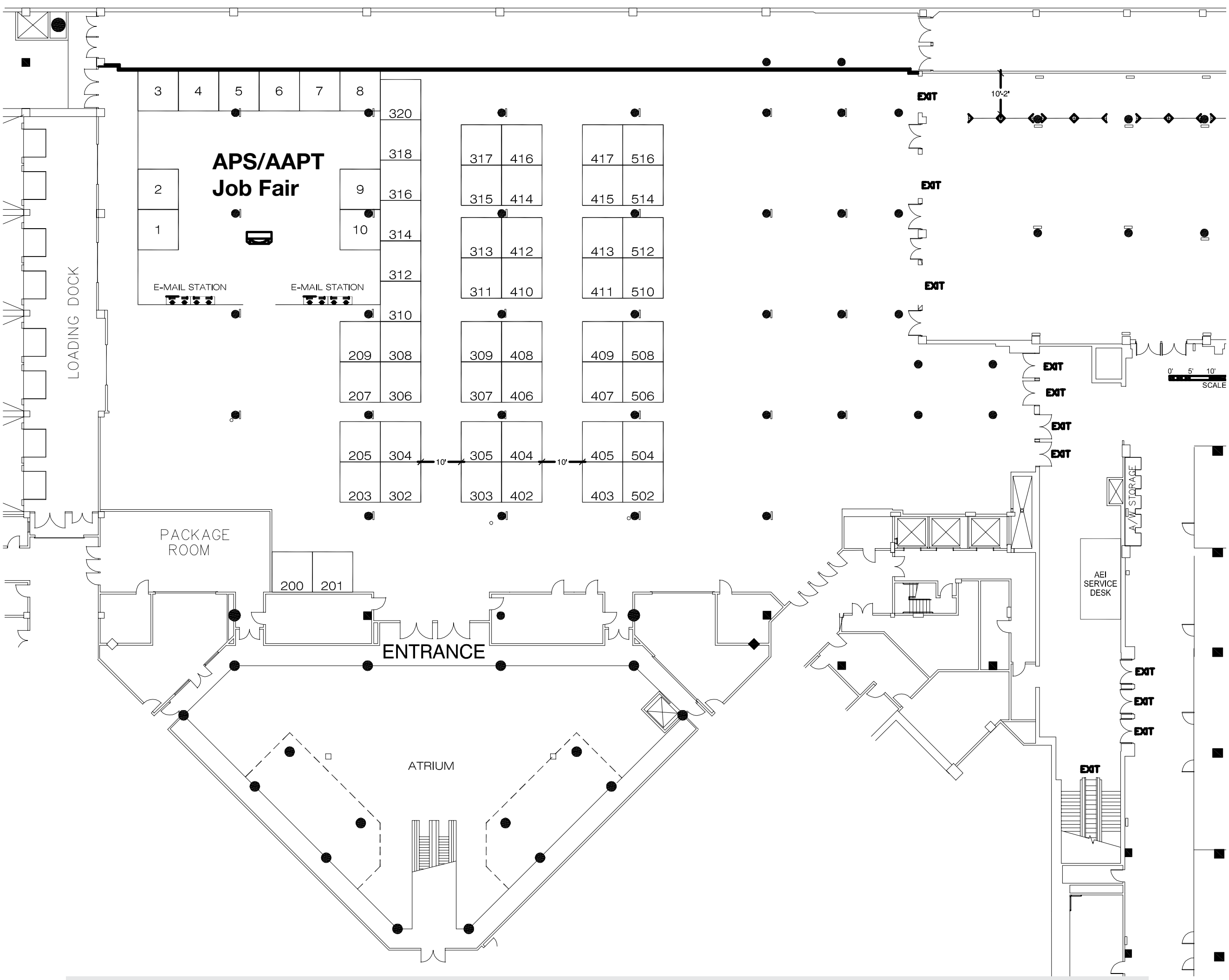

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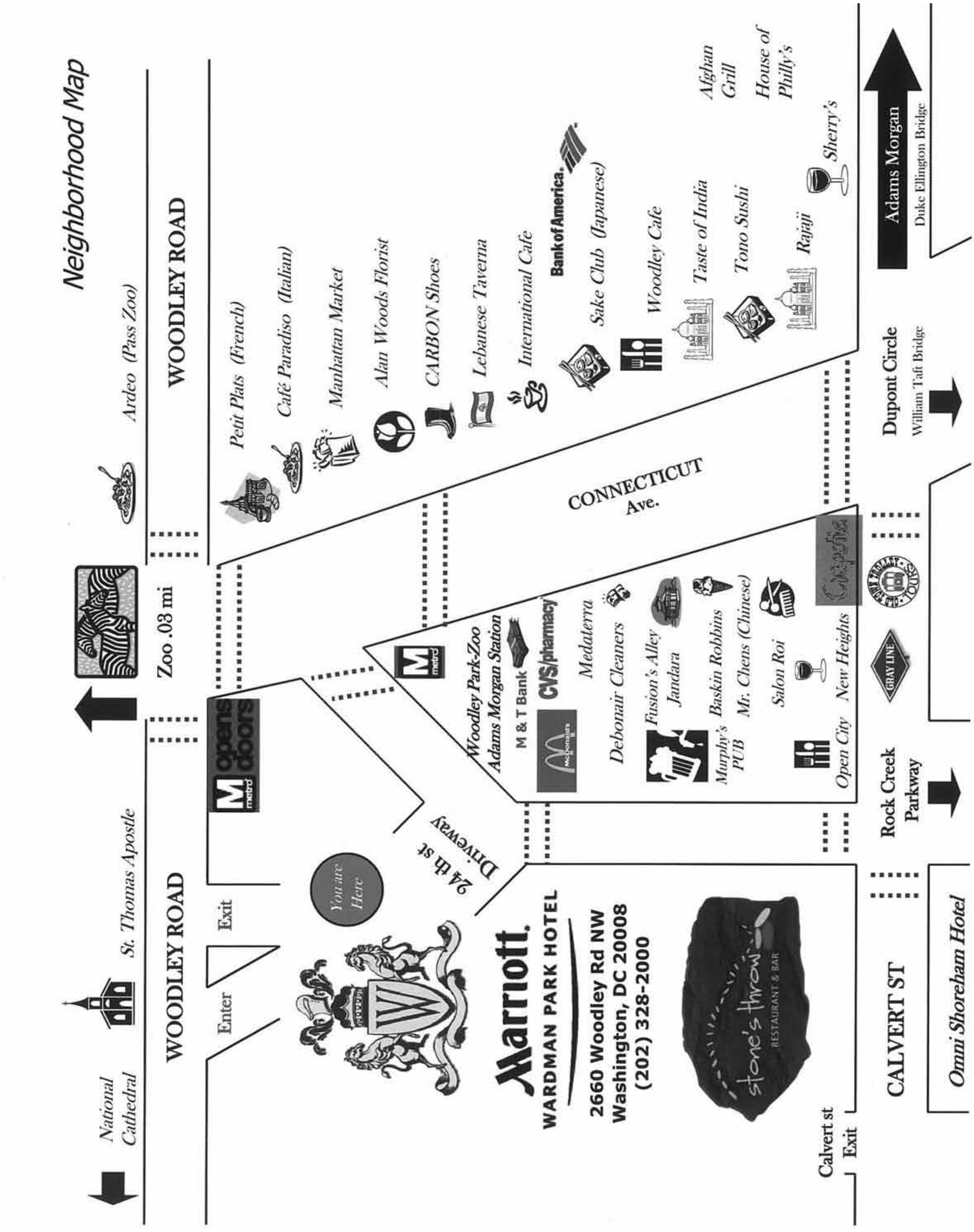
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