AAPT 2009

Winter Meeting

February 12–16, 2009

Chicago, Illinois

In conjunction with AAAS Annual Meeting

AAPT
PHYSICS EDUCATION

American Association of Physics Teachers
One Physics Ellipse
College Park, MD USA 20740-3845
301-209-3300, fax: 301-209-0845
meetings@aapt.org, www.aapt.org

Meeting Information 4
Bus Schedule/information 6
Welcome to Chicago 8
First Time at a Meeting 10
Special Events 11
Committee Meetings 12
Exhibitor Information 14
Commercial Workshops 19
Awards/Plenaries 20
Session Finder 22
Meeting at a Glance 25
Workshops 29
SESSION ABSTRACTS
- Friday 36
- Saturday 38
- Sunday 63
- Monday 90

Index of Contributors 104
Our Donors 107
Index of Advertisers 107
Map of Exhibit Hall 108

Welcome to Chicago!

Beyond the standard committee meetings, exhibits, and ceremonial sessions, the Chicago AAPT meeting offers a rich spectrum of invited and contributed sessions, posters, workshops, crackerbarrels, and plenaries on disciplinary and interdisciplinary topics ranging from exciting new areas of contemporary research through the substance of what we teach at all levels to the history of physics, uses of technology, and recent research in physics education. In addition, we are having our meeting in conjunction with AAAS, whose symposia and special events span all sciences, and those who register with either organization will be welcome at a large fraction of the events arranged by the other.

While a single theme would be difficult to identify for any AAPT meeting, we have, at this meeting, taken particular pains to highlight the contributions of Chicagoans to physics research and teaching. To that end, we have arranged a workshop at the Chicago Museum of Science and Industry (W08), field trips to Fermilab, invited talks by several Fermilab researchers (DA and NA), a session on the Manhattan project (LJ), a panel on the Illinois State Physics Project (LG), a panel on physics first (KA), several posters highlighting projects by Chicago-area high school students (PST1), a session (OG) in which Chicago-area high school teachers provide take-home demonstrations, a session (OH) in which you can view prize-winning demonstrations developed by students at Glenbrook South High School, a Share-A-Thon arranged largely by teachers in Chicago schools, and a demo show featuring particularly Chicago-area teachers. There is also a session (OC) on the International Year of Astronomy designed to whet your appetite for the fuller recognition that will be part of the 2009 summer meeting.

In an effort to respond to those who have expressed concerns over the attention given to posters at past meetings, each poster in sessions PST1 and PST2 will be on display for a full day, and at least 1.5 hours of unopposed time for posters has been distributed throughout each day. So that some presenters may visit with other presenters, those with odd-numbered posters will be at their posters during half of the unopposed time, and those with even-numbered posters will be at their posters during the other half of that time.

In the past six months, I have been made acutely aware that putting together the schedule of an AAPT meeting provides a challenge not unlike that posed by a Jackson Pollock puzzle, and complete elimination of conflicts is almost certainly impossible. The program sorters (Shannon Mandel, Michelle Strand, Charles Henderson, and Gordon Ramsey), AAPT staff in the Programs and Conferences Dept. (Tiffany Hayes, Cerena Cantrell, Janet Lane, Natasha Randall, and Annette Coleman), and I regret any conflicts that remain. At the same time, those who worked with me on this monumental task deserve deep appreciation for their diligence and creativity in solving the scheduling puzzle as fully as they have. The AAPT area chairs and committee members and all the presenters and presiders also deserve sincere thanks for their contributions to assuring a varied, full, and valuable meeting.

Enjoy the meeting and—time permitting—Chicago! I am confident your challenge will be much less in finding interesting things to do than in deciding which of several compelling but conflicting events will be of greatest value to you.

David M. Cook
Vice President and Program Chair
Lawrence University
Appleton, WI

Special Thanks:

AAPT thanks the following persons for their outstanding dedication and selfless contributions to the Winter Meeting:

Paper Sorters: Shannon Mandel, Michelle Strand, Gordon Ramsey, and Charles Henderson.

Our local organizers: Gordon Ramsey (Loyola University) and Samuel Dyson (Walter Payton College Preparatory H.S.)

Fermi Lab's: Spencer Pasero, of the Education Office in the Workforce Development and Resources Section at Fermilab, who helped in identifying speakers for the two sessions about research at Fermilab and also who arranged the two field trips to Fermilab.!

Speaker-Ready Room

There will be a Speaker Ready room located in the Hyatt, **Grand Suite 3.** Participants should take their presentations there to prepare for the sessions.

The hours are:

Thurs., Feb. 12: 7 a.m–6:30 p.m.
Friday, Feb. 13: 7 a.m.–6:30 p.m.
Saturday, Feb. 14: 7 a.m.–6:30 p.m.
Sunday, Feb. 15: 7 a.m.–6:30 p.m.
Monday, Feb. 16: 7 a.m.–12 p.m.

Resource Room for Registrants with Disabilities

Hyatt Regency, East Tower, Blue Level, Skyway Conference Center, Room 282

Thurs, Feb. 12: 12–5:30 p.m.
Fri, Feb. 13: 8–5:30 p.m.
Sat, Feb. 14: 8–5:30 p.m.
Sun, Feb. 15: 8–5:30 p.m.
Mon, Feb. 16: 8 a.m.–12 p.m.

Mobility assistance will be provided on request for persons with disabilities within and outside the conference facilities.

Call the AAPT Registration desk at the Hyatt, 312-239-4820, for information.

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TeachSpin Inc
Tel-Atomic Inc
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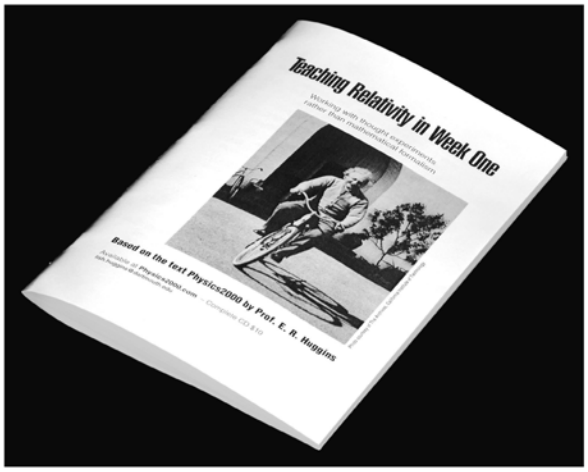
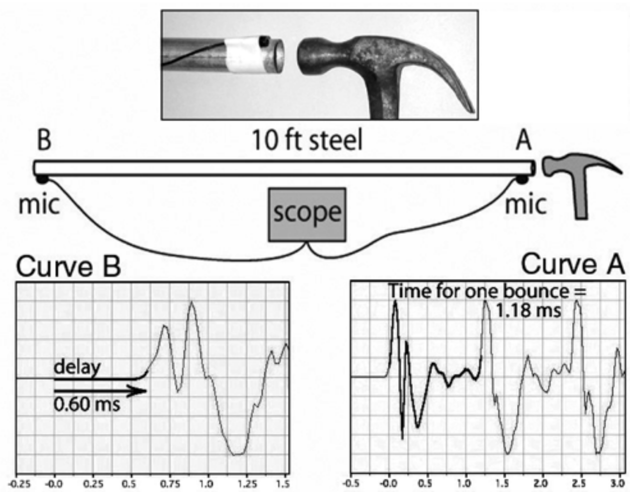
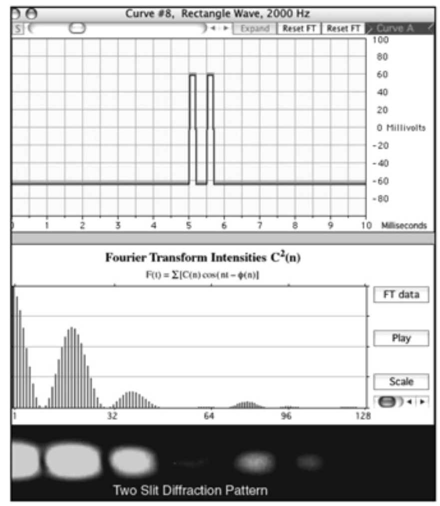
Free Workshop: Physics2000.com



Come to the popular Physics2000 workshop where you learn how to include 20th 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**.



Speed of Sound in a Steel pipe
Using MacScope's stereo input, we find that a sound pulse travels down a 10 ft. (3.048m) steel pipe in .60 milliseconds. We get about the same speed for a compressional pulse in a fine steel guitar string. (See TPT, Jan. 2008 and Mar. 2008.)

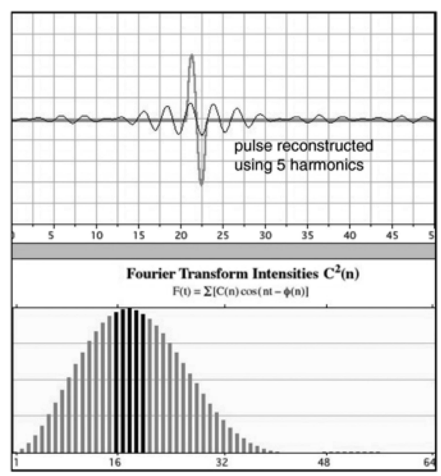


Fourier Optics
The Fourier transform of a slit structure is proportional to the diffraction pattern produced by the slits. (See TPT Sept. 2007.)

As calculus is the backbone of classical physics, **Fourier analysis** plays a similar role in understanding **quantum mechanics**. We wrote the free audio oscilloscope program **MacScope II** (for Mac & Windows) to make it easy to use Fourier analysis in your introductory physics course. In the workshop we will show you how to use MacScope to measure the speed of sound in a steel pipe, study Fourier optics, and teach the time-energy form of the uncertainty principle.

The workshop is more than free—attendees receive complimentary copies of the Physics2000 CD and volumes I & II of Physics2000.

HRC Stetson Suite F, Saturday, Feb. 14, 3:30 p.m.



Uncertainty Principle
Using MacScope's pulse Fourier transform, we study the harmonic structure of a short pulse. (See TPT, Jan. 2007.)

Bus Schedule to Workshops and Fieldtrips

**All buses will load outside the Crystal Ballroom Foyer, located in the Hyatt Regency's West Tower*

Date: Thursday, February 12, 2009

- 7:15 a.m. – Bus departs Hyatt Hotel to Walter Payton College Prep for Workshops
- 7:30 a.m. – Bus departs Hyatt Hotel to Walter Payton College Prep
- 8 a.m. – Bus departs Hyatt Hotel to Fermilab for Fieldtrip
- 8:25 a.m. – Bus departs Hyatt Hotel to Walter Payton College Prep
- 12:15 p.m. – Bus departs Walter Payton College Prep, returning to the Hyatt Hotel
- 12:15 p.m. – Bus departs Hyatt Hotel to Walter Payton Prep
- 5 p.m. – Bus departs Fermilab, returning to the Hyatt Hotel
- 5:15 p.m. – Buses depart Walter Payton College Prep, returning to the Hyatt Hotel

Date: Friday, February 13, 2009

- 7:15 a.m. – Bus departs Hyatt Hotel to Walter Payton College Prep for Workshops
- 7:30 a.m. – Bus departs Hyatt Hotel to Walter Payton College Prep
- 8 a.m. – Bus departs Hyatt Hotel to Fermilab for fieldtrip
- 8:30 a.m. – Bus departs Hyatt for Walter Payton College Prep
- 8:30 a.m. – Bus departs to the Chicago Museum of Science and Industry for Workshop 08
- 9:30 a.m. – Bus departs Hyatt Hotel to the Walter Payton College Prep
- 12:15 p.m. – Bus departs Walter Payton College Prep, returning to the Hyatt Hotel
- 12:30 p.m. – Bus departs Chicago Museum of Science and Industry, returning to the Hyatt
- 12:15 p.m. – Bus departs Hyatt Hotel to Walter Payton College Prep for Workshops
- 5 p.m. – Bus departs Fermilab, returning to the Hyatt Hotel
- 5:15 p.m. – Buses depart Walter Payton College Prep, returning to the Hyatt Hotel

Watch for our Cyber Cafe:

to be located in the Exhibit Hall during regular Exhibit Hall hours! (Friday, 11–6; Saturday, 10–6; and Sunday, 10–5)

Lodging Information

Hyatt Regency Chicago
151 East Wacker Drive
Chicago, IL 60601
Telephone: (312) 565-1234
Fax: (312) 239-4414
Group Rate: $183 single, $208 double
Parking: Overnight - $48

The Fairmont Chicago
200 North Columbus Drive
Chicago, IL 60601
Telephone: (312) 565-8000
Fax: (312) 856-1032
Group Rate: $175 single/double
Parking: Overnight - $49

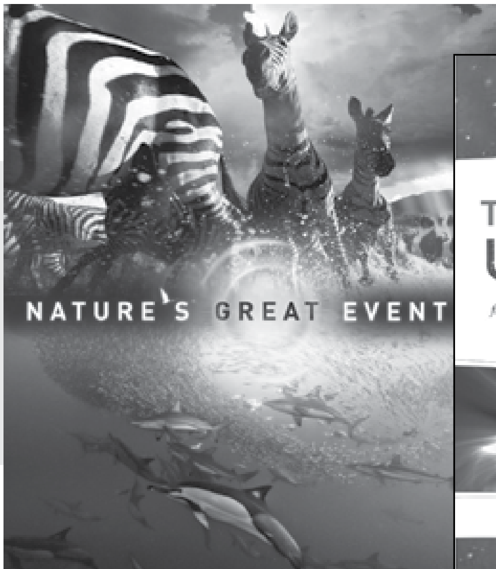
Hyatt Regency Chicago

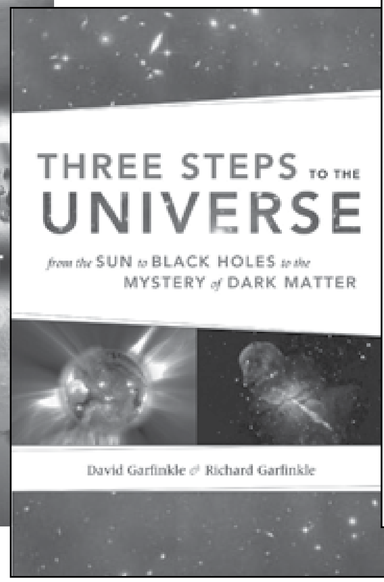

The Fairmont Chicago

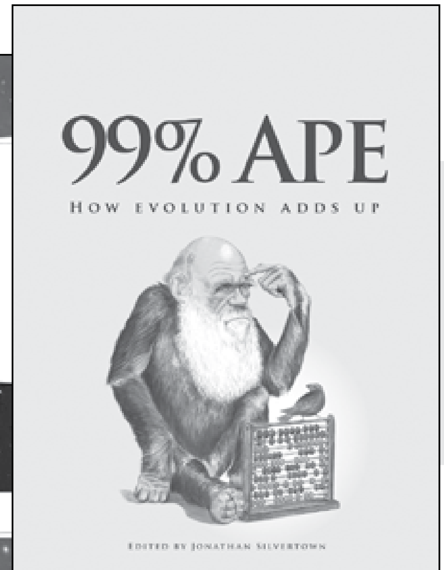
AAPT Programs and Conferences team!

Contact: Tiffany Hayes, Cerena Cantrell, Natasha Randall, Janet Lane, Annette Coleman, 301-209-3340; meetings@aapt.org
or at the Registration desk at the Hyatt, 312-239-4820 (Feb. 11–16, 2009)

SCIENCE *New from Chicago*







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Welcome to the Windy City!

Chicago, "Chi-town," is the largest city in the Midwest and the third largest in the United States. Adjacent to Lake Michigan, "Chicagoland" has a population of more than 9.7 million people in three states—Illinois, Wisconsin, and Indiana.

History

Chicago was founded in 1833 near a portage between the Great Lakes and the Mississippi watershed. With just 350 people that year, it grew rapidly to over 4000 in 1837. It soon became a transportation hub for the country, with rail and water lines. In 1871, most of the city burned in the **Great Chicago Fire**. 300 people died, 18,000 buildings were destroyed, and nearly 100,000 of the city's 300,000 residents were left homeless. The fire led to the incorporation of stringent fire-safety codes that included a strong preference for masonry construction.

Chicago accepted immigrants from eastern Europe from the end of the Civil War through the end of the First World War, as well as thousands of African Americans coming north in the Great Migration, starting in 1910. During its first century as a city, Chicago grew at a rate that ranked among the fastest growing in the world. Within 40 years, the city's population grew from slightly under 30,000 to over 1 million by 1890.

Chicago became notorious worldwide for its violent gangsters in the 1920s, most notably Al Capone, and for its political corruption in one of the longest tenures of political machinery in the United States. The city has long been a stronghold of the Democratic Party and has been home to numerous influential politicians, including the new president of the United States, Barack Obama.

Education

There are 680 public schools, 394 private schools, 83 colleges, and 88 libraries in Chicago proper. Since the 1890s, Chicago has been a world center in higher education and research. There are three universities in or immediately adjoining the city—Northwestern University, DePaul University, and the University of Chicago—which are among the top echelon of doctorate-granting research universities. Prominent Catholic universities in Chicago include Loyola University and DePaul University. The city also has a large community college system known as the City Colleges of Chicago.

Also, Fermilab is located in Batavia, IL, about 45 miles west of Chicago.

Things to do in Chicago:

• *Adler Planetarium & Astronomy Museum*

Opened in 1930 as the first planetarium in this hemisphere, the museum includes new exhibits, state-of-the-art computer technology, and planetarium theaters including the Universe Theater. 1300 S. Lake Shore Dr.

• *Sears Tower Skydeck*

Breathtaking 360 degree views from the tallest building in the Western Hemisphere. Take the new Acoustiguide Skylights tour – just add $5.50 to your visit. 233 S. Wacker Dr.

• *Hancock Building Observatory*

94 stories up high—walk along the edge and feel the air in your hair—there's no glass but there is a stainless steel screen to protect you. 875 N. Michigan Ave., 1-888-875-VIEW (8439).

• *Chicago Museum of Science and Industry*

Many many exhibits including Networld, Imaging, The Whispering Gallery, and Omnimax Theater. 5700 S Lake Shore Dr., 773-684-1414. Print a 2-for-1 coupon on our website, www.aapt.org.

• *The Art Institute of Chicago*

The Art Institute of Chicago holds one of the world's great art collections. 111 S. Michigan Ave., 312-443-3600

• *Navy Pier*

Navy Pier showcases a unique collection of restaurants and shops in addition to unequaled recreational and exhibition facilities. The Family Pavilion is anchored by the 50,000-square-foot Chicago Children's Museum and Navy Pier's 440-seat IMAX Theater. It is also home to 40,000 square feet of exciting restaurants and retail shops. 600 E. Grand Ave. 312-595-PIER

Traveling to Chicago:

AAPT Conference attendees may take advantage of a 5% discount on American Airlines, American Eagle and AmericanConnections. You must reference the promotion code A3429AN.

By Air:

• **Midway Airport** is located 10 miles from downtown Chicago. During rush-hour travel times can take up to 45 minutes. The cost of taking a taxi between Midway and downtown is approximately $28-$32.

• **O'Hare International Airport** is located 13 miles from downtown Chicago. During rush-hour travel times can take approximately one hour. The cost of taking a taxi between O'Hare and downtown varies from $30-$50, depending on travel time.

By Train:

Amtrak offers long-distance services to and from Chicago's Union Station via New York, Seattle, New Orleans, San Francisco, Los Angeles, and Washington, D.C. Amtrak also provides a number of short-haul services throughout Illinois and toward nearby Milwaukee, Indianapolis and Detroit.
Phone: 800-872-7245

By Bus:

Greyhound Lines, Inc., is the largest provider of intercity bus transportation, serving more than 2,300 destinations with 13,000 daily departures across North America.
Phone: 800- 231-2222.

Rental Car Information:

With great discounts and the highest levels of service, there has never been a better reason to rent with Avis! For an AAPT discount on a car rental, visit the Avis Car Rental website and reference the promotion code J945158.

Ground Transportation:

• Go Airport Express: 888-284-3826 or visit: www.airportexpress.com/shuttles/shuttle-faq.html

• Public Transit: The Chicago Transit Authority (CTA) offers direct train service from both airports to downtown. The CTA is also an effective way to move around the city. A one-way ticket is $2. Daily and weekend passes are available. For route, fare, and schedule information, call 312-836-7000 every day from 5 a.m. to 1 a.m. (CT) or go to: http://www.transitchicago.com

First Time at an AAPT Meeting?

Welcome to the Chicago AAPT Winter Meeting! 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 that you can talk to and share experiences with. This is especially true during lunch and dinner.

- Area Committee meetings are not only for members of the committee but also for friends of the committee. You are welcome to attend any Area Committee meeting. You should be able to find one or two committees that match your interests. Their meeting times are listed in 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 Timer's Gathering. 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. Their talks are longer and go into some depth. Posters, which will be up all day and at which presenters will be stationed during times indicated in the schedule, and 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. Crackerbarrels provide an opportunity for informal discussion with those interested in the announced topic.

- 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.

AAPT
PHYSICS EDUCATION

Special Events
2009 Winter Meeting

Thursday, Feb. 12:

–Fermi Lab Field Trip
9 a.m.–5 p.m.

Friday, Feb. 13:

–Fermi Lab Field Trip
9 a.m.–5 p.m.

–Exhibit Show
11 a.m.–6 p.m.
Hyatt, Riverside Center

–Chicago Museum (W08)
9 a.m.–12 p.m.
Chicago Museum of Science & Industry

–Demo Show
8–9 p.m.
Hyatt, Crystal B

–AAPT Welcome Dessert
9–10 p.m.
Hyatt, Crystal Foyer

Saturday, Feb. 14:

–Breakfast for Retirees
7–8 a.m.
Fairmont, Regal

–First Timers Gathering
7–8 a.m.
Fairmont, State

–Exhibit Show
10 a.m.–6 p.m.
Hyatt, Riverside Center

–AAPT Richtmyer Memorial Award Plenary
Rotating Galaxies and Dark Matter
Vera Rubin, Carnegie Institution of Washington
9–10 a.m.
Fairmont, Imperial Ballroom

–Spouses' Gathering
10–11 a.m.
Hyatt, Monarch Ste., E. Tow., 34th fl.

–Young Physicists' Meet and Greet
12–1:30 p.m.
Fairmont, Crystal

–AAPT Plenary/AAAS Symposium
Exciting Research at Fermilab
Speakers: Niki Saoulidou, Rob Roser, Michael Crisler
1:30–3 p.m.
Fairmont, Imperial Ballroom

–AAPT Oersted Medal Plenary
The History and Fate of the Universe
George F. Smoot III, Lawrence Berkeley Laboratory and University of California, Berkeley
8–9 p.m.
Hyatt, Regency A

Sunday, Feb. 15:

–Breakfast for 2-Year College Faculty
7–8 a.m.
Fairmont, Embassy

–Exhibit Show
10 a.m.–5 p.m.
Hyatt, Riverside Center

–Multicultural Luncheon
12–1:30 p.m.
Fairmont, Regal

–Great Book Giveaway
4–5 p.m.
Hyatt, Riverside Center

–AAPT Symposium
Early High School Physics
Panel, Leon Lederman
1:30–3:30 p.m.
Fairmont, Imperial Ballroom

Monday, Feb. 16:

–AAPT and AIP Awards
2:30–4 p.m.
Hyatt, Grand Ballroom EF

–Plenary: Dark Matter in the Lab.
11:30 a.m.–12:30 p.m.
Hyatt, Grand Ballroom EF

Committee Meetings

Thursday, February 12

Area Chairs Orientation	1–4:30 p.m.	Hyatt, Comiskey
Investment Advisory Committee	3:30–4:30 p.m.	Hyatt, Columbus AB

Friday, February 13

Publications Committee	7:30–10:30 a.m.	Fairmont, Gold
Meetings Committee	7:30–10:30 a.m.	Hyatt, Board of Trade Room
Resource Letters Editorial Board	11:30 a.m.–2:30 p.m.	Hyatt, Board of Trade Room
Nominating Committee I	3:30–5 p.m.	Hyatt, Skyway 260
Programs Committee I	3:30–5:30 p.m.	Fairmont, Moulin Rouge
SI Units & Metric Educ. Committee	5:30–7 p.m.	Hyatt, Skyway 260
PTRA Advisory Committee	5:30–7:30 p.m.	Hyatt, Water Tower
Review Board	5:30–7 p.m.	Hyatt, Picasso
Section Officers Exchange	5:30–6:30 p.m.	H-Crystal A
Section Representatives	6:30–8 p.m.	H-Crystal A

Saturday, February 14

Physics Bowl Advisory Committee	7–8:30 a.m.	Fairmont, Embassy
Graduate Education Committee	7–8:30 a.m.	Fairmont, Ambassador
Minorities in Physics Committee	7–8:30 a.m.	Fairmont, Regent
Educational Technologies Committee	7–8:30 a.m.	Fairmont, Chancellor
Membership and Benefits Committee	7–8:30 a.m.	Fairmont, Crystal
PERTG	7– 8:30 a.m.	Hyatt, Crystal A
RQEHSPT	7–8:30 a.m.	Hyatt, Board of Trade Room
Bauder Fund	12–1:30 p.m.	Hyatt, Board of Trade Room
Undergraduate Education Committee	12–1:30 p.m.	Fairmont, Chancellor
International Education Committee	12–1:30 p.m.	Fairmont, Regent
Science Education for the Public	12–1:30 p.m.	Fairmont, Ambassador
Committee on Governance Structure	12–1:30 p.m.	Hyatt, Picasso
Women in Physics Committee	12–1:30 p.m.	Fairmont, International Ball.
AAPT Council Meeting	4–5:30 p.m.	Fairmont, Embassy

Sunday, February 15

Research in Physics Education (RiPE)	7–8:30 a.m.	Fairmont, Ambassador
Laboratories Committee	7–8:30 a.m.	Fairmont, State
Professional Concerns Committee	7–8:30 a.m.	Fairmont, Gold
Teacher Preparation Committee	7–8:30 a.m.	Hyatt, Crystal A
Pre-High School Committee	7–8:30 a.m.	Fairmont, Regal
History and Philosophy Committee	7–8:30 a.m.	Hyatt, Crystal C
High School Committee	12–1:30 p.m.	Fairmont, Crystal
Two Year College Committee	12–1:30 p.m.	Fairmont, Regent
Apparatus Committee	12–1:30 p.m.	Fairmont, Moulin Rouge
Awards Committee	12–1:30 p.m.	Fairmont, Embassy
Space Science & Astronomy Committee	12–1:30 p.m.	Fairmont, Gold
Interest of Senior Physicist Committee	12 –1:30 p.m.	Fairmont, State

Monday, February 16

Programs Committee II	7–9 a.m.	Hyatt, Skyway 260
Nominating Committee II	7–9 a.m.	Hyatt, Water Tower
Lotze Scholarship Committee	7:30–8:30 a.m.	Hyatt, Gold Coast

Please note: The time and place for meetings of the Audit, Finance, and Venture Fund Committees will be arranged by the chairs of those committees.

Exhibitor Information

Booth #305, 307, 309

American Association of Physics Teachers

1 Physics Ellipse
College Park, MD 20740
mlapps@aapt.org
www.aapt.org; www.compadre.org

comPadre: Booth 303

Visit the AAPT booth to see our line of physics toys and gifts, first-time books from our Physics Store Catalog, new and favorite discounted T-Shirts, and Member-Only merchandise. These items will be available to order at the booth. Pick up copies of AAPT's informational brochures on some of the leading physics education programs such as PTRA and Physics Olympiad. Free 2008 AAPT High School Physics Photo Contest Winners posters. Find out about some fun online physics demos and lessons from comPADRE.

AAPT Shared Books

Browse through featured titles from many publishers. The Great Book-Giveaway will be held Sunday at 4 p.m. when the books are raffled off. Get raffle tickets at the AAPT booth before Sunday at 4 p.m.

Booth #308, 310

American Physical Society

One Physics Ellipse
College Park, MD
301-209-3244
plisch@aps.org
www.aps.org

The American Physical Society has free resources for every teacher! Visit the booth to register for our middle school science adventure, adopt physicists for your high school class, learn about minority scholarships, talk with an editor of the peer-reviewed journal *Physics Education Research*, pick up free posters, and much more.

Booth # 109

American 3B Scientific

2189 Flintstone Dr., Ste O
Tucker, GA 30084-5023
678-405-5606
adamwaterson@a3bs.com
www.a3bs.com

Outfit your Physics Laboratory with quality 3B lab supplies and equipment.The 3B Physics shop has a wide variety of unique and innovative items for teaching the physical sciences and performing compelling classroomdemonstrations of the physical principles of our universe.

Booth #317

Arbor Scientific

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734-477-9370
scott@arborsci.com
www.arborsci.com

Tools that teach physical science, physics, and chemistry are on display. Try the most fascinating, dynamic, hands-on methods to demonstrate the key concepts outlined in our state standards. Preview the latest software for physics and chemistry.

Booth #314

Brooks/Cole Cengage Learning

10 Dans Dr.
Belmont, CA
650-637-7569
sarah.miskelly@cengage.com
www.cengage.com

Brooks/Cole, a part of Cengage Learning, can't wait to show you our hot-off-the press, first-edition text, *College Physics: Reasoning and Relationships*, by award-winning physicist Nicholas J. Giordano. Visit us at booth 314 to see this text along with our complete physics front list and demos of our technology solutions.

Booth #306

CiSE

One Physics Ellipse
College Park, MD
301-209-3043
alcolema@aip.org
www.computer.org/cise

Computing in Science and Engineering (CiSE) magazine is a joint publication of the IEEE Computer Society and the American Institute of Physics. It covers computational science and engineering research for a broad range of technical fields.

Booth #103

CPO Science, School Specialty Science

80 Northwest Blvd.
Nashua, NJ
603-579-3467
drivard@delta-edu.com
www.cposcience.com

CPO Science focuses on educators, so educators can focus on achievement by providing high-quality, inquiry-based teaching and learning systems for science, in grades 6-12. CPO offers innovative science textbook programs (that integrate the student text, teacher support materials, and lab equipment), and nationally recognized professional development programs.

Booth #318

Design Simulations Technologies

43311 Joy Rd.
Canton, OH
734-446-6935
alan@design-simulation.com
www.design-simulation.com

Design Simulation Technologies develops physics-based simulation software that is used by students, educators, and engineers. Interactive Physics is used by more than 13,000 schools worldwide to teach and experience the concepts of physics. Working Model 2D is used by universities for teaching about kinematics, dynamics, and machine design and also by professional engineers for simulating the performance of their designs. Dynamic Design Motion is used by CAD designers and engineers to evaluate the performance of their CAD designs before prototype parts are built.

Booth #211, 213

Educational Innovations, Inc.

362 Main Ave.
Norwalk, CT
203-229-0730
info@teachersource.com
www.teachersource.com

Educational Innovations, Inc.—teacher owned and operated! Committed to bringing you SUPER, WOW, NEAT! science supplies, guaranteed to make your colleagues, students, or grandkids sit up and take notice! Our products bring out the scientist in everyone—we Make Science Sizzle!

Booth #201

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H-ITT is the next generation in Classroom Response Systems offering both IR and RF systems priced to fit any school's budget without sacrificing quality. With a Classroom Response System from H-ITT you get VALUE, RELIABILITY, USER FRIENDLY OPERATIONS, and FREE SOFTWARE.

Booth #205

Jet Propulsion Laboratory

4800 Oak Grove Dr.
Pasadena, CA
818-393-1397
charmaine.d.mayes@jpl.nasa.gov
www.jpl.nasa.gov

Managed by the California Institute of Technology (Caltech), JPL builds and operates unmanned spacecraft for the National Aeronautics and Space Administration (NASA). Among its current projects are the Cassini-Huygens mission to Saturn, the Mars Exploration Rovers (Spirit and Opportunity), the Mars Reconnaissance Orbiter, and the Spitzer Space Telescope.

Booth #202

Johns Hopkins University Center for Talented Youth

McAuley Hall
5801 Smith Ave., Ste 400
Baltimore, MD 21209
410-735-4100

The Johns Hopkins University Center for Talented Youth matches bright students and talented teachers in three-week summer residential and day programs throughout the United States and the world. We seek outstanding instructors to work with a variety of courses in physics, astronomy and engineering.

Booth #319

McGraw-Hill Higher Education

501 Bell St.
Dubuque, IA
800-553-4920
mary_donnelly@mcgraw-hill.com
www.mhhe.com

McGraw-Hill Higher Education offers a wide variety of solutions for your many course needs including: Astronomy, University Physics, College Physics, Physical Science, and Conceptual Physics. To learn more about how we can help you and your students be more successful, stop by booth #319.

Booth #301

Modus Medical Devices, inc.

781 Richmond St.
London, ON Canada
519-438-2409
ryarnell@modusmed.com
www.modusmed.com

Modus, a leading manufacturer of radiotherapy quality assurance equipment, presents VISTA™ Ed, a cone beam optical CT scanner designed for teaching computed tomography in the classroom. VISTA Ed invokes the same physical principles as X-Ray CT imaging using light photons instead of X-Ray photons, allowing students to fully investigate the physics and technology of computed tomography. The scanner also comes with several laboratory guides that have been developed for student experiments to demonstrate medical imaging physics.

Booth #113, 115

PASCO scientific

10101 Foothills Blvd.
Roseville, CA
800-772-8700
most@pasco.com
www.pasco.com

Please visit the PASCO booth to see our new Structures System for building and testing bridges. Also see PASCO's new curved dynamics track, ideal for making hills for Conservation of Energy. We also have a new Function Generator which has more features for a lower cost.

Booth #102, 200

Pearson

1 Lake St.
Upper Saddle River, NJ
201-236-5887
megan.lisi@pearson.com
www.pearsonhighered.com

As the number one publisher in physics and astronomy, with market-leading textbooks and the most widely used and most educationally proven physics homework, tutorial and assessment system available, our goal is to partner with instructors, authors, and students to create content and tools that take the educational experience forward.

Booth #310

Physics Teacher Education Coalition

One Physics Ellipse
College Park, MD
301-209-3273
plisch@aps.org
www.ptec.org

The Physics Teacher Education Coalition has the goal of improving the education of future physics teachers. We will provide information on membership, conferences, and resources for physics teacher education.

Booth #315

Physics2000.com

29 Moose Mt. Lodge Rd.
Etna, NH
603-643-2877
Lish.huggins@dartmouth.edu
www.physics2000.com

Come by the Physics2000.com exhibit booth for copies of our *The Physics Teacher* articles on using the free MacScopeII audio oscilloscope to teach and use Fourier analysis in an introductory physics course. We present the Physics2000 text that starts with Special Relativity and comfortably includes 20th century physics in an introductory course.

Booth #414

Qwizdom, Inc.

12617 Meridian East
Puyallup, WA
253-845-7738
jean@qwizdom.com
www.qwizdom.com

Qwizdom combines standards-based RF technology with online assessment, curriculum, and content-sharing software to provide a complete instructional solution for the classroom. The Interactive Learning System includes student remotes and the Q7, a full functioning tablet, allowing teachers to control student response system features, viewresponse data, and more.

Booth #416

Sargent-Welch (Cenco Physics)

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716-874-9093
sdoak@sciencekit.com
www.sargentwelch.com

Combining world-class quality and innovation, CENCO Physics strives to deliver ground-breaking physics equipment and experiments designed for student use. Each apparatus and activity is designed to meet exacting standards of precision and accessibility. Exceedingly accurate in demonstrating core physics principles, CENCO Physics products are also the most conducive for classroom and laboratory use.

Booth #311

SENSR

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Elkader, IA
565-245-3200
rg@sensr.com
www.sensr.com

Bringing the World into the Classroom. The Sensr GP1 and GP2x are 3-axis acceleration recording instruments that let you monitor and evaluate dynamic environments. They record and characterize: motions, vibrations, bumps, shocks, impacts, free-falls, attitude changes, tipping and temperature. Measuring and Recording Dynamic Motion has never gotten EASIER.

Booth #312

Society of Physics Students

One Physics Ellipse
College Park, MD
301-209-3008
lquijada@aip.org
www.aip.org/education/sps/

SPS is the Society of Physics Students along with the associated honor society of physics, Sigma Pi Sigma. Through its donors, and through its parent organization, the American Institute of Physics (AIP), SPS supports scholarships, research awards, physics project awards and outreach awards for undergraduates. SPS supports a Summer Science Research Clearinghouse, where thousands of summer research positions are listed, at www.the-nucleus.org , as part of the physics digital library ComPADRE.

Booth #207

Space Telescope Science Institute

3700 San Martin Dr.
Baltimore, MD
410-338-4857
slalbert@stsci.edu
http://hubblesource.stsci.edu

NASA's Hubble Space Telescope and the other Great Observatories science missions have forever altered our understanding of space and our place in it. Museum and planetarium audiences can now join these great journeys of celestial exploration as never before. The Office of Public Outreach at Space Telescope Science Institute, home of the Hubble, offers ViewSpace, an exhibit program that transforms a display hall or planetarium lobby into a constantly updated kaleidoscope of inspiring astronomy and earth science presentations. ViewSpace uses an internet-connected PC and a large-format screen to show multimedia educational programs that combine beautiful, high resolution images, digital movies, animations, interpretive text and evocative music. Find us at http://hubblesource.stsci.edu.

Booth #316

Spectrum Techniques

106 Union Valley Rd.
Oak Ridge, TN
sales@spectrumtechniques.com
www.spectrumtechniques.com

Spectrum Techniques is the premier manufacturer of nuclear measuring instruments and accessories for education. Products range from simple Geiger Counters to advance Gamma Ray Spectrometers combined with an extensive line of license exempt radioisotope sources. Instruments can be operated as stand-alone or connected to Windows computers making them well suited for classroom demonstration. We offer complete solutions to meet your nuclear science requirements.

Booth #212

TeachSpin

2495 Main St.
Buffalo, NY
716-885-4701
breynolds@teachspin.com
www.teachspin.com

TeachSpin's hands-on instructional apparatus will intrigue and challenge your students with both classic and modern explorations that can yield research grade data. Come see the three new instruments in action. With the new Pulsed NMR we can study fluorine as well as proton NMR and even "see" inequivalent protons! The Torsional Oscillator offers explorations of harmonic motion that are visible, tangible, accessible, and measurable. From introductory measurements of torsion constants and moments of inertia to varied damping systems and sophisticated forms of driven oscillation, the data from this apparatus is so embarrassingly good that your students will just have to believe the math. Quantum Analogs—acoustic experiments modeling quantum phenomena—Come play with the world's largest "hydrogen atom." First find the frequencies that correspond to the quantum states of a "real" hydrogen atom and then create plots that match the textbook pictures of individual orbitals. Students can also investigate bonding/anti-bonding in hydrogen molecules and a wide variety of semiconductor band gaps.

Booth #404

TEL-Atomic

P.O. Box 924
Jackson, MI
517-783-3039
telatomic@mindspring.com
www.telatomic.com

On exhibit, the TEL-X-Ometer for performing x-ray diffraction experiments, now equipped with computer control for automatic operation. In addition, a compact, computerized Cavendish Balance featuring a 24 bit capacitive sensor largely insensitive to pendulous modes of oscillation will be demonstrated. An easy to set up cloud chamber which operates without dry ice will also be shown.

Booth #313

The Science Source

299 Atlantic Hwy.
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207-832-8344
paul.rogers@thesciencesource.com
www.thesciencesource.com

For over 35 years Daedalon has manufactured quality upper-level apparatus for teaching physics in high school and college. Working under the parent company The Science Source, we are the exclusive U.S. dealer for PHYWE Systeme, the largest manufacturer of educational scientific apparatus in Germany.

Booth #214

Vernier Software & Technology

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503-277-2299
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Vernier Software & Technology has been producing data collection hardware and software for 28 years. Stop by our booth to see what is new. Also enter to win your own LabQuest or Wireless Dynamic Sensor System.

Booth #111

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W.H. Freeman works with instructors, authors, and students to enhance the physics teaching and learning experience. W.H. Freeman will be demonstrating PhysicsPortal, a comprehensive learning resource containing a media-enhanced eBook, interactive conceptual resources, branched tutorials, video analysis exercises, and a powerful assessment manager featuring integrated WebAssign questions. Go to www.whfreeman.com/physics to learn more.

Booth #218

W.W. Norton & Company

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The oldest and largest publishing house owned wholly by its employees, W. W. Norton & Company, Inc. publishes about 400 trade, college, and professional titles each year.

Booth #304

WebAssign

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www.webassign.net

WebAssign, the premier online homework, quizzing, and testing system, continues to have all of the features you want. Access questions from all major physics and astronomy textbooks, or write your own. Check out our latest offerings with assignable simulations, assignable examples with basic and specific feedback. Give partial credit with conditional weighting. Give group assignments.

Booth #206, 208

Wiley

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kgreiner@wiley.com
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Founded in 1807, John Wiley & Sons, Inc. provides must-have content and services to customers worldwide. Its core businesses include scientific, technical, and medical journals, encyclopedias, books, and online products and services; professional and consumer books and subscription services; and educational materials for undergraduate and graduate students and lifelong learners.

Commercial Workshops

CW01: And You Thought It Was About Homework–The Way You Imagined Teaching Could Be™

Sponsor: WebAssign
Date: Friday, Feb. 13
Time: 12–1:30 p.m.
Room: Hyatt Stetson Suite G

Help your students learn with WebAssign. Find out what's new. WebAssign, the premier online homework, quizzing, and testing system, continues to have all of the features you want and includes content from all major publishers. Access questions from all major physics and astronomy textbooks, or write your own. Check out our latest offerings with assignable simulations, assignable examples with content-specific hints and feedback, more online components and tutorials—all specific to your textbook. Give partial credit with conditional weighting. Assign practice questions. Give group assignments. Select questions for your assignments knowing how difficult each question is and how many students have tried it before. Prepare your students for labs and collect their lab data, analysis, and reports—all using WebAssign. Streamline your work flow with WebAssign. It is easy to use, reliable, and helps you stay connected, your way. Quickly access student responses, view item analysis for each question, communicate using class forums. Find out how to integrate WebAssign with Blackboard, Shibboleth, D2L, and other registration systems. Over 1 million students have successfully used WebAssign.

CW02: Measuring the Charge to Mass Ratio of an Electron, It's Back to the Classic WL0623

Sponsor: Cenco Physics
Date: Friday, Feb. 13
Time: 5–6:30 p.m.
Room: Hyatt Stetson Suite F

Come to our workshop and perform the classic e/m experiment, using state-of-the-art equipment. The experts at Cenco have brought back the classic e/m apparatus that has the largest magnetic field and bulb in the industry. Come give the experiment a text run before anyone else. In this hands-on workshop participants will set up and perform the e/m experiment and verify the e/m ratio. At the end of the session there will be multiple give-aways, including gift certificates and different apparatus.

CW03: Physics2000.com – Free Workshop

Sponsor: Physics2000.com
Date: Saturday, Feb. 14
Time: 3:30–5 p.m.
Room: Hyatt Stetson Suite F

Physics2000.com is a college-level introductory physics course developed at Darmouth College that begins with special relativity, ends with quantum mechanics, and in-between covers the usual topics with a 20th Century focus. The approach eliminates the great divide between classical and modern physics. If you visit our exhibit booth we will show you how to use our powerful yet free MacScope II laboratory oscilloscope program (works on Windows, too) to teach Fourier analysis and the time-energy form of the uncertainty principle. We will also try to convince you to attend our workshop where you will receive a free copy of the CD version and the printed version of the Physics2000 text.

CW04: Race into Physics with CPO Science Energy Car

Sponsor: CPO Science
Date: Saturday, Feb. 14
Time: 12–1:30 p.m.
Room: Hyatt Stetson Suite G

Presenter: Erik Benton - Subject to change
Grades: 6-12
Science Area – Chemistry/Physics Science
National Standards Focus: Science Content Standards

Explore the concepts of speed, velocity, and acceleration. Make studying friction and momentum simple. Check out Newton's laws, use the law of conservation of energy, and calculate work done with our inquiry-based investigations that are integrated with student reading text and our unique Teacher's Guide to offer both students and teachers a complete hands-on learning experience with CPO's exciting Car.

CW05: Circular Motion and the Loop Track—How DOES that Marble Stay on the Track?

Sponsor: CPO Science
Date: Sunday, Feb. 15
Time: 8–9:30 a.m.
Room: Hyatt Stetson Suite E

Presenter: Erik Benton- Subject to change
Grades: 6-12
Science Area – Physics/Physical Science
National Standards Focus: Science Content Standards

Why don't you fall off of a coaster track when it turns you upside down? Can you really calculate the speed of an object looping the loop based on just the radius of the track? We can! Come explore circular motion, centripetal force, and centripetal acceleration with our looping coaster track. Calculate the speed of a rolling steel marble with photogates and our CPO Timer 3. Come see observation, calculation, and formula deviation mesh together with CPO's loop track.

CW06: Medical Imaging Physics- Vista - Cone Beam Optical CT Scanner

Sponsor: Modus Medical Devices
Date: Saturday, Feb. 14
Time: 4–5:30 p.m.
Room: Hyatt Stetson Suite E

Presenter: John Miller

The last few decades have seen rapid growth in the use of X-Ray Computed Tomography (CT) in health care. Widespread use and rapid innovation in CT have contributed to the need for improved training for physicists and related health-care professionals. The physical principles of Computed Tomography (CT) are difficult to demonstrate in a teaching environment. Most CT Scanners are dedicated medical systems in regular clinical use— this limits access for education. Furthermore, the use of X-Rays and the complexity of the controls on medical CT scanners limit the ability of students to interact with the scanner and to investigate relationships between acquisition and reconstruction parameters and the resultant CT image. The Vista - Cone Beam Optical CT Scanner invokes the same physical principles as X-ray CT imaging using light photons not X-Ray photons. Several laboratories have been developed to demonstrate medical imaging physics. In this workshop we will demonstrate some of the capabilities of the Vista Scanner and discuss the content of prepared student labs. Scanner demonstrations will include:

a) *Acquisition* – projection images (analogous to digital radiography) of a translucent object, detector characteristics, multiple projection angles for CT, fan, and cone angles.

b) *Image Review* – pretreatment of images for CT reconstruction, filtering, sinograms, corrections for scattering.

c) *Reconstruction* – Feldkemp back-projection, image resolution, and voxel dimensions, data management.

d) *3D Image* – interact with the reconstructed image, artefacts, dynamic range.

Awards

Hans Christian Oersted Medal

George F. Smoot III, Lawrence Berkeley Laboratory
and University of California, Berkeley
The History and Fate of the Universe

Saturday, February 14, 8-9 p.m.; Hyatt, Regency A


George F. Smoot III

George Smoot has done forefront work in cosmology using microwave radiation detectors in airplanes, high-altitude balloons, and satellites. He is best known for his analysis of data gathered by the COBE satellite. His differential microwave radiometer enabled him to detect temperature differences as small as 0.001 K. His work provided the first evidence of structure in the early Universe and smaller ripples in the temperature of the cosmic background radiation, consistent with Big Bang theory. For his major findings, George Smoot shared, with John Mather, the 2006 Nobel Prize in Physics. His *Wrinkles in Time: Witness to the Birth of the Universe*, co-authored with Keay Davidson, provides many details about his scientific journey.

Floyd K. Richtmyer Memorial Award

Vera Rubin, Carnegie Institution of Washington
Rotating Galaxies and Dark Matter

Saturday, February 14, 9-10 a.m.; Fairmont, Imperial Ballroom

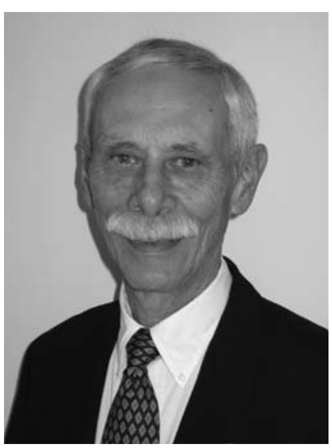

Vera Rubin

Vera Rubin's pioneering work in astronomy on rotation rates of dozens of galaxies has shown that this velocity does not decrease at large distances from the galactic center. A decrease would be expected if the center-seeking force were due to the gravitational pull of the galaxy's luminous matter. This led to the conclusion that the universe contains copious amounts of "dark matter" that was heretofore undetected. In 1993 Vera Rubin received the National Medal of Science, the United States' highest scientific award, for her pioneering research...which demonstrated that much of the matter in the universe is dark. In 1996, Vera Rubin authored the book *Bright Galaxies Dark Matters (Masters of Modern Physics)*.

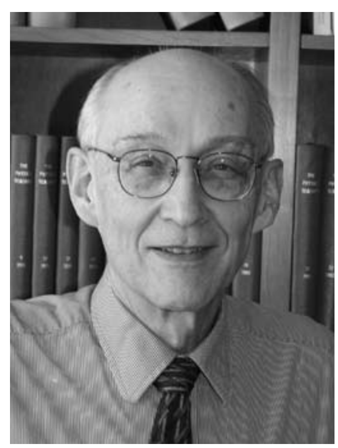
Distinguished Service Citations

Monday, February 16, 2:30–4 p.m.; Hyatt Regency, Grand Ballroom EF

Paul Hickman has had a distinguished career as an optical engineer, a high school physics teacher and associate professor of education. His long years of service to AAPT include leadership in PTRA, PhysTEC, the Teacher Preparation Committee, and being the first recipient of AAPT's Excellence in Pre-College Physics Education award.


Paul Hickman

Charles Holbrow, Dana Professor of Physics Emeritus at Colgate University and Adjunct Professor at MIT, has had a distinguished career as a physics teacher, textbook author, nuclear physics researcher, and physics historian. He served as Associate Editor of *Physics Today*, AAPT President, AAPT Senior Staff Physicist, and AAPT Interim Executive Officer.


Charles Holbrow

Distinguished Service Citations (continued)

Bob Shurtz has been a distinguished physics teacher at the Hawken School for many years, and served as Academic Director of the U.S. Physics Olympiad Team. Other service to AAPT includes PTRA work, being Ohio Section President, and chairing the High School Committee. His many awards include the Tandy Prize.

Bob Shurtz

Gary White is Director of the Society of Physics Students and Sigma Pi Sigma, and Assistant Director of the Education Division of the American Institute of Physics. Prior to his post at AIP, he taught at Northwestern State University, where he was voted Outstanding Teacher of the Year in 1996.

Gary White

Courtney Willis teaches at the University of Northern Colorado, after a distinguished career as a high school teacher. He served as AAPT Examinations Director, Chair of the High School Committee, presented at AAPT workshops, contributed frequently to *The Physics Teacher,* and served as President and Secretary-Treasurer of the Colorado-Wyoming Section.

Courtney Willis

Plenaries

Saturday, February 14, 1:30–3 p.m.; Fairmont, Imperial Ballroom
AAPT Plenary/AAAS Symposium
Exciting Research at Fermilab
David Cook presiding and co-organized by Gordon Ramsey
Speakers
Niki Saoulidou of the Particle Physics Division/Neutrino Dept. at Fermilab will speak about Neutrino Physics
Rob M. Roser of the Particle Physics Division/CDF/Physics at Fermilab will speak on collider physics
Michael B. Crisler of the PPD/Experimental Physics Projects/Astrophysics at Fermilab will speak about WIMPs

Sunday, February 15, 1:30–3:30 p.m.; Fairmont, Imperial Ballroom
AAPT Plenary
Early High School Physics: Building a Foundation for Understanding the Sciences
Panel Moderator Leon Lederman has worked tirelessly to raise awareness for what he calls a potential revolution in science education. He wants Physics First efforts that preserve the integrity of the three core disciplines while connecting them to form a coherent high school science sequence.
Panelists
– **Paul Hickman,** a longtime physics teacher and Physics First advocate, will set the stage for the discussions with an overview of this movement to reorder the traditional high school science sequence.
– **Marsha Rosner** studies how biochemical signals promote the growth, differentiation or death of cells. She will share her thoughts about how physics can support understanding in high school biology and chemistry.
– **Ron Kahn,** a former award winning physics teacher, will speak to the statewide efforts initiated by Rhode Island's Governor Donald Carcieri. The project seeks to implement an improved science sequence in Rhode Island's high schools.
– **Gabriel de la Paz,** an active high school physics teacher, will speak to the A-TIME for Physics First statewide partnership effort in Missouri. He serves as a peer teacher for professional development efforts.
– **Corinne Williams,** who is now an Assistant Superintendent at a local area school system, will share some data, observations and thoughts from her doctoral work on Physics First.
– **John Hubisz,** who just completed a review of textbooks appropriate for Physics First, will speak to the instructional materials available to support early high school physics courses.

Monday, February 16, 11:30 a.m. - 12:30 p.m.; Hyatt Regency, Grand Ballroom EF
AAPT Plenary
Dark Matter in the Laboratory
Joseph Lykken, Fermilab

2:30–4 p.m.
AAPT Awards & Presidential Transfer – Passing of the gavel from Lila Adair to Alex Dickison.

Saturday, Feb. 14, 2009 – Session Finder

	H- Crystal Ballroom Foyer	F- Imperial	F- Ambassador	F- Regent	F- Chancellor	H- Crystal A	H- Regency C	H- Crystal C	H- Grand C North	F- State	F- Regal	F- Embassy	H- Columbus AB	H- Columbus CD	H- Columbus EF	H- Columbus GH	H- Columbus IJ	H- Columbus KL	H- Grand A	H- Grand B	H- Grand C North	H- Grand E	H- Regency A
8:00 a.m.	Poster Session I																						
8:30 a.m.																							
9:00 a.m.		**AA** Richtmyer Award																					
9:30 a.m.																							
10:00 a.m.			**BA** Nuclear & Particle Physics	**BB** Frontiers in Space Science	**BC** PER in High Schools	**BE** Teacher Preparation		**BF** *Panel:* STEM Instruction															
10:30 a.m.									**BG** (Joint w/ AAAS) Women in Physics														
11:00 a.m.																							
11:30 a.m.							**BD** Physics & Society																
12:00 p.m.										**CA** *Crk. Brl.* PER Faculty	**CB** *Crk.* Grad. Students	**CC** *Crk. Brl.* TYC											
12:30 p.m.																							
1:30 p.m.		**DA** Plenary: Fermilab Research (Joint w/ AAAS																					
2:00 p.m.																							
3:00 p.m.																							
4:00 p.m.																							
5:45 p.m.													**EA** SPS Research & Outreach	**EB** Women & Minorities	**EC** Capstone Experiences	**ED** *Panel:* Computation in Undergrad Physics	**EE** Teaching with Technology	**EF** Unconventional Labs	**EG** Innovations in Biophysics	**EH** Simulating the Universe on your Computer	**EI** Materials Research-Grad. Students Talk to Teachers	**EJ** Astronomy Labs & Projects	
6:00 p.m.																							
6:30 p.m.																							
7:00 p.m.																							
7:15 p.m.																							
8:00 p.m.																							**FA** Oersted Award
8:30 p.m.																							
8:45 p.m.																							
9:00 p.m.																							

Sunday, Feb. 15, 2009 – Session Finder

	F-Ambassador	H-Crystal Ballroom Foyer	H-Columbus EF	F-Regent	F-Gold	F-Moulin Rouge	H-Crystal A	H-Crystal C	F-State	F-Chancellor	H- Gold Coast	F-Imperial	H-Columbus AB	H-Columbus CD	H-Grand A	H-Columbus EF	H-Columbus GH	H-Columbus IJ	H-Columbus KL	H-Grand B	H-Grand C North	H-Grand D North
7:00 a.m.		Poster Session II																				
7:30 a.m.																						
8:00 a.m.																						
8:30 a.m.	**IA** Teach-Physics Around World		**HB** Disci-plined-Based Sci. Educ. Research (Joint w/ AAAS)	**IB** Astro. Educ. Research	**IH** PER Around the World	**II** *Panel:* Educ. Tech.																
9:00 a.m.							**IE** Particle Physics in High School	**IF** Role of Comm. Colleges	**IG** Support for Novice Teachers													
9:30 a.m.																						
10:00 a.m.						**IJ** Inter-active Lectures				**ID** Advanced Labs												
10:30 a.m.																						
11:00 a.m.																						
11:30 a.m.																						
12:00 p.m.	**JB** *Crk. Brl.* Interna-tional Issues									**HA** *Crk. Brl.* PER Solo Faculty	**JA** *Crk. Brl.* Phys. & Society											
12:30 p.m.																						
1:00 p.m.																						
1:30 p.m.												**KA** *Sympos-ium:* Early High School Physics										
2:00 p.m.																						
2:30 p.m.																						
3:00 p.m.																						
3:30 p.m.																						
6:00 p.m.													**LA** Project-based Physics	**LB** Upper-Level Curric.		**LD** College Labs & Curric-ulum	**LF** Good Teach-ing Ideas	**LG** *Panel:* Ilinois State Physics Project	**LH** H.S. Peda-gogies Based on PER			
6:30 p.m																						
7:00 p.m.															**LC** Energy & the Environ-ment							
7:30 p.m.																						
8:00 p.m.																				**LI** Teacher Prep-araton	**LJ** Legacy of the Manhat-tan Proj.	**LK** PER: Problem Solving
8:30 p.m.																						
9:00 p.m.																**LE** Educ. Technologies						
10:00 p.m.																						

Key: H = *Hyatt Regency* F = *Fairmont Chicago*

	H-Skyway 260	H-Water-Tower	H-Comiskey	H-Gold Coast	H-Truffles	H-Grand Suite 5	H-Grand Ballroom EF	H-Columbus CD	H-Grand D North				
9:15 a.m.	**MA** PER: Student Under-standing & Scientific Reasoning	**MB** New Ideas for High School Physics	**MC** Use of Tablet PCs in the Undergrad Curriculum	**MD** Assessment of Teacher Preparation	**ME** Researching Use of Clickers in Physics Lectures	**MF** Making Transition from Intro. to Upper-Level Courses							
9:30 a.m.													
10:00 a.m.													
10:30 a.m.													
11:15 a.m.													
11:30 a.m.							**NA** *Plenary:* Dark Matter in the Lab-oratory						
12:00 p.m.													
12:30 p.m.	**OA** PER: Implement-ing Reforms	**OB** Modeling Instruction in Physics Classrooms	**OC** Highlights of the Interna-tional Year of Astronomy 2009	**OD** Educational Technology Demos	**OG** Make & Take Physics Equipment	**OH** Demon-stration Exhibits Created by Students		**OF** Post-Deadline Papers	**OI** Post-Deadline Papers (see Addendum for abstracts)				
1:30 p.m.													
2:00 p.m.													
2:30 p.m.							**PA** *Plenary:* AAPT Awards & Presidential Transfer						
3:00 p.m.													
3:30 p.m.													
4:00 p.m.													

Key: H = *Hyatt Regency* F = *Fairmont Chicago*

Meeting-at-a-Glance

Meeting-at-a-Glance includes sessions, workshops, committee meetings and other events, including luncheons, Exhibit Hall hours and coffee break times, plenary sessions, and receptions. All rooms will be at the Hyatt Regency Chicago (H) or Fairmont Chicago (F). Some workshops will be held offsite at Walter Payton College Preparatory High School.

WEDNESDAY, Feb. 11

6–8 p.m.		Pre-registration Pickup	H-Grand Ballroom Foyer

THURSDAY, Feb. 12

7 a.m.–4:30 p.m.		REGISTRATION	H-Grand Ballroom Foyer
8 a.m.–12 p.m.	W02	InterActions in Physical Science	H-Columbus CD
8 a.m.–5 p.m.	W03	Teaching Physics for the First Time	Walter Payton Prep
8 a.m.–5 p.m.	W11	Research-Based Alternatives to Problem Solving	H-Columbus IJ
9 a.m.–12 p.m.	T02	Seeing the Invisible	H-Columbus EF
9 a.m.–5 p.m.	W12	Developing Physics Teacher Knowledge	H-Columbus KL
9 a.m–5 p.m.		Special Tour of Fermi Lab	Walter Payton Prep
1–4:30 p.m.		Area Chairs Orientation	H-Comisky
3:30–4:30 p.m.		Investment Advisory Committee	H-Columbus AB
1–5 p.m.	W04	NTIPERS: Conceptual Reasoning Tasks for Intro. Mechanics	H-Columbus CD
1–5 p.m.	W06	Inquiry-Based Learning for High School Teachers	Walter Payton Prep
1–5 p.m.	W07	Using Digital Cameras and Tablet PCs to Analyze Motion	Walter Payton Prep
5–10 p.m.		AAPT Executive Board	H-Soldier Field

FRIDAY, Feb. 13

7 a.m.–4:30 p.m.		REGISTRATION	H-Grand Ballroom Foyer
7:30–10:30 a.m.		Publications Committee	F–Gold
7:30–10:30 a.m.		Meetings Committee	H-Board of Trade
8 a.m.–12 p.m.	W01	Improving Student Learning in Your Astronomy Class	H-Haymarket
8 a.m.–12 p.m.	W13	Modeling Mechanics: From Free Fall to Chaos	Walter Payton Prep
8 a.m.–12 p.m.	W14	Physics by Inquiry	H-Water Tower
8 a.m.–5 p.m.	W31	Teaching Astronomy with Technology	H-Picasso
9 a.m.–12 p.m.	W08	Chicago Museum of Science and Industry	Museum
9 a.m.–12 p.m.	T07	A New Model of Instruction for Urban Classroom	Walter Payton Prep
9 a.m.–5 p.m.		Special Tour of Fermi Lab	Walter Payton Prep
10 a.m.–12 p.m.	T04	Civic Engagement and Service Learning: SENCER Project	F-Chancellor
10 a.m.–12 p.m.	T06	ComPADRE	H-Skyway 269
10:45 a.m.–3:30 p.m.		AAPT Executive Board	H-Soldier Field
11 a.m.–5 p.m.		Job Fair Interviews	H-Stetson Suite D
11 a.m.–5 p.m.		Job Fair Booths	H-Grand/Colum. Foyer
11 a.m.–6 p.m.		EXHIBIT SHOW (*coffee break: 3 p.m.*)	H-Riverside Center
11:30 a.m.–2:30 p.m.		Resource Letters Editorial Board	H-Board of Trade
12–1:30 p.m.	CW01	WebAssign Workshop	H-Stetson Suite G
1–5 p.m.	W18	Designing a Diagnostic Learning Environment	Walter Payton Prep
1–5 p.m.	W19	PET and PSET	H-Skyway 273
1–5 p.m	W20	Exploring Beyond the Solar System	H-Haymarket
1–5 p.m.	W22	Tutorials in Introductory Physics	H-Water Tower
1–5 p.m.	W23	Model Building Investigations	Walter Payton Prep
1–5 p.m.	W24	Ben Franklin Is My Lab Partner	H-Wrigley
1–5 p.m.	W25	Underrepresented Groups in Physics	H-Dusable
1–5 p.m.	W26	Open-Source Tutorials: PER-Based Instruction	H-Skyway 269
1–5 p.m.	W27	Math, Science, and Teacher Ed. Faculty Collaboration	H-Skway 272
3:30–5 p.m.		Nominating Committee I	H-Skyway 260
3:30–5:30 p.m.		Programs Committee I	F-Moulin Rouge
5–6:30 p.m.	CW02	Cenco Physics Workshop	H-Stetson Suite F
5:30–6:30 p.m.		Section Officers Exchange	H-Crystal A
5:30–7 p.m.		Review Board	H-Picasso
5:30–7 p.m.		SI Units & Metric Educ. Committee	H-Skyway 260
5:30–7:30 p.m.		PTRA Advisory Committee	H-Water Tower
6:30–8 p.m.		Section Representatives	H-Crystal A
6–8 p.m.		High School Share-A-Thon	H-Crystal C
6–8 p.m.		SPS Poster Reception	H-Crystal Foyer
7:30–9:30 p.m.		REGISTRATION	H-Grand Ballroom Foyer
8–9 p.m.		Demo Show	H-Crystal B
9–10 p.m.		Welcoming Reception	H-Crystal Foyer

SATURDAY, Feb. 14

7–8 a.m.		Retirees Breakfast	F-Regal
7–8 a.m.		First Timers Gathering	F-State
7–8:30 a.m.		Physics Bowl Advisory Committee	F-Embassy
7–8:30 a.m.		Graduate Education Committee	F-Ambassador
7–8:30 a.m.		Minorities in Physics Education	F-Regent
7–8:30 a.m.		Educational Technologies Committee	F-Chancellor
7–8:30 a.m.		Membership and Benefits Committee	F-Crystal
7–8:30 a.m.		PERTG	H-Crystal A
7–8:30 a.m.		RQEHSPT	H-Board of Trade
8 a.m.–7:45 p.m.	PST1	Poster Session I *(all authors present from 8–9 a.m.)*	H-Crystal Foyer
7:30 a.m.–5 p.m.		REGISTRATION	H-Grand Ballroom Foyer
9–10 a.m.		Richtmyer Award Presentation	F-Imperial Ballroom
10–11 a.m.		Spouses' Gathering	H-Monarch Ste., E. Twr., 34th fl.
10–11:30 a.m.	BC	Physics Education Research in High Schools	F-Chancellor
10 a.m.–12 p.m.	BA	Nuclear and Particle Physics	F-Ambassador
10 a.m.–12 p.m.	BB	Frontiers in Space Science and Astronomy	F-Regent
10 a.m.–12:10 p.m.	BE	Interdisciplinary Nature of Teacher Preparation	H-Crystal A
10 a.m.–12 p.m.	BF	Reforming STEM Instruction	H-Crystal C
11:20 a.m.–12 p.m.	BD	Physics and Society	H-Regency C
10 a.m.–4 p.m.		Job Fair Interviews	H-Stetson D
10 a.m.–4 p.m.		Job Fair Booths	H-Grand/Columbus Foyer
10 a.m.–6 p.m.		EXHIBIT SHOW (*coffee break, 3 p.m.*)	H-Riverside Center
10:30 a.m.–12 p.m.	BG	Advancing Women in Physics (***Joint with AAAS***)	H-Grand C North
12–1:30 p.m.	CW04	CPO Science Workshop, Race into Physics	H-Stetson Suite G
12-1:30 p.m.		Bauder Fund	H-Board of Trade
12–1:30 p.m.		Undergrad Education Committee	F-Chancellor
12–1:30 p.m.		International Education Committee	F-Regent
12–1:30 p.m.		Science Education for the Public	F-Ambassador
12–1:30 p.m.		Committee on Governance Structure	H-Picasso
12–1:30 p.m.		Women in Physics Committee	F-International Ballroom
12–1:30 p.m.	CA	Crackerbarrel: Professional Concerns of PER Faculty	F-State
12–1:30 p.m.	CB	Crackerbarrel: Professional Concerns of Graduate Students	F-Regal
12–1:30 p.m.	CC	Crackerbarrel: Two-Year Colleges	F-Embassy
12–1:30 p.m.		Young Physicists Meet and Greet	F-Crystal
1:30–3 p.m.	DA	Exciting Fermilab Research Plenary (***Joint with AAAS***)	F-Imperial Ballroom
3:15–3:45 p.m.	PST1	Poster Session I (*all authors with even numbers present*)	H-Crystal Foyer
3:30–5 p.m.	CW 03	Physics2000.com Workshop	H-Stetson Suite F
4–5:30 p.m.	CW06	Modus Medical Devices Workshop	H-Stetson Suite E
4–5:30 p.m.		AAPT Council Meeting	F-Embassy
5:45–7:15 p.m.	EA	SPS Research and Outreach	H-Columbus AB
5:45–7:25 p.m.	EB	Retaining and Recruiting Women and Minorities in Physics	H-Columbus CD
5:45–7:15 p.m.	EC	Capstone Experiences	H-Columbus EF
5:45–7:15 p.m.	ED	Computation in Undergraduate Physics	H-Columbus GH
5:45–7:25 p.m.	EE	Best Practices for Teaching with Technology	H-Columbus IJ
5:45–7:15 p.m.	EF	Unconventional Labs	H-Columbus KL
5:45–7:15 p.m.	EG	Innovations in Biophysics	H-Grand A
5:45–7:15 p.m.	EH	Simulating the Universe on Your Computer	H-Grand B
5:45–7:15 p.m.	EI	Materials Research: Graduate Students Talk to Teachers	H-Grand C North
5:45–7:15 p.m.	EJ	Astronomy Labs and Projects	H-Grand E
7:15–7:45 p.m.	PST1	Poster Session I (*all authors with odd numbers present*)	H-Crystal Foyer
8–9 p.m.	FA	Oersted Medal Presentation	H-Regency A

SUNDAY, Feb. 15

7–8 a.m.		Breakfast for Two-Year College Faculty	F-Embassy
7–8:30 a.m.		Laboratories Committee	F-State
7–8:30 a.m.		Professional Concerns Committee	F-Gold
7–8:30 a.m.		Research in Physics Education Committee (RiPE)	F-Ambassador
7–8:30 a.m.		Teacher Preparation Committee	H-Crystal A
7–8:30 a.m.		Pre-High School Committee	F-Regal
7–8:30 a.m.		History and Philosophy Committee	H-Crystal C
8 a.m.–7:45 p.m.	PST2	Poster Session II	H-Crystal Foyer
8–8:30 a.m.	PST2	Poster Session II (*all authors with even numbers present*)	H-Crystal Foyer
8–9:30 a.m.	CW05	CPO Science Workshop, Circular Motion and the Loop Track	H-Stetson Suite E
7:30 a.m.–5 p.m.		REGISTRATION	H-Grand Ballroom Foyer
8:30–9:30 a.m.	II	Educational Technology	F-Moulin Rouge
8:30–10:30 a.m.	IA	Teaching Physics Around the World	F-Ambassador
8:30–10:30 a.m.	IB	New Results in Astronomy Education Research	F-Regent
8:30–11:30 a.m.	HB	Disciplined-Based Science Educ. Research (***Joint with AAAS***)	H-Columbus EF
9–10:30 a.m.	IF	Role of Community Colleges in Teacher Preparation	H-Crystal C
9–11 a.m.	IG	Mentoring and Support for Novice Teachers	F-State
9–11:30 a.m.	IE	Particle Physics in High School	H-Crystal A
10 a.m.–12 p.m.	IJ	Interactive Lecture Demonstrations	F-Moulin Rouge
10 a.m.–5 p.m.		EXHIBIT SHOW (*coffee break: 3 p.m.*)	H-Riverside Center
10:15–11:15 a.m.	ID	What Is the Curriculum for the Advanced Labs?	F-Chancellor
11:30 a.m.–12 p.m.	PST2	Poster Session (*all authors with odd numbers present*)	H-Crystal Foyer
12–1:30 p.m.	JA	Crackerbarrel on Physics and Society	H-Gold Coast
12–1:30 p.m.	HA	Crackerbarrel on PER Solo Faculty	F-Chancellor
12–1:30 p.m.	JB	Crackerbarrel on International Issues	F-Ambassador
12–1:30 p.m.		Multicultural Luncheon	F-Regal
12–1:30 p.m.		Exhibitors' Luncheon	H-Grand Suite 5
12–1:30 p.m.		Apparatus Committee	F-Moulin Rouge
12–1:30 p.m.		High School Committee	F-Crystal
12–1:30 p.m.		Awards Committee	F-Embassy
12–1:30 p.m.		Space Science and Astronomy Committee	F-Gold
12–1:30 p.m.		Interest of Senior Physicists Committee	F-State
12–1:30 p.m.		Two-Year College Committee	F-Regent
1:30–3:30 p.m.	KA	AAPT Symposium: Early High School Physics	F-Imperial
4–5 p.m.		Great Book Giveaway	H-Riverside Center
5–6 p.m.	PST2	Poster Session II (*all authors will be present*)	H-Crystal Foyer
6–7 p.m.	LB	Rethinking the Upper-Level Curriculum	H-Columbus CD
6–8 p.m.	IH	PER Around the World	H-Crystal C
6–8 p.m.	LA	Project-Based Physics	H-Columbus AB
6–8 p.m.	LG	Illinois State Physics Project	H-Columbus IJ
6–8 p.m.	LH	High School Pedagogies Based on PER	H-Columbus KL
6–8:40 p.m.	LD	College Labs and Curriculum	H-Columbus EF
6–9:10 p.m.	LF	Good Teaching Ideas	H-Columbus GH
7:15–10 p.m.	LC	Energy and the Environment	H-Grand A
8–10 p.m.	LI	Using Research to Guide Science Teacher Preparation	H-Grand B
8–10 p.m.	LJ	Men and Women of the Manhattan Project	H-Grand C North
8–10 p.m.	LK	PER: Problem Solving in Lectures and Labs	H-Grand D North
9–10 p.m.	LE	Education Technologies in Instruction	H-Columbus EF

MONDAY, Feb. 16

7–9 a.m.		Programs Committee II	H-Skyway 260
7–9 a.m.		Nominating Committee II	H-Water Tower
7:30–8:30 a.m.		Lotze Scholarship Committee	H-Gold Coast
8 a.m.–3 p.m.		REGISTRATION	H-Grand Ballroom Foyer
9:15–11:15 a.m.	MA	PER: Student Understanding and Scientific Reasoning	H-Skway 260
9:15–11:15 a.m.	MB	New Ideas for High School Physics	H-Water Tower
9:15–11:15 a.m.	MC	Use of Tablet PCs in Undergrad Curriculum	H-Comiskey
9:15–11:15 a.m.	MD	Assessment of Teacher Preparation	H-Gold Coast
9:15–11:15 a.m.	ME	Researching Use of Clickers in Physics Lectures	H-Truffles
9:15–11:25 a.m.	MF	Making Transition from Intro. to Upper-Level Courses	H-Grand Suite 5
11:30–12:30 p.m.	NA	Plenary: Dark Matter in the Laboratory	H-Grand Ballroom EF
12:30–2:30 p.m.	OA	PER: Implementing Reforms	H-Skyway 260
12:30–2:30 p.m.	OB	Implementing Modeling Instruction in Physics Classrooms	H-Water Tower
12:30–2:30 p.m.	OC	Highlights of the International Year of Astronomy 2009	H-Comiskey
12:30–2:30 p.m.	OD	Educational Technology Demonstrations	H-Gold Coast
12:30–2:30 p.m.	OG	Make and Take Session	H-Truffles
12:30–2:30 p.m.	OH	Student Demo Session	H-Grand Suite 5
12:30–2:30 p.m.	OF	Post-Deadline Papers	H-Columbus CD
12:50–2:30 p.m.	OI	Post-Deadline Papers (see Addendum for abstracts)	H-Grand D North
2:30–4 p.m.	PA	Awards and AAPT Presidential Transfer	H-Grand Ballroom EF
4:30–9 p.m.		AAPT Executive Board	H-Soldier Field

Workshop Abstracts

THURSDAY, February 12, 2009

W02: InterActions in Physical Science

Sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–12 p.m. Thursday
Member Price: $60 **Non Member Price:** $85
Location: Hyatt, Columbus CD

Robert H. Poel, 3140 Wood Hall, Western Michigan University, Kalamazoo, MI 49024; 269-387-3336; bob.poel@wmich.edu

InterActions in Physical Science is an NSF-supported, standards-based, quided inquiry physical science curriculum that was built using the research on the teaching and learning of science. In this workshop, participants will be introduced to the InterActions curriculum, experience several activities, watch and analyze video from InterActions classrooms, and work through part of the professional development materials that support teachers and help students do inquiry at the middle-school level. Emphasis will be placed on how these materials can be used to help students understand the nature of scientific inquiry and how scientists make and support their claims. Time will also be scheduled to discuss strategies of how to engage pre-high school students in interactive learning environments.

W03: Teaching Physics for the First Time

Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Thursday
Member Price: $80 **Non Member Price:** $100
Location: Walter Payton College Prep

Jan Mader, 1900 2nd Ave., S., Great Falls, MT 59405; 406-268-6388; jan_mader@gfps.k12.mt.us

Mary Winn, 2623 Watrous Ave., Tampa, FL 33629; 813-254-3852; winnmmw@aol.com

With the decline in the number of physics graduates who enter the teaching profession, many teachers are assigned to teach physics and physical science with little or no formal preparation. *Teaching Physics for the First Time* is designed to provide the novice and experienced instructor who has been assigned physics or physical science with a standards and benchmark-correlated learning cycle curriculum. Examples of lesson plans, lab activities, demonstrations and sample assessments for core topics from kinematics to magnetism will be presented.

W09: Cantilevers and Nanotech

Cancelled

Sponsor: Committee on Physics in Two-Year Colleges
Co-Sponsor: Committee on Physics in High Schools
Time: 8 a.m.–5 p.m. Thursday
Member Price: $65 **Non Member Price**: $95
Location: Walter Payton College Prep

Matthias W. Pleil, Manufacturing Training and Technology Center (MTTC), 800 Bradbury SE, Suite 235, Albuquerque, NM 87106; 505-272-7157; mpleil@unm.edu

The simple cantilever is not only a commonly observed system in our everyday life, but also a key component in many Micro and Nano-based sensor and actuator systems. These applications range from the atomic force microscope and nano-enabled micro cantilever sensing arrays to physical memory storage devices able to store terabytes of data on a square inch platform. The experiment presented in this workshop is intended to provide a means of cross-linking many STEM disciplines in a hands-on learning environment. Students discover how to acquire time-dependent position data, calibrate, graph, and analyze to determine the natural frequency of a system as mass is added. From this experience, students then discover how to engineer the system resonance frequency by adjusting the material and geometric specifications. Once these concepts are understood, the students can extrapolate down to the micro and nano scale and review current micro/nano-technology applications. Laptop and digital camera will enhance your experience at this workshop.

W10: Physics: Understanding by Design

Sponsor: Committee on Physics in Pre-High School Education
Time: 8 a.m.–5 p.m. Thursday
Member Price: $115 **Non Member Price:** $140
Location: Walter Payton College Prep

Julia Olsen, Steward Observatory, University of Arizona, Tucson, AZ 85721; 520-626-3236; jolsen@as.arizona.edu

The most recent wave of science education reforms aim at changing science learning from memorization of facts to the doing of science. To successfully do science in the classroom requires careful planning for conceptual understanding, not only doing activities. This workshop (appropriate for all educators K-college) is based on *Understanding by Design* by Wiggins and McTighe, and will focus on designing physics/physical science instruction leading to student understanding of concepts as well learning basic knowledge and skills. This model of planning is especially relevant in today's classrooms where student academic diversity is the norm and standards are foundational. Participants should bring their own curricular materials to work with, and each will develop a unit plan useful for their own teaching, no matter what grade level and content. This workshop will be based on individual needs of participants, who will also each receive a copy of *Understanding by Design*, 2nd ed.

W11: Research-Based Alternatives to Problem Solving in General Physics

Sponsor: Committee on Research in Physics Education
Time: 8 a.m.–5 p.m. Thursday
Member Price: $69 **Non Member Price:** $94
Location: Hyatt, Columbus IJ

Kathleen A. Harper, Dept. of Physics and Astronomy, Denison University, Granville, OH 43023; 740-587-5498; harper.217@osu.edu

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

David P. Maloney, Indiana University Purdue University - Fort Wayne, Fort Wayne, IN 46805; maloney@ipfw.edu

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.

T02: Seeing the Invisible (NASA)

Sponsor: Committee on Space Science and Astronomy
Time: 9 a.m. –12 p.m. Thursday
Member Price: $50 **Non Member Price:** $75
Location: Hyatt, Columbus, EF

Mandy P. Frantti, Munising H.S., 810 W M28, Munising, MI 49862; 906-387-2103 Ext 240; mpfrantti@hotmail.com

What's out there in our universe? Participants will engage in a captivating hands-on activity, observing different wavelengths of "light" or electromagnetic energy and what can be used to "block" it. Most wavelengths can't be seen with the eyes, so how scientists detect it and how that information is being used will be the focus of the session. Examine ultraviolet, infrared, radio, and find out about the most exciting of all—gamma rays and the distant universe! The activities can be done in a middle or high school classroom.

W12: Developing Physics Teacher Knowledge

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Apparatus
Time: 9 a.m.–5 p.m. Thursday
Member Price: $92 **Non Member Price:** $117
Location: Hyatt, Columbus KL

Eugenia Etkina, Rutgers University, New Brunswick, NJ 08901-1183; 732-932-7496 ext 8339; 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 content specialist from that of the pedagogue. PCK involves knowing students' original ideas and potential difficulties, alternative ways to represent those ideas, assessment strategies, and effective instructional methods within a particular discipline. What constitutes physics PCK and how can prospective and practicing physics teachers construct and improve theirs? What is the difference between PCK of a college instructor and a high school physics teacher? What elements of a teacher preparation program and what specific activities help physics teachers develop their PCK? In this interactive workshop participants will tackle the above questions and develop some strategies for improving their own PCK, incorporating the building of teacher PCK into their physics courses, methods courses, and teacher preparation programs.

W04: NTIPERS: Research-Based Conceptual Reasoning Tasks for Introductory Mechanics*

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Two-Year Colleges
Time: 1–5 p.m. Thursday
Member Price: $45 **Non Member Price:** $70
Location: Hyatt, Columbus CD

David P. Maloney, Indiana University-Purdue University Fort Wayne, Fort Wayne, IN 46805; 260-481-6292; maloney@ipfw.edu

Curtis Hieggelke, Joliet Junior College, Joliet, IL 60431, curth@comcast.net

Steve Kanim, New Mexico State University, Las Cruces, NM 88003-8001, skanim@nmsu.edu

This workshop will deal with various alternative task formats that can be used to make instructional materials that impact and improve student learning and understanding of physics concepts in mechanics. These exercises are based, in part, on efforts in Physics Education Research and thus are called TIPERs (Tasks Inspired by Physics Education Research). Such tasks support active learning approaches and can be easily incorporated into instruction in small pieces. This workshop will feature new TIPERs in the area of mechanics but the techniques can be deployed in all areas of physics. The first part of the workshop will explore various formats, their characteristics, and how they can be used. Participants will work in groups to develop a set of TIPERs that address a concept, principle, or relationship in mechanics. These TIPERs sets will be shared with and critiqued by the group. This workshop will also include new nTIPER "clickers."

*This work is supported in part by a CCLI grant #0632963 from the Division of Undergraduate Education of the National Science Foundation.

W05: How to Implement a Pedagogy Course for Undergraduate and Graduate Learning Assistants

Cancelled

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Thursday
Member Price: $75 **Non Member Price:** $100
Location: Hyatt, Columbus EF

Valerie K. Otero, University of Colorado Boulder, Boulder, CO 80309; 303-492-7403; valerie.otero@colorado.edu

Steve Iona, University of Denver, steve.iona@earthlink.net

The purpose of this workshop is for participants to learn how to implement a pedagogy course for undergraduate and graduate learning assistants (or teaching assistants). Workshop participants will explore learning assistants' prior knowledge of teaching and learning and will investigate some of our goals (implicit and explicit) to help learning assistants move toward an understanding of research-based teaching. We will provide participants with materials and guides for implementing pedagogy lessons in their own institutions. We will also spend some time trouble-shooting issues that may have come up in participants' early attempts to implement such a course.

W06: Inquiry-Based Learning for High School Teachers

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Thursday
Member Price: $75 **Non Member Price**: $100
Location: Walter Payton College Prep

Maxine C. Willis, Dept. of Physics and Astronomy, Dickinson College, Carlisle, PA 17013; 717-245-1955; willism@dickinson.edu

Priscilla Laws, Dickinson College; lawsp@dickinson.edu

Marty Bamberger

This is a hands-on workshop designed for teachers interested in using materials in their physics classes that will engage their students in inquiry-based active learning. Participants will work with activities from kinematics, dynamics, energy and optics from the updated Activity-Based Physics High School CD (ABP HSCD). These student-centered curricular modules are based on the outcomes of physics education research and are linked to the national standards. They make extensive use of computers for data collection and analysis. The outcome of this approach is that students learn physics by doing physics. The curricula on the ABP HSCD include: RealTime Physics, Tools for Scientific Thinking, Workshop Physics and Interactive Lecture Demonstrations. All of the equipment and software used in this workshop are compatible with both Mac and Windows computers and use interface equipment from both Vernier Software and PASCO.

W07: Using Digital Cameras and Tablet PCs to Analyze Motion of Objects

Sponsor: Committee on Educational Technologies
Time: 1–5 p.m. Thursday
Member Price: $55 **Non Member Price:** $80
Location: Walter Payton College Prep

Paul M. Waechtler, New Trier High School, 7 Happ Road, Northfield, IL 60093; 847-784-6740; waechtlp@newtrier.k12.il.us

Mary Beth Barrett, New Trier High School, barrettm@newtrier.k12.il.us

John Miller, New Trier High School; millerj@newtrier.k12.il.us

Ryan Dunn

This is a hands-on workshop where participants will record videos of moving objects using a digital camera. Graphs of the motion will be created using video analysis software. The participants will then annotate the graphs using the tablet functionality of a Tablet PC.

Participants will have the ability to complete activities from a variety of topics, including kinematics, momentum, energy, rotational motion, and simple harmonic motion.

FRIDAY, February 13, 2009

W01: An Introduction to Improving Student Learning by Conducting Education Research in Your Astronomy Class

Sponsor: Committee on Space Science and Astronomy
Time: 8 a.m. –12 p.m. Friday
Member Price: $45 **Non Member Price:** $70
Location: Hyatt, Haymarket

Janelle M. Bailey, University of Nevada - Las Vegas, Las Vegas, NV 89154-3005; 702-895-4756; janelle.bailey@unlv.edu

Timothy F. Slater, University of Wyoming; tslater@as.arizona.edu

Stephanie J. Slater

This participatory workshop for college and university astronomy and physics faculty provides an overview and introduction to the motivations, strategies, methodologies, and publication routes for conducting science education research in their own classrooms in order to improve astronomy education. Participants will evaluate the value of various education research questions, identify strengths and weaknesses of several research design methodologies, learn how to obtain Institutional Review Board approval to conduct education research on human subjects, and become more aware of how education research articles are created for publication in journals such as the *Astronomy Education Review.*

W13: Modeling Mechanics: From Free Fall to Chaos*

Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Friday
Member Price: $55 **Non Member Price:** $80
Location: Walter Payton College Prep

Mario Belloni, Davidson College, PO Box 6910, Davidson, NC 28036-6910; 704-894-2320; mabelloni@davidson.edu

Wolfgang Christian, Davidson College; wochristian@davidson.edu

Anne J. Cox, Eckerd College, St. Petersburg, FL 33711; coxaj@eckerd.edu

Easy Java Simulations, Ejs, is a free and open source tool for creating Java simulations. Unlike other software programs designed to make programming easier for programmers, the structure of the Ejs environment allows users to focus on the process of building simulations, and therefore the underlying physics, as opposed to the technical aspects of building simulations. In this workshop participants will learn how to use Ejs to create simple and advanced simulations for mechanics. We will distribute on a CD the Ejs programming environment and several completed curricular units. The workshop will be based on templates that can be easily adapted to simulate other, more advanced, physical phenomena. Participants are encouraged to bring their own laptops with a CD drive and the latest version of Java installed.

*The Open Source Physics Project is generously supported by the National Science Foundation (DUE-0442581).

W14: Physics by Inquiry*

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Time: 8 a.m. –12 p.m. Friday
Member Price: $75 **Non Member Price:** $100
Location: Hyatt, Water Tower

Lillian C. McDermott, Dept. of Physics, University of Washington, Box 351560, Seattle, WA 98195-1560; 206-685-2046; peg@phys.washington.edu

This workshop focuses on how college and university physics faculty can contribute to the professional development of pre-college (K-12) teachers. Participants will have an opportunity to gain hands-on experience with *Physics by Inquiry*,[1] instructional materials designed to provide teachers with the background needed to teach physics and physical science as a process of inquiry. Excerpts from a video produced by WGBH will be used to illustrate interactions between teachers and instructors during a course based on these instructional materials.[2] Participants will also gain an understanding of how physics education research has guided the design of the curriculum. In addition, there will be a discussion of various intellectual and practical issues. Volumes I and II will be provided to participants.

1. L.C. McDermott and the Physics Education Group at the University of Washington, *Physics by Inquiry: An Introduction to Physics and Physical Science,* Volumes I and II (Wiley, New York, 1996).

*Development was supported, in part, by the National Science Foundation.

2. *Physics by Inquiry: A Video Resource* (WGBH, Boston, 2000).

W15: Using Experimental Tracks in Intermediate/Advanced Physics Laboratories to Foster Physical Insight and Independence

Cancelled

Sponsor: Committee on Physics in Undergraduate Education
Time: 8 a.m.–12 p.m. Friday
Member Price: $35 **Non Member Price:** $60
Location: Walter Payton College Prep

Mark F. Masters, Physics Dept., Indiana Purdue-Fort Wayne, Fort Wayne, IN 46805; 260-481-6153; masters@ipfw.edu

Timothy T. Grove

In intermediate/advanced physics laboratories, students are often exposed to many different investigations. Unfortunately, this usually leads to very little depth in the student's understanding. This workshop presents the participants with an alternative approach to intermediate undergraduate laboratories in which the students complete a series of conceptually linked investigations (tracks) that vary from simple mechanical to modern physics investigations. For reporting laboratory results we advocate poster sessions. Participants in this workshop will be engaged in discussion about the nature of laboratory investigation and "tracks." Apparatus will be set up so that the participants can experience a "tracked" series of investigations. We will role play a poster session so that attendees can get an idea of how one can probe student understanding using this method. At the end of the session, groups will brainstorm new experimental tracks. (This was developed using support from NSF CCLI Grant # 0127078)

W29: Haunted Physics Lab—Organize and Construct a Kid Magnet On-Campus Outreach Event

Cancelled

Sponsor: Committee on Science Education for the Public
Co-Sponsor: Committee on Apparatus
Time: 8 a.m.–5 p.m. Friday
Member Price: $100 **Non Member Price:** $125
Location: Hyatt, Gold Coast

Patricia A. Sievert, 146 Swen Parson Hall, Northern Illinois University, DeKalb, IL 60115; 815-753-1201; psievert@niu.edu

Richard Flarend, Penn State University - Altoona; ref7@psu.edu

How do we get 1100 children and adults to visit the Dept. of Physics on a single Saturday afternoon in rural Illinois? We invite them to a Haunted Physics Laboratory! Mixing a bit of Halloween fun with some good solid physics in the form of interactive displays has led to a series of very successful outreach events. Come investigate 70 of our displays, make some of your own, and learn how to publicize and carry out a Haunted Physics Laboratory of your own, starting with equipment you have on hand or purchase at your local discount store. Haunted labs can be effective outreach events for universities, community colleges, high schools, and even middle schools. The morning session will concentrate on activities in our "dark room" and the afternoon session will focus on activities done in a lighted room or hallway.

W30: Using Research-Based Curricula and Tools to Revitalize Your Introductory Course

Cancelled

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Friday
Member Price: $85 **Non Member Price:** $110
Location: Walter Payton College Prep

David R. Sokoloff, Dept. of Physics, 1274 University of Oregon, Eugene, OR 97403-1274; 541 346-4755; sokoloff@uoregon.edu

Ronald Thornton, Tufts University; csmt@tufts.edu

Priscilla Laws, Dickinson College; lawsp@dickinson.edu

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.

W31: Teaching Astronomy with Technology

Sponsor: Committee on Educational Technologies
Time: 8 a.m.–5 p.m. Friday
Member Price: $70 **Non Member Price:** $95
Location: Hyatt, Picasso

Kevin M. Lee, 205 Ferguson Hall, University of Nebraska, Lincoln, NE 68588-0111; 402-472-3686; klee6@unl.edu

This workshop will survey a variety of educational technologies useful for engaging students in both high school and introductory college classrooms. Special emphasis will be placed on simulation usage and peer instruction. Participants will work on computers gaining familiarity with the astrophysical simulations of the Nebraska Astronomy Applet Project (NAAP) and its web-based assessment capabilities. Participants will also design peer instruction sequences to be used in the classroom using the computer-based modules of the ClassAction Project. A lighter emphasis will be placed on using computerized ranking tasks and on comparing available options for online homework, astronomy laboratories, and desktop planetariums. All participants will receive NAAP, ClassAction, and computerized ranking task materials on CD.

T07: A New Model of Instruction for the Urban Physics Classroom* **

Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Physics in Undergraduate Education
Time: 9 a.m.–12 p.m. Friday
Member Price: $45 **Non Member Price:** $70
Location: Walter Payton College Prep

Mel S. Sabella, Dept. of Chemistry and Physics, Chicago State University, 9501 S. King Dr. - SCI 232, Chicago, IL 60628; 7739952172; msabella@csu.edu

Samuel Bowen, Kim Coble, 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 sessions, 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 this type of course. The workbook contains lecture notes, discussion questions, TIPERS, problem-solving tasks, and laboratories that are often broken up. Much of 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)

W08: Chicago Museum of Science and Industry

Sponsor: Committee on Science Education for the Public
Time: 9 a.m.–12 p.m. Friday
Member Price: $85 **Non Member Price:** $110
Location: Chicago Museum of Science and Industry

Stanley J. Micklavzina, Dept. of Physics, 1274 University of Oregon, Eugene, OR 97404; 541-346-4801; stanm@uoregon.edu

Richard Flarend, Penn State University - Altoona; ref7@psu.edu

Gain inspiration and strategies for teaching physics and developing outreach activities at this half-day workshop at the Museum of Science and Industry, the largest science museum in the Western Hemisphere. You'll hear about the museum's innovative education programs, get a sneak peak at new exhibitions of awe-inspiring size and scale, and take a tour of iconic exhibits such as the U-505 Submarine and Coal Mine. Participants are invited to spend the rest of the day exploring the museum's 14 acres of exhibit space. **Transportation will be provided. Continental breakfast will be provided.**

T04: Civic Engagement and Service Learning: The SENCER Project

Sponsor: Committee on Professional Concerns
Co-Sponsor: Committee on Physics in Two-Year Colleges
Time: 10 a.m.–12 p.m. Friday
Member Price: $25 **Non Member Price:** $50

Location: Fairmont, Chancellor

Theo Koupelis, Edison State College, 8099 College Pwy. SW, Fort Myers, FL 33919; 239-489-9229; 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.

T05: Mining the Hidden Web

Cancelled

Sponsor: Committee on Professional Concerns
Time: 10 a.m. –12 p.m. Friday
Member Price: $35 **Non Member Price:** $60
Location: Hyatt, Wrigley

Pat T. Viele, 286 Clark Hall, Cornell University, Ithaca, NY 14853-2501; 607-255-0067; ptv1@cornell.edu

The Internet and the World Wide Web are growing at an amazing rate. This tutorial is designed to give participants skills for fast, efficient searching of the Internet. In this digital age, skill in evaluating the information one finds on the Internet is essential. This tutorial will also offer some guidelines for evaluating information.

T06: ComPADRE*

Sponsor: Committee on Educational Technologies
Time: 10 a.m. –12 p.m. Friday
Member Price: $30 **Non Member Price:** $55
Location: Hyatt, Skyway 269

Bruce Mason, Dept. of Physics & Astronomy, University of Oklahoma, 440 W. Brooks St., Norman, OK 73019; 405-325-3961; bmason@ou.edu

ComPADRE is a network of web-based resource collections for teaching physics and astronomy. Each collection focuses on a particular audience, such as high school teachers, introductory astronomy, or physics students. This tutorial will introduce the collections, explore the available resources, and give experience with the personalization tools. Specific topics covered will depend on the interests of the tutorial participants. Attendees are encouraged to bring their own computers to make the tutorial a hands-on experience.

*ComPADRE is funded by the National Science Foundation and is part of the National Science Digital Library.

W18: Designing a Diagnostic Learning Environment: A Workshop for Teacher Educators

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Friday
Member Price: $60 **Non Member Price:** $85
Location: Walter Payton College Prep

Stamatis Vokos, Physics Dept., Seattle Pacific Univ., 3307 Third Ave. W, STE 307, Seattle, WA 98119-1957; 206 281-2385; vokos@spu.edu

Pamela A. Kraus

While many teachers engage in frequent assessment, typically this means that they identify whether the student has the "right" idea, and if not, the instruction presents more of the right idea. A diagnostic learning environment is one in which assessments are used for formative purposes, i.e., to identify the fine structure of students' understanding and reasoning, and to help a teacher decide which aspects of student thinking might be troublesome so that she/he may address specific student ideas with targeted instruction. To employ formative assessment effectively, teachers need deep subject matter knowledge and robust pedagogical content knowledge. Participants will experience a diagnostic learning environment and learn about issues that arise in setting up teacher professional preparation programs that are focused on formative assessment. Participants will learn about the Diagnoser Project's free instructional tools to help diagnose pre-college student thinking and guide instructional decisions. Participants are encouraged to bring a laptop.

W19: PET and PSET: Courses for Prospective Teachers and General Education Students*

Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in Pre-High School Education
Time: 1–5 p.m. Friday
Member Price: $54 **Non Member Price:** $79
Location: Hyatt, Skyway 273

Valerie Otero, University of Colorado at Boulder, Boulder, CO 80309-0249; 303-492-7403; Valerie.Otero@Colorado.edu

Fred Goldberg, San Diego State University; fgoldber@sciences.sdsu.edu

Physics and Everyday Thinking (PET) and Physical Science and Everyday Thinking (PSET) are each one-semester courses that can serve the needs of both prospective and practicing elementary teachers and as a general education science course. Both PET and PSET engage students in four types of activities: (1) standards-based physics or physical science content, (2) nature of science, (3) learning about one's own learning, and (4) learning about the learning of elementary students. PET and PSET use a similar course pedagogy and activity sequence that is guided by research on student learning of physical science. The PET course content focuses on the themes of interactions, energy, forces and fields. PSET focuses on interactions, energy, forces and atomic-molecular theory. During much of the workshop participants will view and discuss video from college PET and PSET classrooms, and from elementary classrooms.

*Supported in part by NSF Grant ESI-0096856. PET and PSET are published by It's About Time, Herff Jones Education Division.

W20: Exploring Beyond the Solar System

Sponsor: Committee on Space Science and Astronomy
Co-Sponsor: Committee on Teacher Preparation
Time: 1–5 p.m. Friday
Member Price: $70 **Non Member Price:** $95
Location: Hyatt, Haymarket

Janelle M. Bailey, University of Nevada - Las Vegas, Las Vegas, NV 89154-3005; 702-895-4756; janelle.bailey@unlv.edu

Lindsay Bartolone, Pamela Greyer, Pamela Harman, Erika Reinfeld

Explore the biggest questions about our place in space and time. Many new astronomy learners, students and adults alike, are unfamiliar with the universe beyond the solar system. This workshop provides an opportunity to deepen content knowledge and to practice strategies for teaching and learning about current scientific models and evidence for the origin and evolution of our universe of galaxies. The "Beyond the Solar System" project investigated student misconceptions and exemplary classroom strategies. Each participant will receive the project final product, a DVD produced for NASA Universe Education Forum at the Harvard-Smithsonian Center for Astrophysics. Key concepts, evidence, researchers, student ideas, and classrooms and resources will be presented from the DVD. Modeling the Universe, Exploring with Telescopes, Measuring Galaxies with Telescopes, and Cosmic Timeline inquiry-based lesson plans will be featured.

W21: Three-Color Astronomy Images by High School Students

Cancelled

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Friday
Member Price: $75 **Non Member Price:** $100
Location: Hyatt, Burnham

David W. McDonald, Sidney H.S.,1012 4th Ave. SE, Sidney, MT 59270; 406-433-2330; jswords@mcn.net

Joy-Lyn McDonald

Probe the universe. Find new features in many celestial objects. Study young stars. Learn how to make those beautiful colored images of astronomy objects. We will construct three-color images from narrow-band filter images. These images can be found at sources such as IR from Spitzer Space Telescope, visual from the STScI Digitized Sky Survey and others. Using computer programs like Adobe Photoshop (with FITS Liberator plug-in), and free software such as ds9, Spot, and Leopard, participants will gain hands-on experience constructing the three-color images. Programs and data files will be available on laptops for AAPT participants to practice the process during presentation. Then their students can learn the process as well, and be engaged in active inquiry and work on authentic astronomy research, and create their own three-color images. Handouts will be provided and if participants bring USB thumbdrives, they can take copies of all files with them.

W22: Tutorials in Introductory Physics

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Friday
Member Price: $75 **Non Member Price:** $100
Location: Hyatt, Water Tower

Lillian C. McDermott, Dept. of Physics, University of Washington, Box 351560, Seattle, WA 98195-1560; 206-685-2046; 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. L.C. McDermott, P.S. Shaffer, and the Physics Education Group at the University of Washington, *Tutorials in Introductory Physics*, First Ed. (Prentice Hall, 2002). Development was supported, in part, by the National Science Foundation.

W23: Model Building Investigations of Field Creation and Transformer Operation

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Friday
Member Price: $65 **Non Member Price:** $90
Location: Walter Payton College Prep

Melvin S. Steinberg, Physics Dept., Smith College, Northampton, MA 01063; 413-586-1488; meladele@crocker.com

Participants will use simple experiments from the recently completed CASTLE curriculum to generate image-based electromagnetic field concepts (which conventional instruction introduces mathematically) and make dynamic electromagnetic phenomena visualizable. A portable radio detects electric field radiated by accelerating charge whenever a battery-and-wire circuit is closed or opened. The magnetic field around the final current suggests formation by electromagnetic radiation, and the effect of wire shape on radio reception shows this magnetic field is given energy that radiation carries to the radio after the circuit is opened. Detecting current in a coil through which a magnet is moving reveals a charge-pushing agent in the coil, suggesting curly electric field in proportion to rate of change of magnetic field (Faraday's Law). A small transformer, introduced via its bulb-lighting ability as an "AC battery," drives a coaxial-coils transformer which causes predictable bulb brightness changes when coil overlap and iron core insertion are varied.

W24: Ben Franklin Is My Lab Partner

Sponsor: Committee on History & Philosophy of Physics
Time: 1–5 p.m. Friday
Member Price: $60 **Non Member Price:** $85
Location: Hyatt, Wrigley

Robert A. Morse, St. Albans School, Mount St. Albans, Washington, DC 20016; 202-537-6452; robert_morse@cathedral.org

Benjamin Franklin's experiments and observations on electricity established not only his reputation as a scientist, but also 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 and sharing both his wisdom and doubts, while clearly conveying his fascination with electricity. As Franklin was not formally schooled 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 by the author 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 equipment. Participants will receive take-home equipment and a CD-ROM containing the workshop manual, a collection of Franklin's letters relating to electricity, and movie clips illustrating the experiments.

W25: Reaching, Teaching, and Keeping Underrepresented Groups in Physics (College Level)

Sponsor: Committee on Minorities in Physics
Time: 1–5 p.m. Friday
Member Price: $42 **Non Member Price**: $67
Location: Hyatt, Dusable

Juan R. Burciaga, Dept. of Physics, Whitman College, Walla Walla, WA 99362; 509-527-4916; burciaj@whitman.edu

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

W26: Open-Source Tutorials: PER-Based Instructional Materials with Resources to Facilitate Modification and Implementation

Sponsor: Committee on Research in Physics Education
Time: 1–5 p.m. Friday
Member Price: $52 **Non Member Price:** $77
Location: Hyatt, Skyway 269

Rachel E. Scherr, Physics Education Research Group, Dept. of Physics, University of Maryland, College Park, MD 20742; 301-405-6179; rescherr@umd.edu

Andrew Elby, University of Maryland; elby@physics.umd.edu

Instructors inevitably need to adapt even the best reform materials to suit their local circumstances. We offer a package of research-based, open-source, epistemologically focused mechanics tutorials, along with the detailed information instructors need to make effective modifications and provide professional development for TAs. In particular, our tutorials are embedded with comments from the developers, advice from experienced instructors, and video clips of students working on the materials.

W27: Math, Science, and Teacher Ed Faculty Collaboration: An Interdisciplinary Approach to Preservice Teacher Education in Math and Science

Sponsor: Committee on Physics in Pre-High School Education
Time: 1–5 p.m. Friday
Member Price: $50 **Non Member Price:** $75
Location: Hyatt, Skyway 272

Paul J. Dolan, Jr., Physics Dept., Northeastern Illinois University, Chicago, IL 60625; 773-442-5785; P-Dolan@neiu.edu

Heather Patay, Tanya Cofer, Wayne Landerholm, George Pryjma, Isidor Ruderfer, Emma Turian, NEIU

Vinay Duggal, Panagos Papageorgiu, Wright College

Richard Kampwirth, Sheila McNicholas, Truman College

The Math and Science Concepts Minor program, a consortium based at Northeastern Illinois University, Harry S. Truman College, and Wilbur Wright College, differs from previous math and/or science concentrations in that it is an interdisciplinary minor that provides appropriate content material, an intentional focus on metacognitive processes and content specific pedagogy. It is, in essence, an applied mathematics concentration focused in scope for diverse city college and university students preparing to be educators, and primarily to become educators who teach middle school (6th through 9th grades). We will briefly introduce the program, and then break into smaller groups, so that faculty who teach several of the course pairs, along with students who have completed that course pair, can facilitate sample activities from their courses. Participants will be able to rotate among the several activities. These activities will be selected so as to engage participants in the sample learning activities.

W28: Physics Front: Capabilities and Possibilities

Cancelled

Sponsor: Committee on Physics in High Schools
Time: 1–5 p.m. Friday
Member Price: $55 **Non Member Price:** $80
Location: Hyatt, Field

Cathy Ezrailson, University of South Dakota, Vermillion, SC 57069; 605-677-5830; Cathy.Ezrailson@usd.edu

Caroline Hall

The Physics Front offers K-12 teachers a place online to find and share high-quality physics teaching resources including lesson plans, labs, simulations, and reference materials. All these materials are organized by subject, grade level, and course type. This website also gives teachers the tools to collaborate and share expertise. Topics covered in this workshop will include: collecting, organizing, and sharing resources from the collection; submitting new resources; navigating and building Physics Front topical units; and Physics Front discussions, comments, and reviews. Participants wishing to actively engage, hands-on, in the workshop should bring their own laptop computers; we hope to have enough participants with computers so that they can work online in pairs. Wireless Internet connections will be provided.

FRIDAY, Feb. 13

Registration *Hyatt Grand Ballroom Foyer*	7 a.m.–4:30 p.m. and 7:30–9:30 p.m.
H.S. Share-a-Thon *Hyatt Crystal C*	6–8 p.m
Welcome Dessert Reception *Hyatt Crystal Foyer*	9–10 p.m
Exhibits *Hyatt Riverside Center*	11 a.m. – 6 p.m.
Demo Show *Hyatt Crystal B*	8–9 p.m.

Session: SPS Undergraduate Research and Outreach (posters)

Location: H-Crystal Foyer
Sponsor: Committee on Physics in Undergraduate Education
Date: Friday, Feb. 13
Time: 6–8 p.m.

Presider: Gary White

FRI01: 6 p.m. Physics Outreach with an Olympics Themed Open House

Jessica H. Belle, Augustana College, 639 38th St., Box 144, Rock Island, IL 61201; Jessica-Belle@augustana.edu*

Our SPS Chapter has a history of involvement in community outreach. Our most recent event is an open house titled "Olympic Fever." This particular open house is unique because it involves other on-campus student groups, including the environmental organization, and the Asian multicultural group. The goal is to use something exciting, like the Olympics, to get children in the community involved in learning some of the physical principles behind the games they love (like angular momentum, projectile motion, and drag), as well as some of the ways in which these games impact the countries they occur in. All of this is done through the use of exciting demonstrations. Using this approach, this open house aims to help these children to integrate physics into the way they view the world around them. *Sponsor: Cecilia Vogel

FRI02: 6 p.m Observations of Various TEM Modes of an Nd:YAG Infrared Laser

Jose Guerrero, Lewis University, 714 Bangs St., Aurora, IL 60505; guerrejo@lewisu.edu*

Chance Eiker, Lewis University

We describe the construction of a Nd:YAG diode-pumped infrared laser as well as the analysis of various Transverse Electromagnetic Modes induced to operate in the laser cavity. The output coupler had six degrees of freedom, so it was possible to misalign the cavity to produce higher order modes. In order to characterize these modes, we built a scanning detector system and measured the beam characteristics in two dimensions. We present graphically generated three-dimensional intensity profiles for TEM00 and several additional transverse mode profiles. We projected the various beams onto a screen and took digital pictures through an infrared viewer. The results clearly demonstrate the symmetry predicted by theory. *Sponsor: Joseph Kozminski, Lewis University

FRI03: 6 p.m. Performance and Monitering of Zero Degree Calorimeter at CMS

Heidi J. LeSage, University of Kansas, 2001 West 6th St., Apt. A5, Lawrence, KS 66044; hlesage@ku.edu

The CMS Zero Degree Calorimeter is designed to measure photons and neutrons for pp and PbPb collisions at TeV energies. The detector can be used for physics and for measuring the brightness and luminosity of the beams. This poster will show the performance of the calorimeter in test beams and describe the monitoring systems we have developed to ensure that the calorimeter is working correctly.

FRI04: 6 p.m. Binary Orbital Motion of Electrically Charged Spheres in Weightlessness

Lulu Li, Rhodes College, 2000 North Parkway, Memphis, TN 38112; lilu@rhodes.edu

Deseree Meyer and Brent Hoffmeister, Rhodes College

The similar mathematical forms of Coulombs' Law of Electrostatics and Newton's Law of Gravitation predict that two oppositely charged spheres should be able to move in a binary orbit about their center of mass using only the electric force as the force of attraction. To test this prediction, we conducted an experiment in July 2008 aboard a specialized C-9B aircraft in NASA's Microgravity University Program which simulates the conditions of weightlessness. We successfully achieved multiple binary orbits between the two spheres. The orbital motion was analyzed using VideoPoint software to measure the orbital interaction of the spheres.

FRI05: 6 p.m. U.W.P. Society of Physics Students Physics Is Phantastic Phunshop

Justin D. Reeder, U.W. Platteville Society of Physics Students, 1 University Plaza, Platteville, WI 53818; reederj@uwplatt.edu

Has your physics club been looking to host an event in the community to stimulate interest in physics but you're not sure exactly how or what to do? Or are you a teacher just looking for cool physics projects? If so then come and check out the zany fun that the U.W. Platteville chapter of SPS has with our Physics is Phantastic Phunshop. This annual event invites 6th grade students from southwest Wisconsin to partake in a day of physics exploration through physics demonstrations and workshops. Our members put on demonstrations related to a topic in physics and then we have workshops that apply that knowledge from the demonstrations to a specific technology used in everyday life. Past themes have included: rockets, airplanes, speakers, rubberband cars, and much more!

FRI06 6 p.m.. Building an Active Student Group to Complement Undergraduate Physics Education

Andrew C. Schenk, Millikin University, 260 N. Oakland Ave., Box 402, Decatur, IL 62522; aschenk@millikin.edu

Casey R. Watson, Millikin University

Over the course of the last two years, my fellow physics majors and I have cultivated an active SPS chapter that is recognized both by our university and by the general public in the surrounding area. Our group is fundamental to the outreach efforts of our Dept. and to our successful collaboration on course work and research. In my presentation I will discuss the ways in which our group has increased student interest in the field of physics, promoted a larger number of public outreach activities, and bolstered recruiting efforts.

FRI07: 6 p.m. Berry's Phase in a Superconducting Josephson Phase Qubit

Anthony Tyler, Drexel University, 427 N. Union St., Philadelphia, PA 19104; at792@drexel.edu

Roberto C. Ramos, Drexel University

One of the simplest manifestations of Berry's phase is in a quantum two-level system that exhibits an energy degeneracy. A microscopic two-level system such as a spin-1/2 particle in a magnetic field B has been shown to pick up a Berry's phase when its eigenstate is slowly cycled in parameter space. In this paper, we discuss how a Berry's phase is picked up by a macroscopic artificial atom consisting of a current-biased Josephson junction qubit subjected to a sequence of high-frequency signals. From this, we propose an experiment to measure the Berry's phase in this qubit using NMR techniques and quantum http://www.physics.drexel.edu/research/lowtemp/

FRI08: 6 p.m. Polymer Electrolyte Membrane Fuel Cell with Aligned Carbon Nanotube Electrode*

Ann V. Call, Kettering University/Argonne National Laboratory, 219 W Oakley Dr., NW, Apt. 105, Westmont, IL 60559; call0320@kettering.edu

Gabriel Goenaga, Junbing Yang, and Di-Jia Liu, Argonne National Laboratory

Carbon nanotubes (CNTs) have been considered a promising material for various applications. Electro-catalyst support for polymer electrolyte membrane fuel cells (PEMFCs) is one of them. There have been a number of reports on CNT-based membrane electrode assembly (MEA) in PEMFC, but CNTs in these electrodes are oriented randomly and the advantages associated with the structural properties of CNTs were not fully utilized. We report here on our progress in fabricating and evaluating MEA made of catalyst decorated, vertically aligned carbon nanotube (ACNT) layers. For comparison, a commercial MEA prepared through the ink-based process was also tested under similar conditions. Improved performance was observed for ACNT-based MEA, particularly at high current region, suggesting enhancement in mass transport and improved water management.

*This work was supported by the U.S. Dept. of Energy, Office of Energy Efficiency and Renewable Energy.

FRI09: 6 p.m. The Brazil Nut Effect in Microgravity

Andrew Vanden Heuvel, The Prairie School, 4050 Lighthouse Dr., Racine, WI 53402; avheuv@gmail.com

Terah Hennick, Alex Janiuk, and Alex Meyer, The Prairie School

The Brazil Nut Effect (BNE) is the well-known experiment where large grains, when agitated, rise to the top of a container full of smaller grains. Out of the many variables that impact the motion of a large intruder in the BNE, gravity is undoubtedly one of the most important. It is also the most difficult to manipulate. We had the opportunity to participate in a zero gravity flight through the Northrup-Grumman Weightless Flights of Discovery Program. We designed a mobile apparatus to test the efficiency of the BNE in the absence of gravity. Surprisingly, we discovered that under microgravity conditions the Reverse Brazil Nut Effect is established. Furthermore, we found that the rise and fall times of the intruder were not significantly impacted by the absence of gravity.

SATURDAY, Feb. 14

Registration *Hyatt Grand Ballroom Foyer*	7:30 a.m.–5 p.m.
Richtmyer Award – Vera Rubin *Fairmont, Imperial Ballroom*	9–10 a.m.
Job Fair *Hyatt, Grand/Columbus Foyer*	10 a.m.–4 p.m.
Fermilab Research Plenary w/ AAAS *Fairmont, Imperial Ballroom*	1:30–3 p.m.
Oersted Medal – George Smoot *Hyatt, Regency A*	8–9 p.m.

Session PST1: Poster Session I: Curriculum and Laboratories/Energy and the Environment/Astronomy and Astrophysics/Miscellany/Projects by High School Students

Location: H-Crystal Ballroom Foyer
Sponsor: AAPT
Date: Saturday, Feb. 14
Time: 8 a.m.–7:45 p.m.

(All authors will be present from 8–9 a.m. and then as noted below)

PST1-01: 7:15–7:45 p.m. Historical Papers for High School Physics Labs

Cancelled

Alan Gnospelius, Design and Technology Academy, 5110 Walzem Rd., San Antonio, TX 78218; agnosp@neisd.net

I will display some historical documents that I've used to pique the interest of high school students prior to a physics lab. This Poster Session will have displays and hand-outs of the papers.

PST1-02: 3:15–3:45 p.m. Teaching Physics in a Science Club

Marcelo M. F. Saba, Clube de Ciências Quark, R. Teopompo de Vasconcelos, 86, S. José dos Campos, SP 12243-830; marcelosaba@gmail.com

Ralf Gunter and Suny Watanabe, Colégio Poliedro

Doing science and physics projects in science clubs is a very efficient and enthusiastic way of showing high school students the beauty of the scientific method and the challenges faced by physicists. In this work, some successful experimental projects done at the Quark Science Club will be shown as examples of how science clubs can make an enormous contribution to physics education. Quark Science Club is a nonprofit organization that is coordinated by a Ph.D. researcher, and that involves undergraduate students and high school students.

PST1-03: 7:15–7:45 p.m. BalloonSat and LabPro: High Altitude Balloon Experiments for High School Students

Kim Mason, Physics Dept., The University of Central Arkansas, Conway, AR 72035; kim.mason09@gmail.com*

William V. Slaton, The University of Central Arkansas

BalloonSat is a NASA and Arkansas Space Grant Consortium funded program that gives secondary education students the opportunity to design and build scientific payloads to send to high altitudes aboard helium-filled weather balloons. Recently a flight was conducted with Vernier's LabPro data acquisition system recording atmospheric temperature and pressure. Altitude was inferred from post-flight GPS data and indicated the balloon reached the edge of the tropopause. The transition into the tropopause was also indicated by the change in the temperature and pressure data taken from the launch. This data will be presented and used to demonstrate atmospheric pressure's exponential dependence on altitude as well as the dry adiabatic lapse rate. Comparisons to theory will also be presented. Hands-on experiments such as these utilizing data acquisition devices common in the technology

Session AA: AAPT Richtmyer Award

Location: F-Imperial Ballroom
Sponsor: AAPT
Date: Saturday, Feb. 14
Time: 9–10 a.m.

Presider: *Lila Adair*
Co-Presider: *Harvey Leff*

Vera Rubin

Rotating Galaxies and Dark Matter

Vera Rubin, Senior Fellow, Dept. of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC 20015-1305; rubin@dtm.ciw.edu

From the time of the earliest humans to the present, each civilization has told stories about the universe. How we understand the universe is dictated in large measure by the available technology. In the last century, we learned that we inhabit a galaxy of 200 billion stars, that the universe is populated by billions of galaxies, and that galaxies are moving away from each other. Equally important, we now understand that everything evolves: stars are born, evolve, and die; galaxies grow at the expense of their neighbors. I will describe the evidence that the stars, galaxies, and clusters of galaxies that populate the universe make up less than 5% of its matter. The remaining matter is dark, and is only detected by its gravitational effect on the brightmatter we study. While virtually everything we know about the universe we have learned in the 20th century, still more remains unknown.

enhanced classroom offer secondary education students and teachers the opportunity to do meaningful scientific explorations of the Earth.

*Steve Addison (Current President of the AOK region of AAPT).

PST1-04: 3:15–3:45 p.m. A Learning Progression for Nanoscale Magnetism in Grades 7-12

David Sederberg, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907; dsederbe@purdue.edu

Lynn Bryan, Purdue University

The transition from macroscale to nanoscale offers exciting phenomena, not only engaging to students, but essential to understanding nanoscience, beyond mere reference to size. This research presents the initial results of an effort to describe a learning progression to help students in grades 7-12 understand the unique and extraordinary behavior of nanomagnetic particles and magnetic fluids. More than an instructional sequence of topics in the curriculum, a learning progression uses sets of ideas or concepts within related topics and embedded assessment to form a convergence of conceptual understanding. Pre- and post-assessments from a teacher professional development institute and student artifacts are used to describe successes as well as discontinuities in learners' development of the concepts of nanoscale magnetism. An implication of this work is that it may be used to inform level-appropriate strategies for both instruction and assessment for the implementation of nanoscience education into classroom practice.

PST1-05: 7:15–7:45 p.m. Teaching Nuclear Science

Stuart Gluck, Johns Hopkins University Center for Talented Youth, McAuley Hall, 5801 Smith Ave., Suite 400, Baltimore, MD 21209; stu@jhu.edu

Vince Bonina, Johns Hopkins University Center for Talented Youth

How can we bring the excitement of cutting-edge particle physics to the high school classroom? For the past three summers, Johns Hopkins University's Center for Talented Youth (CTY) has offered a nuclear science course for gifted students in grades seven through 10. Students learn everything from the discovery of radioactivity to the standard model, and engage in hands-on activities such as constructing a cloud chamber and simulating a chain reaction. This poster session will reveal the curriculum for this popular class, including syllabi and sample lessons.

PST1-06: 3:15–3:45 p.m. Physics, Rockets and Aerial Photography

Suny Watanabe, Colégio Poliedro, R. Teopompo de Vasconcelos, 86, S. José dos Campos, SP 12243-830; marcelosaba@gmail.com*

Ralf Gunter, Colégio Poliedro

Marcelo Saba, Clube de Ciências Quark

Building and launching a rocket was a great opportunity to learn more deeply several topics of high school physics. Pressure, action and reaction, speed and acceleration, terminal velocity, air drag, and several other physics concepts and laws were explored during the building and launching of a amateur experimental rocket that was also used for aerial photography.

*Sponsor: Marcelo M F Saba (co-author and member)

PST1-07: 7:15–7:45 p.m. Incorporating Active Learning into High School Physics Teaching in India

Margaret Hill, Dept. of Physics, Southeast Missouri State University, One University Plaza, MS6600, Cape Girardeau, MO 63701; phill@semo.edu

Boby Jose, Sacred Heart Catholic Girls Secondary School

Indian High School physics is based on the British Exam driven curriculum, where final exams are high-stakes and can determine both a student's future and the future success of the teacher or institution. There is much pressure to teach using the traditional lecture method. However, teachers are finding this unsatisfactory, since students are often unable to apply what has been learned and they complain that the subject has little to do with real world issues and events. A visit last spring from Indian high school teachers to the United States resulted in a counter exchange, funded by an IREX grant, to send American teachers overseas. Here we discuss the issues raised and lessons learned as a result of a two week trip to Kerala, India, where we met with high school science teachers and presented workshops on how to efficiently incorporate Active Learning Techniques into the physics classroom.

PST1-08: 3:15–3:45 p.m. Try to Fly: A Flight Simulator as Teaching Tool

Neva Capra, Aeronautical Museum Gianni Caproni, Via Lidorno 3, Trento, 38100; neva.capra@mtsn.tn.it

Educators well know that to increase the participation of their students it may be useful to propose arguments that they are interested in and practical activities based on modern technologies. Science and physics undoubtedly allow one to find out arguments of really appealing technological content. Moreover, it is quite well understood that students want to practice (not only just listen to!) what they are taught and, referring to the physics of flight, a possibly more intriguing way to get into direct touch with the experimental side of flight is, obviously, to fly! A difficult approach for understandable reasons, but there is an alternative, totally affordable, way to address this: the one we adopted in the temporary hands-on exhibition "Try to fly." The history of flight simulation from the first airplanes to space exploration, i.e. to consider the adoption of a simulated flight experience based on a computer game.

PST1-09: 7:15–7:45 p.m. Fusion and Particles in the Classroom

Nicholas Guilbert, Peddie School, South Main St., P.O. Box A, Hightstown, NJ 08520; nguilbert@peddie.org

G. Samuel Lightner, Westminster College (emeritus)

Ted Zaleskiewicz, University of Pittsburgh (emeritus)

Gordon J. Aubrecht, Ohio State University

One possible source of near-term electricity has been fusion reactions that produce solar energy for us to use on Earth. The Contemporary Physics Education Project (CPEP), a volunteer nonprofit organization of educators and scientists, has been developing materials to support the introduction of contemporary physics topics into high school and college introductory physics for 20 years. This talk will feature the wallchart Fusion and Plasma Physics as well as supporting activities and materials. Placemat size charts will be distributed to those in attendance. Special emphasis will be given to using the chart to explain how fusion can contribute to the future.

PST1-10: 3:15–3:45 p.m. *Science News* in the Physics Classroom

Laura McCullough, University of Wisconsin-Stout, 103E Jarvis Hall Science Wing, Menomonie, WI 54751; McCulloughL@uwstout.edu

I have assigned the newsmagazine *Science News* in my classes for three years.* Each week, students choose any article and write a brief paper. For two years, I kept track of what topic each student chose each week. In this poster, I present an analysis of topics chosen by students, and relationships to other factors such as cover article, related pictures, and length of article.

*L. McCullough, "Science News in the Science Classroom," *J. of Coll. Sci. Teach.* **36**(3) (2006), 30-33.

PST1-11: 7:15–7:45 p.m. Students' Projects in Large Introductory Physics Courses at Ryerson University

Marina Milner-Bolotin, Ryerson University, 350 Victoria St., Toronto, ON M5B2K3; mmilner@ryerson.ca

M. Juliana Carvalho, Ryerson University

One of the major challenges of teaching introductory physics courses to non-physics majors is motivating students and encouraging their interest in the subject. Since Ryerson places an emphasis on experiential learning right from the start, project-based instruction in large first-year courses (~150 students each) is a sensible pedagogical choice. This poster describes the design, implementation, and evaluation of the semester-long projects of students in two large introductory physics courses: Physics for Architecture and Physics for Computer Science. At the end of the term, the two courses host a common project exhibit, during which the students demonstrate and explain their work (physics models relevant to architectural design and computer simulations of physical phenomena) to their classmates, wider university community, and the general public. Student feedback shows that this type of instruction promotes effective group work and helps students see connections between physics concepts and the world around us.

PST1-12: 3:15–3:45 p.m. Teaching Studio-Based Second-Year Modern Physics Course with Technology

Marina Milner-Bolotin, Ryerson University, 350 Victoria St., Toronto, ON M5B 2K3; mmilner@ryerson.ca

"Modern Physics for Physics Majors"* is a second-year course for medical physics students at Ryerson University. While the course topics are traditional (relativity, thermodynamics, atomic physics), the course pedagogy is rather different. The course is taught in a studio-based format in a special Technology-Rich Classroom with interactive lectures intertwined with the computer-simulation-based labs and problem solving activities. The poster will present the information on course design and implementation, as well as the results of the study of the impact of this technology-rich learning environment on student academic and affective outcomes.

The studio-based format course implementation became possible due to the support of the HP Technology Award for Ryerson University for 2008-2010 school years and due to the support of the Ryerson University Teaching and Learning Office.

PST1-13: 7:15–7:45 p.m. Conceptual Electricity and Magnetism Problem Database*

John C. Stewart, Physics Building, University of Arkansas, Fayetteville, AR 72701; johns@uark.edu

This poster introduces a new digital resource for teaching and evaluating introductory electricity and magnetism classes: a digital library of highly characterized, multiple-choice, conceptual electricity and magnetism problems. The library contains more than 1000 problems that were algorithmically constructed from a collection of introductory sources. Each problem is characterized by the complexity of its solution and by the fundamental intellectual steps found in the solution. Evaluation construction, administration, and analysis tools are provided through the library's website. Problems may be downloaded for use in exams or as clicker questions. Instructors may also design and administer conceptual evaluations online. There is no cost associated with using any of the facilities of the site.

*Supported by NSF- DUE 0535928.

PST1-14: 3:15–3:45 p.m. Teaching Electromagnetism from a Relativistic Viewpoint

Roberto B. Salgado, Dept. of Physics, Mount Holyoke College, 50 College St., South Hadley, MA 01075; rsalgado@mtholyoke.edu

Jammer & Stachel (1980)[1] suggested that a Galilean-invariant theory of Electomagnetism [formulated by Le Bellac & Levy-Leblond (1973)][2] can be used as a stepping stone in a new pedagogical approach to teaching Lorentz-invariant electromagnetism. We present a formulation of this idea in the context of Spacetime Trigonometry, a new geometric-framework for teaching relativity.

1. M. Jammer, & J. Stachel, "If Maxwell had worked between Ampere and Faraday: An historical fable with a pedagogical moral," *Am. J. Phys.*, **48**(1), (1980) 5-7.

2. M. Le Bellac, & J.M. Levy-Leblond,. "Galilean electromagnetism," *Nuovo Cimento*, **14B**, (1973) 217-233. (For Spacetime Trigonometry, refer to http://www.aapt-doorway.org/Posters/SalgadoPoster/SalgadoPoster.htm)

PST1-15: 7:15–7:45 p.m. Teaching Relativity with Pictures (Spacetime Diagrams)

Roberto B. Salgado, Dept. of Physics, Mount Holyoke College, 50 College St., South Hadley, MA 01075; rsalgado@mtholyoke.edu

We present two new approaches for teaching relativity with Minkowski Spacetime Diagrams. 1) We present an animated visualization of the proper-time elapsed along an observer's worldline. Using the textbook storyline of the Michelson-Morley experiment (interpreted with light-clocks), we construct the spacetime paths of light-rays associated with this experiment. These paths mark off intervals of proper-time in units of ticks, where each tick is intuitively visualized as the intersection of the future light-cone of one tick-event with the past light-cone of the next tick-event. 2) We present a unified formalism for two-dimensional Euclidean space, Galilean spacetime, and Minkowski spacetime. Beginning with a unit circle for each of the three geometries, we use familiar techniques from the analytic geometry and trigonometry of Euclidean space to develop the corresponding analogues for Galilean and Minkowski spacetimes and immediately provide them with physical interpretations. We envision a physics curriculum in which the ideas of relativity are introduced early and gradually developed.

PST1-16: 3:15–3:45 p.m. Gaining Physical Insight and Independence in the Modern Physics Laboratory*

Mark F. Masters, Dept. of Physics, Indiana University Purdue University Fort Wayne, Fort Wayne, IN 46805; masters@ipfw.edu

Timothy Grove and David P. Maloney, Indiana University Purdue University Fort Wayne

Imagine you are investigating new physics with tools that you have never used previously and you have to reproduce results achieved by many others. How would you proceed to acquire the data? What would you learn in the process if you were given fairly detailed directions? This is the dilemma faced by many students in the modern physics laboratory. Students only have their introductory laboratory experience to guide them through more difficult investigations involving much more complex physics. Rather than having students perform a series of unrelated classic modern physics investigations, we developed an approach to the modern physics laboratory course that involves conceptually focused investigations to help the students through these difficulties and improve their understanding of physics, experimentation and independence. The conceptually focused investigations typically start with an "introductory physics like" analog of the"modern physics" phenomenon they are to investigate. The subsequent investigations build upon these concepts.

*Supported by NSF DUE #0127078

PST1-17: 7:15–7:45 p.m. Very Very Simple Construction of a Spherical Air Bearing

Mark F. Masters, Indiana University Purdue University Fort Wayne, 2101 Coliseum Blvd., E., Fort Wayne, IN 46805; masters@ipfw.edu

Clint Reynolds

Hans Suedhoff

Mike De Armond

We present a very simple method of constructing a spherical air bearing for use in student laboratories. The method consists of casting the bearing out of polyester resin and requires tools no more complex than a drill press. A single air bearing can be constructed for less than $25. Frictional effects indicating that the drag is proportional to the angular velocity and an investigation of precession are used to demonstrate the functionality of this bearing.

PST1-18: 3:15–3:45 p.m. Contemporary Physics Experiments for a Redesigned Physics Curriculum

Roberto Ramos, Drexel University, 3141 Chestnut St., Philadelphia, PA 19104; rcr32@drexel.edu

Michel Vallieres and Somdev Tyagi, Drexel University

We have developed a series of contemporary physics laboratory experiments for a redesigned introductory physics series of courses for engineering students at Drexel University. For nearly 15 years, physics was taught under a specialized engineering curriculum called TDEC with a laboratory component that used the black-box approach. In 2006, the physics department redesigned the physics curriculum so that both lecture and laboratory emphasized conceptual understanding and unity of physical concepts across different topics. To prepare students for the 21st Century, the curriculum was infused with modern physics topics at an early stage. New freshmen physics experiments were developed, including measurement of the speed of light, spectroscopy of quantum dots, and quantum tunneling using an STM. New lab write-ups featured a pedagogical pre-lab and a "Just for Fun" section where students explore physics through "playing" and guided exploration. Student surveys and diagnostic tests show that this approach has been effective. http://www.pages.drexel.edu/~rcr32/Phys101/Phys_101_highlights.pdf

PST1-19: 7:15–7:45 p.m. Good Use for a Bad Ruler

Alan J. Scott, University of Wisconsin-Stout, 103G Science Wing, Menomonie, WI 54751; scotta@uwstout.edu

Students often have difficulty understanding and applying the concepts of experimental inaccuracies and instrument calibration. These concepts are also called measurement precision and accuracy. The goal of this research is to use distorted rulers to probe students' mastery of basic measurement skills and help them learn about experimental inaccuracies. It also serves to advance their understanding of instrument calibration.

PST1-20: 3:15–3:45 p.m. Robotics as a Context for Teaching Engineering Physics

Martin S. Mason, Mt. San Antonio College, 1100 N. Grand Ave., Walnut, CA 91789; mmason@mtsac.edu

Robotics provides an exciting context for teaching introductory engineering physics. A robot provides systems that require the integration of content from mechanics, thermodynamics, E&M, optics and several topics from modern physics. Engineering students enjoy the opportunity to apply physics content to robots that they design and build.

PST1-21: 7:15–7:45 p.m. Spectrum Analysis Method Using Two-beam Michelson Interferometer

Kwangmoon Shin, Seoul National University, San 56-1, Sillim-dong, Kwanak-ku, Seoul, Korea 151-748; manga6@snu.ac.kr*

Youngchang Kang, Seoul National University

Sungmuk Lee, Seoul National University

We studied spectral analysis of various sources using interference fringe pattern. For this, we made interference fringe using the Michelson interferometer. We obtained the fringes by digital CCD sensor. And analyzing those fringes with fourier transform, we could get their spectrum information. Especially we used two sources. One source was He-Ne laser for optical ruler, and the other was sample source for spectral analysis. By this configuration, we acquired spectral distribution of sample source by only one measurement so easily, and the result was robust regardless of irregular movable mirror motion. Moreover the Michelson interferometer was consisted like the Lego block system—it was easy to assemble the system for students.

*Supported by Science Education for the Next Society, Seoul Natioinal University's BK2.

PST1-23: 7:15–7:45 p.m. Adapting a Photoelectric Effect Lab for the First-Year Laboratory

Jennifer Blue, Miami University, 133 Culler Hall, Oxford, OH 45056; bluejm@muohio.edu

Mark Fisher, Miami University

The first-semester physics laboratory for scientists at Miami University encompasses quantum physics. It is a challenge to construct a laboratory about the photoelectric effect before students have learned circuits! We have adapted a photoelectric effect laboratory exercise for the first-year laboratory. The apparatus will be presented, as will student results and student reaction to the lab exercise.

PST1-24: 3:15–3:45 p.m. Michelson Interferometer with Simple Movable-Mirror-Scanning-Apparatus for Applying to Undergraduate Laboratory*

Youngchang Kang, Seoul National University, San 56-1, Sillim-dong, Kwanak-ku, Seoul, 151-748; riverowindow@hanmail.net

Kwangmoon Shin and Sungmuk Lee, Seoul National University

The interferometer has been used to explain explain waves and optics in the classroom. By receiving the interference fringe pattern, and doing Fourier transform to the result, we could analyze the spectrum of light. In this study, we focus on the movable mirror of a Michelson interferometer, because it had been known that it's important to constitute adequate movable-mirror-scanning-system for acquiring precise spectrum. When we used a servo motor for moving the mirror, there existed irregular motion and backlash. And when we used PZT to scan the mirror, it was enough stability to measure, but it was expensive, so it's difficult to use for experiments for undergraduate students. Therefore, we made simple and cheap movable-mirror-scanning-apparatus of Michelson interferometer. We composed an interferometer that is used for the undergraduate laboratory, and analyzed performance of the system.

*Supported by Science Education for the Next Society, Seoul Natioinal University's BK21.

PST1-25: 7:15–7:45 p.m. Moessbauer Spectroscopy and Photoluminescence Investigations on Diamond Carbonados

Robert N. Jones, Morgan State University, 1700 East Coldspring Ln., Baltimore, MD 21251; robertjones1988@gmail.com

Ernest C. Hammond and Eugene Hoffman, Morgan State University

An analysis of diamond carbonados found in parts of the Central African Republic shows that the material consists of many elements including iron. The material examined is extremely hard and comes from Bangu, Central African Republic. One of the unanswered questions is: Does the material come from outer space or is it a part of the natural processes occurring on Earth? Magee, in his doctoral thesis submitted to the Australian National University, indicated the presence of the iron minerals hematite and goethite and suggested that some of these carbonados diamonds may have formed on impact with the Earth by meteorites. Both American and Russian scientists have disputed the impact theory because of various temperature and pressure considerations. Moessbauer spectroscopy is a very useful tool in distinguishing the iron components in materials. Preliminary analysis indicated that magnetite (Fe3O4) was a major iron component. This investigation extends those studies using more detail computer modeling on the data to look for the presence of additional iron minerals. Moessbauer spectroscopy and photoluminescence studies on diamond carbonados will be discussed in detail during this presentation.

PST1-26: 3:15–3:45 p.m. Location: Construction of an Inexpensive Copper Heat-Pipe Oven

Timothy T. Grove, Dept. of Physics, Indiana University Purdue University Fort Wayne, 2101 Coliseum Blvd., E. Fort Wayne, IN 46805; grovet@ipfw.edu

Mark F. Masters, Indiana University Purdue University Fort Wayne

We present a new, low-cost method of building an all copper heat-pipe oven. Copper heat pipe ovens have several advantages over more traditional stainless steel ovens. They heat up/cool down much more rapidly than stainless ovens which makes the copper version more viable for advanced physics instructional laboratories. Copper ovens are also much lower in construction costs. For our design, the construction parts are available at local hardware and plumbing supply stores, and the assembly techniques employed are simple and require no machining.

PST1-27: 7:15–7:45 p.m. ATE Program for Physics Faculty*

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Dwain M. Desbien, Estrella Mountain Community College

The ATE Program for Physics Faculty is in its third year providing three-day workshops and conferences for two-year college and high school physics faculty. This poster will describe some of the projects that were developed at these workshops/conferences and provide information about some of post-workshop projects developed by the participants who attended.

*Partial funding provided by NSF ATE Grant #0603272

PST1-28: 3:15–3:45 p.m. PTEC.org – The National Science Digital Library Collection on Teacher Preparation

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comPADRE is the National Science Digital Library portal for physics and astronomy education. PTEC.org (http://PTEC.org) is the comPADRE collection for physical science teacher preparation and the Internet home of the PTEC (Physics Teacher Education Coalition) organization. The PTEC collection contains a growing set of resources including articles on teacher preparation, best-practice materials, PTEC conference proceedings, national reports, and teacher recruiting materials. When you registered for PTEC's annual conference, you probably did so through the site. The site seeks to serve a community of institutions dedicated to improving physics and physical science teacher preparation by promoting the sharing of information and by capturing best-practice techniques. We seek your input as to how to better fill the needs of the PTEC community and to distribute the expertise of this community to the world.

PST1-29: 7:15–7:45 p.m. Encouraging Appropriate Beliefs About Science Knowledge in Future K-8 Teachers

Keith Oliver, Grand Valley State University, 1 Campus Dr., Allendale, MI 49401; oliverke@gvsu.edu

One of my objectives in my science classes for future elementary teachers is that my students leave my course viewing knowledge more like a scientist. I have measured student views about knowledge using the EBAPS [1] survey. Initial results showed a decline in student scientific views about knowledge. In response, I made some course modification. Results from the first semester are encouraging. I will present results from several semesters, the changes I made in the course, and discuss implications for the design of future courses.

1. Epistemological Beliefs Assessment for Physical Science (EBAPS).

PST1-30: 3:15–3:45 p.m. Courses Proposed to Teachers at the MTSN

Neva Capra, Natural Science Museum of Trento, Via Calepina 14, Trento, 38100; neva.capra@mtsn.tn.it

The Natural Science Museum of Trento, Italy, offers teachers various opportunities to update their teaching skills, ranging from educational workshops, to thematic conferences held by professionals, to the "Teachers tea": an informal way for teachers to share with colleagues, researchers and educators their best practices. Since to a Natural Science Museum belongs different disciplinary branches, the issues proposed for teacher preparation needs to be as interdisciplinary as possible. In recent years, in collaboration with other institutions, several courses have been offered to teachers to update their knowledge on topics that are part of the physics curricula, i.e. we proposed the physics of sound in an unusual way: Alongside a theoretical presentation, we offered simple hands-on experiments related to the content explained, and links to other disciplines. Physics is indeed a fundamental key to the interpretation of the naturalistic disciplines that use its tools for the construction of their knowledge.

PST1-31: 7:15–7:45 p.m. Recruiting/Retaining Majors in Mississippi: Lessons from Jackson State University

Jacob Clark Blickenstaff, University of Southern Mississippi, 505 Court St., Hattiesburg, MS 39401; jacob.blickenstaff@usm.edu

Mehri Fadavi, Jackson State University

The ethnicity and gender distribution of physics majors has not changed substantially in recent years in the United States in spite of efforts to recruit more women and under-represented minority students. The AIP Enrollments and Degrees Report for 2006 shows that in most Dept.s fewer than 25% of undergraduate physics graduates are female, and nationally fewer than 5% of physics undergraduate degrees are awarded to African Americans. Jackson State University has maintained an approximately even ratio of male to female physics majors in recent years, and graduated four African American female physics majors in 2007. JSU is one of only nine institutions in the country that graduates three or more African American physics majors in an average year. This poster, created in collaboration with JSU faculty, describes the recruitment and retention efforts at JSU, and provides contextual data on physics majors at other institutions of higher education in Mississippi.

PST1-32: 3:15–3:45 p.m. Quantum Physics Should be Taught as a Field Theory

Art Hobson, Dept. of Physics, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

Quantum field theorists have long understood that electrons and other material "particles" are quanta of various matter fields, just as photons are quanta of the electromagnetic field, and that a field quantum is a discrete and irreducible portion (or "chunk," or "bundle") of a field, occupying an extended spatial region. But this understanding has not seeped through to most teachers and textbook writers at the introductory or undergraduate levels. Hence, there is still much discussion and perplexity among students and instructors 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. 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). Each field quantum (each electron) comes through both slits, resolving the paradoxes.

PST1-33: 7:15–7:45 p.m. Photovoltaic Electrolysis

Aaron I. Maitland, Embry-Riddle Aeronautical University, Daytona Beach, FL 32114; maitldb3@erau.edu

Joseph Mosca, Embry-Riddle Aeronautical University

The goal of this project is to explore the feasibility of producing hydrogen gas by using photovoltaics to power electrolysis of water. The first step will be to determine the amount (volume/mass) of hydrogen that can be extracted from a given amount of water. We will also need to determine the optimal amount of current/potential difference needed to extract the hydrogen from the water. Once the electric requirements are determined we can determine the requirements for the photovoltaics.

PST1-34: 3:15–3:45 p.m. Comparing Wind and Solar Alternative Energy Production as a Classroom Project

Lee R. Schreiner, Guilford High School, 5620 Spring Creek Rd., Rockford, IL 61114; lee.schreiner@rps205.com

We are using a 1-kW solar array on the school as a source of comparison to a 3-kW vertical axis wind generator on a building in the neighborhood. Students are studying the factors that influence the amount of electrical power that is generated and looking at the economics of using wind versus solar in a small-scale commercial setting. All data is available on the Internet by browser.

PST1-35: 7:15–7:45 p.m. How Warm Was 2008?

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The data for world temperature has shown a dramatic increase since 1880. How does 2008 stack up? The announced result will be put into the context of the last several decades.

PST1-36: 3:15–3:45 p.m. Every Nation Should Require College Scientific Literacy Courses for All

Art Hobson, Dept. of Physics, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

Research by Jon Miller, professor of Interdisciplinary Studies and director of the International Center for Scientific Literacy at Michigan State University, shows that U.S. scientific literacy courses for nonscience college students pull the United States into second place in international rankings of adult scientific literacy, even despite the poor science scores of U.S. primary and secondary school students as compared with other nations. The far lower adult scientific literacy rankings of most European nations and other industrialized nations appear to be due to the lack of any such college scientific literacy requirement in those nations. Instituting such a requirement in all nations, and improving the quality and quantity of such courses on U.S. campuses, would increase global scientific literacy significantly, arguably doubling Europe's scientific literacy rate. In view of this result and the world's crying need for scientific literacy, physics educators should make physics for nonscientists their top priority.

PST1-37: 7:15–7:45 p.m. Improving Student Motivation by Addressing Societal Problems

Thomas B. Bogue, Northwestern College of Iowa, 529 Arizona Ave., SW, Orange City, IA 51041; tbogue@nwciowa.edu

Physics is often perceived by students as a highly abstract field with little real-world applicability. This can degrade student motivation. In an effort to improve student motivation and actively demonstrate the utility of physics in everyday life, I provided my introductory classes with opportunities to discuss various societal issues involving the physics we studied. At the beginning of a week, students were assigned research on the chosen topic. At the end of the following week, students discussed the issue in a two-hour class. This allowed "hot topics" and societal problems such as alternative energy, Science Debate 2008, and the current economic crisis to enter the classroom. Goals included enhancing student motivation, applying science knowledge and critical thinking to real-world problems, and increasing interest in physics. Learning gains were measured through the use of the CSEM, and student motivation was monitored with frequent class surveys and informal interviews.

PST1-38: 3:15–3:45 p.m. What Do Students in Introductory Astronomy Courses Believe Science Is?

Deborah Hanuscin, University of Missouri, 303 Townsend Hall, Columbia, MO 65203; hanuscind@missouri.edu

Angela Speck and Lanika Ruzhitskaya, University of Missouri

The vision of scientific literacy outlined by AAAS in Science for All Americans extends beyond knowing simple facts and principles, to developing an understanding of science itself. It is insufficient for students to be able to recite theories of science and not know how knowledge claims in science are justified, what counts as evidence, or how theory and evidence interact. Nonetheless, research over the past years demonstrates students K-16 hold misconceptions, not only about content, but about how science works. Identifying these misconceptions and effective ways to address them is critical to developing science literacy within our courses. In this study, we examined the ideas that students enrolled in an introductory astronomy course held about what science is and how scientific knowledge is developed (pre/post), and characterized them according to their coherence with goals for scientific literacy. Implications for effective classroom instruction are identified.

PST1-39: 7:15–7:45 p.m. Using Learner-Centered Strategies to Improve Student Understanding About Stars

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Kentaro Nagamine, University of Nevada, Las Vegas

As faculty increasingly adopt learner-centered strategies for their introductory astronomy classes, it is important to determine whether such strategies are positively impacting student learning. One measure of student achievement that has been adopted is the use of concept inventories to measure changes in understanding of a specific topic over some period of instruction. The Star Properties Concept Inventory (SPCI) was used as a pre/post-test in a lecture-only course during spring 2007 and again in fall 2007 when the instructors incorporated Peer Instruction-style questions and Lecture Tutorials. Initial analysis shows that although pre-test results were not significantly different between the two semesters, post-test results for the fall 2007 semester are statistically significantly higher than those of the spring 2007 offering. This result supports the idea that learner-centered strategies are more effective at supporting student understanding than are traditional lecture-only methods.

PST1-40: 3:15–3:45 p.m. Telescope Related Group Projects in Astronomy 101

Noella L. D'Cruz, Dept. of Natural Sciences, Joliet Junior College, 1215 Houbolt Rd., Joliet, IL 60431; ndcruz@jjc.edu

Since introductory astronomy courses are taken mostly by nonscience majors, it is challenging to keep these students engaged with the astrophysical concepts. Nowadays, several active learning methods such as lecture-tutorials, think-pair-share questions, etc. are being employed to help students learn the material more easily. At Joliet Junior College, we teach around 170 students each semester. In spring '08, we decided to use group projects in addition to lecture-tutorials, think-pair-share questions and ranking tasks to hold students' interest beyond the classroom. We offered two group projects, both of which were related to telescopes to highlight that 2008 was the 400th anniversary of the invention of the telescope. We will present students' reactions to these projects.

PST1-41: 7:15–7:45 p.m. A Peer Instruction Module for Teaching Cosmology

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Christopher M. Siedell, University of Nebraska

Edward E. Prather, University of Arizona

This poster will describe a new module of the ClassAction project focusing on cosmology. Heavy emphasis is placed upon Hubble's law and how the expansion has the same appearance from any vantage point in the universe. Details of the Big Bang are covered including recombination, the deuterium bottleneck, and reasons for nucleosynthesis being limited. Critical thinking is emphasized by asking students to interpret tables of data and diagrams. ClassAction is a collection of materials designed to enhance the metacognitive skills of college and high school introductory astronomy students by promoting interactive engagement and providing rapid feedback. The main focus is dynamic peer instruction questions that can be projected in the classroom. Instructors have the capability to recast these questions into alternate permutations based on their own preferences and formative feedback from the class. The questions can be easily selected from a FLASH computer database and are accompanied by outlines, graphics, and simulations which the instructor can utilize to provide feedback. These materials are publicly available at http://astro.unl.edu and are funded by NSF grant #0404988.

PST1-42: 3:15–3:45 p.m. Hawaii Student/Teacher Astronomy Research (HI STAR)

Mary Ann Kadooka, University of Hawaii Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI 96822; kadooka@ifa.hawaii.edu

Michael Nassir, University of Hawaii Institute for Astronomy

Catherine Garland, Castleton College

James D. Armstrong, University of Hawaii Institute for Astronomy

This HI STAR program, a one-week summer camp, equips middle and high school students with research skills and background to conduct original astronomy research projects. The students passionate about astronomy are recruited through the mini-workshops held on all islands during the school year. These motivated students thrive on physics/astronomy lectures and image processing, photometry and light curve lessons. They work with astronomer mentors on comet, asteroid, galaxy, variable star, and extrasolar planet group projects using image data sets. They do remote observing with two meter Faulkes Telescope on Haleakala, Maui, and 16-inch DeKalb Observatory Telescope in Auburn, IN. We will highlight the projects that students continue to work on and were entered in the 2008 Science Fair as well as upcoming ones for 2009. Our network of astronomer mentors, teacher advisers, and student participants has been developing for a few years to ensure exemplary astronomy research projects.

PST1-43: 7:15–7:45 p.m. The Center for Astronomy Education Great Lakes Regional Teaching Exchange

Michael C. LoPresto, Henry Ford Community College, 5101 Evergreen, Dearborn, MI 48128; lopresto@hfcc.edu*

The NASA/JPL Center for Astronomy Education (CAE) http://astronomy101.jpl.nasa.gov/ is dedicated to the professional development of instructors of introductory astronomy through workshops and the exchange ideas and experiences. The Great Lakes Regional Exchange (GLRE) of the CAE, founded at a workshop in in Dearborn, MI, in 2007 has recently formed a partnership with the Michigan Section of the AAPT, functioning as its "Astronomy-arm." A workshop and paper session were run parallel to sessions at the MiAAPT Spring 2008 meeting at Western Michigan University, more collaboration is being planned for the Spring 2009 meeting. The goal of the poster will be to disseminate information about the CAE and its Regional Exchanges and to encourage the GLRE's partnership with the MiAAPT to serve as a prototype for other such collaborations and to possibly serve as a focal point for discussions among GLRE members who may be in Chicago about future plans.

*Author is the Coordinator of the NASA/JPL CAE Great Lakes Regional Teaching Exchange and a Past President of the MiAAPT Section.

PST1-44: 3:15–3:45 p.m. A Model for Observational Astronomy Courses

Gregory A. Topasna, Virginia Military Institute, Dept. of Physics and Astronomy, Lexington, VA 24450; TopasnaGA@vmi.edu

Observational astronomy courses have the unique challenge of incorporating the complimentary pedagogical aspects of daytime lectures and nighttime observations. The challenge to overcome is the nature in which four-credit hour science courses are typically taught—lecturing for three credit hours with a one-credit hour lab each week. The fluid nature in planning astronomical observations is such that maintaining the typical four-hour lecture/lab paradigm is untenable. The observational astronomy course taught at Virginia Military Institute follows a model that overcomes both the static nature typically encountered in lectures and sporadic nature of observations by incorporating an extensive number of hands-on exercises intimately related to the observational and data reduction aspects of astronomy. The result is that students are actively engaged in learning and knowledge sharing that increase a student's confidence of knowledge in observational astronomy.

PST1-45: 7:15–7:45 p.m. Ideas for the Daytime Astronomy Teacher

Rosa M. Villastrigo, Johns Hopkins University Center for Talented Youth, 5801 Smith Ave., Suite 400, Baltimore, MD 21209; rosa.villastrigo@jhu.edu

Vince Bonina, Johns Hopkins University Center for Talented Youth

How do astronomy instructors incorporate labs into a daytime course? For more than a decade, Johns Hopkins University's Center or Talented Youth (CTY) has offered a very successful and popular summer astronomy course to gifted seventh through 10th grade students that involves very little nighttime observation. This poster describes the activity-based approach used by CTY instructors, including sample syllabi, texts, labs, and other materials.

PST1-46: 3:15–3:45 p.m. Using Student-Accesible Digital Cameras for the R-athon.

Rich DeCoster, Niles West High School, 5701 W. Oakton St., Skokie, Il 60077; ricdec@niles-hs.k12.il.us

Most students have access to digital cameras. The R-athon was developed during my work at the ARCS program at Yerkes Observatory. In the R-athon the student learns the constellations and the location of the R-variable star within the constellation. The student studies the variable and determines when it is bright enough to be photographed. The goal is to acquire the greatest number of pictures of R-variable stars. Also the students should take pictures of the constellation when the R-variable is not visible to the camera. In the process the student will also acquire a curiosity about variables, and one hopes, extend themselves in this topic.

PST1-47: 7:15–7:45 p.m. NevadaSat: Student Projects in Aerospace Science & Engineering

Daniel Loranz, Truckee Meadows Community College, 7000 Dandini Blvd - RDMT 321L, Reno, NV 89512; dloranz@gmail.com

Jeffrey LaCombe and Eric L. Wang, University of Nevada, Reno

NevadaSat offers students hands-on experiences in aerospace science and technology through a combination of projects in high-altitude ballooning and high-powered rocketry. NevadaSat projects have real-world constraints directly analogous to commercial aerospace ventures. In addition, the projects are high impact and generally leave students with positive and lasting impressions.

PST1-48: 3:15–3:45 p.m. Exploring the High Energy Universe with DS9

Doug Lombardi, Chandra X-ray Observatory-E/PO, 515 W. Cheyenne, Suite C, North Las Vegas, NV 89030; dalombardi@interact.ccsd.net

Donna Young and Pamela Perry, Chandra X-ray Observatory-E/PO

The Chandra X-ray Observatory is the most sophisticated X-ray observatory launched by NASA and is designed to observe X-rays from high-energy objects in the universe, such as stellar nurseries, dying stars, supernovae explosions remnants, neutron stars, pulsars, and black holes. Chandra downloads millions of pieces of information to Earth, and to control, process, and analyze this flood of data, scientists rely on computers, not only to do calculations, but also to change data into images. Astronomy students can participate in this analysis process by using the freely available DS9 software, developed by the Chandra scientists. With accompanying tutorials and educational activities, students learn how to use DS9 and turn their computer into a virtual Linux machine. Students are able to access the archived Chandra X-ray data, and use the DS9 software to investigate supernovae and galaxies using analysis tools such as radial profiles, light curves, energy spectra and histograms.

PST1-49: 7:15–7:45 p.m. Student Observations of Open Clusters Using Tzec Maun Telescope

Clint H. Poe, Mission College, 3000 Mission College Blvd., Santa Clara, CA 95054; clint_poe@wvm.edu

We present work on open clusters done by students in an introductory astronomy class at a two-year college. The students took images of the clusters using the remote access AP 206 telescope near Cloudcroft, NM, operated by the Tzec Maun Foundation. The students acquired fits images through Bessel B and V filters. Each set of observations consisted of a standard image to calibrate the filters to standard magnitudes and a cluster image to measure the V and B-V for one cluster. The student groups obtained an HR diagram for their cluster and estimated the distance and age of the cluster. Student groups could then compare their results with other student groups to demonstrate the variation of distance and ages of open clusters. This project is part of our continuing efforts to use actual astronomical data in an introductory college astronomy lab.

PST1-50: 3:15–3:45 p.m. Internal and External Assessments for the Andes Homework System

Brett van de Sande, Arizona State University, School of Computing and Informatics, P.O. Box 878809, Tempe, AZ 8528 -8809; bvds@asu.edu

Kurt Vanlehn, Arizona State University

Andes is an intelligent tutor homework system designed for use in a two-semester introductory physics course. We describe a tightly controlled multi-year study run at the U.S. Naval Academy demonstrating the effectiveness of Andes relative to pencil-and-paper graded homework. We also show how Andes itself can be used to measure student learning, as they solve homework problems. We use a variety of chronometric and accuracy measurements to assess how long it takes students to master concepts, skills, and problem-solving strategies. See http://www.andestutor.org/

PST1-51: 7:15–7:45 p.m. Photonics: Assessing Diverse Students Using Self-Instructional Video in Optics

Pamela O. Gilchrist, The Science House-North Carolina State University, 909 Capability Dr., Research Building IV, Suite 1200, Raleigh, NC 27606; pamela_gilchrist@ncsu.edu

Joyce P. Hilliard-Clark, John C. Bedward, Joy C. Clark, and Kimberly R. Smalls-McDougal, The Science House-North Carolina State University

Imhotep Academy Photonics program address the question of "how to integrate scientific content, student encouragement and parental support to engage minority high school students in physics an area of a national need?" African-American students do not take advanced mathematics and science courses, especially physics, in high school. We measured the instructional impact of a self-instructional video and traditional face-to-face lessons on diverse learners' conceptual understanding of optical physics, mathematics, and computer programming. Thirty-four high school students from 10 N.C. counties participate in 300 hours of inquiry-based optics, laser technology, investigations and externships through the National Science Foundation (NSF) Information Technology Experiences for Students and Teachers (ITEST) Photonics Leaders Program. Upon successful completion, students earn scholarship stipends and are equipped with skills for higher education and the global workplace. One hundred percent of the students attend a four-year university and 80% of the students have a science and mathematics major.

PST1-52: 3:15–3:45 p.m. LivePhoto Physics: Video Analysis Exercises Workshops*

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Priscilla W. Laws and Maxine C. Willis, Dickinson College

Patrick J. Cooney, Millersville University

The LivePhoto Physics Project is creating video clips and classroom-tested video analysis activities that can be used for lecture demos, in-class exercises, labs and homework. A preliminary study showed a gain in learning when selected video-analysis materials were added to an introductory physics course at Dickinson College. The project is offering three-day and one-week LivePhoto workshops for college and university physics instructors at all levels. Participants will learn how digital video analysis can be used in conjunction with physics education research findings to help students overcome learning difficulties. In addition, workshop participants will take part in a large controlled study of the effectiveness of these video-analysis curricular materials at diverse institutions.

*This Project has been supported by National Science Foundation grants 0089380, 0424063 and 0717699
(http://livephoto.rit.edu/)

PST1-53: 7:15–7:45 p.m. Teaching How Things Work Using Clickers, Demonstrations and Videos

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I will describe in detail how I introduced a How Things Work-type course at Drexel University and report the impact of a variety of pedagogical innovations implemented through it. This course, which pioneered the classroom use of clickers at Drexel, was largely successful and influenced the development of a Chemistry analog: Why Things Work. During the course, students were polled with clicker-based questions before and after a physics demo or video to probe for misconceptions and to check learning. An Advanced Technology Module allows for discussion of more contemporary topics that seemed to excite students. More recently, I have used the Wileyplus homework environment to further engage the students through homework. Student surveys, interviews and physics diagnostic tests were fielded at the beginning and at the end of the course. I will present results that indicate increased student engagement and demonstrated understanding. http://www.pages.drexel.edu/~rcr32/htw/phys135.htm

PST1-54: 3:15–3:45 p.m. Teaching 1-D and 2-D Motion with a Digital Camera

Vincent J. Bonina, Johns Hopkins University Center for Talented Youth, 5801 Smith Ave, McAuley Hall Suite 400, Baltimore, MD 21209; vbonina@jhu.edu

A digital camera is a relativity low-cost and reusable experimental tool for observing and recording the motion of objects that can yield accurate quantitative results with proper data analysis. This poster provides examples of observing 1-D and 2-D motion using a digital camera, gathering position and time data from the observations, and analyzing this motion using standard video player software. The poster also provides sample lessons for implementing these experiments in the classroom. These lessons place emphasis on allowing students to design their own experiments and showing them that real physics analysis can be done with everyday technology.

PST1-55: 7:15–7:45 p.m. Accelerometers Everywhere!

Laura M. Nickerson, Beaver Country Day School, 791 Hammond St., Chestnut Hill, MA 02467; physnicks@gmail.com

Accelerometers are found in increasing numbers in students' and teachers' personal electronics—iPods, iPhones and other cell phones, laptops, and video game remote controllers. This data can be gathered and analyzed in a physics classroom without using pricey accelerometers from scientific companies, rather just by using devices that students and teachers are already carrying around in their pockets. Several "apps" are available very inexpensively through the iTunes Store for the iPod Touch and iPhones; these applications can be used to access the data from the accelerometer in the iPod or iPhone. Free software can be downloaded from the Internet for Wii remote controllers as well. These sets of data can be used to analyze a car's motion, a golf swing, a roller coaster ride—the possibilities are endless! Come and play with some accelerometers that you may already own and explore their use in your classroom.

PST1-56: 3:15–3:45 p.m. Open, Online, Physics Homework Forums: The Wave of the Future

Brett van de Sande, Arizona State University, School of Computing and Informatics, P.O. Box 878809, Tempe, AZ 8528-8809; bvds@asu.edu

Carla van de Sande, Arizona State University

Homework assignments provide students with an opportunity to practice solving problems as they apply concepts taught in the classroom. However, if students are unable to complete problems on their own, then the potential benefit of a homework assignment is lessened. Open, online, homework-help forums are websites where students can post questions from their coursework. By participating in these homework forums, students have access to more knowledgeable peers and experts who voluntarily provide help and encouragement. In this poster, we explore one such forum, www.physicsforums.com, that hosts thousands of tutoring exchanges each month. We collected a month's worth of tutoring exchanges for introductory physics homework. We analyze the participation structure of the exchanges by tabulating conversational turns, giving insight into the social interactions that occur. We also qualitatively analyze the exchanges based on the quality of the instruction and the sophistication of the pedagogical approaches employed by the tutors.

PST1-57: 7:15–7:45 p.m. The Laboratory Wiki: Using Drupal to Foster Student Collaboration

Michael G. Nichols, Creighton University, 2500 California Plaza, Omaha, NE 68178; mnichols@creighton.edu

Keeping a scientific notebook to document experimental observations is a fundamental skill taught to students in all of the sciences. In the last decade, there has been a significant shift from paper to electronic documentation in many disciplines. Given this, and the degree of student enthusiasm over web-based online communities, we have started a pilot project to evaluate how this new technology might be used to enhance collaboration in the research and teaching laboratory. Using Drupal, an open-source, modular content management system, we have developed a secure, interactive, online laboratory community. In lab, students login to the laboratory wiki to record observations, tabulate measurements, and document data analysis in individual and/or small-group collaborative notebooks. Any form of digital information can be directly incorporated. Design variations to support research and upper-division laboratory courses will be described, along with comparisons of student work and reactions from the students and faculty.

PST1-58: 3:15–3:45 p.m. Videoconferencing as a Tool for After School Physics Education

Robert A. Lecusay, Laboratory of Comparative Human Cognition, University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093; rlecusay@ucsd.edu

Brian Gravel, Tufts University

Noah Finkelstein, Laurel Mayhew, University of Colorado, Boulder

We examine the use of computer-supported videoconferencing in an after-school physics teaching-learning activity. The activity, part of a multi-institutional physics education research project, involves university physics educators in Colorado using videoconferencing technology to conduct physics lessons with children and young adults at an after-school center located in Southern California. Undergraduates (social science majors) from a local California university visit the center and participate in the activity as mediators between the remote physics educators and the local participants. We detail the social and technical organization of this activity. In particular, we focus on the interactional constraints that emerge from the use of videoconferencing technology, and examine the role played by these constraints in shaping forms of face-to-face and video-mediated communication that promote a shared understanding of the physics concepts introduced in this activity.

PST1-59: 7:15–7:45 p.m. Understanding Statistical Mechanics and Biophysics Using Excel

Peter H. Nelson, Benedictine University, 5700 College Rd., Lisle, IL 60532; pHnelson@ben.edu

A new approach to teaching statistical mechanics and biophysics is presented using the classic two-box system from statistical mechanics as an example. This approach makes advanced physics concepts accessible to a broad audience including undergraduates with no calculus background. Students develop a simple Excel spreadsheet that implements a kinetic Monte Carlo (kMC) simulation algorithm "from scratch." The students discover for themselves the properties of the system by analyzing the simulation output in a directed, activity-based exercise. By changing the number and initial distribution of the particles, students see how the system approaches equilibrium and how system variability changes with system size. A finite difference solution is also implemented in Excel, and students compare its predictions with the kMC results. This approach is quite different from using "canned" computer demonstrations, as students design, implement, and debug the simulation themselves—ensuring that they understand the model system intimately.

PST1-60: 3:15–3:45 p.m. Student and Faculty Views of Cheating

Rudy Michalak, University of Wyoming, 1000 E. University Ave., Laramie, WY 82071; rudim@uwyo.edu

We have evaluated student and faculty perception of cheating for a broad range of situations from plagiarism to honesty in exams. Contributors in the survey were given the opportunity to rank effectiveness of various measures that could be taken against cheating, based on their personal view. The survey sample consisted of the students of a sophomore physics class of 25 (about half engineering majors and half physics majors) and the attendees of a TA training in physical sciences (four physics faculty, 12 new physics and chemistry TAs).

PST1-61: 7:15–7:45 p.m. The Effects of Ultraviolet Radiation on Dusty Plasma

Rachel Chen, Watchung Hills Regional High School, 108 Stirling Rd., Warren, NJ 07059; rachelchen16@gmail.com*

Eric Liu, Watchung Hills Regional High School

Plasmas are used to coat surfaces, including pharmaceutical products and semiconductors, and etch nanometer-sized circuit pathways in microchips, processes which require precision. The dust particles removed during etching become charged in the plasma and contaminate the microchips. This investigation studied the effects of ultraviolet radiation on dusty plasma parameters. The experiment was conducted on a DC argon glow discharge plasma with micrometer-sized silicon dioxide dust in a vacuum chamber with pressures on the order of 100 mTorr. The plasma was exposed to a high- intensity UV light of a wavelength 115-400nm, and the plasma parameters were measured with a Langmuir probe. UV radiation induced photoelectric emission from the particles, decreasing the negative charge of the dust. An understanding of the charging mechanisms and the changes in collective plasma behavior in dusty plasmas could be used to develop methods to improve the surface coatings and prevent contamination.

* Sponsor: Sophia Gershman, Watchung Hills Regional High School

PST1-62: 3:15–3:45 p.m. Fibroblast Growth on Hydrogels with Gradient in Mechanical Stiffness

Arunima Sil, Watchung Hills Regional High School, 108 Stirling Rd., Warren, NJ 07059; sunsetcow16@hotmail.com*

Frank X. Jiang and Noshir Langrana, Rutgers The State University of New Jersey

Tissue-engineering strategies have emerged as alternatives and/or compliments to numerous other therapies that are being developed and implemented to aid spinal cord regeneration. This research investigates the potential of the mechanical stiffness gradient in directing cellular

polarity and growth by employing a polyacrylamide (PAAM) gel. Fibroblasts are grown on the gels with 4-10% (monomer concentration) gradient following the rinsing, functionalization, and protein conjugation. At DIV (days in vitro) 4, fibroblasts are fixed, stained with DAPI for intact cells, and characterized. The effect of the spatially varying mechanical stiffness on cell morphology is examined. The results of this study will provide insight to the implant design for tissue engineering applications.
*Sponsor: Sophia Gershman, Watchung Hills Regional High School

PST1-63: 7:15–7:45 p.m. Water Disinfection Using Electrical Discharge in Gas Bubbles

Meghan Whelan, Watchung Hills Regional High School, 108 Stirling Rd., Warren, NJ 07059; mewhelan@optonline.net*

Kathy George, Christopher Strock, Watchung Hills Regional High School

Electrical discharge in bubbled water has been used for disinfection and decontamination of water. The use of gas bubbles significantly reduces the power consumption. The disinfection standards still present a challenge for the use of the electrical discharge. Electrical discharge in gas bubbles in water produces UV radiation, energetic electrons, ions, and free radicals, such as the strong oxidizers, OH and O. The use of electrical discharge eliminates the need for environmentally dangerous chemicals and results in a multi-level approach to treatment. A new reactor, and a power supply have been constructed, to investigate the possibility of meeting the industry standards for disinfection. The new reactor design improves reactor efficiency and scalability. Escherichia coli are used as model bacteria for this investigation and the treatment conditions are optimized for maximum effectiveness.
*Sponsor: Sophia Gershman, Watchung Hills Regional High School

Session BA: Nuclear and Particle Physics in the Upper-Level Curriculum

Location: F-Ambassador
Sponsor: Committee on Physics in Undergraduate Education
Date: Saturday, Feb. 14
Time: 10 a.m.–12:00 p.m.

Presider: Juan R. Burciaga

BA01: 10–10:30 a.m. Discovering the Quantum Universe

Invited – Marcela Cerena, Theoretical Physics Dept., Fermi National Accelerator Laboratory, MS106, P.O. Box 500, Batavia, IL 60510; carena@fnal.gov

Particle physics is on the verge of important discoveries that will address some of the most fundamental questions of science:
-- The origin of mass of the elementary particles
-- The unification of all the forces, including gravity
-- The explanation of the matter-antimatter imbalance of the Universe
-- The origin of Dark Matter and Dark Energy
I will show ongoing and near future collider experiments, using the Tevatron at Fermilab and The Large Hadron Collider at at CERN, that will re-shape our understanding of the Universe.

BA02: 10:30–11 a.m. Topical Nuclear Science Research at an Undergraduate Institution

Invited – Graham F. Peaslee, Hope College, Chemistry Dept., 35 E 12th St., Holland, MI 49424; peaslee@hope.edu

Paul A. DeYoung, Hope College

Hope College has a concentration of nuclear scientists and a long history of integrating undergraduate research and education. As a result, we operate both an ion beam analysis laboratory and run the Hope College Nuclear Group with NSF funding to do basic and applied research in nuclear physics. This research thrust also results in extensive undergraduate training in nuclear science, which has yielded dozens of graduates entering the STEM workforce over the past decade. While we recruit and train physics majors, we have also broadened our research emphasis to include interdisciplinary projects with significant chemistry, geology, environmental science, and forensic science components. Students from a diverse range of science majors are included in our Nuclear Group, and a variety of topical research projects are provided for the physics program. Examples of recent research projects and their implementation will be presented, as well as an overview of student outcomes.

BA03: 11–11:30 a.m. Big Physics Research and Small Colleges: The Mongol Horde Model

Invited – Bryan A. Luther, Concordia College, 901 8th St. S., Moorhead, MN 56562; luther@cord.edu.*

A collaboration of 10 institutions, including a large number of undergraduate schools, proposed, constructed, and conducted experiments with a highly efficient large-area neutron detector located at the National Superconducting Cyclotron Laboratory. The Modular Neutron Array (MoNA) is designed to detect high-energy neutrons in experiments that explore the neutron dripline using rare isotope beams. The MoNA collaboration serves as a model for involving undergraduates from small colleges and universities in large-scale experimental nuclear physics research at a national user facility. The advantages and challenges of this “Mongol Horde” model will be discussed.
*Sponsor: Juan Burciaga

BA04: 11:30 a.m.–12 p.m. GUTs, TOEs and Stringy Things: Biology or High-Energy Physics?

Invited – Gordon P. Ramsey, Loyola University Chicago, 25311 S. 88th Ave., Frankfort, IL 60423; gpr@hep.anl.gov

The study of high-energy physics (HEP) is fundamental to understanding the basic structure of matter. With the Large Hadron Collider (LHC) in Europe going online, it is timely, state-of-the-art research. A basic understanding of HEP should be included in the undergraduate curriculum. This should include instruction on the fundamental known families of particles and how they interact via the known forces of nature. This is accomplished by understanding the Standard Model in terms of the elements of the theory and how experimentalists test the models proposed by theorists. Coverage of the areas of the current research should include theoretical, phenomenological and experimental aspects of the field, including theories that attempt to unify the known forces. This talk will suggest related topics that can be included at various stages of the undergraduate (and high school) curriculum and appropriate references for each topic.

Session BB: Frontiers in Space Science and Astronomy

Location: F-Regent
Sponsor: Committee on Space Science and Astronomy
Date: Saturday, Feb. 14
Time: 10 a.m.–12 p.m.

Presider: Daniel M. Smith, Jr.

BB01: 10–10:30 a.m. The Cosmic Microwave Background: Cosmic Rosetta Stone

Invited – Michael S. Turner, Kavli Institute for Cosmological Physics/University of Chicago, 5640 S. Ellis Ave., Chicago, IL 60637-1433; mturner@uchicago.edu

The Cosmic Microwave Background (CMB) provides a very clear view of the universe at a simpler time, the time before stars, galaxies and other structures. By studying the tiny variations (parts in a million) in the CMB intensity across the sky which were discovered by NASA’s

COBE satellite, we can learn about how the universe began, what it is made of, its vital statistics (age, shape, speed of expansion, etc.) and even clues about its destiny. I will review what WMAP and ground-based CMB experiments have already revealed about the universe, as well as discussing the exciting future ahead with ESA's Planck mission and plans for even bolder experiments in the future.

BB02: 10:30–11 a.m. PLANCK: Looking Back Toward the Dawn of Time

Invited – George F. Smoot, III, University of California, Berkeley, US Planck Team, Smoot Group, Lawrence Berkeley National Lab, 1 Cyclotron Rd., MS 50-5005, Berkeley, CA 94720; GFSmoot@lbl.gov*

Charles R. Lawrence, NASA / Jet Propulsion Laboratory, US Planck Team Lead Project Scientist

Philip M. Lubin, University of California, Santa Barbara, US Planck Team

Bruce Partridge, Haverford College, US Planck Team

Planck, the third-generation satellite after COBE and WMAP to measure the 2.726-Kelvin Cosmic Microwave Background (CMB), is scheduled to launch in early 2009. Placed in orbit around the Sun-Earth L2 point at a distance of 1.5 million km from Earth, Planck will measure the fluctuations of the CMB, as well as its polarization, with unprecedented sensitivity, angular resolution, and frequency coverage. This will lead to a dramatic reduction in the uncertainties of fundamental cosmological parameters, such as the total mass-energy content of the Universe, baryonic and dark matter densities, and distance to the surface of last scattering, and set constraints on fundamental physics at energies greater than 10^15 GeV. Planck will also produce a wealth of information on the properties of extragalactic sources, as well as dust and gas in our own galaxy. In this talk we will describe the instrumentation, orbit, expected outcomes, and progress of Planck.

*Sponsor: Jatila van der Veen.

BB03: 11–11:30 a.m. Current Status of the Fermi Gamma-ray Space Telescope

Invited – Daniel J. Suson, Purdue University Calumet, 2200 169th St., Hammond, IN 46323-2094; suson@calumet.purdue.edu (On behalf of the Fermi LAT collaboration)*

The Fermi Gamma-ray Space Telescope (formerly GLAST) was launched on June 11, 2008. After a very successful instrument check-out period, the telescope entered its science observation mode. This talk will provide an overview of the LAT and discuss the status and latest results from the telescope.

*Sponsor: Jatila van der Veen

BB04: 11:30–12 p.m. Our Miserable Future

Invited – Lawrence M. Krauss, Arizona State University, School of Earth and Space Exploration, P.O. Box 871404, Tempe, AZ 85287-1404; krauss@asu.edu

In this talk, I will ruminate on the future of the universe itself, and also on the future of life within it, using as my starting point recent observations in cosmology. I will first discuss why the universe we appear to inhabit is the worst of all possible universes, as far as considerations of the quality and quantity of life is concerned. I will then address several fascinating questions that have arisen as a result of our discovery that the dominant energy of the universe resides in empty space.

Session BC: Physics Education Research in High Schools

Location: F-Chancellor
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Research in Physics Education
Date: Saturday, Feb. 14
Time: 10–11:30 a.m.

Presider: John Lewis

The two purposes of this session are (1) for physics education researchers to discuss research that they would like to conduct with high school students and for the researchers to recruit high school teachers with whom they can collaborate, and (2) for physics education researchers to describe research that they have already conducted with high school students.

BC01: 10–10:10 a.m. PUM: Connecting Research on Student Learning with the Pre-college Classroom*

Suzanne White Brahmia, Dept. of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

Hector Lopez, Tara Bartiromo, and Eugenia Etkina, Rutgers

Physics Union Mathematics (PUM) is a new physics curriculum spanning from middle to high school. The physics curriculum is based on the Investigative Science Learning Environment (ISLE) in which students engage in the thought processes physicists use to construct new knowledge. ISLE was found to help students both learn physics and develop scientific abilities at the college level. An important feature of PUM is the development of mathematical reasoning skills from the outset in the context of learning physics. PUM is based on ISLE, made grade-appropriate and infused with grade-appropriate mathematical tools. Starting September 2008, 40 New Jersey teachers are implementing pilot modules of the curriculum. Module design, teacher training, piloting, and assessment of the results are based on the recommendations of the science education, physics education research and research on professional development. We will share the results of the implementation of two modules.

*Sponsored by NSF grant # DRL-0733140

BC02: 10:10–10:20 a.m. Impact of the PRISST Program on Teacher and Student Learning

Jeff Morgan, Dept. of Physics, University of Northern Iowa, 315 Begeman Hall, Cedar Falls, IA 50614-0150; Jeff.Morgan@uni.edu

Lawrence T. Escalada, University of Northern Iowa

The University of Northern Iowa Physics Resources and Instruction for Secondary Science Teachers (PRISST) program, a two-year professional development program for out-of-field high school physics teachers seeking the State of Iowa Grades 5-12 Physics Teaching Endorsement, recently concluded. The PRISST program provided participants with professional development in physics content and pedagogy with a focus on interactive engagement techniques utilizing PRISMS PLUS and Modeling Instruction. The teachers were provided support and resources as they implemented these techniques in their classrooms. Teachers and their students completed a number of conceptual assessments as both pre-tests and post-tests, focusing on physics content, mathematical proficiency, and scientific reasoning. The average normalized change scores [1] and classroom observations were used to analyze the impact of the program on student and teacher learning over a two-year period. Results and insights gained will be shared.

1. Mark & Cummings, "Normalized change," *Am. J. Phys.* **75**(1), (2007) 87-91.

BC03: 10:20–10:30 a.m. Comparing Assessment Formats in Identifying Students' Ideas of Force Concepts

Sharon Schleigh, East Carolina University, Flanagan Bldg. Rm 317, Greenville, NC 27858; schleighs@ecu.edu

This study examined how closely an Interview assessment (IA) and a constructed response assessment (CR) assessed students' ideas about force concepts, comparing how students were coded for force meanings and for consistency in their theoretical structures. Variables included the order of the assessment, the sex of the participants, and the preference of the format. The study includes a comparison of previous studies using similar coding schemes and methodologies. Results suggest that the formats provide the same information in both the cell-by-cell analysis and the overall analysis. There is a possibility of a bias in the CR format by order and the coding for consistency ($p = .76$) and in the interaction between sex and the IA in terms of coding for best-matched-meaning ($p = .066$). This suggests that the CR format can be used to replace the IA format, which is found to be costly and timely in implementing for studies, and nearly impossible to implement in classrooms.

BC04: 10:30–10:40 a.m. False Dichotomies: Are Conceptual Questions Really Easier than Numeric Questions?

Joseph L. Zawicki, SUNY Buffalo State College, 1300 Elmwood Ave., Sc #130, Buffalo, NY 14222-0195; zawickjl@buffalostate.edu

Daniel L. MacIsaac, Luanna S. Gomez, and Kathleen A. Falconer, SUNY Buffalo State College

Timothy Johnson, WNYRIC, Erie I BOCES

We examined select items from recent New York State Regents Physics examinations, including response analyses for more than 1500 student papers. Student response data revealed that conceptual items were among the most difficult, which was an unexpected outcome for several vociferous physics teachers in statewide physics teacher electronic community conversations. The nature of such conceptual questions, their relation to student physics understanding, and implications for physics instruction are described.

BC05: 10:40–10:50 a.m. How a Complexity of Physics Problems Affects Students' Problem Solving

Jungho Choi, Seoul National University, Seoul National University, 599 Gwanakro., Seoul, 151-748; hosu8188@snu.ac.kr

Dongryeol Jeon, Seoul National University

Some conceptual tests were developed to study students' difficulties in physics problem solving. Most of these tests focus on physical concepts only. Concept is the core in solving physics problems. But solving a problem is a complex process that cannot be achieved by concept alone. The more complex problems are in structure, the harder to solve problems. To be used as an indicator of the complexity of a given problem, we define degree of complexity that is based on variables initially given in the problem, variables that are necessary during solving a problem, core concepts and equations. These elements are weighted to define the complexity. We chose mechanical problems of various degree of complexity. The degree of complexity for each problem is highly linear-regressed to the rate of correct answers. But the degree of complexity is not valid to explain the result of conceptual problems.

BC06: 10:50–11 a.m. Secondary Students' Understandings in Diagrams of Standing Waves in Pipes

Jeongwoo Park, Seoul National University, 18-213B San 56-1 Shillim-Dong, Kwanak-Gu, Seoul, Korea 151-747; pjw1006@snu.ac.kr

Junehee Yoo, Seoul National University

Diagrams are one of the main components of textbooks to describe physical phenomena and theoretical models. Diagrams in physics textbooks reflect understandings and models of physicists and physics teachers rather than students' understandings. Standing waves in pipes are not easy to visualize by two-dimensional diagrams in physics textbooks. So, many elements, such as solid line, dashed line, arrow, coloring, and gradations, are used to visualize the physical phenomena in pipes for more understanding by students. In this study, diagrams of standing waves in pipes in 18 physics textbooks are analyzed and the 11th grade students' understanding are investigated.

BC07: 11–11:10 a.m. Proposal on Diffraction of Light Using Online Sensor and Modelling

Alberto Stefanel, Physics Dept., University of Udine, Via Delle Scienze 208, Udine, 33100 Italy; stefanel@fisica.uniud.it*

Marisa Michelini and Lorenzo Santi, University of Udine

Optical physics is a relevant topic in the upper secondary school curricula, in order to recognize the wave behavior of light and to bridge classical and quantum description of the world. Our approach to this topic, aimed to build formal thinking, is based on common life diffraction phenomena and their role in different contexts, for example in art. The interpretation of diffraction patterns is proposed by a phenomenological exploration using online sensor measurement of light intensity distribution, produced by single and multiple slits. Huygen's principle is used for a computer modeling activity aimed to fit the diffraction pattern. A research-based curricular path is developed by using this proposal, on the basis of pilot experimentations in Italian classes.
*Sponsor: Paula Heron

BC08: 11:10–11:20 a.m. Particle Physics Masterclass: Possibility for Learning the Nature of Science?

Michael J. Wadness, Medford High School/UMass Lowell/QuarkNet, 7 Morse Lane, Natick, MA 01760; mjwadness@verizon.net

This presentation addresses the problem of science literacy, focusing specifically on students' lack of understanding about the nature of science. In March of 2009, research will be conducted to determine if QuarkNet's Particle Physics Masterclass provides a fruitful program for students to learn about the nature of science. The Masterclass is a national program where students come to a local area research institute and interact with particle physicists through lectures, informal discussions, and work together to analyze real particle physics data. This presentation highlights the research questions and methodology This research will be done as dissertation research for a Doctorate in Education from UMass Lowell. QuarkNet is funded in part by the National Science Foundation and the Department of Energy.

BC09: 11:20–11:30 a.m. Integrating Modeling and Tutorials into a High School Physics Curriculum

Stephen Kaback, The Blake School, 511 Kenwood Pkwy., Minneapolis, MN 55402; skaback@blakeschool.org

At The Blake School, in Minneapolis, we have created an introductory physics curriculum for the general student population that brings together elements from The Modeling Method of High School Physics (David Hestenes and the Modeling group at Arizona State University) and Tutorials in Introductory Physics and Physics by Inquiry (Lillian McDermott and the Physics Education Group at University of Washington). The general learning cycle for the class uses a model development, concept enrichment, and model deployment approach. In this talk, we will introduce features of the curriculum and discuss assessments methods.

Session BD: Physics and Society Education

Location: H-Regency C
Sponsor: Committee on Science Education for the Public
Date: Saturday, Feb. 14
Time: 11:20 a.m.–12 p.m.

Presider: *Jane Flood*

BD01: 11:20–11:30 a.m. Phascination in Physics — Dr. Donaldson's Haunted Physics Lab

Nancy L. Donaldson, Rockhurst University, 1100 Rockhurst Rd., Kansas City, MO 64063; nancy.donaldson@rockhurst.edu

This presentation will discuss a four credit hour physics course developed at Rockhurst University as a core curriculum liberal arts class for nonscience majors. The course was taught using a hands-on, inquiry-based constructivist pedagogy to teach physics principles in waves and sound, light and color, and current electricity. For the course final, each student developed a project for Rockhurst's Haunted Physics Laboratory, presented the project to more than 300 K-16 students, faculty and visitors, and wrote four conceptual physics questions that were included in the haunted lab manual. One of the major benefits of this course—in addition to it being very fun to teach—was its ability to interest and excite nonscience majors about physics principles. Students were able to "see physics in their world" and apply principles learned in an interesting and "spooky" fashion. Excitement was contagious, the students excelled, and we had a wonderful Haunted Lab!

BD02: 11:30 –11:40 a.m. Engaging Ethics in the Physics Curriculum: Theory, Practice and Assessment?

Jean-Francois S. Van Huele, Brigham Young University, Physics and Astronomy, N151 ESC BYU, Provo, UT 84602-4681; vanhuele@byu.edu

I report on my experience with ethics teaching in the physics curriculum from introductory undergraduate classes to graduate seminars. What works and what doesn't? How much is too little? When are students most likely to be engaged? Does teaching about ethics influence ethical practice? How do you define and how do you measure learning outcomes in the ethics of physics? The information contained in this talk will be original but largely anecdotal, not unlike engaging ethics in the physics curriculum.

BD03: 11:40–11:50 a.m. Infusing Social Topics into Introductory Physics Courses

Art Hobson, Dept. of Physics, University of Arkansas, Fayetteville, AR 72701; ahobson@uark.edu

To be relevant to our larger society, physics education must deal with physics-related social issues. To this end, a few minutes or an entire lecture can be devoted to such issues at appropriate points in physics courses. This is especially true of courses for nonscientists, courses that are flexible and that should surely be presented in a way that is socially relevant for students. Possible topics include the scientific process, the automobile, the steam-electric power plant, exponential growth and population growth, ozone depletion, global warming, the search for extraterrestrial life, pseudoscience including creationism, radioactive dating and the geological ages, biological effects of radiation, risk assessment, the Manhattan project, nuclear weapons, nuclear terrorism, nuclear power, energy resources, energy efficiency, and the energy/environment conundrum. My general physics textbook for nonscientists, *Physics: Concepts and Connections*, incorporates these topics.

BD04: 11:50 a.m.–12 p.m. Teaching About the Nature of Science

James K. Simmons, Shawnee State University, 940 Second St., Portsmouth, OH 45662; jsimmons@shawnee.edu

Calls for science educators to place greater emphasis on teaching about the nature of science (NOS) have come from many corners. Sometimes, these calls are motivated by a desire to improve evolution education, in the belief that a better understanding of NOS increases the probability that a student will accept the theory of evolution. However, aspects of NOS can be, and sometimes are, presented with insufficient care and precision, such that they provide resources the anti-evolution activists can (and do) use to strengthen their arguments. In this talk, I describe two such aspects of NOS, and describe how they can be taught more carefully in the introductory physics curriculum.

Session BE: Interdisciplinary Nature of Teacher Preparation

Location: H-Crystal A
Sponsor: Committee on Teacher Preparation
Date: Saturday, Feb. 14
Time: 10 a.m.–12:10 p.m.

Presider: Dan MacIsaac

BE01: 10–10:30 a.m. A Researcher's Perspective on Teacher Preparation in Chemistry

Invited – George M. Bodner, Dept. of Chemistry, Purdue University, West Lafayette, IN 47907; gmbodner@purdue.edu

Having served on the Council for the American Chemical Society for almost 25 years, the author can provide an overview of the process by which the ACS Committee on Professional Training was created, how the CPT sets standards for undergraduate programs, and how the standards for pre-service chemistry teachers compare with those for B.S. chemistry majors. As someone who has been involved in research in chemical education for almost 30 years, he can provide insight into teacher's reactions to standards-based reform that came from research done in his group. And as someone who has run a research group in which almost 70 graduate students have worked toward M.S. or Ph.D. degrees in chemical education, he can examine some of what we have learned about preparing teachers for careers as faculty in chemistry departments, in colleges of education, or as faculty with joint appointments in both chemistry and education.

BE02: 10:30–11 a.m. Best Practices in Elementary Science Teacher Preparation

Invited – Sandra Abell, Univ. of Missouri Columbia, 303 Townsend, Columbus, MO 65211; abells@missouri.edu

What do elementary teachers need to know and be able to do to be effective science teachers? How can elementary science teacher preparation programs help them to develop the knowledge, skills, and dispositions to teach science? What is the role of the College of Arts & Sciences? What is the role of the College of Education? What is the role of the local schools? This talk will synthesize the research on preparing future elementary teachers and provide examples of best practices in elementary science teacher preparation. The author will use examples from her extensive teaching and research experiences in science teacher learning.

BE03 11–11:30 a.m. The Interdisciplinary Nature of Teacher Preparation

Invited – James A. Middleton, Arizona State University, Box 871011, Tempe, AZ 85287-1011; jimbo@asu.edu

The system of teacher preparation in science and mathematics in the United States is fundamentally wrong. When one takes the needs of business and industry into account with the disciplinary intellectual needs of the STEM fields, it becomes clear that a new kind of knowledge professional is needed. This address promotes a model of STEM teacher preparation reform that builds knowledge of content, pedagogy, and practical application of science and mathematics through engineering design. Briefly, engineering design involves the creation of ostensible products (e.g., technologies, tools, systems, organizations) that solve problems of import to society. In the new economy, such problems will be focused on complex, interacting variables related to sustainability, economics, health and poverty, and other critical systems. To develop professionals with the capacity to apply STEM knowledge and skills in such complex domains, we must redesign teacher preparation programs to produce teachers with these skills. Examples from NSF engineering projects with teachers are used to illustrate these principles and project the new vision of teacher preparation.

BE04: 11:30–11:40 a.m. Teaching Science to Elementary Education Majors Through Problem-Based Learning

Keith Sturgess, The College of Saint Rose, 432 Western Ave., Albany, NY 12203-1490; keith.sturgess@strose.edu

Mary Cosgrove, The College of Saint Rose

The College of Saint Rose is known regionally for its K-6 teacher preparation programs. Historically, elementary education majors have been required to select two science courses on their own. Few selected courses that prepared them for the breadth of science content found in an elementary classroom. To respond to this problem, the college recently developed a two-course science sequence required for all elementary education majors—a first course in physics and chemistry co-taught by a physicist and chemist and a follow-on course in biology and earth science that is also co-taught. This year, the instructors of the first course developed a new curriculum based on the Science Education for New Civic Engagements (SENCER) model. Our course topic was "The High Price of Gasoline," and all the physics and chemistry for the semester was developed around that topic. This presentation will cover our plan, course execution, and some outcomes.

BE05: 11:40–11:50 a.m. Building the STEM Teachers "Community of Practice" Through Learning Academies

Milijana Suskavcevic, University of Texas at El Paso, 500 W. University Ave., El Paso, TX 79912; milijana@utep.edu

Olga Kosheleva, Brian Giza, Laura Serpa, UTEP

The paper explores science education research opportunities in the context of the Learning Academies professional development program. This program has been designed to achieve two major goals: 1) increase the number of in-service secondary math and science teachers in the school districts with MAT degrees and 2) increase secondary level mathematics and science teacher's conceptual understanding of basic STEM topics and their connectivity through experimentation, lesson plan development, and exemplary pedagogy. Several important aspects of the project will be shared with the session participants including the analysis of the integrated lesson plans produced by the disciplinary heterogeneous groups of teachers and uses of technology to build the "community of practice."

BE06: 11:50 a.m.–12 p.m. Physicists on Physics Education

Genrikh Golin, Touro College, 448 Neptune Ave., #15K, Brooklyn, NY 11224; genrikhgolin@yahoo.com

Many physics educators are now seeking ways to improve the system of physics education. In this regard the heritage of the great scientists of the past and the present can prove to be very valuable. Although these outstanding scientists were not dealing with research in the field of education, many of them were excellent teachers and brought forward very interesting ideas about different areas in physics education: the content of school and college curriculum; the correlation between theory and experiment in the science education; creativity and its developing; the usage of history and philosophy of science in teaching; the role of mathematics in teaching physics and many others. We familiarize the students—future science teachers with the pedagogical ideas of famous scientists such as: A.Ampere, N.Bohr, L.De Brogle, A. Einstein, J.Maxwell, M.Planck, I.Rabi, and others.

BE07: 12–12:10 p.m. Funding Opportunities for Physics Teacher Certification Candidates

Daniel L. MacIsaac, SUNY Buffalo State College, 1300 Elmwood Ave.; Sc #222, Buffalo, NY 14222-1095; macisadl@buffalostate.edu

Joseph L. Zawicki, David S. Abbott, and Kathleen A. Falconer, SUNY Buffalo State College

We will contrast a number of large-scale (state and national) initiatives financially supporting (tuition, fees, and real costs) physics teacher certification candidates. We will discuss programs in which our students have participated.

Session BF: Reforming STEM Instruction: An Examination of Four Core Change Strategies

Location: H-Crystal C
Sponsor: Committee on Research in Physics Education
Date: Saturday, Feb. 14
Time: 10 a.m.–12 p.m.

Presider: Noah Finkelstein

BF01 10 a.m.–12 p.m. An Overview of the Four Core Categories of Change Strategies for Reforming STEM Instruction*

Panel – Charles R. Henderson, Physics Dept., Western Michigan University, Kalamazoo, MI 49008-5252; charles.henderson@wmich.edu

Andrea Beach, Western Michigan University

Noah Finkelstein, University of Colorado, Boulder

R. Sam Larson, Kaiser Permanente

Based on an interdisciplinary literature review, Henderson, Beach, Finkelstein, and Larson[1] have proposed four core categories of change strategies used to promote instructional changes in higher education: 1) disseminating curriculum and pedagogy, 2) developing reflective teachers, 3) developing policy, 4) developing shared vision. The four categories are based on the answers to two fundamental questions. Does the change strategy seek to directly impact individuals or environments and structures? Is the intended outcome of the change prescribed or emergent? This talk will provide an overview of the categorization criteria and a description of each category. Subsequent talks in this session will provide a more detailed look at each of the four core strategies in practice from the perspective of the individual presenters.

* Supported, in part, by NSF #0623009 and #0723699.

1. Henderson, C., Beach, A., Finkelstein, N., & Larson, R. S., (2008, June). *Preliminary Categorization of Literature on Promoting Change in Under-*

graduate STEM. Paper presented at the Facilitating Change in Undergraduate STEM symposium, Augusta, MI. <http://www.wmich.edu/science/facilitating-change/PreliminaryCategorization.pdf>.

BF02: 10 a.m.–12 p.m. Disseminating Curriculum and Pedagogy: Peer Instruction

Panel – Eric Mazur, Harvard University, 29 Oxford St., Cambridge, MA 02138; mazur@physics.harvard.edu

I coined the term "Peer Instruction" (and the associated "ConcepTests") to describe a technique I was starting to implement in my class in an NSF proposal I wrote 1991. I implemented the technique to solve a problem in my own class, never anticipating the wide acceptance the technique (and the terms) would find over the course of the next decade and a half. The technique has found a broad following across disciplines, across institutions, and across the world, even if some adaptations stray far from my original ideas. What is it that accounts for the method's rapid dissemination? Does the dissemination of pedagogical innovations require more oversight so as to make sure the original intent is preserved? Or is the adaptability and the ensuing sense of ownership that adopters develop part of the success?

BF03: 10 a.m.–12 p.m. Developing Reflective Teachers: Faculty Learning Communities

Panel – Andrea L. Beach, Western Michigan University, 3430 San Gren Hall, Kalamazoo, MI 49008; andrea.beach@wmich.edu

Milton D. Cox, Miami University of Ohio

One of the most powerful ways to develop reflective teachers is to implement Faculty Learning Communities (FLCs). FLCs are cross-disciplinary communities of 8-12 faculty engaged in an active, collaborative, year-long curriculum focused on helping faculty implement new (to them) teaching approaches. They are more structured and intense than other faculty development approaches, and have yielded measurable changes in participants' instructional practices and attitudes about teaching. This session will present the fundamentals of FLCs, the outcome of data from a national dissemination project, and ways that FLCs can be used to promote change in STEM instructional practices.

BF04: 10 a.m.–12 p.m. Developing Policy for Reforming Engineering Education: The ABET Criteria

Panel – William E. Kelly, American Society for Engineering Education, 1818 N St., NW, Suite 600, Washington, DC 20036; w.kelly@asee.org

New outcomes-based accreditation criteria implemented in 1996 are contributing to measurable positive change in undergraduate engineering education. The current ABET Engineering Criteria, only slightly changed since they were introduced, have already contributed to demonstrable improvement in student outcomes. Most engineering undergraduate programs in the United States are accredited by ABET, Inc. (formerly the Accreditation Board for Engineering & Technology). In the 1980s and 1990s, engineering programs and industry became increasingly concerned with the, then rigid, approach to engineering accreditation and demanded change. ABET responded with outcomes-based criteria built around stakeholder-vetted definitions of the attributes of engineering graduates. ABET commissioned a study of the impact of the new criteria entitled "Engineering Change" which demonstrated that the new Criteria themselves are driving measurable improvement in important student outcomes. This talk will focus on both the positive and negative impacts the Criteria and supporting accreditation procedures have had on engineering education.

*Sponsor: Charles Henderson, Associate Professor, Physics and Science Education,Western Michigan University

BF05: 10 a.m.–12 p.m. Developing Shared Vision: Distributed Leadership

Panel – Jennifer Z. Sherer, University of Pittsburgh, 115 Benefit St., Providence, RI 02903; jzsherer@pitt.edu*

In this talk I explore a core strategy for changing instructional practice in STEM-developing shared vision—by asking, How does distributed leadership theory help us understand how to develop a shared vision of high-quality instruction across an educational organization? Though change is a constant in organizations, the challenge of figuring out how to successfully implement planned change has been a perennial one for both scholars and practitioners. I use a longitudinal case study of an urban K-8 school to examine the role of distributed leadership in developing a shared vision of instructional change. Specifically, I consider two elements of school practice to understand elements of planned change. First, I consider the design and implementation of organizational routines. By exploring the evolution of organizational routines over time, I show how a leadership team shifted instructional practice. Second, I consider the formal and informal social networks that were built around instruction. Interactions facilitate change in schools. An examination of social networks that emerge in school practice provides a window into how shared vision can be built. Finally, I discuss implications for practice through the lens of the Institute for Learning's Disciplinary Literacy in science.

*Sponsor: Charles Henderson

Session BG: Advancing Women in Physics Internationally (Joint Session with AAAS)

Location: H-Grand C North
Sponsor: Committee on Women in Physics
Co-Sponsors: Committee on International Physics Education, AAAS
Date: Saturday, Feb. 14
Time: 10:30 a.m.–12 p.m.

Presider: Luz Martinez-Miranda

BG01 10:30 a.m.–12 p.m. What Influences the Interests of Girls for Physics?

Panel – Barbara Sandow, Free University Berlin, Institute of Experimentalphysics, Arnimallee 14, Berlin, Germany D_14195; sandow@physik.fu-berlin.de

This talk presents some findings, examples of best practice, and recommendations resulting from the workshop "Attracting Girls to Physics" organized as part of the International Conference on Women in Physics, Seoul in 2008. Young people in general want to work with something worthwhile and fulfilling. What this means depends on the culture and social development on their country. How does the interest in physics fit in this picture? Several studies have addressed the question of what it is about physics that makes girls turn away. "Prototypical" physics, envisioned as difficult, hierarchical and objective, is commonly reproduced in classrooms thus undermining the more inclusive physics. The workshop was an excellent opportunity to identify best practices, worldwide. It was agreed that the image of science in general is formed at an early age. For this reason, enabling outreach activities to young children and school-age children, both girls and boys, is a key element. New, successful outreach projects to children below the age of 11 years were reported by several countries. The experiences and the expectations will be discussed.

BG02: 10:30 a.m.–12 p.m. Attracting Girls to Physics and Science Classes

Panel – Catherine A. Massey, Las Cruces High School, 1307 Park Drive, Las Cruces, NM 88005; camassey@zianet.com

The high school classroom is a good place to encourage more participation by girls and minorities in physics and other sciences. This talk will report on similarities and differences among countries in approaches and success in getting girls interested in the "hard sciences" in high school. Some successful strategies have included summer science camps for girls, the presence of female role models and supportive male teachers, classrooms that spark curiosity and provide prescriptive, informational feedback, and positive images of women in scientific careers. Being supportive of girls and minorities and showing students that their abilities can improve over time, with work, are also helpful. Since this symposium is joint with AAPT, having the views of a high school teacher will appeal to a broad audience and translate the ideas into lessons for teachers, curriculum developers, text writers, parents, and those organizing enrichment activities aimed toward attracting girls to science.

BG03: 10:30 a.m.–12 p.m. How Can We Keep and Advance More Women in Physics

Panel – Arthur Bienenstock, Stanford University, Bldg. 160, Room 223, Stanford, CA 94305-2205; arthurb@stanford.edu*

To strengthen the economy, maintain national security, improve the environment, etc., it is vital that the United States maintain a strong science and technology workforce, including physics. Complicating the situation is the fact that white male interest in engineering and the physical sciences has been declining over the last three decades and the nation is expected to face major demographic changes. To maintain the S&T workforce, the United States and other nations must increase the participation of women and underrepresented minorities. This, in turn, requires that department chairs and others in positions of authority to actively encourage their participation. Success will require that there be, and be perceived to be, gender equity in the S&T community. Recommendations of the American Physical Society Gender Equity Conference and the International Conference on Women in Physics will be presented.

•Sponsor: Beverly Hartline

Session CA: Crackerbarrel: Professional Concerns of PER Faculty

Location: F-State
Sponsor: Committee on Research in Physics Education
Date: Saturday, Feb. 14
Time: 12–1:30 p.m.

Presider: Thomas Foster

Session CB: Crackerbarrel: Professional Concerns of Graduate Students

Location: F-Regal
Sponsor: Committee on Research in Physics Education
Date: Saturday, Feb.14
Time: 12–1:30 p.m.

Presider: Mary Bridget Kustusch

Session CC: Two-Year College Crackerbarrel

Location: F-Embassy
Sponsor: Committee on Physics in Two-Year Colleges
Date: Saturday, Feb. 14
Time: 12–1:30 p.m.

Presider: Karim Diff

Session DA: AAPT Plenary – Exciting Research at Fermilab (Joint Session with AAAS)

Location: F-Imperial Ballroom
Sponsor: AAPT
Co-Sponsor: AAAS
Date: Saturday, Feb. 14
Time: 1:30–3 p.m.

Presider: David Cook

—**Niki Saoulidou's** involvement with experimental neutrino physics started in 1996: as an undergraduate from the University of Athens, Greece. He came to Fermilab as a summer student, and started working on the DONUT (Direct Observation of the NUTau) experiment. He received a Ph.D. in 2003 from the Univ. of Athens, Greece, on data analysis for DONUT. The same year, as a Fermilab Post Doctoral Research Associate, he started working on hardware, software, data taking, and analysis for the MINOS (Main Injector Neutrino Oscillation Search) experiment. In 2006, as a Fermilab Wilson Fellow, he started working for the NOvA (Numi Off axis neutrino Appearance) experiment, which will start data taking in 2013. He also actively participated in the developing and planning of future, world-leading, neutrino oscillation experiments at Fermilab for the next decade (decades) to come.

—**Robert M. Roser** earned a Ph.D. in Physics from the University of Rochester, Rochester NY (1994), an MS in Physics, University of Rochester, Rochester NY (1986), and a B.S. in Physics, University of Connecticut, Storrs CT (1984). He has been a scientist at Fermi National Accelerator Lab since 2000. He is CDF Co-Spokesperson (2005 – Present) – This is an elected two year position. CDF is an international collaboration composed of approximately 620 collaborators from 63 institutions and 15 countries. During his tenure thus far, they have made the transition from performing a "first look" at the physics with double the "Run 1" data set to one where they are now publishing with 2 fb-1 datasets and preparing for a large number of 3 fb-1 results this spring. His research in experimental high-energy elementary particle physics focuses on one of the central mysteries in physics: the origin of electroweak symmetry breaking and the mechanism by which fundamental particles are endowed with mass. He has collaborated for the past 12 years on the CDF experiment at Fermilab, where he continues to pursue each of these topics.

—**Michael B. Crisler** received his Ph.D .from the Ohio State University in 1983 and has been a scientist at Fermilab for as long as he can remember. His research interests have included the physics of strange particles, charm particles, and neutrinos, but he has always had a soft spot in his heart for the search for "exotic" particles. Having misspent his youth searching for axions, he is now delighted to be hot on the trail of the elusive particles that make up the dark matter of our universe. He participated in the Cryogenic Dark Matter Search experiment which developed highly specialized ultra cold solid state detectors which have, to date, provided the best sensitivity for dark matter interactions. His current work is focused on the development of a new type of bubble chamber that is a strong candidate to be the leading technology for the next generation of dark matter experiments.

DA01: Exciting Neutrino Physics at Fermilab

Niki Saoulidou, Wilson Fellow, Fermilab PPD/Neutrino; niki@fnal.gov

Saoulidou will discuss the fascinating neutrino story from "birth" to "observation" with emphasis on the phenomenon of neutrino oscillations. Then, he will focus on the tremendous knowledge gained in the past decade from neutrino oscillation experiments worldwide. Finally, he will focus on the remaining open questions in neutrino physics, their importance, and the strategy developed to address them with near- and long-term neutrino oscillation experiments at Fermilab.

DA02: The Fermilab Tevatron Program: Its Accomplishments and Future Aspirations

Robert M. Roser, Fermilab, P.O. Box 500, M.S. 312, Fermi National Accelerator Lab, Batavia, IL 60510; Roser@fnal.gov

The field of particle physics is at an exciting point—the tevatron program is gathering sufficient statistical precision to be able to search for more and more rare processes in our quest for new physics beyond the Standard Model. Furthermore, this program is making a wide range of precision measurements helping us better understand the world we live in. A new discovery may be lurking behind each analysis at the Tevatron. Meanwhile the Large Hadron Collider at CERN is about to take over the leadership of the energy frontier and open new and exciting windows into our world. The only certainty about the future is that it is going to be very interesting. Roser will discuss the Tevatron program, its history, successes to date, and what we hope to accomplish before it is over.

DA03: The Search for Weakly Interacting Massive Particles

Michael B. Crisler, Fermi National Accelerator Laboratory, P.O. Box 500, M.S. 209, Batavia, IL 60510; mike@fnal.gov

There is considerable evidence that approximately 85% of the matter in our universe is an unknown form called "dark matter" which still eludes direct detection. The most consistent explanation holds that the dark matter in our universe is the relic density, left over from the big bang, of an as yet undiscovered weakly interacting neutral elementary particle. While modern particle physics theory provides an abundance of candidate particles, none have been observed experimentally either in particle accelerator or direct detection experiments. The search for experimental techniques that might detect and characterize these new particles is an exciting area of research at Fermilab. While considerable effort around the world has been focused on the development of new detector technologies to search for dark matter interactions, recent work at Fermilab has centered on the revival of a very old technology, the bubble chamber. This new application of an old technique has already increased the reach of our search for dark matter. Recent results, comparison of techniques, and prospects for future searches will be discussed.

Session EA: SPS Undergraduate Research and Outreach

Location: H-Columbus AB
Sponsor: Committee on Physics in Undergraduate Education
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Gary White

EA01: 5:45–5:55 p.m. Zero-G with NASA

Lulu Li, Rhodes College, 2000 North Pkwy., Memphis, TN 38112; lilu@rhodes.edu

Deseree Meyer, Brent Hoffmeister, Rhodes College

This summer, in NASA's Microgravity University Program, we successfully achieved the world's first purely binary orbit between two oppositely electrically charged spheres in weightlessness. Weightless conditions were achieved aboard a specialized C-9B NASA aircraft that flies in a parabolic trajectory. This presentation will describe the Microgravity University program and show video of our experiment performed in flight.

EA02: 5:55–6:05 p.m. Expanding Science Education Through Astronomy Outreach

Robert T. Arn, Millikin University, 25 Medial Place, Decatur, IL 62521; barn@millikin.edu

Daniel R. Miller, Millikin University

This talk will highlight the astronomy outreach activities presented by the Society of Physics Students at Millikin University. Over the past two years the group has presented to more than 3000 people in the local communities and various national and foreign outreach. This talk will share ideas on how to get students to participate in these activities and market them in a way to get the public to participate. In particular we will show content on engaging the public on astrophotography, cosmology, and star lore.

EA03: 6:05–6:15 p.m. Fighting Wrong Beliefs

Kevin H. Thomas, University of Central Florida, 1000 NW 40th Dr., Gainesville, FL 32605; kevin.h.thomas@gmail.com*

Pseudoscience is a growing threat to scientific research and public support of science. Physics In Films is a general education course at UCF that promotes science literacy and debunks science misunderstandings and popular pseudoscientific claims. Data were collected via interviews, surveys, essays, and overall student performance. The results of the data gathered were compared against similar NSF findings. Overall, the consensus on the belief of pseudoscientific claims resembled that of the national surveys. However, student performance and essays show the course to be quite successful at persuading students to start questioning ideas presented to them as proven and stop accepting popular claims based only on anecdotal support.

*Advisor: Costas Effthimiou , Univ. of Central Florida-Gainesville

EA04: 6:15–6:25 p.m. Detection of Berry's Phase in a Josephson Junction Phase Qubit

Anthony Tyler, Drexel University, 427 N. Union St., Philadelphia, PA 19104; at792@drexel.edu

Roberto C. Ramos, Drexel University

When a quantum mechanical system prepared in one of its eigenstates is varied slowly and returned to its initial conditions, the state gains a geometric phase factor (Berry's phase) in addition to a dynamical phase. We discuss how to derive Berry's phase in a current-biased Josephson junction using a sequence of high-frequency signals. From this, we propose an experiment to measure the Berry's phase of the two-level artificial atom through NMR techniques and quantum state tomography.

http://www.physics.drexel.edu/research/lowtemp/

EA05: 6:25–6:35 p.m. SOCKs and Summer Camps

Jenna K. Smith, Rhodes College, Rhodes Box 2496, 2000 North Parkway, Memphis, TN 38112; smijk@rhodes.edu

A large focus of the Society of Physics Students is outreach, both in undergraduate institutions and in the community. Each year, the Society of Physics Students summer interns develop and put together the SPS Outreach Catalyst Kit, or SOCK. The theme of the 2008 kit is "Makin' Waves" and it includes three topics: polarization, sound waves, and reflection and refraction. Each topic uses fun toys such as long springs, Boomwhackers®, and Jell-O® to engage college students and school children alike. Development of the SOCK is complemented by working with the summer camps at the Materials Research Science and Engineering Center (MRSEC) at the University of Maryland. This talk will present the 2008 SOCK as well a summary of the 2008 MRSEC Summer Camps.

EA06: 6:35–6:45 p.m. Analytical and Experimental Analysis of Optical Holography

Poster – Eliza K. Grove, Physics Dept., Southeast Missouri State 727 North Sprigg St. Unit B, Cape Girardeau, MO 63701; ekgrove1s@semo.edu*

Va'Juanna Wilson, Southeast Missouri State University

Analytically, we considered Fourier transform and the superposition of two waves in order to study holography. Our experiment tested various methods of producing holograms, ranging from transmission to reflection and double beam exposures. Our experiences showed us that reflection holograms produced the most efficient and clear exposures. Also, the He-Ne laser worked better than the diode laser. We also found that shorter exposure times produced the most defined holograms.

*Mentor: Jai Dahiya, Southeast Missouri State

Session EB: Best Practices in Recruiting and Retaining Women and Minorities in Physics

Location: H-Columbus CD
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Women in Physics
Date: Saturday, Feb. 14
Time: 5:45–7:25 p.m.

Presider: Kathleen Falconer

The number of women and minorities in physics has increased in the last decade. This increase has been the result of many different factors including the increased number of students taking physics as well as improved recruitment and retention of underrepresented groups. Current best practices in recruitment and retention will be examined.

EB01: 5:45–6:15 p.m. Seemingly Fair Practices in Science that Disadvantage Women of Color

Invited – Angela Johnson, St. Mary's College of Maryland, 18952 E. Fisher Ave., St. Mary's CIty, MD 20686; acjohnson@smcm.edu

Black, Latina, and American Indian women are underrepresented in the sciences; in 2001, they made up less than two percent of employed Ph.D. scientists. This talk will explore how the culture of science is closely aligned with the cultural skills of white middle class men. Using data from an ethnographic study of 19 women science majors of color at a predominantly white Research I university, discussion will address some of the teaching practices and cultural values which, despite the stated intentions of some science professors to retain women students of color, served to benefit white students and male students at the expense of the women in this study. The discussion end with what high school teachers and college professors can do to better prepare women of color to survive this culture as well as to dismantle unintended barriers in their own classrooms.

EB02: 6:15–6:45 p.m. Improving Learning for Underrepresented Groups in Introductory Physics for Engineering Majors

Invited – Suzanne White Brahmia, Dept. of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854; brahmia@physics.rutgers.edu

The Extended Physics program at Rutgers University has been successfully improving the learning and degree completion of students from groups underrepresented in STEM majors (science, technology, engineering and mathematics) for nearly 20 years. This talk will target what we are doing to address the issues known to contribute to the low representation of women and some ethnic minority groups in STEM professions. We present examples of our diversified learning activities and assessment that include an added focus on mathematical and scientific reasoning. We will present information on the assessment instruments we've developed that help us measure whether or not we are reaching our goals.

EB03: 6:45–6:55 p.m. Challenging Diverse Female Students to Pursue STEM Careers

Joyce P. Hilliard-Clark, The Science House-North Carolina State University, 909 Capability Dr., Research Building IV, Suite 1200, Raleigh, NC 27695; hilliard_clark@ncsu.edu

Pamela O. Gilchrist, John Bedward, Joy C. Clark, Kimberly C. Smalls-McDougal, The Science House-North Carolina State University

Historical data indicates African Americans do not take advanced mathematics and science courses, especially physics, in high school. Therefore, we are using a variety of strategies for providing instruction in leadership, experimentation, research writing, communications, and scientific presentation to work with students, families, and teachers in promoting selection of and academic achievement in challenging science and physics courses. Seventy-five African American students with more than 56% being females are participating in year-round Photonics programs at The Science House on N.C. State University's Centennial Campus. Students from 16 counties in North Carolina learn about fiber optics, communications, and the properties of light. Imhotep Academy Photonics programs address the question of how to integrate scientific content, student encouragement, and parental support to engage minority high school students to experience success in Science, Engineering, Technology and Mathematics STEM areas of national need.

EB04: 6:55–7:05 p.m. Effectiveness of a Preparatory Course on At-Risk Freshmen's Physics Performance

Sara J. Rose, University of Illinois, Urbana-Champaign, 1110 West Green St., Urbana, IL 61801; sararose@uiuc.edu

Gary Gladding, University of Illinois, Urbana-Champaign

We designed and implemented the physics component of an on-campus summer preparation program for "at-risk" incoming freshmen. Enrollment in the six-week program is limited to 40 students from urban schools and low-sending counties whose students have traditionally struggled with maintaining satisfactory grades and enrollment in engineering majors. The physics course is designed to help students acclimate to the rigor and content of required college-level physics courses. Course activities aim to foster appropriate epistemological beliefs and attitudes, and skills including self evaluation, comprehension and generation of graphs, symbolic manipulation, comprehension and interpretation of word problems, problem-solving strategies, and productive group work. Content covered includes trigonometry, vector analysis, constant velocity and acceleration, relative motion, free-fall and projectile motion, and centripetal acceleration. We will present analysis of student performance from pre-to-posttest and of subsequent physics performance.

EB05: 7:05–7:15 p.m. Lessons from the Rickover Summer Experience for High School Students

Derrick Svelnys, Rickover Naval Academy, 5900 N. Glenwood, Chicago, IL 60660; dmsvelnys@cps.edu

Kim Lister, Susan Fischer, Argonne National Laboratory Physics Division

For the last three years we have organized a one-week physics summer school at Argonne National Laboratory for high school students from Rickover Naval Academy, a selective enrollment high school in Chicago with a large minority population. The school has many facets; "hands-on" experiments, visits to laboratory facilities, science lectures, discussion of scientific careers, and report writing. The school is aimed at showing students the possibilities of science careers at all levels, and linking the science they learn in class to cutting-edge research topics. We are still learning from the students how to best achieve these goals. Development of the school course content and feedback we have received will be discussed. The program expanded to chemistry this past year and we are looking to expand into biology in the future. This research was supported by the DOE Office of Nuclear Physics under contract DE-AC02-06CH11357.

EB06: 7:15–7:25 p.m. Improving Enrollment of Women in Introductory Physics Courses

R. Steven Turley, Brigham Young University, N308 ESC, Provo, UT 84602; turley@byu.edu

Stephanie Magleby, Brigham Young University

We redesigned the format of our introductory calculus-based physics course to increase the number of women choosing to explore physical science, engineering, or technology as a career. Changes included integrating the course in a supportive community with good social connections, adopting a more cooperative teaching/learning strategy, presenting an opportunity to explore interests before committing to a major, preventing students from feeling stigmatized or isolated, and providing professional role models. With these changes, enrollments increased from a handful of students to 38% of the class. We will present data from focus groups, surveys, interviews, and student performance to identify what made the course appealing to women students and what contributed to their success.

Session EC: Capstone Experiences and Required Upper-Level Projects

Location: H-Columbus EF
Sponsor: Committee on Physics in Undergraduate Education
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Ernest Behringer

EC01: 5:45–6:15 p.m. Sustaining the Growth of a Successful Undergraduate Physics Program

Invited – Gubbi R. Sudhakaran, University of Wisconsin - La Crosse, 1725 State St., La Crosse, WI 54601; sudhakar.gubb@uwlax.edu

The University of Wisconsin-La Crosse's well-known undergraduate physics program revitalization has led to phenomenal growth in the number of majors. To sustain growth and further improve quality for our program, the department has developed and aggressively marketed an essential undergraduate research experience and implemented an assessment-oriented capstone course. The undergraduate research experience is instrumental in attracting and retaining quality students to the program and attracting extramural support for research projects. UW-L physics majors participating in undergraduate research publish papers in peer-reviewed journals, present papers at national conferences, and receive national awards. The capstone course directly measures our program goals with a suite of tasks; the physics Major Field Test, a faculty-created Math Skills Test, a Fermi Questions Test, and communications assignments, both written and oral. This data-driven assessment dictates effective changes to our curriculum. The success of these initiatives is evident from our sustained growth and excellence.

EC02: 6:15–6:45 p.m. Capstone Birth Pangs

Invited – Gary S. Chottiner, Dept. of Physics, Case Western Reserve University, Rockefeller Building, Cleveland, OH 44106-7079; gsc2@po.cwru.edu

The Case Western Reserve University Department of Physics began requiring senior research projects for all our majors in the mid-1990s. Before that, these projects were available only to students who excelled in their earlier coursework. The resulting evolutionary and revolutionary changes in the nature of the projects undertaken by our majors and in the mechanisms used to manage our senior project program will be described. An archive of projects and descriptions of some of our policies can be found at http://www.phys.cwru.edu/undergrad/Senior%20Projects/. The CWRU faculty recently made capstone projects a requirement for all undergraduate students. This requirement was phased in over several years and this year's graduating class will be the first for which all students must complete a capstone. The Department of Physics program served as a model for the institutional capstone, although there were some additional issues that surfaced and which will be be described.

EC03: 6:45–6:55 p.m. Highlights of BYU Undergraduate Capstone Experiences

R. Steven Turley, Brigham Young University, N308 ESC, Provo, UT 84602; turley@byu.edu

Jean-Francois S. Van Huele, Branton Campbell, Eric Hintz, Brigham Young University

Over the past 15 years, BYU has focused on three elements of its undergraduate capstone experiences that significantly enhance the value of these projects to the students and the department. These elements include publishing student work, using these experiences as direct evidence for assessment of our undergraduate programs, and effectively managing large numbers of participating students. The nature of these required projects varies according to students' focus on research, applications, or teaching.

Session ED: Computation in Undergraduate Physics: New Developments

Location: H-Columbus GH
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in Undergraduate Education
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Norman Chonacky

The invited speakers will report on progress in computational physics integration into courses at their institutions over the past two years and hold a discussion as a panel.

ED01 5:45–7:15 p.m. An Integrated Mode of Computational Physics Instruction

Panel – Kelly R. Roos, Bradley University, 1501 West Bradley Ave., Peoria, IL 61625; rooster@bradley.edu*

This presentation will describe continuing efforts to integrate computational physics topics into their "natural habitat" in the upper-level Statistical Mechanics and Thermodynamics course in the physics department at Bradley University. I will also describe my recent attempt to "evangelize" one of my colleagues in the department and his reaction; that is, I will describe my attempt to try to get someone with absolutely no previous experience with computations to do this cool stuff in his course too.

*Norman Chonacky

ED02: 5:45–7:15 p.m. Lessons We Learned Adding Computation to Our Curriculum

Panel – Marty Johnston, University of St. Thomas, M.S. OWS 153, 2115 Summit Ave., St. Paul, MN 55105; mejohnston@stthomas.edu

We have reworked our courses to integrate computational skills throughout the curriculum. Initially, we focused on revising the content of our existing physics courses. It was a departmental effort, with experts in computation sharing ideas and techniques with their colleagues to strengthen all courses. Our upper-level courses now have an added computational focus and many of our introductory courses do as well. The efforts to reform computation pedagogy in physics have spilled into other areas. This past year an interdisciplinary group of faculty from engineering, physics, and computer science, redesigned the introductory computing course required of our respective majors into a workshop approach. Material is presented in a just-in-time manner with a multi-disciplined emphasis. Initial offerings of the course have gone well. It is becoming clear that the need for refinement and growth will never cease, but our students increasing computational skills indicate the effort is worth it.

ED03: 5:45–7:15 p.m. Computational Methods at Austin Peay State University, 3 Years Later

Panel – B. Alex King III, Dept. of Physics and Astronomy, Austin Peay State University, P.O. Box 4608, Clarksville, TN 37044; kinga@apsu.edu

Jaime R. Taylor, Austin Peay State University

In 1999, the Department of Physics and Astronomy at Austin Peay State University undertook a major reinvention of its core physics curriculum. The new curriculum incorporated computational methods as a major component. In 2006, we reported on the effects of this restructuring "Using Computational Methods to Reinvigorate an Undergraduate Physics Curriculum".[1] In the three years since, significant changes continue to be made at APSU in the area of computational methods, including a new Governor's School in computational methods, a successful computational research grant from the National Science Foundation, new faculty, and the formation of a formal "computational research group."

1. J. R. Taylor and B. A. King III

Session EE: Best Practices for Teaching With Technology

Location: H-Columbus IJ
Sponsor: Committee on Educational Technologies
Date: Saturday, Feb. 14
Time: 5:45–7:25 p.m.

Presider: Michelle Strand

EE01: 5:45–5:55 p.m. Live Photo Physics Activities and Interactive Lecture Demonstrations*

Maxine C. Willis, Dept. of Physics and Astronomy, Dickinson College, Carlisle, PA 17013; willism@dickinson.edu

Priscilla W. Laws, Dickinson College

Robert B. Teese, Rochester Institute of Technology

Patrick J. Cooney, Millersville University

The LivePhoto Physics Project** team has created a collection of research-based classroom-tested activities for introductory courses that promote active learning through analysis of real world phenomena. These curricular materials are flexible and can be used in lecture demonstrations, as in-class exercises, in tutorials, laboratories and for homework. The set features inquiry-based video analysis exercises and includes investigations in mechanics, electricity, magnetism, heat, thermodynamics, waves, geometric optics and sound. In the assignments, students gather data by pointing and clicking on an object as the event unfolds in a 20- to 30-frame movie. Using the data collected from these "live photos", students develop computer analysis skills in graphing and analytical mathematical modeling. This paper will highlight several activities showing both their breadth and depth. These include examples from mechanics, thermodynamics, electricity, light and waves.

*This Project has been supported by National Science Foundation grants 0089380, 0424063 and 0717699
**(http://livephoto.rit.edu/).

EE02: 5:55–6:05 p.m. Innovative Interactive Lecture Demonstrations Using Wireless Force Sensors

Garett W. Yoder, Eastern Kentucky University, Moore 351, 521 Lancaster Ave., Richmond, KY 40475; garett.yoder@eku.edu

Jerry D. Cook, Eastern Kentucky University

Interactive demonstrations are a powerful new tool to help instructors bring state-of-the-art teaching pedagogies into the college-level introductory physics classroom. We have used the new technology of Vernier's Wireless Dynamics Sensor System (WDSS) to develop three new interactive demonstrations for the first-semester introductory physics (calculus-based or algebra-based) classroom. These three are the Force Board, to demonstrate the vector nature of forces, addition of vectors and the 1st condition of equilibrium; the Torque Bar, to demonstrate the Torque and the second condition for equilibrium; and the Circular Motion Platform (to demonstrate/discover the nature of the acceleration for a object exhibiting uniform circular motion.) With the force sensors, all three of these are easy to set up and use in any classroom or laboratory situation and allow more instructors to utilize the technique of interactive demonstrations.

EE03: 6:05–6:15 p.m. Bringing Technology into Physics Classrooms*

Nouredine Zettili, Jacksonville State University, 700 Pelham Road N., Jacksonville, AL 36265; nzettili@jsu.edu

We want to present ideas on ways of bringing technology to physics classrooms. Ideas to be discussed here were developed while working on an outreach initiative to support a number of school districts in northeast Alabama with ways to improve high school physics education. This initiative is part of Project IMPACTSEED (IMproving Physics And Chemistry Teaching in SEcondary Education), a grant funded by the Alabama Commission on Higher Education as part of the No Child Left Behind (NCLB) act. IMPACTSEED aims at helping high school teachers learn and master the various physics topics. Teachers are offered year-round support through a rich variety of programs, most notably a series of make-and-take technology workshops. Through our inquiry-based, hands-on approach, we have identified a number of ways of bringing technology into physics classrooms. A number of technology projects were developed to show students how physics connects to the technological devices around us.

EE04: 6:15–6:25 p.m. Using Apple's Keynote to Teach Physics

Jeffrey M. Wetherhold, Parkland High School, 2700 N. Cedar Crest Blvd., Allentown, PA 18104; jnlwetherhold@enter.net

Apple's Keynote has allowed integration of homemade cartoons, video footage, Internet links, and animated derivations into physics lectures. A few of the presentations created by the presenter along with some tips on how to create your own will be shared.

EE05: 6:25–6:35 p.m. Model-Based Reasoning on Refraction with Animations

ChihEn Ko, Tamkang University, 151 Ying-chuan Rd., Tamsui, Taiwan 25137; kochihen@mail.tku.edu.tw

Cheng-Chih Chien, University of Toronto

It is now realized that adding old contents in a new technology, such as using animations to reproduce visible phenomena, may hardly be able to promote motivation or learning effectiveness. In this study, the refraction module is designed based on the model-based reasoning approach to help 7th grade students understand the fundamental mechanism as well as explain refraction-related phenomena. The model-based reasoning activity design is composed of three stages. First, use hands-on activities to create a simple causality space in learners' minds. Second, illustrate the fundamental mechanism of system components with animations. Finally, design guiding questions to conduct thought experiments in which learners explore the interaction between the system components and the environments. The learning outcomes are assessed by new scenarios that appear to be unfamiliar to learners but contain the same concepts as learned.

EE06: 6:35–6:45 p.m. Cellphone Science

Kyle Forinash, Indiana University Southeast, School of Natural Sciences, New Albany, IN 47150; kforinas@ius.edu

Raymond F. Wisman, Indiana University Southeast

Science education is necessarily grounded by exploratory laboratory experiments. What if students had a science lab in their pocket every waking moment? An educator's fondest wish is that students explore beyond the classroom; but for the data-driven experimental sciences, scientific exploration requires collecting data that generally requires lab equipment. While the average school lab fits neither a student's budget nor in their pocket, cell phones and gaming systems are a required possession for most. Using such devices, we demonstrate classic physics experiments to show that students have the means to explore science on their own. Further, because the devices fit either in one's pocket or hand, the equipment is both available and mobile, allowing for new types of student experiments. We share the preliminary results of our attempt to create a mobile laboratory from consumer electronic devices commonly possessed by students. We first present a brief overview of the motivation for using cell phone and gaming technology in science experiments, then demonstrate experiments using a cell phone-based sound frequency analyzer and an accelerometer, and close with suggestions for other experiments.

EE07: 6:45–6:55 p.m. Blackberry in Physics at ITESM

Rosa Maria Garcia-Castelan, ITESM Campus Ciudad de Mexico, Calle del Puente 222, Mexico, DF 14380; rmggarci@itesm.mx

Luis Neri, Victor Robledo, ITESM Campus Cludad de Mexico

Francisco Pérez, ITESM Campus Santa Fe

At ITESM, Physics I (Classical Mechanics) is the first course that all engineering students must take. For the 2008 fall semester all students and professors got a Blackberry in which lots of videos and quizzes give a deeper insight of the class. All Blackberry activities were produced at ITESM Campus Ciudad de Mexico and Santa Fe by faculty members and the Virtual University staff. The prons and cons of the Blackberry experience in physics will be shared with the audience.

EE08: 6:55–7:05 p.m. Printable Web Page Application Questions from The New York Times

John P. Cise, Austin Community College, 1212 Rio Grande St., Austin, TX 78701; jpcise@austincc.edu

For the past three years articles from *The New York Times* that have physics applications have been used to inhance student interest in physics. Articles with excellent original graphics are edited into a single Word page. Additional graphics are added to make the physics more understandable. Short introductory remarks are made, questions, hints and answers are given. The web formated word page is uploaded to The New York Times physics applications website: http://CisePhysics.homestead.com/files/NYT.htm .These application questions are easy to access and print by students for extra credit. I use these web applications as introductory examples for a physics concept to be taught. The applications are mostly in: mechanics, materials, heat, and waves. These single webpages make good quiz and test questions in indruductory physics. 250 pages exist. Students enjoy these web-accessable current physics application pages from *The New York Times*.

EE09: 7:05–7:15 p.m. Tips, Tricks, Successes and Failures with Video Homework Solutions

Eric Ayars, California State University, Chico, Campus Box 202, Dept. of Physics, Chico, CA 95929-0202; ayars@mailaps.org

For the last several years the presenter has been providing video-based homework solutions for some fraction of the problems in his introductory course. These have been provided to the students via both web-based Quicktime videos and video-podcasts through iTunes. Student response to these videos has been overwhelmingly positive. Some of the tools I use to create these videos, and some of the surprising discrepancies between student responses and actual student use, will be presented.

EE10: 7:15–7:25 p.m. Is Andes Getting Better? The Evolution of a Homework System

Brett van de Sande, Arizona State University, School of Computing and Informatics, P.O. Box 878809, Tempe, AZ 85287-8809; bvds@asu.edu

The Andes intelligent tutor homework system has now been used in the classroom since 2000. One question that arises for any teaching practice, and especially one that involves a complicated technology, is whether it improves with time. How well does it scale to more topics and more problems? Is the quality of instruction improving? Is the student experience better? To address these questions, we look at a variety of metrics to see how Andes has changed over the years.

See http://www.andestutor.org/

Session EF: Unconventional Labs

Location: H-Columbus KL
Sponsor: Committee on Laboratories
Date: Saturday, Feb. 14
Time: 5:45 –7:15 p.m.

Presider: Kathleen Falconer

EF01: 5:45–6:15 p.m. Connecting Theory and Experiments with Computer Models

Invited – Ruth Chabay, Dept. of Physics, NC State University, Box 8202, Raleigh, NC 27695-8202; ruth_chabay@ncsu.edu

Bruce Sherwood, NC State University

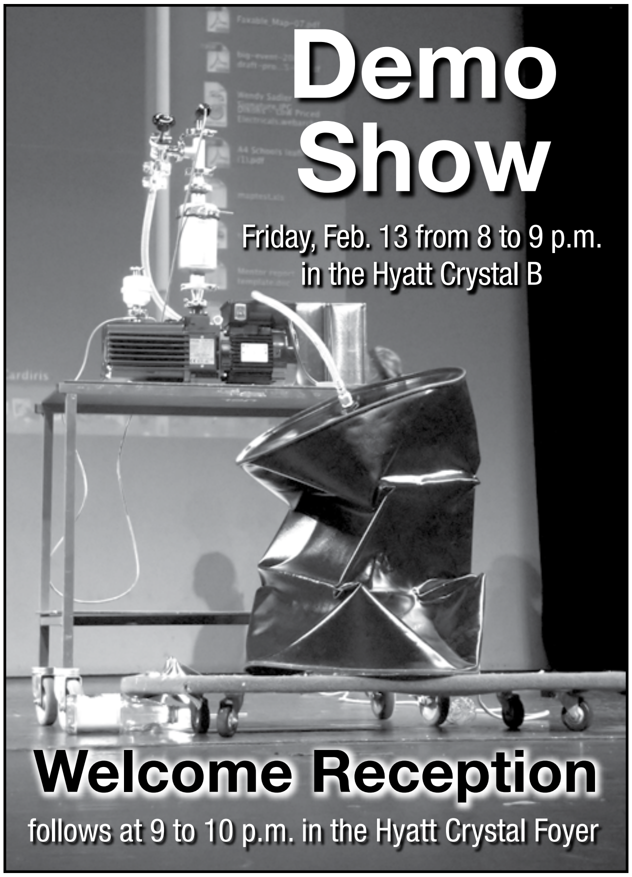
In introductory calculus-based physics courses using the *Matter & Interactions*[1] curriculum, students learn to write small computer programs to model the behavior of physical systems, starting from fundamental physics principles, rather than from secondary derived formulas. By incorporating their own experimental data into these computer models, students can compare model predictions to their own laboratory observations. Such comparisons can easily extend to non-ideal systems which cannot be analyzed analytically by students at this level, such as mass-spring systems affected by viscous friction and moving objects affected by air resistance. Building computer models also allows students to explore "what-if" scenarios such as the motion of a spacecraft near a planet and a moon, or the trajectory of a positron in an electromagnetic wave.

1. R. Chabay and B. Sherwood, *Matter & Interactions,* 2d Ed., Wiley, New York (2007).

EF02: 6:15–6:45 p.m. Design Principles for an Effective Laboratory Environment

Invited – Valerie K. Otero, University of Colorado, 249 UCB, Boulder, CO 80309; valerie.otero@colorado.edu

The Physics and Everyday Thinking (PET) Curriculum is based on five design principles derived from research on how people learn. These principles include cognitive and socio-cultural aspects of learning and learning environments. In the PET laboratory environment, students collect and interpret phenomenological and model-like evidence using laboratory apparatus and computer simulators and use this evidence to make and support claims in small groups and whole class discussions.



There is no textbook used for the course, instead, students are expected to create the main physics ideas through the process of consensus and evidence-based argumentation. Special "Learning About Learning" activities are embedded throughout the curriculum. In these activities, students make claims about their own learning, about scientists' learning, and about younger students' learning. This presentation will describe the design principles, course structure, and learning environment and will discuss the effectiveness of the course on students' learning and attitudes about science.

EF03: 6:45–7:15 p.m. Large Lecture Theater In-Seat Experiments for Introductory Physics

Invited – Daniel L. MacIsaac, SUNY Buffalo State College, 1300 Elmwood Ave., Sc #222, Buffalo, NY 14222-1095; macisadl@buffalostate.edu

We present and discuss examples of short qualitative and quantitative hands-on activities for teaching introductory mechanics, electrostatics and optics. These activities are designed to provide students with direct experience to physics phenomena and to support student discourse and investigation of phenomena within the many restrictions of a lecture setting.

Session EG: Innovations in Biophysics

Location: H-Grand A
Sponsor: Committee on Minorities in Physics
Co-Sponsor: Committee on Women in Physics
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Juan R. Burciaga

EG01: 5:45–6:15 p.m. Force Transmission in Living Cells

Invited – Margaret L Gardel, University of Chicago, 929 E. 57th St, GCIS E233, Chicago, IL 60637; gardel@uchicago.edu

The ability of individual cells to sense and generate mechanical force is essential to cellular physiology and can profoundly affect the health of entire organisms. Adherent cells generate traction stresses on their surrounding extracellular matrix (ECM) to control matrix remodeling and tissue morphogenesis. Proper regulation of these forces is required in development and maintenance of healthy vasculature and cardiac health. While mechanisms of force generation at the molecular level are established, our understanding of how these forces are variably transmitted to cellular length scales by the cellular cytoskeleton is largely unknown. A major constituent of the cytoskeleton is a semi-flexible biopolymer, F-actin, that is bundled and cross-linked into networks by a large variety of actin-binding proteins (ABPs). To elucidate the mechanisms of force transmission through the F-actin cytoskeleton, we study the mechanical properties of and dynamics F-actin networks both in vitro and in vivo. In vitro F-actin networks exhibit a rich variety of elastic behavior that result from the competition of thermal and enthalpic effects. In vivo, we have identified that movement of F-actin is utilized to regulate the magnitude of force that cells exert on their surrounding extracellular environment. Thus, these biophysical measurements in vivo and in vitro of living cells contribute to our understanding of the physics of living, biological matter and establish a framework to understand force transmission from the molecular to the cellular level.

EG02: 6:15–6:45 p.m. The Use of Small Angle Scattering for Bio-physics Research

Invited – Jacob Urquidi, Dept. of Physics MSC 3D, New Mexico State University, Las Cruces, NM 88003; jurquidi@nmsu.edu

The X-ray and Neutron Scattering (XNS) group of the Dept. of Physics at New Mexico State University is home to the 10-meter small angle diffractometer that had been the backbone of Oak Ridge National Laboratory's materials scattering group for many years. With its expanded Q-range allowing for samples ranging from 0.5 nm to 300 nm, it is well suited for the study of today's nano-materials and biological macromolecular assemblages. This talk will look at the advantages of small angle X-ray scattering to biological problems and will include current projects involving the use of the 10-meter instrument in my laboratory. The first of these involves the investigation of structural intermediates during the folding process of globular proteins. Of particular interest is understanding the relationship between structure and thermodynamics as a protein unfolds. The second involves an investigation of the morphology of bone. The use of neutrons as a probe will also be discussed.

EG03: 6:45–7:15 p.m. Dynamics of Protein-DNA Interactions

Invited – Anjum Ansari, University of Illinois at Chicago, 845 W. Taylor St., (M/C 273), Chicago, IL 60607; ansari@uic.edu*

The broad aims of this research are to make precise measurements of the constantly fluctuating shapes ("conformations") of biological macromolecules, such as proteins and nucleic acids (DNA and RNA), and to elucidate the role of these fluctuations in biomolecular interactions that are central to biology. An outstanding question underlying gene regulation is how a particular protein recognizes its specific binding site on DNA. Many specific binding proteins bend or kink DNA at these sites, and the protein also undergoes extensive conformational rearrangements. These concerted changes in proteins and DNA are key to the recognition process. To elucidate the molecular mechanism, it is essential to study the dynamics of the conformational rearrangements that lead to the precise recognition. We use laser temperature-jump to disturb the protein-DNA complex, and fluorescence spectroscopy to monitor the conformational dynamics. This technique reveals the dynamics in the submicrosecond-to-millisecond time range, and fills a longstanding void in the biophysical studies of protein-DNA interactions.

*Sponsor: Juan Burciaga

Session EH: Simulating the Universe on Your Computer

Location: H-Grand B
Sponsor: Committee on Space Science and Astronomy
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Kevin Lee

The power of visualization software has recently made huge leaps forward. Tools such as Google Sky, the WorldWide Telescope, Stellarium, and others create many new possibilities in classrooms and informal science activities. This session will illustrate many of these new technologies and provide examples of how they are being used to convey understanding of of the universe.

EH01: 5:45–6:15 p.m. Teaching with Stellarium Software

Invited – Karrie M. Berglund, Digitalis Education Solutions, Inc., P.O. Box 2976, Bremerton, WA 98310; karrie@DigitalisEducation.com

This session will provide a general overview of the features of the free, open-source planetarium software Stellarium, as well as ideas for teaching with the software. Several activities designed for a variety of age groups and astronomy topics will be demonstrated.

EH02: 6:15–6:45 p.m. Using WorldWide Telescope to Explore Hubble's Universe

Invited – Frank Summers, Space Telescope Science Institute, 3700 San Martin Dr., Baltimore, MD 21218; summers@stsci.edu

WorldWide Telescope (WWT) is free astronomy software for browsing the night sky in great detail using diverse methods of exploration. Users can pan and zoom both the sky and planets, view using various observing wavelengths, access image galleries, take guided tours, connect to Internet resources, control telescopes, and more. Most important for the teaching of astronomy is the ability for any user to create and share their own custom astronomy tours. At the Space Telescope Science Institute, we have made the collection of Hubble press release images available through WWT in their correct geospatial context and at full megapixel resolution.

EH03: 6:45–7:15 p.m. Visualizing the Entire Universe

Invited – Mark U. SubbaRao, Adler Planetarium and Astronomy Museum, 1300 S. Lake Shore Dr., Chicago, IL 60091; msubbarao@adlerplanetarium.org

Modern astronomical surveys have led to an explosion of our knowledge of the Universe. Fortunately, our ability to display this information with modern computer graphics hardware has been growing just as fast. There are a number of pieces of computer software that allow the display of vast three-dimensional data sets in venues from the home computer to the planetarium dome. This presentation will enumerate some of the unique scientific visualization challenges inherent in displaying observed cosmological dataset by addressing questions such as: How do we display observed datasets spanning vast cosmological epochs in an expanding universe? What are the effects of redshift distortions? And how do we represent observational effects such as sample masks, incompleteness, and measurement error?

Session EI: Current Directions in Materials Research: Graduate Students Talk to Teachers

Location: H-Grand C North
Sponsor: Committee on Graduate Education in Physics
Co-Sponsor: Committee on Physics in High Schools
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Melissa Eblen-Zayas

Condensed matter and materials physics is a vibrant subfield of physics that can be both imminently practical, addressing alternative energy challenges or aiding in the development of novel electronic devices, while also exploring fundamental questions about the structure and properties of common and exotic materials. The Chicago area, with Argonne lab as well as a number of research universities, is home to much exciting materials research, and this session will highlight four examples. Professor Carlo Segre will provide an introduction, and then session participants will rotate between posters given by graduate students excited to share their current research in condensed matter and materials physics with teachers of all levels.

EI01: 5:45–6:15 p.m. Graduate Students Discuss their Research at the Advanced Photon Source

Invited – Carlo U. Segre, Illinois Institute of Technology, BCPS Dept, Physics Division, Chicago, IL 60616; segre@iit.edu*

The Advanced Photon Source (APS) at Argonne National Laboratory is the premiere structural tool for materials science and physics research in the United States. In this session, we will provide attendees with a flavor for the research being conducted at the APS by giving them an opportunity to hear directly from four graduate students whose research takes advantage of this unique instrument.

*Sponsor: Melissa Eblen-Zayas

Session EJ: Astronomy Labs and Projects

Location: H-Grand E
Sponsor: Committee on Space Science and Astronomy
Date: Saturday, Feb. 14
Time: 5:45–7:15 p.m.

Presider: Jordan Raddick

Incorporating labs into an astronomy project increases student learning, yet astronomy labs offer unique challenges since astronomy is an observational science and since most courses are taught during the day. How do astronomy instructors overcome these challenges? What types of activities are most useful for students? How can labs and projects be used to improve a course?

EJ01: 5:45–6:15 p.m. Putting the Universe in Your Students' Hands: Astronomy Research Projects

Invited – Catherine A. Garland, Castleton State College, Natural Sciences Department, Castleton, VT 05735; catherine.garland@castleton.edu

Mary Ann Kadooka, Institute for Astronomy, University of Hawaii at Manoa

The availability of educational remote observing time on telescopes, coupled with the accessibility of archival astronomical data, has greatly increased our ability to involve students at all levels in authentic astronomy research. We will discuss the approach taken at the Institute for Astronomy (University of Hawaii-Manoa) which combines summer student and teacher programs with on-site and e-mentoring to support students in their research. Projects have included the study of asteroids, the Sun, variable stars, and galaxies. While the majority of our students have been at the high school level, the projects are easily adapted upward to the college level and downward to middle school. The benefits of involving young students in scientific research include sparking their interest in the joys of scientific discovery and encouraging them to consider studying science or engineering in college.

EJ02: 6:15–6:45 p.m. Astronomy LITE

Invited – Kenneth Brecher, Dept. of Astronomy, Boston University, 725 Commonwealth Ave., Boston, MA 02215; brecher@bu.edu

Over the past several years we have developed hands-on (and eyes-on) resources for use in introductory undergraduate astronomy courses as part of "Project LITE – Light Inquiry Through Experiments." These center on geometrical, physical, and quantum aspects of light. A major part of our strategy has been to couple optical materials with JAVA and Flash applets to gives students the chance to do actual experiments concerning geometrical optics, diffraction, fluorescence, phosphorescence, polarization, and other topics by making use of the light emitted from computer screens. We have also developed and tested a "Light and Spectroscopy Concept Inventory." In addition, we have devised more than 200 Flash applets that allow students to directly explore many aspects of visual perception. In this presentation, we will demonstrate a variety of these interactive experiences. All of the software can be found at http://lite.bu.edu. Project LITE is supported by NSF Grant #DUE-0715975.

EJ03: 6:45–6:55 p.m. Construction and Validation of an Alternative Astronomy Diagnostic Test

Stephanie J. Slater, University of Wyoming CAPER Team, 1000 E. University Blvd. (Dept 3374), Laramie, WY 82071; sslater3@uwyo.edu*

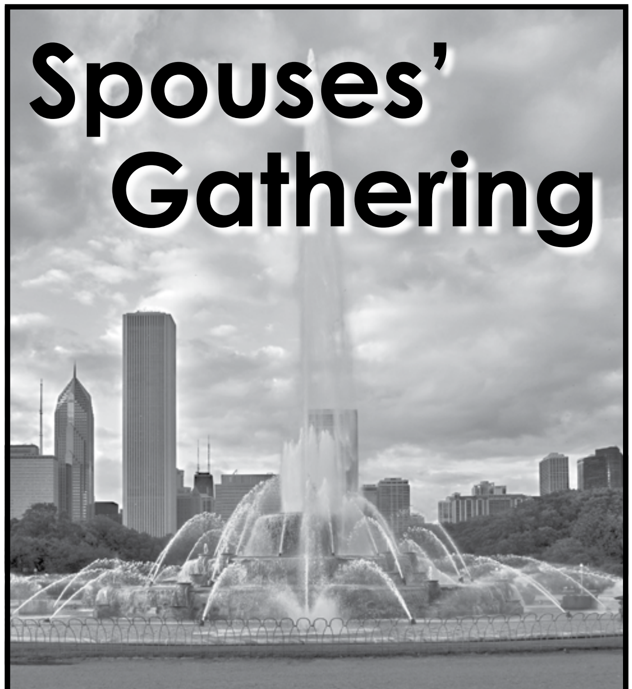
Considerable effort in the teaching and learning of astronomy has focused on developing assessment tools in the form of multiple-choice conceptual diagnostics and content knowledge surveys. This has been critically important for establishing the initial knowledge state of students and measuring impacts of innovative instructional interventions. Unfortunately, few of the existing instruments were constructed upon a solid list of clearly articulated and widely agreed upon learning objectives. Moving beyond the 10-year-old Astronomy Diagnostics Test, we developed and validated (and are in a position to disseminate) a new criterion referenced assessment tool, which is tightly aligned to the consensus-learning goals stated by the AAS Chair's Conference on ASTRO 101, the AAAS Project 2061 Benchmarks, and the NRC National Science Education Standards, called the Test Of Astronomy Standards (TOAST). Through iterative development, this multiple-choice instrument has a high degree of reliability and validity for instructors and researchers.

*Sponsor: T.F. Slater

EJ04: 6:55–7:05 p.m. Assessing the Effectiveness of a Comparative Planetology Activity

Michael C. LoPresto, Henry Ford Community College, 5101 Evergreen, Dearborn, MI 48128; lopresto@hfcc.edu

Different groups of several students each are assigned to plot histograms comparing the values for different properties, mass, radius, density etc., of the solar system's eight planets and Pluto and transfer them to chalk/white boards. Then, guided by a worksheet, students analyze the class's complete set of histograms and attempt to group planets into categories based on similarities and differences in the data. Results of the activity itself and group discussion questions based on it will be reported as well as pre- and post-testing results compared to sections that have not done the activity but received lectures on the topic.



Learn about Chicago
Saturday, Feb. 14, 10 – 11 a.m.
Hyatt, Monarch Ste., E. Tower, 34th floor

Session FA: Oersted Medal Presentation

Location: H-Regency A
Sponsor: AAPT
Date: Saturday, Feb. 14
Time: 8–9 p.m.

Presider: Harvey Leff

George F. Smoot, III

The History and Fate of the Universe

George F. Smoot, III, University of California, Berkeley, US Planck Team, Smoot Group, Lawrence Berkeley National Lab, 1 Cyclotron Rd., MS 50-5005, Berkeley, CA 94720; GFSmoot@lbl.gov

Using our most advanced techniques and instruments, we sift through relic clues and evidence to understand the events surrounding the birth and subsequent development of the universe. A precision inspection and investigation of the Cosmic Scene, along with careful analysis, discussion, and computer modeling, have allowed us to determine what happened over billions of years with amazing certainty and accuracy. Some of the findings are surprising and show shocking twists of plots. There remain even more mysteries to be solved. In spite of that, we can tell the tale of the creation and history of the universe, and show key supporting evidence, some from very early times, to provide a direct image of the embryo universe.

SUNDAY, Feb. 15

Registration 8 a.m.– 3 p.m.
Hyatt, Grand Ballroom Foyer

Early High School Physics Symposium 1:30–3:30 p.m.
Fairmont, Imperial Ballroom

Exhibit Show 10 a.m.–5 p.m.
Hyatt, Riverside Center

Great Book Giveaway 4–5 p.m.
Hyatt, Riverside Center

Session PST2: Poster Session II: Assessment/PER Issues/Miscellany/ Post-Deadline Posters

Location: H-Crystal Ballroom Foyer
Sponsor: AAPT
Date: Sunday, Feb. 15
Time: 8 a.m.–7:45 p.m.

(All authors will be present from 5–6 p.m. and when noted below)

PST2-01: 11:30 a.m.–12 p.m. Student Performance Using Case-Reuse Strategies In Group Learning Interviews*

N. Sanjay Rebello, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; srebello@phys.ksu.edu

Fran Mateycik, Kansas State University

David Jonassen, University of Missouri-Columbia

Case-based reasoning (CBR) is the process of solving a real-world problem based on precedent examples and problems. Case-reuse promotes CBR by employing problem pairs that share similarities in deep structure. We conducted focus group learning interviews with 10 students in an algebra-based class a total of eight times during the semester. Data were also collected from five multiple-choice examinations taken during the semester. The last three questions on each examination were jeopardy, text editing, and problem posing. Our results show a statistically significant difference on some, but not all of these problems between our cohort group and the rest of the class, although there is no statistically significant difference between the cohort group and the rest of the class on the remainder of the exam questions. We will discuss the implications of our results and ongoing plans in this project.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

PST2-02: 8–8:30 a.m. Assessing Case Reuse Strategies Using Contrasting Cases and Text-Editing*

Fran Mateycik, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; mateyf@phys.ksu.edu

David Jonassen, University of Missouri-Columbia

N. Sanjay Rebello, Kansas State University

A cohort of 10 students participated in a semester-long study focused on facilitating case reuse strategies in problem solving. These students were interviewed individually at the mid-point and the end of the semester. These hour-long interviews required students to perform three separate tasks. 1) Rate and explain similarities between eight problem pairs, 2) Identify the principles, equations and irrelevant information in a set of six problems that shared similarities, and 3) Read a challenging problem and determine which problems from the collection used in the similarity task above might be most and least helpful as worked out examples. This poster will report on the results from our individual interviews and general trends among students while working through each of these three tasks, as well as the implications of our results.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

PST2-03: 11:30 a.m.–12 p.m. Applying a Simple Rubric to Assess Student Problem Solving

Jennifer L. Docktor, University of Minnesota, School of Physics and Astronomy, Minneapolis, MN 55455; docktor@physics.umn.edu

Kenneth Heller, University of Minnesota

At Minnesota we have been developing a rubric to evaluate students' written solutions to physics problems that is easy to use and reasonably valid and reliable. This poster gives examples of the rubric's application to student solutions in a calculus-based introductory physics course for science and engineering students. We also examine the rubric's usefulness for different types of problems and solutions that span the multiple physics topics within a first-semester course.

PST2-04: 8–8:30 a.m. Gender Differences in High School Preparation for University Introductory Physics

Jennifer L. Docktor, University of Minnesota, School of Physics and Astronomy, Minneapolis, MN 55455; docktor@physics.umn.edu

Kenneth Heller and Leonardo Santiago, University of Minnesota

This study examines the pre-test results for the Force Concept Inventory, a Math Skills test, and self-reported high school preparation for males and females to determine if they have any predictive power for success in a college calculus-based introductory physics course. Two different classes are examined: introductory physics for engineering and physical science students which is about 20% female and introductory physics for biological science students which is about 60% female. These courses were taught at the University of Minnesota where part of the pedagogy is based on Cooperative Group Problem Solving.

PST2-05: 11:30 a.m.–12 p.m. The Gender Gap on the FCI – Question by Question

Richard D. Dietz, Physics Dept., University of Northern Colorado, Greeley, CO 80639; rdietz@unco.edu

Matthew R. Semak and Courtney W. Willis, University of Northern Colorado

The existence of a gender gap in performance on the Force Concept Inventory has been established by several studies. Those studies have focused on the total score achieved by students on the FCI and subsequent gains in the total score when the instrument is administered again after instruction. Here we use the normalized gain on each of the 30 FCI questions to determine if particular questions present greater difficulty for females. We find that for 90% of the questions males not only perform better but have a greater normalized gain than females.

PST2-06: 8–8:30 a.m. Power Analysis, Effect Size, and What Is Significance Anyway?

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

When effect size first entered into PER, it was treated just like any other statistical test: crunch the formula and interpret the results. However, effect size is more than just another t-test. Jacob Cohen spent part of his professional life trying to raise awareness of the role of power analysis in the behavioral sciences. Effect size does address power concerns, but is one of the four parameters an investigator needs to decide when designing experiments. This poster and available handouts will explain these concepts in more detail and work an example.

PST2-07: 11:30 a.m.–12 p.m. Assessing the Validity of a Standardized Physics Test

Jill A. Marshall, University of Texas, 1 University Station D5705, Austin, TX 78712-0382; marshall@mail.utexas.edu

Eric Hagedorn, University of Texas, El Paso

Jerry O'Connor, San Antonio College

The Texas Physics Assessment Team (TPAT) examined the Texas Assessment of Knowledge and Skills (TAKS) to determine whether it is a valid indicator of the physics preparation needed for future course work and employment, and of the knowledge and skills needed to act as an informed citizen in a technological society. We categorized science items from the 2003 and 2004 10th and 11th grade TAKS by content area(s) covered, knowledge and skills required to select the correct answer, and overall quality. We also analyzed a 5000 student sample of item-level results from the 2004 11th grade exam using standard statistical methods employed by test developers (factor analysis and Item Response Theory). Triangulation of our results revealed strengths and weaknesses of the different methods of analysis. The TAKS was found to be only weakly indicative of physics preparation and we make recommendations for increasing the validity of standardized physics testing.

PST2-08: 8–8:30 a.m. Secondary Students' Understanding in Diagram of Standing Waves in Pipe

Jeongwoo Park, Seoul National University, 18-213B San 56-1, Shillim-Dong, Kwanak-Gu, Seoul, Korea 151-747; pjw1006@snu.ac.kr

Junehee Yoo, Seoul National University

Many textbooks describe one phenomenon with different diagrams. According to Educational Reconstruction Model, students' perspective and analysis of the physics contents are treated with the same relevance. The present study is focused on students' perspective. In this study, students' understanding of different diagrams of standing waves in pipes and the effect of the element of a diagram on students' understanding is investigated. Nine Korean textbooks and nine university physics textbooks are investigated, and about 200 students of the 11th grade participated in this study. The sample students were asked to draw and explain air particles' vibration in a closed pipe after seeing two or three diagrams. The responses were categorized and analyzed by network analysis. Many students did not understand the meaning of line, color, arrow of diagram. This result could suggest that diagrams need detailed captions.

PST2-09: 11:30 a.m.–12 p.m. Who Failed Our Daughters?

Taoufik Nadji, Interlochen Arts Academy, 3552 Faculty Ln., Interlochen, MI 49643; nadjit@interlochen.org

In a first of its kind two-year study, at the high school level, of gender differences in physics performance, the author will present the results of his study. In addition, the author would welcome and greatly appreciate any comments, suggestions, and pedagogical ideas that would help make sense of the puzzling aspects of the results of the study and their validity.

PST2-10: 8–8:30 a.m. Comparison of Conceptual Conflict Collaborative Group Intervention with Peer Instruction

Marina Milner-Bolotin, Concordia University, 350 Victoria St., Toronto, ON M5B 2K3; mmilner@ryerson.ca

Calvin Kalman, Concordia University

Tetyana Antimirova, Ryerson University

There have been proposed some effective ways of eliciting and addressing student misconceptions in the physics "gateway" courses. Two of these teaching methods have been especially popular among physics instructors: peer instruction, as proposed by Eric Mazur, and Conceptual Conflict Collaborative Learning Pedagogy, as proposed by Calvin Kalman. Both methods rely on social interactions in the process of learning, but they are structured quite differently. The goal of the current study is to compare the effectiveness of both approaches in a large lecture setting (N=250 students) in an undergraduate physics course at a large urban university. The poster will present the preliminary findings of the study.

PST2-11: 11:30 a.m.–12 p.m. A Mixed-Methods Comparison of Students' Perceptions in a Large-Scale Setting

Melissa S. Yale, Purdue University, 1201 West State St., West Lafayette, IN 47907; myale@purdue.edu*

Daniel Able, Lynn Bryan, Deborah Bennett, Mark Haugan, Purdue University

The focus of this study was to examine the relationship between students' perceptions of a novel, reform-oriented introductory calculus-based physics course (*Matter and Interactions* by Chabay and Sherwood), and its impact on their attitude toward physics and perceived problem solving abilities. To evaluate the large-scale implementation of the Matter and Interactions curriculum at a major Midwestern university, a mixed-methods model of data collection was used. The Colorado Learning Attitudes about Science Survey (CLASS) was administered pre- and post-semester to collect quantitative data about students' attitudes. Students' open-ended responses to how the course changed their thinking about physics and the most important things they learned in the course were then compared with specific Likert-scale items on the CLASS that relate to conceptual understanding and problem solving. This comparison has implications for assessing students' perceptions and attitudes of novel physics curricula being implemented in large-scale settings.

*Sponsor: Lynn Bryan

PST2-12: 8–8:30 a.m. Supporting Tutorial Teaching Assistants' Buy-in to Reform Instruction

Renee Michelle Goertzen, Dept. of Physics, University of Maryland, College Park, College Park, MD 20742-4111; goertzen@umd.edu

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

Experienced tutorial instructors and developers are well aware that successful implementation includes establishing norms for learning in the tutorial classroom. The teaching assistants (TAs) who lead each tutorial section are important arbiters of these norms. TAs who value tutorials are more likely to convey their respect for the material and the tutorial process to the students, as well as learning more themselves. Professional development programs for TAs typically include activities to help TAs appreciate the power of tutorial instruction. Our research suggests that specific professional development activities are not likely to be effective. Instead, it appears that what we call the "tutorial infrastructure"—including classroom, departmental, and institutional levels of implementation—has the potential to strongly affect the value that TAs attach to tutorials, and probably outweighs the influence of any particular activity that we might prepare for them.

PST2-13: 11:30 a.m.–12 p.m. Studying the Effectiveness of Lecture Hall Design on Group Interactions

Sissi Li, Physics Dept., Oregon State University, 301 Weniger Hall, Corvallis, OR 97330; lisi@onid.orst.edu

Dedra Demaree, Oregon State University

At Oregon State University, we are undergoing 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. The aim of our current study is to see if student discourse during group work is affected by the classroom design. We are observing and recording student groups during group work in the same course with the same instructor but in two different lecture halls. One lecture hall has traditional close-packed tablet arm seating, while the other has swivel chairs, double-row tiers, additional pathways for instructor interaction, and enhanced technology to facilitate instructor mobility. As this project is ongoing, this poster will showcase our research methods and our observation rubric for analyzing student discourse. We will also show details of the lecture hall design and give our preliminary findings.

PST2-14: 8–8:30 a.m. Implementation of The Physics Suite at the University of Central Florida

Dan Maronde, Dept. of Physics, University of Central Florida, UCF P.O. Box 162385-MAP310, Orlando, FL 32816-2385; maronde@physics.ucf.edu*

Enrique Del Barco, Costas Efthimiou, and Tim McGreevy, University of Central Florida

The University of Central Florida Physics Department is in the second year of an NSF CCLI grant. The project is comparing the learning of students taught using various components of The Physics Suite with the learning of students taught with traditional methods. Some of the lecture sections of both Physics I, Mechanics, and Physics II, Electricity & Magnetism, are including Interactive Lecture Demonstrations as part of the instruction. Several of the Lab sections corresponding with Physics I & II are using Real Time Physics. Student performance is compared among four groups: Students who have been taught using both of the applied elements of The Physics Suite, students who have had one component or the other, and students who have learned in a traditional lecture and lab.

*Sponsor: Costas Efthimiou

PST2-15: 11:30 a.m.–12 p.m. Critical Analysis of Embedded Assessment in Large-Scale Curriculum Reform

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Lynn Bryan and Mark Haugan, Purdue University

Our research focuses on the use of embedded assessments to gauge student content knowledge in a reform-based introductory physics course [*Matter and Interactions*, Chabay & Sherwood, Wiley (2007)]. In this study, we examined the characteristics of 39 instructor-generated free-response examination problems using qualitative analysis based on generative and literature-based categories: primary concepts assessed (e.g., fundamental physics principles), secondary concepts or skills assessed (e.g., problem-solving learning goals), level of scaffolding provided, and explication of goal/problem statement. Our analysis revealed several barriers to using these assessment resources: inconsistencies in problem style, structure, and emphasis; inconsistencies in how primary/secondary goals are assessed; and issues with instructor-provided scaffolding. These issues are being addressed through interaction with the instructors to ensure use of examination questions that assess course learning goals. Research methodology for future experiment design will also be discussed. Our results have implications for embedded assessment design beyond the *Matter & Interactions* context.

PST2-16: 8–8:30 a.m. PRISST: Professional Development for Out-of-Field High School Physics Teachers

Lawrence T. Escalada, Dept. of Physics, University of Northern Iowa, 317 Begeman Hall, Cedar Falls, IA 50614-0150; Lawrence.Escalada@uni.edu

Jeff Morgan, University of Northern Iowa

The state of Iowa, like many states, faces a crisis in high school physics education: the shortage of qualified high school physics teachers. The University of Northern Iowa Physics Resources and Instruction for Secondary Science Teachers (PRISST) program addressed the existing shortage by providing professional development for out-of-field high school physics teachers who are seeking the State of Iowa Grades 5-12 Physics Teaching Endorsement. The two-year program included two intensive four-week summer institutes, academic year professional learning experiences and support, and collaboration with master high school physics teachers with the support of school administrators and Area Education Agencies. PRISST provided teachers with professional development in physics content and pedagogy with the focus on interactive engagement techniques utilizing PRISMS PLUS and Modeling Instruction. Teachers were also provided with curriculum and equipment resources as they implemented these techniques in their classrooms. A description of the program and its effectiveness will be provided.

PST2-17: 11:30 a.m.–12 p.m. Results from Physics by Inquiry Professional Development Programs for Teachers*

Robert J. Endorf, Dept. of Physics, University of Cincinnati, P.O. Box 210011, Cincinnati, OH 45221-0011; robert.endorf@uc.edu

Donald Axe, Amy Girkin, and Jeffrey Radloff, University of Cincinnati

Kathleen M. Koenig, Wright State University

Results will be presented from a study on the effectiveness of the *Physics by Inquiry* professional development programs conducted at the University of Cincinnati for K-12 teachers each year since 1996. An evaluation of pre-test and post-test data will be presented that demonstrates that the programs have produced large gains in the teachers' science content knowledge, science process skills, and in the teachers' confidence in their ability to prepare and teach inquiry-based science lessons. The study is based on data collected from more than 400 teachers who have completed one of our Physics by Inquiry Professional Development Programs, using *Physics by Inquiry*[1] modules developed by Lillian McDermott and the Physics Education Group at the University of Washington.

* 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).

PST2-18: 8–8:30 a.m. Lawson Classroom Test of Scientific Reasoning Scores and Student Background

Kathleen M. Koenig, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435; kathy.koenig@wright.edu

Tianfang Cai, Beijing JiaoTong University

Jing Wang, Jing Han, and Lei Bao, The Ohio State University

Although students' general abilities of learning have attracted much attention recently, the relationship between student background and scientific reasoning ability as measured by Lawson's Classroom Test of Scientific Reasoning has not been fully studied. We investigated this relationship for students at multiple grade levels including middle school, high school, and college. Student background was gathered including school type (public vs private), school performance index rating, prior math and science courses taken by the student, gender, and state-mandated student test scores. This poster presents our data and a summary of findings in addition to next steps.

PST2-19: 11:30 a.m.–12 p.m. Examining Student Reasoning About Ratios and Proportions

Andrew Boudreaux, Western Washington University, 516 High St., Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

Stephen E. Kanim, New Mexico State University

It is well known that proportional reasoning is challenging for younger students, and significant time is spent in K-12 mathematics classes working on ratios and proportions. Piaget treated facility with proportional reasoning as an indicator of formal scientific reasoning skills, and believed that there was a relatively sudden transition from concrete to formal reasoning at around age 15. However, many studies of physics students have shown that a significant fraction of college-age students still struggle with proportional reasoning tasks. An alternative explanation for why students struggle with questions about proportional reasoning is that they do not recognize the tasks that are used to measure these skills as being about making sense of proportions. In this view, almost all students have the ability to reason about proportion, but the format of the questions that are asked and of the circumstances in which they are asked does not "cue" appropriate associations. At New Mexico State University and Western Washington University, we have been conducting investigations into the student reasoning about ratios and proportions. In this poster, we present results from these investigations, including data from initial experiments that are intended to distinguish between the two hypotheses described above. Populations involved in the study include students in university physics courses for nonscience majors as well as students in the algebra- and calculus-based introductory physics courses.

PST2-20: 8–8:30 a.m. Applying Scoring Rubrics in Physics Laboratory Experiments

Roel D. Taroc, Siquijor State University, Old Capitol Circle, North Poblacion, Larena, Siquijor, Philippines 6226; wingroe@yahoo.com

This is an output of the Dissertation entitled, "Perceptions on Scoring Rubrics in Evaluating Physics Laboratory Experiments of Students in Siquijor Province: Basis for Utilization." The results of this study have revealed that establishing a standard grading in physics experiments such as scoring rubrics is a necessity to improve performance. Hence, this is hereby recommended to be utilized in evaluating the physics laboratory experiments of students. Students should understand that experimental evidence is the basis of the knowledge of the laws of physics and that physics is not merely a collection of equations and textbook problems. Experts believe that rubrics improve students' end products and therefore increase learning. When teachers evaluate papers or projects, they know implicitly what makes a good final product and why. Developing a grid and making it available as a tool for students' use will provide the scaffolding necessary to improve the quality of their work and increase their knowledge. Scoring Rubrics are powerful tools for both teaching and assessment. It can improve and monitor performance by making teachers' expectations clear and by showing students how to meet these expectations. They are powerful tools for teaching and assessing.

PST2-21: 11:30 a.m.–12 p.m. Dimensional Analysis of Gender Difference in Scientific Reasoning

Tianfang Cai, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; tfcai1998@gmail.com

Xiumei Feng, Central China Normal University

Jing Han, Lei Bao, The Ohio State University

Kathy Koenig, Wright State University

Gender differences in content learning of science and mathematics has been widely studied; however, there hasn't been much large-scale research on gender differences in scientific reasoning. Using the Lawson's classroom test of scientific reasoning, we collected data with more than 10,000 students in China and the United States spanning from 3rd grade to college. In this presentation, we report gender differences of the Lawson test results from students in both countries at different grade levels. Further, we will discuss results of fine analysis of gender differences on different reasoning skills measured by the Lawson test.

PST2-22: 8–8:30 a.m. Item and Skill Dimension Analysis of Scientific Reasoning Assessment Instruments

Tianfang Cai, Physics Dept., Beijing Jiaotong University, No.3 Shangyuancun, Haidian District, Beijing, China 100044; tfcai1998@gmail.com

Jing Han, Jing Wang, Xiumei Feng, and Lei Bao, The Ohio State University

In assessment of students' reasoning, several skill dimensions are commonly measured including proportional reasoning, control variables, probabilistic reasoning, combinational reasoning, deductive and inductive reasoning, hypothesis evaluation, and logical reasoning. In this presentation, we will review items and skill dimensions of popular assessment instruments on scientific reasoning such as the Lawson's test and introduce new questions that we are developing. Measurement results of these questions will be compared in detail. The results will provide guidance on future development of assessment instruments in scientific reasoning.

*Sponsored by Lei Bao

PST2-23: 11:30 a.m.–12 p.m. Teachers' Views on Science Learning and Reasoning

Jing Han, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210-1117; han.286@osu.edu

Tianfang Cai, Lei Bao, Beijing Jiaotong University

Xiumei Feng, The Ohio State University

Kathy Koenig, Wright State University

We have developed a survey instrument to study people's views on the interactions between science learning and reasoning. Qualitative and quantitative results have been collected with teachers and prospective teachers in both the United States and China. The results suggest that people generally believe in a strong interaction between learning in science content and development of reasoning. However, more detailed analysis reveals that experienced teachers have views different from those of others. We will discuss the result and its implications on our current research and future development.

*Sponsored by Lei Bao

PST2-24: 8–8:30 a.m. Validity and Reliability of Lawson's Classroom Test of Scientific Reasoning

Jing Wang, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; wang.870@osu.edu

Jing Han, Lei Bao, and Xiumei Feng, The Ohio State University

Kathy Koenig, Wright State University

Lawson's classroom test of scientific reasoning has received much attention as a useful tool in assessing students' reasoning abilities. Originally designed for students who took biology classes, Lawson's test is now widely used by educators in other disciplines as an instrument for assessment of reasoning. We collected data from different groups of students, which include thousands of students at K-12 and college level, both from China and the United States. We use factor analysis, item response modeling and other traditional statistical methods to analyze the data, and to evaluate the validity and reliability of the instrument.

PST2-25: 11:30 a.m.–12 p.m. Ten Ways to Engage Your Students with Innovative Technology

Brendan P. Noon, Rochester City School District, Edison Tech IIT, 655 Colfax St., Rochester, NY 14519; brendan.noon@rcsdk12.org

Whether you moodle, google, or doodle, technology is an essential part of developing engaging lessons. This poster presentation demonstrates a variety of innovative methods that are being developed into an online physics curriculum (www.sciencewithmrnoon.com). Some of the lessons that will be highlighted on this poster presentation include creating web-based presentations, Flash animations, video webcasting, interactive quizzes, live web conferencing, virtual simulations, online discussions, webquests, and classroom response systems (clickers).

PST2-26: 8–8:30 a.m. Multimedia PreLab Tutorials in Conservation Laws

Homeyra R. Sadaghiani, California Polytechnic University, Pomona, 3801 W. Temple Ave., Pomona, CA 91768; hrsadaghiani@csupomona.edu

To enhance student preparation, efficiency in the lab, and the attractiveness of the introductory laboratory courses, we have developed online pre-lab tutorials using multimedia flash animations. We have employed a variety of different elements such as text, narration, videos, and simulations, to create an interactive environment to increase student engagement. The tutorials provide students with a brief review of relevant physics concepts, familiarize them with new apparatuses, introduce the lab procedures, and offer them immediate feedback through embedded quiz questions and comments. The preliminary impacts of these pre-lab tutorials on student learning, performance, and attitude will be discussed.

PST2-27: 11:30 a.m.–12 p.m.. The Impacts of Intensive Research Experience on Student Understanding and Attitude Toward Physics

Homeyra R. Sadaghiani, California Polytechnic University, Pomona, 3801 W. Temple Ave., Pomona, CA 91768; hrsadaghiani@csupomona.edu

Alex Samll, California Polytechnic University, Pomona

There is a growing trend of inclusion of more research programs into undergraduate education. In spite of that, the assessment of undergraduate-research experience in physics is limited. This presentation describes a 10-week undergraduate summer research experience for two upper-division physics students at Cal Poly Pomona. The analysis of pre-/post-test data suggests more gains on research methodologies and skills than actual physical concepts underling the research project. We also discuss student attitude change measured by survey and interviews.

PST2-28: 8–8:30 a.m. An Old But Effective Technique

Bruce R. Boller, Washington and Lee University, 4 Gaines Ct., Lexington, VA 24450-1865; bboller@rockbridge.net

Typically, physics majors take an intermediate course in mechanics in the sophomore year. Several months usually have elapsed since the students have thought about physics much less having agonized over the solutions to problems. The "Newtonian Mechanics" course at Washington and Lee University provides an ideal setting to bridge the gap between the introductory physics course and upper-level courses. It is here that student behavior is gradually molded into professional behavior. The routine outlined in red italics below is quite effective for class sizes that are moderate such as up to perhaps 12 students or so. Sample in-class getting-started problems are presented.

PST2-29: 11:30 a.m.–12 p.m. An Actual Level of Difficulty of Test Problems and Its Subjective Perception by Students

Valentin Voroshilov, Physics Dept., Boston University, 590 Commonwealth Ave., Boston, MA 02215; valbu@bu.edu

Developing tests (midterms and finals) is an important part of a job every instructor has to do. The transition from introductory to upper-level courses is difficult sometimes because of a significant increase in the difficulty of tests. Should a test be easy or difficult; how do we measure the difficulty of the test; how do students decide if a test was difficult—should faculty even ask these questions? The assessment process is very subjective, but it is a fundamental part of teaching, since, in a way, it shows how good we are at it. To bridge our understanding of what should be assessed and how, we conducted a survey asking students to evaluate how difficult the test problems were from their point of view and comparing the students' responses with (a) an average grade for each problem (shows its actual difficulty), and (b) instructor's opinion. Preliminary analysis shows that students' evaluation of the difficulty of a test problem, as well as provided by faculty, often does not correlate with the actual difficulty level. The poster provides related data.

PST2-30: 8–8:30 a.m. Particle Phenomenology of Gravitational Events at the TeV Scale

Arunava Roy, Dept. of Physics & Astronomy, The University of Mississippi, Lewis Hall, University, MS 38677; arunava@phy.olemiss.edu

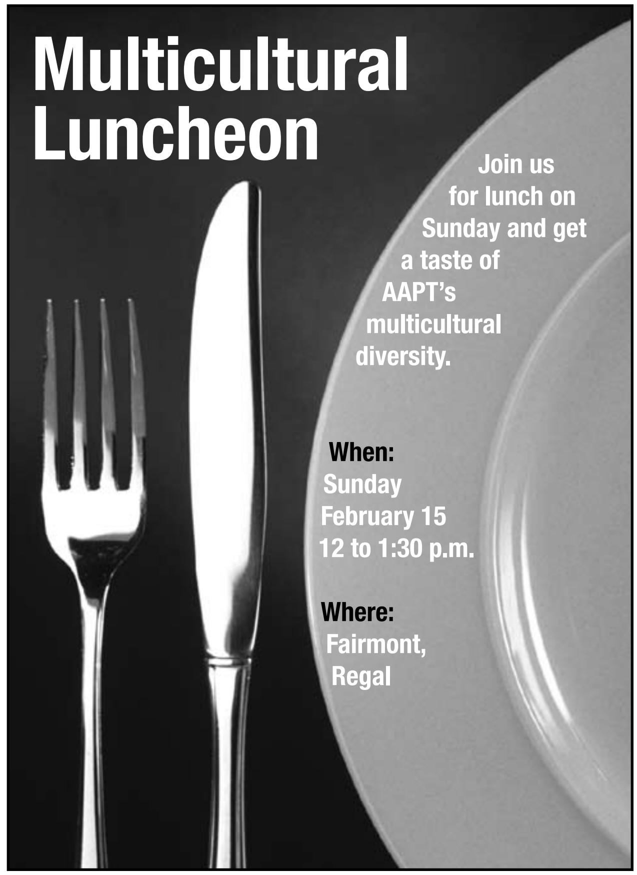
Marco Cavaglia, The University of Mississippi

We show how to differentiate the minimal supersymmetric extension of the standard model (SUSY) from black hole events at the CERN Large Hadron Collider. Black holes are simulated with the CATFISH generator. Supersymmetry simulations use a combination of PYTHIA and ISAJET. Our study, based on event-shape variables, visible and missing momenta, and analysis of dilepton events, demonstrates that supersymmetry and black hole events at the LHC can be easily discriminated. We also discuss how to differentiate BH and string resonances at the LHC.

PST2-31: 11:30 a.m.–12 p.m. Development of Newton's Laws of Motion: Discovery or Invention?

Wheijen Chang, Feng-Chia University, 100 Wen-Hwa Road, Taichung, Taiwan, China 407; wheijen@hotmail.com

Beverley Bell and Alister Jones, The University of Waikato



A review of the history of Newton's laws of motion illustrates the artificial and socialized nature of science knowledge, reflecting the notions of sociocultural views, as well as cognitive and rational endeavors for achieving logical consistency and conceptual coherence, in congruence with the notions of constructivist views. The reflection of both constructivist and sociocultural views challenges the domination of positivist and transmissive commitments reflected by conventional teaching. Three stages of the historical development are discussed, i.e., prior to the *Principia,* the 3rd (last) edition of the *Principia*, and the modern view. The congruence between the historical development and sociocultural views implies that providing sophisticated instruction and engaging students in social interaction/participation are both essential for learners to become familiar with the artificial tools and the ontological and epistemological assumptions of these tools. However, the demand of individual cognition is not overlooked, to achieve better clarification, precision, and coherence in students' conceptual understanding.

PST2-32: 8–8:30 a.m. What a Physics Teacher Learns from Her Teaching

Jiwon Kim, Dept. of Physics Education, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul, Korea 151-742; kjw2333@naver.com

Mihwa Park, Jeongrim Won, and Gyoungho Lee, Dept. of Physics Education, Seoul National University

In Korea, most secondary school teachers teach the same topic to several classes. However, generally, each instruction is different from each other. The purpose of this study was to observe what a physics teacher changed from one class to another class and to understand why she changed. The participant teacher with four years of teaching experience taught "frictional electricity" to six classes in two days, and we videotaped all these lessons. After the lessons, the researchers and the participant teacher watched the videotaped lessons together and discussed what the teacher changed and why these changes occurred. In this study, we found that the teacher modified her teaching practice somewhat because she learned something new, namely "practical knowledge," during her teaching, which she could not expect (or not have) before teaching. We also found that practical knowledge developed during teaching activities affected the teacher's practice in the next classroom.

*This work was supported by the Brain Korea 21 Project in 2008.

PST2-33: 11:30 a.m.–12 p.m. Writing and Peer Review for Advanced Laboratories: A Proposal

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Timothy T. Grove and Stevens Amidon, IPFW

There are a number of significant goals and issues associated with the teaching of advanced laboratories. Faculty teaching advanced laboratories often experience a feeling of isolation. For students, the laboratory is a critical tool for synthesis of the physics knowledge which can be challenging to achieve. Our proposed solution to these seemingly dissimilar issues is a new paradigm for the advanced laboratory that encourages the students to write scientifically, includes calibrated peer reviews, and crosses school boundaries to create a shared mission for faculty. When students write a paper, they submit the article to the journal for review. A reviewer may be a faculty member or another student at another institution. Some of the articles students receive will be calibration articles written by faculty, some will be by students at other institutions. Through this process faculty and students will form communities and students will engage in writing about physics.

PST2-34: 8–8:30 a.m. Visualization and Simulation Capabilities on Modern Computing Hardware

Tad Thurston, Oklahoma City Community College, 7777 S. May Ave., Oklahoma City, OK 73159; thurston@occc.edu

The pace of floating point and graphics computing hardware has, arguably, progressed much faster than physics-simulation software packages designed to take advantage of them. A number of physical situations (Schrodinger solver, N-body particle simulator, spring systems) are simulated in real time along with an interactive visualization of the simulation to estimate rough upper bounds on what can be accomplished in terms of frame rates, polygons rendered, simulation time step and spatial resolution densities, as well as how to estimate the inevitable trade-offs between simulation and visualization calculations. The computing framework uses a compiled language (C++) and the OpenGL (3-D) library.

PST2-35: 11:30 a.m.–12 p.m. Estimations of Electrical Conductivity Above Thunderstorms

Baishali Ray, University of Mississippi, P.O. Box 2812, University, MS 38677; baishali@phy.olemiss.edu

Thomas C. Marshall, University of Mississippi

Electrical conductivity is a fundamental parameter of the upper atmosphere, but it is difficult to measure directly. Many lightning flashes produce transient increases in the electric field (E) above their parent thundercloud. These E transients can be measured with sensors carried above the thundercloud by balloons. In this presentation we combine balloon E data, Lightning Mapping Array data, and radar data to estimate the conductivity above several active small thunderstorms. This paper reports the observation of variations in the electrical conductivity over thunderstorms made in the altitude range from 8 to 13 km for eight Intra Cloud (IC) flashes from three different days in July and August 1999. Our results indicate that conductivity ranges 1.70 x 10^{-13} S/m to 3.20 x10^{-13} S/m over the thunderstorm for our data. Our results are in good agreement with [Holzworth et al., 1991].

PST2-36: 8–8:30 a.m. Estimating Thunderstorm Generator Currents

Baishali Ray, University of Mississippi, P.O. Box 2812, University, MS 38677; baishali@phy.olemiss.edu

Thomas C. Marshall, Maribeth Stolzenburg, and Christopher R. Maggio

A technique has been devised to estimate from observations the thunderstorm generator current, an important parameter for the global electric circuit as well as a measure of the strength of in-cloud charging mechanisms. For one cell the method indicates that during a three-minute time interval the in-cloud charge generation produced an average current of about 0.4 A. Similar analysis in another developing thunderstorm cell with a short lifespan indicates that the early generator current was as large as 0.14 A, but it decreased by a factor of about three as the cell began to dissipate and merge with another cell less than 7 min later. This presentation will describe the method and results, and then compare the estimated generator currents to other estimates of the various currents flowing in the thunderstorm environment.

PST2-37: 11:30 a.m.–12 p.m. Physics Labs with Flavor (Developing Recurrent Studies Methodology)

Mikhail M. Agrest, College of Charleston, 66 George St., Charleston, SC 29424; agrestm@cofc.edu

The methodology of recurrent studies in the practice of teaching introductory physics labs and in studio-style teaching brings flavor into the learning process. It passes on the spirit of research into the teaching/learning process, as it includes prediction of the results of experiments based on modeling and examination of the process and gives students a chance of direct and immediate application of the acquired knowledge[1], providing visual and immediate assessment it enhances learning. The quality of the performance of the experiment tremendously affects the results. Inaccuracy in measurements and in the performance of the procedure leads to inaccurate predictions followed by the doubts of the modeling of the process and affects the evaluation of students' work. This presentation will include a detailed description of how to apply the method to new topics. Recommendations on application of the recurrent method to topics suggested by the participants will be developed and discussed.

1. Mikhail M. Agrest, "Physics Labs with Flavor or The Recurrent Method of Learning of Phenomena in Physics Labs." (*Phys. Teach*, 2009 accepted for publication.)

Session HB: Discipline-Based Science Education Research (Joint Session with AAAS)

Location: H-Columbus EF
Sponsor: Committee on Research in Physics Education
Co-Sponsor: AAAS
Date: Sunday, Feb. 15
Time: 8:30–11:30 a.m.

Presider: Carl Wieman

HB01: Physics Education Research: A Resource for Improving Student Learning

Invited – Lillian C. McDermott, Dept. of Physics, University of Washington, Box 351560, Seattle, WA 98195; lcmcd@phys.washington.edu

Research on the learning and teaching of physics has proved to be an effective means for achieving cumulative improvement in student learning. Results from systematic studies indicate that university students from the introductory to the graduate level often have similar conceptual and reasoning difficulties. Examples will illustrate how findings from research have been used to guide instruction that has proved effective in introductory physics courses, in the preparation of graduate students as teaching assistants, and in the professional development of K-12 teachers. Although the context is physics, analogies can readily be made to other sciences.

HB02: Revealing Unexpected Learning Challenges in Astronomy

Invited – Timothy F. Slater, University of Wyoming, 1000 E. University Blvd., (Dept 3374), Laramie, WY 82071; tslater@uwyo.edu

Following in the footsteps of physics education research, astronomy education researchers are systematically uncovering students' difficulties in learning astronomy. Most of the 250,000 undergraduates enrolled in introductory astronomy survey courses are nonscience majors, presenting a particularly arduous challenge for astronomy professors who are unfamiliar with recent results in cognitive science regarding how people learn. Systematic pre-test, post-test analysis of student achievement and attitudes reveal gains of only 30% on standardized astronomy concept inventories across all conceptual domains, but 60% normalized gains for learner-centered approaches, including tutorial strategies.

HB03: Is the Physics Needed for Chemistry and Biology Majors Taught in First-Year Physics?

Invited – Michael W. Klymkowsky, MCD Biology / CU Teach - University of Colorado, Boulder, UCB347, Boulder, CO 80309; michael.klymkowsky@colorado.edu

Melanie M. Cooper, Chemistry / Engineering and Science Education, Clemson University

While designing foundational courses in biology[1] and chemistry[2], and assessments of student thinking, specifically the Biology Concept Inventory (BCI)[3] and the Chemical Bond and Entropy Concept Inventory, we find ourselves forced to consider student understanding of a number of concepts generally viewed as within the purview of physics, including the laws of thermodynamics, kinetic and potential energy, atomic structure, statistical mechanics, stochastic processes, and quantum tunneling. These concepts underlie processes ranging from bond formation and stability, diffusion and genetic drift, chemical reactions, and enzymatic mechanisms [4], protein folding, macromolecular interactions, regulatory noise and self-organizing systems. Introductory chemistry and biology courses commonly revisit these topics, and studies on student thinking suggest that many key concepts are not well grasped or apparently adequately learned.

1. M.W. Klymkowsky, 2007. Teaching without a textbook: a strategy to focus learning. *CBE Life Sci Educ* 6:190-3.
2. National Science Foundation project DUE 0816692
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HB04: An Overview of Current Chemical Education Research Efforts

Invited – Thomas J. Greenbowe, Dept. of Chemistry, Iowa State University, Ames, IA 50011-3111; tgreenbo@iastate.edu

The research efforts of several chemical education research groups from around the world will be summarized. Experimental research that investigates student comprehension of difficult topics in chemistry will be the focus of this presentation. Research results that indicate an increase in student content knowledge of general chemistry, organic chemistry, and physical chemistry will be highlighted. Working memory, writing to understand science, problem-solving, conceptual understanding, multiple modes of representation, and using the tactics and case studies of current video games are some of the educational areas of interest that will be explored.

Session IA: Teaching Physics Around the World

Location: F-Ambassador
Sponsor: Committee on International Physics Education
Date: Sunday, Feb. 15
Time: 8:30–10:30 a.m.

Presider: Genaro Zavala

This is an invited and contributed session designed for reports from groups around the world working on physics teaching. We are interested in perspectives, results, successes, and challenges around the world, and the effect of the structure of different school systems on physics teaching.

IA01: 8:30–9 a.m. Physics Education in Brazil

Invited – Marco A. Moreira, Federal University of Rio Grande do Sul, Instituto de Física - Caixa Postal 15051 - Campus, Porto Alegre, Brazil RS 91501-970; moreira@if.ufrgs.br

Physics is a required subject in Brazilian schools. However, the number of classes per week is just one or two and it is usually taught as training for the university entrance examination, stimulating rote learning. Teachers are prepared in a specially designed four-year college course, but there are few people interested in it because it is demanding and being a physics teacher means, in practice, teaching up to 40 or 50 classes per week, at different schools, and having hundreds of students. There is no national association of physics teachers, but the Brazilian Society of Physics organizes national meetings and publishes a journal on physics education. Recently, Brazilian universities began to offer professional master's degrees in science education, some of them in physics education, designed for high school teachers. It is too early to evaluate this action but it looks promising to improve physics education in Brazil.

IA02: 9–9:30 a.m. Physics Education in Mexico

Invited – Mora César, CICATA Instituto Politécnico Nacional, Av. Legaria 694, Col. Irrigación, Del. MIguel Hidalgo, Mexico City, Mexico DF 11500; ceml36@gmail.com

In this work we present an overview about physics education in Mexico. Since the World Year of Physics 2005 the National Polytechnic Institute from Mexico City started the first steps organizing a post-graduate program on physics education based on Information and Communication Technologies. Nowadays, our master and doctorate in physics education have successfully gotten students from seven Mexican cities, and we are participating with the Ministry of Education in a national program of training physics teachers for secondary school. Also, Mexican researchers on physics education are very active abroad organizing meetings and workshops of Active Learning Physics. The Latin American Physics Education Network (LAPEN) has been an important sponsor of Mexican activities; we remark that the editorial process of the *Latin American Journal of Physics Education* is made from Mexico. Finally, we discuss several ways of teaching physics in Mexico and results of research projects.

IA03: 9:30–9:40 a.m. A Sounding Balloon Experiment: A High School Research Project

Marcelo M.F. Saba, Quark Science Club, R. Teopompo de Vasconcelos, 86, S. José dos Campos, Brazil SP 12243-830; marcelosaba@gmail.com

Suny Watanabe and Ralf Gunter, Colégio Poliedro

Watching the meteorological balloons customarily launched from our city, we wondered how we could develop an experiment to allow our students to effectively gather data about the low atmosphere and at the same time keep our limited financial budget. When you hear about atmospheric balloons, you usually think about balloons with large envelopes of nylon or mylar with payloads between 1 or 10 kg. They ascend to very high altitudes, have a data radio transmitter, and are not recoverable. This setup would be too expensive for us. In order to keep the cost low, the payload containing the data recorded had to be recovered, and therefore, the balloon must not go tens of kilometers away. Based on some estimates of ascension speed for small balloons and probable horizontal wind intensities, we decided that in order to easily recover the payload we had to limit its ascension to about 3 km high. At this altitude, the payload would have to be released from the balloon by means of a timer. Our envelope consists of four latex 1-m diameter balloons (the biggest we could get) of the kind used at children's parties. Altogether they had a net buoyancy capacity of 500 g, enough to lift a mini digital camera, a sound recorder, batteries and simple electronic circuits that transform the atmosphere temperature into sound frequency. The scientific and educational achievements of this challenging high-school research project will be presented.

IA04: 9:40–9:50 a.m. Modern Techniques of Teaching Physics in Ghana

Kwadwo A. Dompreh, University of Cape Coast, Box MD 812 Madina, Accra, Ghana 00233; eykona9@hotmail.com

Teaching physics in high schools in the eastern region of Ghana is increasingly becoming difficult due to lack of facilities and teachers, but using computer aided techniques and Physics by Inquiry learned from a 2005 AAPT conference, the interest in the subject and performance of students in Physics has increased drastically.

IA05: 9:50–10 a.m. Mobile Physics Teaching Using Film Shows and Demonstrations in Nigeria

Famous Akpojotor, Federal Government College, FGC, Sokoto, Nigeria FGC; famouslink@yahoo.com

Emmanuel Enukpere, College of Education,Warri

Eusibius Aghemeloh, University of Benin, Benin City

Godfrey Akpojotor, Max Planck Institute for Physics of Complex Systems, Dresden/ Delta State University, Abraka

This is a recent project to attract and encourage students at the junior secondary school (JSS) level to take up physics at the senior secondary school level (SSS). The present Nigerian education system is known as the 6-3-3-4 system which translate into six years of primary school, three years at the junior secondary level, three yeasr at the senior secondary level and four years of undergraduate study. General science is taught at the primary level, and integrated science at the JSS level. Taking up physics at the SSS level depends on the interest and grades obtained for mathematics and integrated science. To boost enrollment in physics especially among female students, we have designed this project with a motto: "catch them young." Basically, it involves showing captivating physics films to attract JSS students and thereafter a physics teacher will give a lecture relating to the film, using demonstrations when necessary and also discuss possible careers in physics. Though we have not evaluated it, the enthusiasm of the student participants has been very high in the schools visited so far.

IA06: 10–10:10 a.m. Teaching Electric Circuits in First-Year Undergraduate Laboratories

David Smith, Castel, Dublin City University, School of Physical Sciences, Dublin, Ireland; david.smith4@gmail.com*

Thomas Wemyss, Castel and Paul van Kampen, Castel, Dublin City University

We present the development, implementation and evaluation of electric circuits curriculum for first-year undergraduate nonphysics students in an Irish University. A framework of guided inquiry is used, which focuses on the understanding of students and their ability to conceptualize physics. The constraints imposed by the first-year undergraduate laboratories required that we focused on key elements and that the curriculum was efficient in conveying the relevant concepts. The laboratories commenced in February 2008 and continued for three successive weeks. Pre-test data was collected through an online survey and post-test data was collected through two in-class exams. The preliminary analysis of this data has highlighted some significant student misconceptions, particularly in relation to current; it also highlights considerable improvements in student understanding on completion of the curriculum. This presentation will highlight some of the key findings from the data and will also discuss the approach in developing the curriculum.

*Sponsor: Paul van Kampen

IA07: 10:10–10:20 a.m. Attrition in Scandinavian University Physics

Bjorn F. Johannsen, University of Copenhagen, Universitetsparken 15, Copenhagen, Denmark 2100; bfjohannsen@ind.ku.dk

Investigations into attrition and retention in the United States cannot truly begin prior to students' choice of a major without entailing certain limitations to the scope of such research. One consequence, as also mentioned in "Talking about Leaving" by Seymour and Hewitt, is the difficulty in obtaining figures on "attrition" among students who enrol at university intending to major in physics. Similarly, it is hard to gain insight into the impact of introductory physics courses on student motivation in continuing a career within physics. However, traditional universities in Europe all have strictly defined educational programs, so if a student wishes to obtain a degree in physics, he or she will have to make that choice already when applying for university. This allows a unique window for studying aspects of motivation affected by introductory physics courses and the surrounding educational culture with regards to influencing the probability of retention. Such a study-setup will be presented as will preliminary results.

*Sponsor: Ian Bearden, Niels Bohr Institute, University of Copenhagen, Denmark

Session IB: New Results in Astronomy Education Research

Location: F-Regent
Sponsor: Committee on Space Science and Astronomy
Date: Sunday, Feb. 15
Time: 8:30–10:30 a.m.

Presider: Janelle M. Bailey

These are papers that describe methods and results from conducting studies on the teaching and learning of space science and astronomy.

IB01: 8:30–9 a.m. The Evolution of Peer Instruction in Astronomy

Invited – Kevin M. Lee, University of Nebraska, 205 Ferguson Hall, Lincoln, NE 68588-0111; klee6@unl.edu

Educational research has demonstrated that peer instruction is an effective method of encouraging interactive engagement in the classroom. Technology has allowed peer instruction to evolve from simple text-based questions to sophisticated computer-based delivery systems. This presentation will describe the ClassAction project which consists of a computer database of questions based on rich multimedia resources. Instructors can order these dynamic questions and cast them into alternate permutations based on their own preferences and feedback from the class. Examples will be shown of questions with sophisticated prompts that emphasize critical thinking, the power of carefully crafted sequences of questions, the importance of follow-up questions, and providing feedback with simulations. Results will be presented from a multi-institution study using the Light & Spectra Concept Inventory to evaluate the efficacy of ClassAction materials. These materials are publicly available at http://astro.unl.edu and are funded by NSF grant #0404988.

IB02: 9–9:30 a.m. Exploring the Impact of Astronomy Research Experiences for Teachers

*Invited – Sanlyn R. Buxner, * University of Arizona, 3045 N. Sparkman Blvd., Tucson, AZ 85716; buxner@email.arizona.edu*

A current national interest is having students engage in authentic research experiences to increase their scientific literacy and prepare them for possible STEM careers. Teachers are best prepared to facilitate these experiences if they have engaged in a research experience themselves. A known lack of research experiences for teachers has resulted in institutions offering short research experiences to fill this gap. This study included two summer programs based on astronomy content with capstone projects of field research experiences for participants along-side professional researchers. Programs also included background content knowledge and discussions about student implementation of research. Data was collected in the form of open ended pre-post surveys, program observations, product reviews, and participant interviews. This study investigated the personal and professional value of these experiences for teachers as well aspects of each program that may become integrated into how they think about teaching and conducting research with their students.

*Sponsor: Janelle Bailey

IB03: 9:30–10 a.m. Pushing Past Posner: Modern Conceptual Change Theories

Invited – Doug Lombardi, University of Nevada, Las Vegas, 4505 Maryland Parkway, Box 453003, Las Vegas, NV 89154-3003; lombar37@unlv.nevada.edu

Conceptual change research is dynamic and has appreciable relevancy to astronomy education. However, a recent informal survey of Astronomy Education Review revealed that many authors still rely heavily on the conceptual change model (CCM) proposed by Posner, Strike, Hewson, & Gertzog (1982), with virtually no discussion of more recent perspectives. Ten articles discuss conceptual change as a major component of research, and of these, eight directly depend on the CCM. Because the CCM is based on drawing a parallel between change processes in science and conceptual change in individuals, it is no surprise that the CCM is appealing to astronomy educators. Yet, more recent empirical research, including work done by the original researchers, has shown significant weaknesses with the CCM. This paper reviews modern conceptual change theories, which are strongly supported by empirical studies, and which have direct relevance to concepts important to astronomy education.

IB04: 10–10:30 a.m. Student Conversations During Clicker Sessions: What Are They Telling Us?

Invited – Shannon Willoughby, Montana State University - Bozeman, P.O. Box 173840, Bozeman, MT 59717-3840; willoughby@physics.montana.edu

Mark James, Northern Arizona University

In this study, we provide a qualitative analysis of transcribed Peer Instruction conversations that were generated in response to instructor constructed clicker questions that were posed during the course of three introductory astronomy classes. The analysis highlights three categories of student responses to help emphasize strengths and weaknesses of the technique. Our first category of student conversations reveals the potential of the technique for addressing unanticipated naïve conceptions as well as providing insight into how the technique might be used more effectively to guide instruction. The second category concerns issues related to the instructor's interpretation of the statistical feedback provided by electronic classroom response systems. And our third category draws attention to common pitfalls experienced by students during conversations that led to unproductive interactions. Based on this analysis, we conclude with a set of practical recommendations for instructors seeking to implement this technique with greater effect.

Session ID: What Is the Curriculum for the Advanced Lab?

Location: F-Chancellor
Sponsor: Committee on Laboratories
Date: Sunday, Feb. 15
Time: 10:15–11:15 a.m.

Presider: *David Abbott*

Advanced labs vary widely from institution to institution. There is almost no published information concerning curricular goals, current practices, or best practices. This session seeks accounts of exemplary courses or programs that involve upper-division undergrads in the lab. Accounts should include a description of the course/program, its goals and how you measure the success of the course/program.

ID01: 10:15–10:45 a.m. Scrounging, Hacking, and Writing: Advanced Lab at CSU Chico

Invited – Eric Ayars, Dept. of Physics, California State University, Chico, Campus Box 202, Chico, CA 95929-0202; ayars@mailaps.org

Even with sharply limited space and equipment resources, it is possible to build an advanced lab program that gives students valuable skills and experience. By carefully choosing experiments that can be done with a minimum of expensive equipment, and having the students build much of their own equipment, students gain experience in the experimental design process that they would otherwise miss. We also have a significant writing component in the Advanced Lab course at CSUC, which students have found very helpful in their work beyond graduation.

ID02: 10:45–11:15 a.m. Advanced Labs for Future Hidden Physicists*

Invited – Richard W. Peterson, Dept. of Physics, Bethel University, 3900 Bethel Dr., St. Paul, MN 55112; petric@bethel.edu

Keith R. Stein, Bethel University

In programs such as ours, over one-half of undergraduates with physics and applied physics majors plan for careers in a variety of engineering or applied physics disciplines—often as 3-2 students or as future engineering or optics graduate students. Labs connected with courses such as optics, laser physics, fluids, acoustics, or computer methods should be flexible enough to serve the diversity of these students and their future work. Bringing modern metrological tools together with computational physics seems particularly important and interesting to these students, while it also pushes them to creatively design systems and approaches of their own invention. Examples are chosen from studies of mechanical resonance and shock wave phenomena utilizing MATLAB and FEMLAB in cooperation with holographic, schlieren, and interferometric optical diagnostics.

* Work supported in part by the MN NASA Space Grant and the Carlsen-Lewis Endowment at Bethel University.

Session IE: Particle Physics in the High School

Location: H-Crystal A
Sponsor: Committee on Physics in High Schools
Date: Sunday, Feb. 15
Time: 9–11:30 a.m.

Presider: *Jeffrey Rylander*

Deborah Roudebush and Pat Callahan made this session possible. We will use QuarkNet, Fermilab, and other rescources to bring in particle physicists as invited speakers and talented teachers who have done particle physics in the classroom as contributing speakers.

IE01: 9–9:30 a.m. The Recipe for the Universe in the High School Classroom*

Invited – Randy Ruchti, Dept. of Physics, University of Notre Dame, Notre Dame, IN 46556-5670; rruchti@nd.edu

The high school classroom is a great place to engage and challenge students about the nature of the universe. Notably, particle physics experiments lend themselves well to enriching the curriculum by providing, direct from discovery physics, examples of energy and momentum conservation, particle identification, and the search for new phenomena. Pathways to the classroom are forged through research partnerships of university faculty and staff with high school teachers, immersive research experiences for teachers and students, and the availability of detectors to operate in a classroom setting, and simulated and real data from experiments worldwide for students to analyze. Several national programs that are developing these pathways will be highlighted, including QuarkNet and I2U2 (Interactions in Understanding the Universe).

*Work is supported in part by the National Science Foundation and the Department of Energy.

IE02: 9:30–10 a.m. How Examples From Particle Physics Support Standards-Based Physics Curricula

Invited – Marjorie G. Bardeen, Fermilab, M.S. 226 Box 500, Batavia, IL 60510; mbardeen@fnal.gov

Conservation of momentum and energy. Science as inquiry, the nature of science. Working with vectors, large datasets or the statistics of large numbers. At Fermilab we have worked with master teachers for over 20 years to bring the excitement of cutting-edge physics to the high school classroom. Efforts range from activities that can be sprinkled throughout the curriculum to longer term web-based investigations where students experience the environment of scientific collaborations. Learn what you and your students can do in your classroom . . . tomorrow.

IE03: 10–10:10 a.m. Nuclear Astrophysics Outreach Program Now Employs Researcher's Equipment for Enhancement

Amy DeLine, Central Michigan University, 3925 Gettysburg St., Midland, MI 48642; delin1ad@cmich.edu

Zach Constan, National Superconducting Cyclotron Lab/Michigan State University

Joseph Finck, Central Michigan University

The Physics of Atomic Nuclei (PAN) outreach program of the National Superconducting Cyclotron Laboratory has been revised to now use the Modular Neutron Array (MoNA), a million-dollar research neutron detector. High school teachers and students learn about detectors, Large Hadron Collider Physics and nuclear theory in seminars and then perform experiments with MoNA using their new knowledge. The goal is to prepare teachers to present a unit on nuclear physics and stimulate students to become interested in studying nuclear physics and science in general. Coordinators of the program have found hands-on experiments with real research materials to be very beneficial for the learning of both teachers and students. At the end of PAN 2008, 95% of students and 100% of teachers would "Probably" or "Definitely" recommend the PAN program to their colleagues.

IE04: 10:10–10:20 a.m. Particle Physics Through Cosmology

Todd Brown, University of Pittsburgh at Greensburg, 150 Finoli Dr., Greensburg, PA 15601; ltbrown@pitt.edu

Katrina Brown, Ted Zaleskiewicz, University of Pittsburgh at Greensburg

Robert Reiland, Shadyside Academy

Cherie Harper, Greensburg-Salem High School

The study of cosmology is closely linked to that of particle physics. Our current understanding of the first moments of the universe depends critically upon our insight into the interactions of particles. In addition, dark matter plays an integral role in understanding how the universe is evolving. The Contemporary Physics Education Project (CPEP) has developed a chart, titled "History and Fate of the Universe," that can be used in the high school classroom to teach these topics. The features of this chart and its use in teaching particle physics will be discussed.

IE05: 10:20–10:30 a.m. Use of Cosmic Ray eLab to Teach the Research Process

Deborah M. Roudebush, Oakton High School, 2900 Sutton Rd., Vienna, VA 22181; dmroudebush@fcps.edu

Physics students at Oakton High School use the Cosmic Ray eLab to learn the research process. Students access the database of muon detector data from around the world to develop research questions and practice controlling variable. Advanced students use the Oakton High School muon detector for data collection to support research questions for science fair. The Cosmic Ray eLab is supported in part by the National Science Foundation and the Office of High Energy Physics in the Office of Science, U.S. Department of Energy.

IE06: 10:30–10:40 a.m. Particle Physics for Everyone

R. Michael Barnett, Lawrence Berkeley National Laboratory, 1 Cyclotron Rd., Berkeley, CA 94720; RMBarnett@lbl.gov*

Gordon J. Aubrecht, Ohio State University

Robert Reiland, Shady Side Academy

Particle physics has generated intense interest in physics during the past half century. The Contemporary Physics Education Project (CPEP), a volunteer non-profit organization of educators and scientists, has been developing materials to support the introduction of contemporary physics topics into high school and college introductory physics for 20 years. This talk will feature the latest version of the wallchart on the Standard Model of Particles and Interactions as well as supporting activities and materials. Placemat size charts will be distributed to those in attendance. Special emphasis will be given to how the Large Hadron Collider (LHC) at CERN will affect our knowledge of the Standard Model and using the chart to teach about these topics.

*Sponsor: Gordon Aubrecht

IE07: 10:40–10:50 a.m. The Particle Physics Masterclass*

Shane Wood, Irondale High School/QuarkNet, 2425 Long Lake Rd., New Brighton, MN 55112; shane.wood@moundsviewschools.org

The European Particle Physics Outreach Group (EPPOG) has organized particle physics Masterclasses in which high school students use data from CERN's Large Electron-Positron Collider (LEP) experiments and simulated data from CERN's Large Hadron Collider (LHC) experiments to better understand the world of quarks and leptons. This spring (March 2009) will be the second year in which the United States has participated in the Masterclasses, allowing students to learn more about particle physics through real analysis of particle physics data, and real international collaboration through video conference. This presentation will highlight some of the main features of this Masterclass, 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

IE08: 10:50–11 a.m. Teaching the History of Nuclear Science with the CPEP Wallchart

Michael G. Cherney, Creighton University, 2500 California Plaza, Omaha, NE 68178; mcherney@creighton.edu

Gordon J. Aubrecht, The Ohio State University

Howard Matis, Lawrence Berkeley National Laboratory

The Contemporary Physics Education Project (CPEP), a volunteer nonprofit organization of educators and scientists, has been developing materials to support the introduction of contemporary physics topics into high school and college introductory physics for 20 years. This talk will feature an updated wallchart on nuclear science as well as the supporting activities and materials. Placemat size charts will be distributed to those in attendance. Special emphasis will be given to using the chart to explain the history of nuclear science and the new physics from heavy ion collisions at the Large Hadron Collider (CERN) and at the Relativistic Heavy Ion Collider (Brookhaven National Laboratory).

IE09: 11–11:10 a.m. Particle Physics Through Fusion

Katrina Brown, University of Pittsburgh at Greensburg, 150 Finoli Dr., Greensburg, PA 15601; kwb@pitt.edu

Todd Brown, University of Pittsburgh at Greensburg

The solar p-p fusion chain can be treated in the classroom as an application of particle physics. It can be used to show students an example of matter-antimatter annihilation, the weak interaction, and can be used to introduce fundamental particles such as positrons, electrons, and neutrinos. In addition, if the solar neutrino problem is discussed, considerable material on leptons and neutrinos can be covered while introducing the students to a contemporary physics problem. Ideas for covering this material in the classroom will be discussed.

Session IF: Role of Community Colleges in Pre-High School Teacher Preparation

Location: H-Crystal C
Sponsor: Committee on Physics in Pre-High School Education
Co-Sponsor: Committee on Physics in Two-Year Colleges
Date: Sunday, Feb. 15
Time: 9–10:10 a.m.

Presider: Tom Foster

Many K-8 teachers began their careers at community colleges. These papers are from those who are working at a two-year college and are involved with developing the science knowledge of pre-high school teachers.

IF01: 9–9:30 a.m. Shattering Myths About the Role of Two-Year Colleges in Teacher Preparation

Invited – Leslie A. Roberts, Triton College, 2000 Fifth Ave., River Grove, IL 60634; lroberts@triton.edu

Keith Clay, Green River Community College

Awareness has grown over the past few years concerning the significant contribution two-year colleges (TYCs) make in preparing, training, and educating future teachers and classroom practitioners. The National Organization for Community Colleges in Teacher Preparation (NACCTEP) has long served as a resource and advocate for promoting and supporting the role of TYCs in teacher preparation. Green River Community College (GRCC) has been designated as one of 10 exemplary TYC teacher prep programs in the country; and it has fostered the creation of teacher prep programs at a dozen other TYCs. Learn about the scope and breadth of TYC engagement in the teacher education enterprise. Best practices, such as those developed at GRCC, will be shared. Discover big and small ways that you and/or your physics department can improve teacher prep at your home institution. Bring your questions, challenges and ideas for an exploration of what can be done.

IF02: 9:30–10 a.m. I'm Just a Physics Teacher. What Can I Do?

Invited – Keith A. Clay, Green River Community College, 12401 SE 320th St., Kent, WA 98032; kclay@greenriver.edu

Many two-year colleges have substantial teacher preparation programs, but even more do not. Physics teachers often report frustration in their attempts at teacher preparation. This talk presents time-tested suggestions of big ways and small ways that a physics department or individual can improve teacher prep at his or her school. GRCC has been singled out as one of 10 exemplary TYC teacher-prep programs in the country. GRCC has also fostered the creation of teacher prep programs at a dozen other TYCs. Bring your ideas, questions, and frustrations for an exploration of what can be done.

IF03: 10–10:10 a.m. Having an IMPACT in Middle School

Gordon J. Aubrecht, Ohio State University at Marion, 1465 Mt. Vernon Ave., Marion, OH 43302; aubrecht@mps.ohio-state.edu

In 2004-2005, I was part of a team that won a Department of Education grant, known as IMPACT. We worked with K-12 teachers in Marion and Newark, helping them rethink how they were teaching, helping them ask more (and better) questions. Some of the teachers were from the middle school in Marion, OH. They contacted the administration of the city schools and suggested that I be involved in improving science scores at the middle school level. We submitted a seed grant proposal to the Ohio Department of Education that was funded. We had teachers buy in; the union agreed and each teacher agreed to be part of the program. We submitted a full proposal.

Session IG: Mentoring and Support for Novice High School Physics Teachers

Location: F-State
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Sunday, Feb. 15
Time: 9–11 a.m.

Presider: Paul Hickman

IG01: 9–9:30 a.m. Beginning Science Teacher Induction: Where's the Science?

Invited – Ted Britton, WestEd, 400 Seaport Ct., Suite 222, Redwood City, CA 94063; tbritto@wested.org*

Mentoring and induction program designs often make slim distinctions between beginning elementary and secondary teachers, let alone differentiating between middle and high school teachers, or among teachers of different school subjects. During a decade of international research with beginning mathematics and science teachers, our team has documented wide-ranging, science-specific needs among beginning secondary teachers in four categories: content, pedagogical, curricular, and practical. We illustrate designs and elements of mentoring and induction programs that aim to help beginning science teachers learn more about these aspects of science teaching, rather than focusing mostly on teacher retention. For existence proof, we note longstanding, robust programs in several other countries. In recent years, a few U.S. programs have experimented with serving only mathematics and science teachers. There are programs serving all beginning teachers that now incorporate stronger attention to science-specific elements.

*Sponsor: Paul Hickman

IG02: 9:30–10 a.m. Beginning Teacher Knowledge and Instructional Practices: The First Two Years

Invited – Julie Luft, Arizona State University, Payne Hall, 204B, Tempe, AZ 85287; Julie.Luft@asu.edu*

It is acknowledged that the first years of teaching are the most difficult, yet little is known about the development of subject matter specialists during this period. To address the absence of research in this area, I am following over 100 beginning secondary science teachers as they progress through their first three years of teaching. This presentation will share the results of the first two years of the study, with a focus on teacher knowledge and practice. In the analysis of the data it is evident that the knowledge and practices of beginning teachers can be stifled, sustained, or strengthened. This can be attributed to the support programs offered to beginning teachers, as well as to the school community. The findings from this study reinforce the complexity of being a new secondary teacher, and they support the utilization of induction programs that can sustain and strengthen teacher learning and instruction.

*Sponsor: Paul Hickman

IG03: 10–10:30 a.m. Using Trained Mentors to Keep Physics Teachers in the Classroom

Invited – Elaine Gwinn, Shenandoah High School, 7354 W. U.S. 36, Middletown, IN 47356; jegwinn@bsu.edu

It has long been observed and documented that it is difficult to keep new science teachers from quitting the profession in the first five years of their experience in the classroom. One goal of PhysTEC was to approach this problem and seek answers to this dilemma. As an original PhysTEC site, Ball State University utilized a program design using trained mentors with both pre-service and new in-service science teachers. This talk addresses the steps taken to reach success by retaining 100% of all new Ball State University physics certified teachers from 2000-2007. Through the efforts of the faculty and Teachers in Residence, Ball State has become the largest conduit for new physics teachers in the state of Indiana, an outcome attributed to the efforts made to support these new teachers for at least the first two years of their teaching.

IG04: 10:30–11 a.m. The Exploratorium Beginning Science Teacher Program

Invited – Linda S. Shore, Exploratorium, 3601 Lyon St., San Francisco, CA 94123; lindas@exploratorium.edu*

The Exploratorium Teacher Institute (TI) has a 25-year history of providing middle and high school science teachers with life-long professional development and support. Teachers who are part of the TI alumni network participate in summer institutes, and school-year workshops focusing on strengthening content knowledge and improving pedagogy. Alumni teachers also have access to resources, materials, and online support. Most importantly, these teachers are part of a professional learning community of like-minded colleagues dedicated to developing the craft of inquiry-based science teaching and learning. In 1998, TI launched the first science-focused beginning teacher program in the country. Veteran TI alumni serve as mentors and induct novice middle and high school science teachers into both the profession and the Exploratorium larger guild of alumni teachers. In this session, we will share our strategies and describe what we have learned about the care and feeding of high school physics teachers.

*Sponsor: Paul Hickman

Session IH: Physics Education Research Around the World

Location: H-Crystal C
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on International Physics Education
Date: Sunday, Feb. 15
Time: 6–8 p.m.

Presider: Paula Heron

IH01: 6–6:30 p.m. Developing Formal Thinking Through Physics Education Research in Italy

Invited – Marisa G. Michelini, Physics Dept., Udine University - Italy, via delle Scienze 208, Udine, Italy 33100; michelini@fisica.uniud.it

Building formal thinking and bridging common-sense ideas and the scientific view of the world are two of our main goals. The research process starts with a "reconstruction" of the content to choose the concepts and models that will be the primary learning goals. Empirical research during activities in which students explore phenomena helps identify conceptual "knots" and spontaneous reasoning patterns that must be taken into account. Teaching/learning paths that form part of a vertical curriculum from primary to secondary school (ages 5-17) are developed through pilot experiments carried out by researchers in the classroom and large-scale experiments carried out in collaboration with teachers. The goal is to build formal thinking for the explanation and interpretation of phenomena starting from common-sense reasoning. An example in which quantum physics was taught in secondary school following the Dirac approach and using simple experiments with Polaroid filters and birefringent crystals will be presented.

IH02: 6:30–7 p.m. International Transferability of PER-Based Educational Strategies: A Mexican Experience

Invited – Genaro Zavala, Tecnologico de Monterrey, E. Garza Sada 2501, Monterrey, Mexico NL 64849; genaro.zavala@itesm.mx

Physics education research has proved that active learning is more successful to develop a functional understanding of some of the most basic ideas in physics courses. Most of the instructional materials that are available and use this approach have been developed mostly in the United States. Those strategies were designed with American students in American institutions. For institutions elsewhere, this situation could be different and raises the question if and how these resources could be used and whether they will be successful as well. In this talk I will present research results from a large private university in Mexico where some of the most known educational strategies have been implemented. I will discuss the type of students the institution admits in terms of their initial understanding of physics concepts, their scientific reasoning ability, their Spanish and English language ability and their educational background, all of them as factors for the final learning resultsof students in our institution. Finally, I will contrast these results with our own educational structure with the physics courses we teach.

IH03: 7–7:30 p.m. How Much Have Students Learned—Research-based Teaching on Electrical Capacitance

Invited – Jenaro Guisasola, University of the Basque Country, Plaza Europa 1, San Sebastian, Spain 20018; jenaro.guisasola@ehu.es

Mikel Ceberio, José M. Almudí, and José L. Zubimendi, University of the Basque Country

In electromagnetism syllabus for introductory physics courses it does not usually contemplate a teaching sequence that analyses the transition of specific charges to charged bodies, and constructs an explanatory model of the charging processes on a body. These processes are essential in the model that explains the fundamental electrical process. The teaching sequence targets first-year university students and was designed following two related perspectives: students' common conceptions on this topic and, the notion of "problematized structure" of the teaching sequence. The teaching sequence was implemented and evaluated for two years among engineering students in the first year at the University of the Basque Country (Spain). The results show that the elements within the sequence help students to reconcile a global description with the step-by-step analysis of single interactions.

IH04: 7:30–8 p.m. First-Year Undergraduate Physics Labs: Constructing Knowledge and Understanding Science

Invited – Paul van Kampen, CASTeL, Dublin City University, Dublin, Ireland 9; Paul.van.Kampen@dcu.ie

David Smith and Thomas Wemyss, CASTeL, Dublin City University

The Physics Education Group at the Centre for the Advancement of Science Teaching and Learning (CASTeL) at Dublin City University, Ireland, have restructured the first-year undergraduate physics labs, which cater to more than 200 nonphysics students per year. In order to make the labs relevant and enjoyable, emphasis was put on giving students increasing levels of autonomy, going from tightly guided inquiry to quasi-open investigations; helping students develop transferable experimental skills such as hypothesis testing, control of variables, interpreting and drawing conclusions from their own experimental data; and helping students develop a deeper understanding of basic physics concepts. Online pre-tests along with weekly surveys highlight the student's attainment, attitudes, experiences, and conceptual development. Student feedback and post-test results show that the labs have been transformed. This paper will present an overview of the labs, where they have been successful and aspects that need to be further developed.

Session II: How Educational Technologies Can Reach New and Cross-Over Teachers Who Also Teach

Location: F-Moulin Rouge
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Physics in High Schools
Date: Sunday, Feb. 15
Time: 8:30–9:30 a.m.

Presider: Cathy Ezrailson

How can emerging educational technologies reach new teachers of physics?

II01: 8:30–9:30 a.m. Pathway — 24/7 Online Pedagogical Assistance for Teachers of Physics

Panel – Dean Zollman, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; dzollman@phys.ksu.edu

Brian Adrian, Kansas State University

Scott Stevens and Michael Christel, Carnegie Mellon University

The Physics Teaching Web Advisory (Pathway) is a research and development effort to demonstrate the ability to address issues of many physics teachers via the web. Pathway's "Synthetic Interviews" are a unique way to engage inexperienced teachers in a natural-language dialog about effective teaching of physics. These virtual conversations and related video materials are now providing pre-service and out-of-field in-service teachers with much needed professional development, and well-prepared teachers with new perspectives on teaching physics. In effect Pathway is a dynamic digital library that goes beyond creating a collection of teaching and learning materials. It provides continuously improving assistance and expertise for teachers, all of which is related to the results of contemporary physics education research. The database is a growing digital library and now contains about 6000 different recorded answers and over 10,000 question/answer pairs. Pathway is available at http://www.physicspathway.org.

*Supported by the National Science Foundation under Grants 0455772 & 0455813.

II02: 8:30–9:30 a.m. Social Networking for New and Cross-Over Physics Teachers

Panel – Pat Viele, Cornell University, 286 Clark Hall, Ithaca, NY 14853-2501; ptv1@cornell.edu

Usually there is only one physics teacher per district (if that!), and physics teachers can get lonely. Traditionally, scientists like face-to-face discussions about their research and teaching. The good news is that new social networking software is making it possible to "talk" to colleagues all over the world Although it is perhaps less satisfying than face-to-face contact, the use of social software does facilitate meaningful conversations and the exchange of information and ideas. I will talk briefly about blogs, wikis, Instructional Architect, and services like connotea.

II03: 8:30–9:30 a.m. PTEC.org — An Electronic Community of Institutions Dedicated to Teacher Preparation

Panel – John C. Stewart, University of Arkansas, Physics Building, Fayetteville, AR 72701; johns@uark.edu

The PTEC (Physics Teacher Education Coalition) organization contains more than 100 physics departments dedicated to the improvement of physics and physical science teacher preparation. PTEC.org (http://PTEC.org) is the Internet home of the organization. PTEC.org seeks to connect the 100 member institutions and to facilitate communication within the teacher preparation community by providing access to meeting information and professional development opportunities. PTEC.org is also the National Science Digital Library collection on physical science teacher preparation. The library gathers and organizes the broad expertise of the PTEC organization and its member institutions including PTEC conference proceedings, national reports, research articles, recruiting materials, syllabi, and articles written by PTEC members. The site continuously seeks new ways to capture innovative teacher recruiting and training programs and to reach out and to support physics departments interested in teacher preparation.

II04: 8:30–9:30 a.m. Help for Your Classroom at the Physics Classroom

Panel – Tom Henderson, Glenbrook South High School, 4000 West Lake Ave., Glenview, IL 60026; thenderson@glenbrook.k12.il.us

The Physics Classroom website has a long tradition of helping both physics students and physics teachers. Its easy-to-understand language, abundant graphics, and references to common classroom experiences make it an effective learning tool. First-year teachers and crossover teachers have found it to be a source of ideas for planning lessons, creating PowerPoint presentations, developing student worksheets and finding online activities. Written by a classroom teacher for high school students, The Physics Classroom website offers many opportunities to learn, review and interact. Find out what's old, what's new and what's planned for the future at The Physics Classroom website.

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

Location: F-Moulin Rouge
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Educational Technologies
Date: Sunday, Feb. 15
Time: 10 a.m.–12 p.m.

Presider: David Sokoloff

The results of physics education research and the availability of microcomputer-based tools have led to the development of the activity-based Physics Suite. Most of the Suite materials are designed for hands-on learning, for example student-oriented laboratory curricula such as RealTime Physics. One reason for the success of these materials is that they encourage students to take an active part in their learning. This interactive session will demonstrate—through active audience participation—Suite materials designed to promote active learning in lecture, Interactive Lecture Demonstrations (ILDs). The demonstrations will be drawn from energy, heat and thermodynamics, oscillations and waves, electricity and magnetism, and light and optics. Results of studies on the effectiveness of this approach will be presented. 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.

Session HA: Crackerbarrel: Professional Concerns of PER Solo Faculty

Location: F-Chancellor
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Teacher Preparation
Date: Sunday, Feb. 15
Time: 12–1:30 p.m.

Presider: Paula Engelhardt

Session JA: Crackerbarrel: Physics and Society Education

Location: H-Gold Coast
Sponsor: Committee on Science Education for the Public
Date: Sunday, Feb. 15
Time: 12–1:30 p.m.

Presider: Jane Flood

Join your colleagues for a discussion of how AAPT members can contribute to the teaching of physics-related societal issues. Come with ideas about how to expand or improve the sessions organized by the informal Physics and Society Education group.

Session JB: Crackerbarrel: International Issues

Location: F-Ambassador
Sponsor: Committee on International Physics Education
Date: Sunday, Feb. 15
Time: 12–1:30 p.m.

Presider: Genaro Zavala

Session KA: AAPT Symposium – Early High School Physics: Building a Foundation for Understanding the Sciences

Location: Fairmont, Imperial Ballroom
Sponsor: AAPT
Date: Sunday, Feb.15
Time: 1:30–3:30 p.m.

Presider: Leon Lederman

SYMPOSIUM on Physics Education

Considered by many to be the most concrete of the sciences, physics is the basis for understanding the more abstract concepts introduced in chemistry and biology. At an earlier time when biology primarily concentrated on classification and chemistry focused on applications rather than the atomic structure of matter, it made more sense to follow a biology/chemistry/physics sequence. Putting physics first gives students a basis for understanding the theoretical nature of more advanced science concepts. This movement to reverse the traditional B-C-P science sequence first took hold more than 20 years ago in response to the recommendations of *A Nation at Risk*. Interest in Physics First has recently accelerated due to the strong advocacy by Leon Lederman. Now more than 1200 schools have adopted some version of the Physics First idea as a result of successful national and statewide awareness and implementation efforts.

Leon Lederman

– Paul Hickman, a longtime physics teacher and Physics First advocate, will set the stage for the discussions with an overview of this movement to reorder the traditional high school science sequence.

Science Education Consultant, 23 Rattlesnake Hill Rd., Andover, MA 01810; hickmanp@comcast.net

– Marsha Rosner studies how biochemical signals promote the growth, differentiation or death of cells. She will share her thoughts about how physics can support understanding in high school biology and chemistry.

Director and Charles B. Huggins Professor, Ben May Institute for Cancer Research, The University of Chicago, Chicago, IL 60637; mrosner@ben-may.bsd.uchicago.edu

– Ron Kahn, a former award-winning physics teacher, will speak to the statewide efforts initiated by Rhode Island's Governor Donald Carcieri. The project seeks to implement an improved science sequence in the state's high schools.

Director of Client Services, East Bay Educational Collaborative, 317 Market St., Warren, RI 02885; rkahn@cox.net

– Gabriel de la Paz, an active high school physics teacher, will speak to the A-TIME for Physics First statewide partnership effort in Missouri. He serves as a peer teacher for their professional development efforts.

Clayton High School, 1 Mark Twain Circle, Clayton, MO 63105; delapaz@clayton.k12.mo.us

– Corinne Williams, who is now an Assistant Superintendent at a local area school system, will share some data, observations and thoughts from her doctoral work on Physics First.

Asst. Supt. For Teaching & Learning, Bremen High School District 228, 15233 Pulaski Rd., Midlothian, IL 60445; cwilliams@bhsd228.com

– John Hubisz, who just completed a review of textbooks appropriate for Physics First, will speak to the instructional materials available to support early high school physics courses.

Physics Dept., North Carolina State University, Apex, NC 27502; hubisz@unity.ncsu.edu

Session LA: Project-Based Physics

Location: H-Columbus AB
Sponsor: Committee on Physics in Two-Year Colleges
Date: Sunday, Feb. 15
Time: 6–8 p.m.

Presider: Thomas L. O'Kuma

An invited and contributed session on Project Based Physics includes papers in which physics that is project based is taught. The PBP papers could be for the entire course, the laboratory component or the course, or other approaches.

LA01: 6–6:30 p.m. Project-Based Physics

Invited – Martin S. Mason, Mt. San Antonio College, 1100 N. Grand Ave., Walnut, CA 91789; mmason@mtsac.edu

Projects serve as an organizing principle for sections of the first-semester engineering physics course at Mt. San Antonio College. Students complete three major five-week projects, all of which require them to develop a computational model that will have predictive power. Vpython is used as the language of choice because of its visualization power and ease of use. Implementing projects and computational modeling requires significant amounts of class time. Project-based courses contain both traditional content-based student learning outcomes and nontraditional outcomes. These nontraditional outcomes are more difficult to assess, but may contribute to a student's overall success in science or engineering. Student success in the second-semester engineering physics course is compared for students who completed the computational modeling project based course vs students who completed the traditional course. Student success in subsequent engineering courses and overall program completion rates are compared for the two populations.

LA02: 6:30–7 p.m. PBP: Learning Physics from the Real World

Invited – David Weaver, Chandler-Gilbert Community College, 7360 E. Tahoe Ave., Mesa, AZ 85212; david.weaver@cgcmail.maricopa.edu

My implementation of project-based physics (PBP) flips the course focus from the way I was taught (and the way taught for more than 15 years). Instead of using physics topics (and later, models) as the organizing structure for the course with the applications to follow, our projects serve as the context within which students learn the physics. I will talk about the overall structure of my courses, describe the typical project itinerary, identify my and my students' roles, and show examples of various projects we've used as well as student products from the projects. In addition, I will discuss why I think PBP is important to do and why I think it works so well.

LA03: 7–7:30 p.m. Using Control Systems as a Basis for Brief Physics Projects*

Invited – Frederick J. Thomas, Math Machines, 1014 Merrywood Dr., Englewood, OH 45322; fred.thomas@mathmachines.net

Engineering-style control systems employ physics and math to make things happen, including automatic control of linear and angular motion, lighting, heating and cooling, and more. Starting with a grant from NSF's Advanced Technological Education program in 2002, "Math Machines" have continued to develop as a technique for engaging physics students in the design, testing and revision of mathematical functions that achieve specified physical outcomes under varying input conditions. Examples include programming an RGB light-emitting diode to oscillate with a frequency that depends on temperature, programming a rotating mirror to deflect a light beam onto a moving target, and programming an "algebraically controlled vehicle" to align itself with a magnetic field.

*Based in part upon work supported by the National Science Foundation under Grant No. DUE-0202202.

LA04: 7:30–7:40 p.m. Authentic Experimental Research at the High School Level

Sophia Gershman, Watchung Hills Regional High School, 108 Stirling Rd., Warren, NJ 07059; sgershman@whrhs.org

An expansion of undergraduate and pre-college research opportunities and classes has been taking place in response to the growing need for scientifically savvy citizenry. This paper shares the extensive experience in the development of an educational environment suitable for authentic experimental research conducted by high school students. The framework for building mentorship relationships between teachers and students receives particular attention. The facility development and outside collaborations are also discussed. Specific examples of student projects are presented, including the experiments in psychology, plasma physics, environmental science, and other science fields. The research laboratory environment has been used for teaching Physics and Experimental Design courses, and for special research programs. High school students present unique developmental needs and advantages. High schools provide an opportunity to create a model scientific community that intensifies student learning and helps them develop a broad set of science skills.

LA05: 7:40–7:50 p.m. Teaching Freshman Project-Based Physics in Small Inner City High Schools, 2003-2008

Paul W. Shafer, Aspira of Illinois Inc., 1711 N. California Ave., Chicago, IL 60647; pshafer@mrcscs.aspirail.org

Kristine Kupierski, Monica Gomez, and Diamond Montana, Aspira of Illinois Inc.

We started Aspira Charter High School in a converted warehouse in 2003. We chose applied and conceptual physics as the first of three science courses required by our students to graduate. We had no equipment and few books, but through a project-based approach, teacher team effort, and a method where the students designed and built machines and working experimental apparatus, our students were able to learn experientially physics concepts, formulas, applications of formulas, and mastery of basic physics. We have progressed since the first year to a much more elaborate approach to Physics First.

Session LB: Rethinking the Upper-Level Curriculum

Location: H-Columbus CD
Sponsor: Committee on Physics in Undergraduate Education
Co-Sponsor: Committee on Laboratories
Date: Sunday, Feb. 15
Time: 6–7 p.m.

Presider: Ernest Behringer

LB01: 6–6:30 p.m. Rethinking Upper-Level Curricula in Light of Introductory Physics Reform

Invited – Mark P. Haugan, Dept. of Physics, Purdue University, 525 Northwestern Ave., West Lafayette, IN 47907-2036; haugan@purdue.edu

Several new calculus-based introductory physics curricula have been developed in recent years and some are now being used at major research universities. For example, *Matter & Interactions* [1] is in use at Purdue University, the Georgia Institute of Technology and the North Carolina State University. These new curricula are products of deep reflection on the structure of physics knowledge and of a growing, research-based understanding of student thinking and learning. Their use creates a potential for significant improvement of upper-level physics instruction because they deliver students with new kinds of knowledge and skills to more advanced courses. To convey a sense of this potential for progress, I will examine examples of novel instructional approaches to aspects of quantum mechanics, relativity and other upper-level topics

under development at Purdue and elsewhere.

1. R. Chabay and B. Sherwood, *Matter & Interactions*, 2nd Ed. (Wiley, 2007).

LB02: 6:30–7 p.m. Why Double the Number of Physics Majors?

Invited – Michael Marder, Dept. of Physics, University of Texas, 1 University Station, Austin, TX 78712; marder@mail.utexas.edu

The American Physical Society has adopted a doubling initiative, aiming to double the number of physics majors within about five years. The components of this initiative will be discussed, as well as the significance for the upper-division curriculum of having a potentially large new group of physics majors for whom graduate school in physics is not necessarily the first goal.

Session LC: Energy and the Environment

Location: H-Grand A
Sponsor: Committee on Physics in Two-Year Colleges
Date: Sunday, Feb. 15
Time: 7:15–10 p.m.

Presider: Todd R. Leif

Wind energy is rapidly becoming an essential source of electricity in the United States. This session is about programs or projects related to the wind energy technology environment or any similar alternative energy programs/projects.

LC01: 7:15–7:45 p.m. Renewable Energy Projects for Students at a Liberal Arts College

Invited – Charles F. Niederriter, Gustavus Adolphus College, 800 West College Ave., Saint Peter, MN 56082; chuck@gustavus.edu

Carl D. Ferkinhoff, Cornell University

Jared A. Lee, Penn State University

Jared D. Sieling, Danielle A. Berg, University of Minnesota

Although interest in renewable energy is not new to college campuses, it has increased dramatically in recent years as has the number and variety of student/faculty research projects. Students and faculty at Gustavus were making measurements on Trombe walls in the late 1970s. But, since the spring of 2001, the level of interest has grown. At that time, a small group of students set us off on a path to explore the feasibility of wind energy for our small campus, and ultimately many other forms of renewable energy. We continue to study production from potential wind turbines and the relationship to consumption on campus and conservation. We have also gone on to study energy storage systems in conjunction with intermittent sources, flow batteries, photovoltaics, and solar thermal water heaters. We will report on the successes and failures of these projects as well as our dreams for future renewable energy education.

LC02: 7:45–8:05 p.m. Developing the United States Energy Policy for the 21st Century

Invited – Pat Keefe, Clatsop Community College, 1653 Jerome, Astoria, OR 97103; pkeefe@clatsopcc.edu

Al Bartlett's video, "Arithmetic, Population, and Energy," spells out many of the complex issues related to energy use in our society. Bartlett makes the point that basic arithmetic is the fundamental obstacle preventing us from being able to grasp the relationships between energy production, population, and lifestyles. Although the arithmetic consists of simple mathematical relationships, there are just too many of them that need to be made for students to fully understand the issues. To overcome this problem, a spreadsheet model has been developed. It can be used in a variety of ways to help students study energy and society issues. Using the spreadsheet model, students are able to discuss and research energy and society issues more effectively.

LC03: 8:05–8:25 p.m. The Global Energy Budget — A Modeling Exercise

Invited – Gregory Mulder, Linn-Benton Community College, 6500 Pacific Blvd., Albany, OR 97321; mulderg@linnbenton.edu

The issues related to energy in our society can be complex. Understanding basic relationships between energy production, population and lifestyles can stimulate greater discussion and deeper exploration into energy, the physics of energy, and our society. To be presented is a spreadsheet modeling exercise that can be used in a variety of classes, seminars, and workshop formats in order to motivate students and colleagues toward a better understanding of energy and its impact upon our global society.

LC04: 8:25–8:55 p.m. Energy Efficiency, Carbon, and Getting a Summer Job with DOE

Invited – Don B. Cameron, Lakewood HS / NREL Teacher Fellow, 9700 West 8th Ave., Lakewood, CO 80215; dcameron@jeffco.k12.co.us

The number one way to meet our future energy needs is to reduce the needs in the first place. This talk will focus on carbon emissions for various energy alternatives, from energy efficiency, biofuels, solar, wind, and geothermal. Focus will be on building out teachers' content knowledge so they can have ideas to share with students on where to focus future research in the energy arena. In addition the speaker will share information on the DOE ACTs program, that supplies teacher researcher opportunities at the DOE national labs, and grant money for their programs.

LC05: 8:55–9:05 p.m. Gasoline Direct Injection, Clean Diesel and Hybrid Automobile Engine Technologies

Bernard J. Feldman, Dept. of Physics and Astronomy, University of Missouri-St. Louis, St. Louis, MO 63121; feldmanb@umsl.edu

The dramatic increase in the price of gasoline has fueled a revolution in autombile engine technologies—pardon the pun. My talk will briefly describe the most promising new automobile engine technologies: gasoline direct injection, clean diesel, hybrids and plug-in hybrids. All these new technologies have been developed and road tested, are economically competitive, deliver significantly improved fuel efficiency, and are either available or will be available within the next two years.

Session LD: College Labs and Curriculum

Location: H-Columbus EF
Sponsor: Committee on Physics in Undergraduate Education
Date: Sunday, Feb. 15
Time: 6–8:30 p.m.

Presider: Lili Cui

Co-Presider: Joseph Kozminski

LD01: 6–6:10 p.m. Teaching Physics in a Course on Nanotechnology

Andra Petrean-Troncalli, Austin College, 900 N. Grand Ave., Suite 61556, Sherman, TX 75090; atroncalli@austincollege.edu

I taught an introduction to nanotechnology class in two different venues, a freshman seminar and a January term class. Although the main focus was on nanotechnology and not on physics, the classes offered plenty of opportunities to introduce physics concepts, such as electron bonding, quantum mechanics, semiconductor physics, and optics. Both classes were populated with mostly nonmajors, and although some students were considering majoring in the sciences, the classes attracted students from outside of the sciences as well. The class also looked at some of the interaction between science and society, and during the January term the students did a laboratory activity that involved growing carbon nanotubes. Presentation includes details about the classes and some possible future improvements.

LD02: 6:10–6:20 p.m. Rapid Conversion of Traditional Introductory Courses to an Activity-Based Format

Jerry D. Cook, Eastern Kentucky University, Moore 351, Richmond, KY 40475; Jerry.Cook@EKU.EDU

Garett Yoder, Eastern Kentucky University

The Physics Department at Eastern Kentucky University has begun to completely convert the traditional introductory physics sequence to an integrated studio classroom (called a CELL, Cooperative Educational Learning Laboratory) format that is activity based. In our new courses we use the concept of Forced Response in which we make students confront misconceptions at both the beginning and end of each particular unit. This conversion is planned to be completed in a five-semester time period. Our project requires that seven separate sections each semester be taught in the new format. Problems associated with this rapid conversion include faculty development, scheduling, equipment, lesson plans, unit grouping, administration, developmental time for faculty, and classroom space. Our solutions to problems associated with each of these will be discussed as will our initial evaluations of our new courses and a comparison of student performance in our new activity-based studio courses verses our traditional lecture and separate laboratory formats.

LD03: 6:20–6:30 p.m. Conceptual Electricity and Magnetism Problem Database

John C. Stewart, University of Arkansas, Physics Building, Fayetteville, AR 72701; johns@uark.edu

This talk introduces a new digital resource for teaching and evaluating introductory electricity and magnetism classes: a digital library of highly characterized, multiple-choice, conceptual electricity and magnetism problems. The library contains more than 1000 problems that were algorithmically constructed from a collection of introductory sources. Each problem is characterized by the complexity of its solution and by the fundamental intellectual steps found in the solution. Evaluation construction, administration, and analysis tools are provided through the library's website. Problems may be downloaded for use in exams or as clicker questions. Instructors may also design and administer conceptual evaluations online. There is no cost associated with using any of the facilities of the site. Supported by NSF -DUE 0535928.

LD04: 6:30–6:40 p.m. Modifying the Optics Laboratory for Greater Conceptual Understanding

Timothy T. Grove, Indiana University Purdue University Fort Wayne, 2101 E. Coliseum Blvd., Fort Wayne, IN 46805; grovet@ipfw.edu*

Mark F. Masters, Indiana University Purdue University Fort Wayne

We developed a sequence of optics laboratories that assist the student in understanding critical concepts in optics. Our approach relies upon discussion, direct confrontation of misconceptions, and leading questions as opposed to a series of detailed, cookbook-like instructions. Through the labs we build conceptual understanding in subjects like image formation by lenses and mirrors, ray optics, and ultimately elliptical polarization while fostering laboratory independence. Initial support structure in the laboratory is progressively removed. In the final three weeks, students complete an independent research project. We present details of our laboratory sequence and our impressions of the modifications.

*Sponsor: Mark F. Masters

LD05: 6:40–6:50 p.m. Measuring Model Rocket Engine Thrust Curves

Kim Mason, Physics Dept., The University of Central Arkansas, Conway, AR 72035; kim.mason09@gmail.com*

William V. Slaton, The University of Central Arkansas

Rockets are a dramatic and effective way to introduce the concept of thrust, momentum, and impulse to students. Model rocket engines can be easily obtained and safely used outdoors during a class demonstration or in a laboratory environment. Of interest is the thrust of different sized rocket engines as a function of time. The thrust can be easily measured using Vernier's LabPro data acquisition system and Dual Range Force Sensor. LoggerPro can be used to numerically integrate the area under the thrust versus time curve to give the impulse delivered by the engine. Experimental setup, data acquisition, and experimental results from tests of engines ranging in size from A to D will be presented.

*Sponsor: Steve Addison (Current President of the AOK region of AAPT).

LD06: 6:50–7 p.m. Labs with a Historical Flair

Taoufik Nadji, Interlochen Arts Academy, 3552 Faculty Ln., Interlochen, MI 49643; nadjit@interlochen.org

In this information-sharing session, the speaker will share his experience of how his students combine historical statements of physics laws, old-fashioned proofs, group collaboration, computer interface lab equipment, and PER-inspired techniques to learn physics concepts and their underlying laws. In addition, the session will feature samples of students' work, sample lab ConcepTests developed by the speaker, and additional suggested lab and/or project activities that have been used by the speaker throughout the years.

LD07: 7–7:10 p.m. Active Learning Using Tutorials in Intermediate Optics*

Mark F. Masters, Dept. of Physics, Indiana University Purdue University Fort Wayne, 2101 Coliseum Blvd., Fort Wayne, IN 46805; masters@ipfw.edu

Timothy T. Grove, Indiana University Purdue University Fort Wayne

Active learning is the process through which students in a class are actively engaged in the material under investigation. The success of this method of instruction has been well documented for introductory classes. In advanced (beyond introductory) physics classes there are fewer published results of experience or materials for use in active learning. This may be, in part, due to the mathematical rigor required in advanced classes and the traditional use of derivations to gain insight into physical problem solving. We present our work in developing tutorials to help the students learn and use the mathematics and techniques of derivations as well as develop a stronger conceptual foundation for intermediate optics. These tutorials form a basis for the development of an active learning process in an advanced physics class setting.

*Supported by NSF Grant # DUE 0410760]

LD08: 7:10–7:20 p.m. Advanced Lab: A Training Ground for Responsible Scientists

Joseph Kozminski, Lewis University, 1402 E 55th St., Chicago, IL 60615; kozminjo@lewisu.edu

The Advanced Experimental Physics course is the only laboratory course physics majors at Lewis University are required to take beyond the general physics laboratories. Redesigning the curriculum for this course has been challenging since there are numerous objectives that need to be addressed in a small amount of time, with a limited budget. The curriculum emphasizes four main areas: design and experimentation, data analysis, technical writing and presentation, and research ethics. I will give an overview of how these areas of emphasis are integrated into the course and evaluated, and I will discuss how each contributes to the development of our students as responsible scientists.

LD09: 7:30–7:40 p.m. Flexural Vibration Test of a Cantilever Beam with Force Sensor: Fast Determination of Young's Modulus

Rafael M. Digilov, Technion - Israel Institute of Technology, Department of Education in Technology & Science, Haifa, Israel 32000; edurafi@tx.technion.ac.il

A simple and inexpensive dynamic method for fast determination of Young's modulus at moderate temperatures with the aid of a force sensor is presented. A strip-shaped specimen rigidly bolted to the force sensor forms a clamped-free cantilever beam. Placed in a furnace, it is subjected to free bending vibrations followed by a fast Fourier transform for identifying the resonant frequency, whereby Young's modulus is calculated from the Euler-Bernoulli beam model. Room temperature moduli obtained for a series of diverse industrial materials (stainless steel, copper, aluminum, Perspex, wood and getinax) are in excellent agreement with available literature data. The temperature dependence of Young's modulus for stainless steel measured over the 300-600 K interval is analyzed.

LD10: 7:40–7:50 p.m. Anisotropic Capillary Wave Propagation in a Ripple Tank

Daniel G. Velazquez, Marshall University, Huntington, WV 25703; velazquez@marshall.edu

Thomas Wilson, Marshall University

A preliminary study has been undertaken to demonstrate the anisotropic wave propagation of capillary waves in a water ripple tank. We have fabricated, using a computer-controlled milling machine, a contoured surface upon a Plexiglas plate with gradually deepened (2mm min, 4mm max) angular channels emanating from the center of the plate and spaced every 90 degrees, with an additional cylindrical well in the plate's center, to accept the vibrating ball of the wave generator upon submersion. Provided the difference between the minimum and maximum of the phase velocities for the two corresponding depths of the capillary waves can be made appropriately large, then one would expect to observe interesting folds in the wavefront in the directions of largest phase velocity, corresponding to zero-curvature inflection points in the slowness surface. [See J.P. Wolfe, *Phonon Imaging* (Cambridge University Press, 1998)].

LD11: 7:50–8 p.m. Conceptual Confusions in Teaching Quantum Mechanics

Stuart Gluck, Johns Hopkins University Center for Talented Youth, McAuley Hall, 5801 Smith Ave., Suite 400, Baltimore, MD 21209; stu@jhu.edu

Misconceptions about the conceptual foundations of quantum mechanics are common. As a result, most physicists are taught that Bohr and Heisenberg showed that measurements must bring about a nonunitary collapse of the wavefunction. However, their Copenhagen interpretation is certainly not the only viable account, and actually faces significant difficulties when compared to others in which all temporal evolution is unitary. In this session, we will explain the range of interpretations of quantum mechanics so you can teach students quantum mechanics with conceptual clarity.

LD12: 8–8:10 p.m. A Visual Introduction to Quantum Field Theory

Scott C. Johnson, Intel, 4635 NW 175th Pl., Portland, OR 97229; scott.c.johnson@intel.com

The concept of a quantum field has been the underpinning of all of physics for over half a century. Yet very little of this concept is taught at the undergrad level, probably both because of its notorious difficulty and because of the abstract nature of most presentations on the subject. This presentation will show several models and animations (all freely available and generated with freely available software) that explain and demonstrate the answer to the question, "What is a quantum field?" in a concrete, undergrad-accessible way. The models I use are based on the one-dimensional chain of harmonic oscillators that is often used to introduce phonons or quantum fields at the graduate level. But by changing this model to include multiple interacting particles and by graphing or animating all of the calculations, it becomes an effective demonstration at the undergrad level.

LD13: 8:10–8:20 p.m. Nuclear Barrier Heights Are Potential Waves Due to Nuclear Vibrations

Stewart E. Brekke, Northeastern Illinois University (former grad student), 5500 N. St. Louis Ave., Chicago, IL 60625; stewabruk@aol.com

Most modern physics texts illustrate the nuclear barrier as a smooth curve and the nucleus as motionless. However, the nucleus is vibrating and rotating and therefore, the barrier is a potential wave changing amplitude over time. Since the height of the barrier changes over time, the nuclear barrier height is a variable. Physics texts, from modern physics to quantum mechanics, from elementary to graduate, do not take into account nuclear motion, the barrier as a wave and the barrier height as a variable and should be corrected. Since the potential barrier is a wave, all calculations associated with the static nucleus must be disgarded, including standard Eigenvalues, and new equations and values such as nuclear barrier heights must be formulated and recalculated.

LD14: 8:20–8:30 p.m. Cutting-Edge Undergraduate Research in Nuclear Physics*

Nathan Frank, Illinois Wesleyan University, P.O. Box 2900, Bloomington, IL 61702-2900; nfrank@iwu.edu

Performing cutting-edge research at a small liberal arts institution is a unique challenge. However, a dedicated researcher at a liberal arts institution can still flourish, even in the field of nuclear physics, as has been demonstrated by the MoNA Collaboration. This collaboration provides the opportunity for undergraduate students at their local institutions to participate in research that impacts the field of nuclear physics. Experiments were conducted at the National Superconducting Cyclotron Laboratory at Michigan State University on the structure of neutron-rich isotopes at the edge of stability. The experimental data were analyzed, in part, by undergraduates. Research results and discussion of mentoring undergraduates will be presented.

*Work supported by National Science Foundation Grants PHY-0606007 and PHY-055445

Session LE: Assessment of Effectiveness of Educational Technologies in Instruction

Location: H-Columbus EF
Sponsor: Committee on Educational Technologies
Co-Sponsor: Committee on Research in Physics Education
Date: Sunday, Feb.15
Time: 9–10 p.m.

Presider: Michelle Strand

The use of educational technology is pervasive in today's classroom, but how do we know how effective it is? This session will highlight research into the effectiveness of the use of technology in the classroom.

LE01: 9–9:10 p.m. LivePhoto Physics: The Impact of Video-Analysis Activities on Learning*

Patrick Cooney, Dept. of Physics, Millersville University, P.O. Box 1002, Millersville, PA 17551; pjcooney@millersville.edu

Robert Teese, Rochester Institute of Technology

Priscilla Laws and Maxine Willis, Dickinson College

The LivePhoto Physics Project team is creating a collection of short digital videos clips and associated classroom-tested activities to enhance introductory physics lecture demonstrations, in-class exercises, laboratories and homework. To assess the effectiveness of this approach, the team is developing a brief conceptual evaluation on projectile motion. Free-response versions of this exam were administered during the fall of 2008, both before and after relevant instruction. This paper will examine the role of the students' free responses in the production of a multiple-choice version of this new conceptual evaluation. The team invites interested instructors to join this investigation by attending one of two NSF-funded professional development workshops in June or July of 2009 exploring how digital video analysis can be used in conjunction with physics education research to help students overcome learning difficulties.

*This Project has been supported by National Science Foundation grants 0089380, 0424063 and 0717699 (http://livephoto.rit.edu/).

LE02: 9:10–9:20 p.m. An Assessment of Current Pure-Online Physics Courses

Ricardo J. Rademacher, Futur-e-scape, LLC, 503 McAlpin Ave., Cincinnati, OH 45220; ricardo@futur-e-scape.com

With the repeal of the 50/50 rule by the Higher Education Reconciliation Act of 2005, U.S. Online Enrollments have risen to 3.5M with a 10% growth rate as of 2007. As well, Project Tomorrow shows that in 2007, 41% of 300,000 students surveyed viewed online education as an important part of their future education. In this presentation, Dr. Rademacher will use his three years teaching at a traditional university and his three years of teaching online classes to compare purely online classes with their traditional counterparts. We will see how discussion-based forums can be used to transfer basic physics pedagogy and serve to highly engage physics students. However, we will also see how the laboratory requirement is not being adequately met and varies widely on the institution. The attendee will walk away with a clear understanding of how physics is being taught in purely online classes.

LE03: 9:20–9:30 p.m. Online Homework or Paper and Pencil for High School Students?

Thomas P. Withee, Dept. of Physics, Southern Illinois University Edwardsville, Box 1654, Edwardsville, IL 62026-1654; twithee@siue.edu

Thomas Foster, Southern Illinois University Edwardsville

From the research on expertise, we know that deliberate practice is an essential component of the learning process. With advances in computer technology and the proliferation of the Internet, the use of online homework in the physics classroom is becoming the standard form of practice. Comparing the old with the new, it is natural to wonder what aspects of deliberate practice are present in online homework systems. Of particular interest is the students' use of feedback and how this impacts their problem solving. This study compares the problem-solving skills of the students of several high school teachers. Each teacher had one class do paper and pencil homework and one class use WebAssign. The Problem Solving Skills Measurement (from the University of Minnesota) was used to analyze three problem sets solved by the students in class. The FMCE and CLASS were used to help understand classroom and teacher differences.

LE04: 9:30–9:40 p.m. Multimedia Learning Modules Improve Student Exam Performance in E+M.

Tim Stelzer, University of Illinois, 1110 W Green St., Urbana, IL 61801; tstelzer@illinois.edu

David Brookes, Gary Gladding, Jose Mestre, University of Illinois

Web-based multimedia pre-lectures were added to our reformed introductory electricity and magnetism course. Each module consisted of approximately 20 minutes of narrated animation and students were given credit for completing them before lecture. To compensate for this addition of time, lectures were reduced from 75 minutes to 50 minutes. Presenter will describe these pre-lectures and discuss the analysis of the impact they had on student exam performance.

LE05: 9:40–9:50 p.m. Using Multimedia Modules to Better Prepare Students for Introductory PhysicsLectures

Zhongzhou Chen, UIUC, 1110 W. Green St., Urbana, IL 61801; zchen22@illinois.edu

Students in introductory physics courses were often found to come into lectures with little or no knowledge of basic physics concepts. In this study we report a curriculum intervention using computerized multimedia learning modules (MLM) to better prepare students for lecture. Students' understanding of physics concepts is estimated by their performance on preflight questions which they answer before the lecture. We found that those who viewed MLM performed significantly better on a number of preflight problems, as compared to students' performance in previous semesters without MLMs. Meanwhile, the performance of those who skipped MLMs were statistically undistinguishable from previous semesters. We also found that both weaker students and better students in the course benefit equally from MLMs overall; however, weaker students seem to improve more on easier and more straightforward preflight problems, while better students improve on harder problems and transfer tasks.

LE06: 9:50–10 p.m. How Animating Lecture Slides Affects Eye-Gaze and Cognitive Load

Adam Feil, University of Illinois, 1110 W. Green St., Urbana, IL 61801; adamfeil@uiuc.edu

Tim Stelzer, University of Illinois

A controlled study was conducted to reveal the effect that animation has on students' eye-gaze patterns and cognitive load while viewing Multimedia Learning Modules (MLMs). Static and animated versions of the same narrated slides from an MLM were created, and students were randomly assigned static and animated versions of the slides. Results show that students who viewed animated versions were more likely to be looking at a relevant item on the slide. However, an intentionally added distracting animation reveals that animation can, in some cases cause students' attention to be misdirected. Cognitive load, as measured by a subjective difficulty rating scale, was lower for the animated versions. Implications for multimedia instruction will be discussed.

Session LF: Good Teaching Ideas

Location: H-Columbus GH
Sponsor: Committee on Physics in High Schools
Date: Sunday, Feb. 15
Time: 6–9:10 p.m.

Presider: *Shannon Mandel*

Co-Presider: *Diane Riendeau*

People will share their "Good Ideas" in physics teaching at this session. This could include demos, labs, ways of presenting material, and other good ideas that teachers can use in their classes.

LF01: 6–6:30 p.m. Contagious Physics

Invited – Diane Riendeau, Deerfield High School, 1959 Waukegan Rd., Deerfield, IL 60015; driendeau@dist113.org

Good ideas abound at AAPT meetings. I humbly offer a smattering of the ones I have embraced and adapted to use in my classroom. The collection presented will include ideas for making your classroom more student-centered; sharing your passion with your students, their parents, and your colleagues; and teaching beyond the physics curriculum. Hopefully, one of these ideas will help you become a more contagious physics teacher who spreads the joy and knowledge of physics to your students and beyond.

LF02: 6:30–7 p.m. A Great Way to Begin the Physics Year

Invited – Scott C. Beutlich, Crystal Lake South H.S., 1200 S. McHenry Ave., Crystal Lake, IL 60014; sbeutlich@d155.org

This talk will go over two things I do with all my physics classes in the beginning of the school year. For the past 10 years I have successfully started the first day of school with a station lab activity. I will share the types of activities and typical student reaction. The second part of my talk I will share the reasons why I feel teaching Optics, Waves, and Sound during the first quarter is a great way to get students excited and staying in physics.

LF03: 7–7:10 p.m. Comics in the Classroom

Stephanie A. Magleby, Brigham Young University, N311 ESC, BYU, Provo, UT 84602; sam25@physics.byu.edu

Comic strips can be effective pedagogical and classroom management teaching tools. A well-chosen comic strip can be used to introduce a subject, to teach a concept, or to dispel common physical misconceptions. Comic strips can also be employed to address classroom management and discipline issues in non-threatening ways. Storylines about tardiness, cheating, apathy, procrastination, and cramming are all to be found in the comics, complete with a punch-line reminding the reader about the consequences of such behavior. During crunch times, like finals and midterms, comic strips can show support and empathy or take the edge off of a particularly tough exam. A collection of physics Foxtrot comics sorted by topic will be presented and distributed with the written permission of Bill Amend, the creator of Foxtrot.

LF04: 7:10–7:20 p.m. Music in Motion: Using Musical Instrument Design to Teach Freshman Science and Mathematics*

Robert J. Culbertson, Physics Dept., Arizona State University, Box 871504, Tempe, AZ 85287-1504; robert.culbertson@asu.edu

Dale R. Baker, Michael Oehrtman, Stephen J. Krause, and Janice Thompson, Arizona State University

A project to integrate science, mathematics, and English for incoming university freshmen was begun in fall 2008 by an interdisciplinary team consisting of physics, mathematics, education, engineering, and music faculty. The project involved an 11-credit block of connected courses, called a Learning Community (LC), which includes freshman physical science, first-year mathematics, English composition, and a one-credit integrative seminar. Students in nonscience majors were recruited for the LC. The common thread among the courses was musical instruments: design, construction, and underlying theory. Several construction projects were carried out during the semester using the engineering design principle, and students built and demonstrated their own instruments for their final project. Examples of activities in the LC as well as results from content and attitude assessments will be discussed.

*Supported by NSF No. 07118937

LF05: 7:20–7:30 p.m. Resonance Effects on Buildings Due to Earthquake Disturbances

Nathalie Mukolobwiez, Saint Ursula Academy, 1339 E. McMillan St., Cincinnati, OH 45206; nmukolobwiez@saintursula.org

Michelle D. Beach, Midpark High School

Jaz Dhillon, Withrow High School

Anant Kukreti and Ravi Chalasani, Department of Civil and Environmental Engineering, University of Cincinnati.

Earthquakes can damage or make buildings collapse. This phenomenon offers a real-life example of waves and resonance. In this activity, students experimentally explore ways to minimize the buildings' response to earthquakes. In particular, students investigate which parameters may be changed in order to decrease the effect of the induced seismic force. Using the engineering design process, students develop devices such as base isolators or dampers. They investigate the effects of these devices on the natural frequency and/or damping coefficient of the building. To do so, first, students experimentally determine the stiffness and natural frequency of small-scale (~1/24) Knex models of building frames varying the height or the mass. Second, students evaluate their devices using a shake table simulating earthquakes of different frequencies. Students determine and rank the effectiveness of each of their devices. The experimental investigation allows students to grasp the concepts of waves, resonance and damping effects.

LF06: 7:40–7:50 p.m. Obtaining and Investigating Unconventional Sources of Radioactivity

David R. Lapp, Tamalpais High School, 700 Miller Ave., Mill Valley, CA 94941; drlapp1@sbcglobal.net

This paper provides examples of naturally radioactive items that are likely to be found in most communities. Additionally, there is information provided for how to acquire many of these items inexpensively. The presence of these materials in the classroom is not only useful for teaching about nuclear radiation and debunking the "nuclear free" myth, but also for helping students to understand the history of some of the commercial uses of radioactive materials since the early 20th century. Finally, the activity of each source (relative to background radiation) is provided.

LF07: 7:50–8 p.m. A High School Advanced Lab Course

Nicholas R. Guilbert, Peddie School, South Main St., Hightstown, NJ 08520-1010; nguilbert@peddie.org

Advanced Research Physics is a lab-based high school physics course developed for junior- and senior-year students who have demonstrated both success in an introductory physics course and strong interest in physics but who do not want or need Advanced Placement Physics. The course centers around contemporary physics, both the ideas of physics developed in the 20th century as well as select areas of current research interest in physics. The structure and outline of the course will be reviewed, along with its staffing, budget, and physical plant needs. The setting of the course within the school's science curriculum and relationship of the course to ongoing developments within physics education will be emphasized.

LF08: 8–8:10 p.m. Learning and Teaching Physics from the Inside Out

Shannon T. Thorne-Brackett, DeKalb Early College Academy, 350 Sawdust Trail, Nicholson, GA 30565; Shannon_T_Thorne-Brackett@fc.dekalb.k12.ga.us

This session focuses on strategies for engaging nontraditional students taking physics and physical science. The goal of this presentation is to share various instructional ideas for the physics and physical science classroom geared toward maximizing student engagement while maintaining high expectations. Teachers will learn how to use various rubrics, assessments tools, project-based activities, literacy circles, portfolios, and more, designed to promote student achievement and to improve student learning. Presenter will show student work examples for further examination and discussion. Attendees will walk way with ready-to-use materials for immediate implementation in the classroom. Teachers learn how to help students construct their own learning via discovery versus telling the student.

LF09: 8:10–8:20 p.m. Guidelines for Talking to Children About Science and Enhancing Inquiry Practices

Gary R. Goldstein, Physics Dept.,Tufts University, Robinson Hall, Medford, MA 02155; gary.goldstein@tufts.edu

Brian E. Gravel, Tufts University, Center for Engineering Educational Outreach

Talking with young children about science is an important and enlightening experience. We present guiding principles for such talk to increase the potential for making those experiences meaningful. Piaget showed that children are inquisitive creatures with considerable ability to observe and a strong desire to understand. Through interactions with other people and the outside world, children construct understandings and explanations for their observations. We argue that to guide students toward canonical scientific understanding, their naïve beliefs and natural curiosity should be tapped. Students possess natural sense-making resources that increase their chances for authentic and significant scientific understanding. One approach to making sense in specific subject areas is through interactions with multiple representations of phenomena. A repertoire of representations can guide children toward aspects of the underlying principles while developing important habits of inquiry. In this poster/paper, we expand upon these ideas and offer guidelines for talking about science with children.

LF10: 8:20–8:30 p.m. Things Are Not Always What They Seem

Mikhail M. Agrest, Physics and Astronomy Dept., College of Charleston, 66 George St., Charleston, SC 29424; Agrestm@cofc.edu

Students come to class with the experience of their own observations, with knowledge acquired from their parents, facts learned from books, skills obtained from their previous teachers, and other sources. How accurate were students' observations, how correct were their teachers' conclusions? How ready are your students for new experiences? "I saw it with my own eyes!" is often the students' strongest proof. But do the students interpret correctly what they see? The very concept that it is better to see once rather than to hear a dozen times is not always correct. Things are not always what they seem. Do we always see when we look? How to see the essence in the things we watch? How not to take for granted things assumed to be obvious. This all deserves to be discussed to improve our influence on the students' world outlook. What do you think? Opinions will be appreciated.

LF11: 8:30–8:40 p.m. Proving WTC South Tower Collapse Forces >> F(gravity)

Crockett L. Grabbe, SeaLane Consulting & University of Iowa, 1508 Glendale Rd., Iowa City, IA 52245-3314; SeaLane@mchsi.com

Physics students can be taught a straightforward yet very powerful application of Newton's principles of motion. It is one of direct application to the debate on the issues on 911, and helps students get a grasp on scientific facts in that debate. That application is showing that the forces that ripped the South Tower of the World Trade Center apart were about an order of magnitude larger than the force of gravity. The application should be taught in every class covering mechanics from Newton's principles of motion.

LF12: 8:40–8:50 p.m. Sonography and Physics Classroom Experience Crossover

Erick P. Agrimson, The College of St. Catherine, 2004 Randolph Ave., #4105, St. Paul, MN 55105; epagrimson@stkate.edu

Susan Hummel and Terry Flower, The College of St. Catherine

During the past three years, the departments of physics and sonography at the College of St. Catherine have worked together to improve the learning of students who study sonography. Examples include the integration of traditional lab experiments, such as the Faraday ice pail experiment, alongside an open ultrasound transducer and discussing concepts such as electrical shielding. We have also utilized diffraction gratings to help students understand the importance of wave interference as a sonographer scans a patient. A highlight has been joint lectures discussing image artifacts, including the physics behind the artifact, anatomy involved, as well as the varied scanning techniques that affect the image. This partnership was unique in bringing two disparate campuses together with differing student bodies, to learn common physics principles applied to medical ultrasound concepts. We present an evaluation of these techniques and identify best practices that resulted in improved learning among our students.

LF13: 8:50–9 p.m. An Analysis of the Jumping Ring Experiment

Glenn Lorentz, Loyola University Chicago, 6460 N. Kenmore, Chicago, IL 60626; glorent@luc.edu*

Edison Kociu, Steven Kaplan, Alex Mull-Osborn, and Matthew Rickert, Loyola University Chicago

Through numerous evaluations of cultural and course level studies of electromagnetism in physics and engineering it is electromagnetic induction that is one of the most challenging for students. The jumping ring experiment is often used to demonstrate Lenz' law in conjunction with the "Faraday Effect." The changing AC current in a primary coil forces a light metal ring to jump into the air by generating an AC current in it. Lenz's law is then supposed to explain the repulsion between the two coils. However, the naïve application of Lenz's law does not fully explain the required repulsion. Through a demonstration we show that it is the overwhelmingly inductive, as opposed to capacitive nature of the ring that is responsible for this repulsion.

*Sponsor: Gordon P. Ramsey

LF14: 9–9:10 p.m. Demonstration of the Nonconservative Nature of the Faraday Field

Alexander Mull-Osborn, Physics Dept., Loyola University Chicago, 6525 N. Sheridan Rd., Chicago, IL 60626; agagop@luc.edu

Steven Kaplan, Edison Kociu, Matthew Rickert, and Glenn Lorentz, Loyola University Chicago

A novel demonstration that brings out the nonconservative nature of the Faraday field (the electric field generated by Faraday effect) will be presented. This concept has been discussed in the literature but has yet to move into classes. Since potential difference is not a valid concept when the electric field is nonconservative, this demonstration challenges one to consider just what voltmeters measure. It also serves as an excellent paradigm for teaching the structure of the Faraday field and the effect of a solenoid on the topology of the surrounding space.

Session LG: Celebrating the Beginning and Impact of the Illinois State Physics Project

Location: H-Columbus IJ
Sponsor: Committee on the Interests of Senior Physicists
Date: Sunday, Feb. 15
Time: 6–8 p.m.

Presider: James Hicks

In 1967, a consortium of 11 Illinois colleges and universities secured NSF funding for an initiative titled the Illinois State Physics Project (ISPP). The group's mission was to reverse the declining enrollment in high school physics. In 1970, with NSF funds no longer available, the demise of the ISPP alliance appeared imminent. However, a few physics education leaders in the Chicago area, led by Harald Jensen of Lake Forest College, refused to let the ISPP flame extinguish. In Harald's words, "We can't let this happen. There are just too many worthwhile things coming out of this to let it stop!" The result of Harald's declaration was the formation of the Chicago area ISPP group. For almost 40 years, through sharing and mentoring, ISPP has helped Illinois physics teachers grow professionally. The result: the enhanced teaching and learning of physics. Please join us to celebrate the impact of ISPP and experience the spirit and flavor of a typical meeting. And, as always, there will be a free giveaway.

LG01: 6–8 p.m. ISPP

Panel – Ann Brandon, 401 North Larkin Ave., Joliet, IL 60436; brandon3912@juno.com

LG02: 6–8 p.m. ISPP

Panel – Roy Coleman, 5436-B South Kimbark Ave., Chicago, IL 60615-5284; rcoleman@iit.edu

LG03: 6–8 p.m. ISPP

Panel – Pete Insley, 5652 West Giddings, Chicago, IL 60630; peterinsley@worldnet.att.net

LG04: 6–8 p.m. ISPP

Panel – Gerry Lietz, Dept. of Physics, De Paul University, 2219 North Kenmore Ave., Chicago, IL 60614; glietz@condor.depaul.edu

LG05: 6–8 p.m. ISPP

Panel – Robert J. Pasquesi, New Trier High School, District 203, 7 Happ Rd., Northfield, IL 60093; pasquesr@newtrier.k12.il.us

LG06: 6–8 p.m. ISPP

Panel – Robert Shea, 320 South Harrison St., Algonquin, IL 60102; shea320@sbcglobal.net

LG07: 6–8 p.m. ISPP

Panel – Earl Zwicker, 2601 Touchmark Dr., Appleton, WI 54914-8786; zwicker@iit.edu

Session LH: High School Pedagogies Based on Physics Education Research

Location: H-Columbus KL
Sponsor: Committee on Physics in High Schools
Co-Sponsor: Committee on Research in Physics Education
Date: Sunday, Feb.15
Time: 6–8 p.m.

Presider: Daniel M. Crowe

The purpose of this session is to provide an overview of PER-based pedagogies to high school physics teachers with little or no familiarity with such pedagogies. Developers of PER-based pedagogies that can be used in high schools are especially represented.

LH01: 6–6:30 p.m. The Modeling Methodology of High School Physics Teaching

Invited – James H. Stankevitz, Wheaton Warrenville South High School, 1993 Tiger Trail, Wheaton, IL 60189; jstankev@cusd200.org

The Modeling Methodology of High School Physics Teaching is based on the Physics Education Research done by David Hestenes, Malcolm Wells, and others.[1] Since 1995, over 3000 high school physics teachers have been trained in the Modeling Methodology through summer workshops held at many locations throughout the country. The Modeling Methodology focuses on model-centered instructional objectives and on student-centered instructional design. Details of the methodology and how the physics modeling classroom differs from conventional settings, from both the teacher and student perspectives, will be discussed. Information about upcoming summer workshops will also be provided.

1. Malcolm Wells, David Hestenes, and Gregg Swackhamer, "A Modeling Method for High School Physics Instruction," *Am. J. Phys.* **63**(7), 606-619 (1995).

LH02: 6:30–7 p.m. Introduction to a Diagnostic Learning Environment

Invited – Sherman M. Williamson, Facet Innovations and Seattle Pacific University, 24319 7th Ave. SE, Bothell, WA 98021; wmsonsmtb@aol.com

Research[1] suggests that formative assessment may be the most powerful instructional practice for promoting student learning. When well implemented, formative assessment provides teachers and students the information they need to make both learning and teaching more focused and effective. In this talk, the essential elements of a "diagnostic learning environment" will be outlined. In addition, an overview of the Diagnoser Project Tools[2] to support an effective cycle of teaching and learning will be presented. Used formatively, this free online resource can help to "diagnose" problematic student thinking in science so that the teacher can tune instruction. Examples from topics currently available (motion, forces, waves, properties of matter) will be used to illustrate how physics education research[3] informs the construction of clusters of the facets of student thinking, which in turn provides the framework for the development of the content in the Diagnoser Project Tools.

1. See for example, P. Black, and D. Wiliam, "Assessment and Classroom Learning," *Assessment in Education*, **5**(1), p 7-73 (1998).
2. http://www.diagnoser.com. Registration is free.
3. See for example, L.C. McDermott, and E.F. Redish, "Resource letter on Physics Education Research." *Am. J. Phys.* **67**(9), 755 (1999).

LH03: 7–7:10 p.m. Helping Teachers Assess Student Understanding: The Role of PER*

MacKenzie R. Stetzer, University of Washington, Box 351560, Seattle, WA 98195-1560; stetzer@phys.washington.edu

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

The Physics Education Group at the University of Washington is developing a new inquiry-oriented curriculum for the preparation and professional development of high school teachers, Tutorials for Teachers of Physics. While drawing extensively upon existing materials and ongoing research by the group,[1,2] the curriculum includes tutorials specifically designed to help teachers learn to assess student understanding more effectively. The refinement and testing of these tutorials are part of a larger effort to investigate and enhance the ability of physics instructors at all levels to assess student understanding. Specific examples from these ongoing investigations and curriculum development efforts will be discussed.

*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).

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

LH04: 7:10–7:20 p.m. PRISMS — A High School Physics Curriculum

Lawrence T. Escalada, Dept. of Physics, University of Northern Iowa, 317 Begeman Hall, Cedar Falls, IA 50614-0150; Lawrence.Escalada@uni.edu

Physics Resources and Instructional Strategies for Motivating Students (PRISMS) is a high school physics curriculum that utilizes a learning cycle pedagogy. PRISMS originated in 1982 as a collection of 130 activities related to real-life student experiences. PRISMS was revised and enhanced with funding from the National Science Foundation and made available as PRISMS PLUS. PRISMS PLUS is based on the recommendations of national science education initiatives and physics education research. Students are guided through high-interest activities and engage in exploring patterns and relationships, formulating concepts based on evidence, applying these concepts to new situations, and using the concepts to predict the behavior of physical phenomena. PRISMS PLUS includes more than 40 complete learning cycles with support materials to help students develop conceptual understanding of the basic physics ideas introduced. PRISMS provides the pedagogy for many of the UNI Physics preparation and professional development programs for science teachers.

LH05: 7:20–7:30 p.m. Comparing Gains on Nature of Science for Different Instructors

Rhett Allain, Southeastern Louisiana University, SLU 10878, Hammond, LA 70402; rallain@selu.edu

A previous study [1] showed that pre-service teachers in an activity-based science course improved their understanding of the nature of science more than general students in lecture-based courses. Does teaching such an activity-based course require special training? Normalized gains on the EBAPS (Epistemological Beliefs Assessment for Physical Science)[2] will be compared for three different instructors with different training backgrounds.

1. http://www2.selu.edu/Academics/Faculty/rallain/papers_talks/force_motion_talk_aapt_05.pdf

2. http://www2.physics.umd.edu/~elby/EBAPS/home.htm

LH06: 7:30–7:40 p.m. Teacher Characteristics and Student Learning in Physical Science: Relationships?*

Eleanor W. Close, Seattle Pacific University, 3307 3rd Ave. W., Suite 307, Seattle, WA 98119; closee@spu.edu

Stamatis Vokos, Seattle Pacific University

Pamela Kraus, FACET Innovations

The Department of Physics and the School of Education at Seattle Pacific University, together with FACET Innovations, LLC, are working in partnership with school districts in Washington state through a five-year NSF TPC grant, Improving the Effectiveness of Teacher Diagnostic Skills and Tools. We are working to identify and characterize widespread productive and unproductive modes of reasoning employed by both pre-college students and teachers on foundational topics in physical science. In the first year of the grant, base-line pre- and post-test data were collected from a large number (N ~ 2300) of middle and high school students. Teachers completed questionnaires reporting various characteristics including professional development experience and epistemological beliefs. We will discuss relationships between student learning gains, student achievement on the state science assessment, and teacher characteristics.

*Supported in part by NSF grant #ESI-0455796, The Boeing Corporation, and the SPU Science Initiative.

LH07: 7:40–7:50 p.m. Adaptation of Research-Based Instruction to a Middle School Setting

David E. Meltzer, Arizona State University, Polytechnic Campus, School of Educational Innovation and Teacher Preparation, Mesa, AZ 85212; david.meltzer@asu.edu

Last year I taught the physical science classes for 8th graders at a local middle school, making heavy use of research-based curricular materials originally designed for college-level use. I will discuss various aspects of this experience including students' pre-instruction ideas, modifications made to instructional materials and methods, performance outcomes, and students' subjective responses to the instruction.

Session LI: Using Research to Guide Science Teacher Professional Preparation

Location: H-Grand B
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Teacher Preparation
Date: Sunday, Feb.15
Time: 8–10 p.m.

Presider: Stamatis Vokos

LI01: 8–8:30 p.m. AAAS Project 2061: Tools and Resources for Science Teacher Education

Invited – George E. DeBoer, AAAS Project 2061, 1200 New York Ave., Washington, DC 20005; gdeboer@aaas.org

This talk will describe a variety of research-based tools and resources from AAAS Project 2061 that can be used to support the education of teachers in the physical sciences. Tools and resources will be discussed in six areas related to science teacher preparation: 1) science content knowledge, 2) familiarity with macro phenomena related to the science ideas being taught, 3) familiarity with common student misconceptions, 4) models of content integration, 5) criteria for evaluating curriculum materials, and 6) ways to effectively use assessment to diagnose gaps in student understanding.

LI02: 8:30–9 p.m. Preparing Perceptive Teachers, K-20

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

Renee Michelle Goertzen, Andrew Elby, David Hammer, University of Maryland

Effective science instructors not only give students the opportunity to engage in scientific thinking, but also attend closely to the substance of student thinking that results. That is, teachers in inquiry-oriented classrooms need to interpret the meaning of what students say and do, and make judgments from there about how to respond. This practice is complex and subtle for teachers at all levels—from elementary school through university—partly because nascent scientific reasoning can be difficult to distinguish from nonscientific reasoning. Video examples from real classrooms show what a teacher's attention to the substance of student ideas may look like. Teacher education and professional development can support practitioners in developing this practice by engaging them in close, careful examination and discussion of specific episodes of student thinking. This material is based upon work supported by the National Science Foundation under Grant Nos. 0715567 and 0529482.

LI03: 9–9:30 p.m. A Brief History of Research on Preparation of Physics Teachers*

Invited – David E. Meltzer, Arizona State University, Polytechnic campus, School of Educational Innovation and Teacher Preparation, Mesa, AZ 85212; david.meltzer@asu.edu

Implementation of practical and effective preparation of qualified physics teachers has been a central concern of national policymakers and scientific leaders for more than 50 years. A wide variety of methods have been used and large amounts of resources have been expended on this task. However, to date, there has been relatively little systematic research by disciplinary experts directed at probing the key features of this problem. I will review some of the history of past practices and offer a synopsis of past and present research investigations that bear on the issue.

*Supported in part by APS and AAPT through PhysTEC: NSF PHY-0108787.

Session LJ: Women and Men of the Manhattan Project: The Legacy of Wartime Physics in Chicago

Location: H-Grand C North
Sponsor: Committee on Women in Physics
Co-Sponsors: Committee on History & Philosophy of Physics, Committee on the Interests of Senior Physicists
Date: Sunday, Feb. 15
Time: 8–10 p.m.

Presider: Jill Marshall

LJ01: 8–8:30 p.m. The Manhattan Project and Women Physicists

Invited – Ruth Howes, Ball State University, 714 Agua Fria St., Santa Fe, NM 87501; RHOWES@bsu.edu

The Manhattan Project welcomed women into its laboratories because of the tremendous labor shortages caused by World War II. Many women were active in the new and rapidly developing field of nuclear physics both before and during World War II. This talk tells the stories of some of these women and describes their contributions to the Manhattan Project. Women physicists made significant contributions to the effort to design and build a bomb, and they were proud of the work they did. Their efforts opened laboratory doors to those of us who followed them.

LJ02: 8:30–9 p.m. Being a Young, Female Chemist in Oak Ridge, 1945-1946

Invited – Ellen C. Weaver, retired, 701 Deer Valley Rd., San Rafael, CA 94903-5531; ecweaver1@earthlink.net*

My husband, a physicist, and I, a chemist, worked on the Manhattan Project during WWII. The science was exciting, the mission urgent, living conditions primitive, and recreation sometimes dangerous. Intellectual stimulation was almost constant. At the thermal diffusion plant, S-50, my task was to better shield P-32 and at the experimental graphite pile, X-10, to analyze the products of fission. I campaigned for equal pay for equal work for women. We explored caves and floated down the Clinch River. I plan to relate my recollections from that formative time.

*Sponsor: Jill Marshall

LJ03: 9–9:30 p.m. My Small Part in the Manhattan Project

Invited – Dorothy Gans, 1700 E. 56th St. Apt. 3301, Chicago, IL 60637-5097; marshall@mail.utexas.edu*

Dorothy Gans believes that her part in the Manhattan Project was small, working as a technician in the Metallurgical Laboratory Site B. She had taken chemistry in high school and wanted to continue it in college, but had no money for the university. She had entered junior college when a friend told her that there was a lab in town where she might be able to get work. When she discovered what the project was about, she at first told the director that she wanted no part of it, but he was able to convince her of the need for supporting the war effort. She will relate what it was like for a woman working as a technician as part of the Manhattan Project, and how the experience affected her later life.

*Sponsor: Jill Marshall

Session LK: PER: Problem Solving in Lecture and Lab

Location: H-Grand D North
Sponsor: Committee on Research in Physics Education
Date: Sunday, Feb. 15
Time: 8–10 p.m.

Presider: Paula Engelhardt

LK01: 8–8:10 p.m. Developing a Useful Instrument to Assess Student Problem Solving

Jennifer L. Docktor, University of Minnesota, Tate Laboratory of Physics, 116 Church St., SE, Minneapolis, MN 55455; docktor@physics.umn.edu

Kenneth J. Heller, University of Minnesota

Problem solving is a complex skill that is important for learning physics. Unfortunately, there is no standard way to evaluate problem solving. An assessment tool commonly used for complex processes such as problem solving is a rubric, which divides a skill into multiple categories and defines criteria met to attain a score in each. Such rubrics are often difficult and time-consuming to use. We will report progress on the development of a physics problem-solving rubric that is simple, fast, and requires minimal training yet remains reasonably valid and reliable.

LK02: 8:10–8:20 p.m. Assessment of Textbook Problem-Solving Ability Part I: Overview and Rationale

Karen Cummings, Southern Connecticut State University, 501 Crescent St., New Haven, CT 06515; cummingsk2@southernct.edu

Jeffrey D. Marx, McDaniel College

Development of students' "problem solving ability" is commonly cited as one of the primary goals in introductory physics courses. However, especially if physics education researchers are consulted, there is no broadly agreed upon definition of what is meant by problem solving. 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. In this talk we will give an overview of a multiple-choice instrument we are developing to assess students' ability to solve standard textbook-style problems. In addition, we will make clear our goals and rationale for development of this tool and present opportunities for collaboration and/or beta testing of the instrument.

LK03: 8:20–8:30 p.m. Assessment of Textbook Problem-Solving Ability Part II: Examples

Jeffrey D. Marx, McDaniel College, 2 College Hill, Westminster, MD 21157; jmarx@mcdanie.edu

Karen Cummings, Southern Connecticut State University

This talk, which is a follow-up to "Development of an Assessment of Textbook Problem Solving Ability Part I: Overview and Rationale" will focus on the domain and types of problems we plan to assess with our instrument. Specifically, we are considering how to structure, organize, and present students with multiple-choice items that will reasonably characterize their problem-solving abilities in the realms of dynamics, energy, and momentum. We have chosen to focus on these three basic domains because of their central importance to a wide audience of introductory physics instructors and because they will, potentially, help us avoid the complications of layering multiple levels of conceptual understanding in a small number of items. We hope this presentation will encourage feedback and participation in our project.

LK04: 8:30–8:40 p.m. Group Learning Interviews to Facilitate Case-Reuse in Problem Solving*

N. Sanjay Rebello, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506-2601; srebello@phys.ksu.edu

Fran Mateycik, Kansas State University

David Jonassen, University of Missouri-Columbia

Case-based reasoning (CBR) is the process of solving a real-world problem based on precedent examples and problems. Case-reuse promotes CBR by employing problem pairs that share similarities in deep structure. We conducted focus group learning interviews with 10 students in an algebra-based class a total of eight times during the semester. During each session participants were paired together each working on a different problem. The problems shared deep structure similarities but had surface differences. After students solved these problems, they were asked to discuss their solutions with their partners briefly and discuss the similarities and differences between each of the problems. Finally, students were asked to work with their partners to create their own problem using elements they selected from both original problems. We will discuss how the interview protocol evolved over the semester and the extent to which these interviews facilitated case reuse strategies during problem solving.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

LK05: 8:40–8:50 p.m. Assessing Case Reuse Strategies Using Nontraditional Physics Problems*

Fran Mateycik, Dept. of Physics, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; mateyf@phys.ksu.edu

David Jonassen, University of Missouri-Columbia

N. Sanjay Rebello, Kansas State University

We explore strategies that facilitate the productive use of previous examples in problem solving. A cohort of 10 students participated in eight meetings, which lasted one hour each and focused on facilitating case reuse strategies in problem solving. Data were collected from five multiple-choice examinations taken during the semester. While most of the exams focused on traditional problem solving, the last three questions on each examination were nontraditional tasks: jeopardy, text editing, and problem posing. Individual scores for each examination question were analyzed. Our results show a statistically significant difference on some, but not all of the nontraditional questions between our cohort group and the rest of the class. The results also show that there was no statistically significant difference between the cohort group and the rest of the class on traditional questions. We will discuss the implications of our results and ongoing plans in this project.

*This work is funded in part by the National Science Foundation under grant DUE 06185459.

LK06: 8:50–9 p.m. The Specificity Effect: Separating Efficiency from Innovation in Learning Physics

David T. Brookes, University of Illinois at Urbana-Champaign, 1110 W. Green St., Urbana, IL 61801-3080; dbrookes@illinois.edu

Brian H. Ross, Jose P. Mestre, University of Illinois at Urbana-Champaign

When students learn a new physics principle, that principle can become bound up with salient features of the example(s) in which the principle was instantiated. Rather than suggest this "specificity effect" is a difficulty that needs to be overcome, we suggest that it is an efficient way to solve certain types of physics problems. Even expert problem-solvers use problem surface features to cue relevant principled knowledge. The specificity effect becomes a difficulty when students are unable or unwilling to use the resources they have to consciously evaluate and self-assess their work in progress, in other words, to "innovate." In this talk we will try to disentangle the ideas of "innovation" and "efficiency" in learning physics and discuss the implications of the specificity effect for what our physics students learn and how they learn it.

LK07: 9–9:10 p.m. Effect of Audience on Reporting of Measurement Results

Julian Taylor, Physics Dept., University of Cape Town, 301 Weniger Hall, Corvallis, OR 97331; julespalmsup@gmail.com

Saalih Allie, University of Cape Town

Dedra Demaree, Oregon State Universty

Fred Lubben, University of York

It is well known that students have difficulty with measurement and uncertainty in introductory physics laboratories. As part of a broader program, studies are being carried out at the University of Cape Town to determine what factors might influence students' framing of measurement activities with a view to harnessing productive measurement resources that may be identified. The present work looks into whether audience plays a role in the way information is selected and conveyed when reporting measurement. An instrument comprising a set of written questions based on a scientific measurement scenario was administered to a group of physics freshmen, both before and after a semester of laboratory instruction. The instrument and the analysis framework will be discussed with a focus on the results of three of the questions in which students were asked how they would report to the following audiences, namely, an instructor, a friend, and a formal report.

LK08: 9:10–9:20 p.m. Students' Own Experiments and the Epistemic Processes that They Elicit*

Maria R. Ruibal-Villasenor, Rutgers University, 10 Seminary Pl., New Brunswick, NJ 08901; mruibal@eden.rutgers.edu

Eugenia Etkina, Rutgers University

In the real world we often face situations when we need to solve problems in the area outside of our direct expertise. How do we solve these problems? To investigate the answer to this question, we studied how students approach a situation when they need to design an experiment to determine the value of a physical quantity that they have not seen before without any help from the instructor. We conducted a quantitative study videotaping eight groups of students of different levels of general expertise in physics working on such a problem. We found that different groups framed the task differently, adopting and activating different goals and sets of cognitive resources, therefore they practiced different epistemic games. We observed that students refined and modified their goals as they planned and conducted their experiments. Although students' approaches varied greatly, all students played more adequate epistemic games as their investigation progressed.

*Supported by the NSF grant REC 0529065.

LK09: 9:20–9:30 p.m. Student Understanding of Control of Variables: Deciding Whether or Not a Variable Determines the Behavior of a System

Andrew Boudreaux, Western Washington University, 516 High St., Bellingham, WA 98225-9164; boudrea@physics.wwu.edu

Peter S. Shaffer, University of Washington

Explicit classroom instruction on the control of variables, if delivered at all, usually focuses on the design and interpretation of experiments in order to decide whether or not a variable affects the behavior of a system. Numerous studies have examined the facility of precollege students with this type of reasoning. Over the past five years, efforts at Western Washington University and the University of Washington have been under way to extend this research to additional populations and to more sophisticated reasoning contexts. In particular, we have examined student ability to apply the reasoning needed to identify whether or not a given single variable can be used to predict the behavior of a system. The findings indicate that students of varying age and science background, including pre-college teachers, undergraduates enrolled in physics courses for nonscience majors, and students in the introductory calculus-based physics course, all experience difficulty with this type of control of variables reasoning. Results from written questions and interviews will be used to illustrate specific difficulties.

LK10: 9:30–9:40 p.m. Student Understanding of Slope on Physics Graphs

Andrew F. Heckler, Ohio State University, 191 West Woodruff Ave., Columbus, OH 43210; heckler@mps.ohio-state.edu

Eleanor C. Sayre and Thomas M. Scaife, Ohio State University

We examined students' ability to distinguish between the "*y*" value of a point on a line and the slope of a point on a line. We tested three groups of calculus-based introductory physics students on three kinds of graphs: generic *y* vs. *x* graphs, position vs. time graphs, and electric potential vs position graphs. Questions were posed about slope, speed, and electric field respectively for each group. The graphs and questions in all three groups are isomorphic. Students performed almost perfectly when asked to compare "slopes" on a generic graph, yet their performance decreased significantly when asked to compare speeds or electric fields, where they tend to choose the "*y*" value (height of point on line). Students readily state that "speed is slope" when prompted, yet they do not appear to be spontaneously applying this simple extra step. This exemplifies students' problem of when to apply knowledge.

Monday, Feb. 16

Registration 8 a.m.–3 p.m.
Hyatt, Grand Ballroom Foyer

Plenary: Dark Matter in the Lab 11:30 a.m.–12:30 p.m.
Hyatt, Grand Ballroom EF

AAPT Awards & Presidential Transfer 2:30–4 p.m.
Hyatt, Grand Ballroom EF

Session MA: PER: Student Understanding and Scientific Reasoning

Location: H-Skyway 260
Sponsor: Committee on Research in Physics Education
Date: Monday, Feb. 16
Time: 9:15–11:15 a.m.

Presider: *Valerie Otero*

MA01: 9:15–9:25 a.m. A Hierarchy in Student Understanding of Force, Velocity and Acceleration?

Rebecca J. Rosenblatt, Dept. of Physics, The Ohio State University, 191 W. Woodruff Ave.,, Columbus, OH 43201; rosenblatt.rebecca@gmail.com

Eleanor C. Sayre, Andrew F. Heckler, The Ohio State University

Students' difficulties with conceptual questions about force, velocity, and acceleration have been well documented. However, there has been no single systematic study of student understanding of all paired relations among the concepts of force, velocity, and acceleration. We report on results from a test designed to indicate any hierarchical structure in student conceptual understanding of the relations between force, velocity, and acceleration. For example, we find evidence suggesting that correctly understanding the concept that acceleration and velocity are not directionally related, i.e. an object accelerating to the left does not have to be moving to the left, is necessary but not sufficient for understanding that net force and velocity are not directionally related. These results may indicate a natural and/or necessary evolution of student understanding of the relations among force, velocity and acceleration.

MA02: 9:25–9:35 a.m. What Goes Up Sometimes Comes Down: Students' Changing Understanding*

Eleanor C. Sayre, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43201; le@zaposa.com

Andrew F. Heckler, The Ohio State University

As part of a large study of how student ideas change in response to instruction, we collect student test data many times throughout a course, allowing for the measurement of the changes of student knowledge with a time resolution on the order of a few days. In this talk, we report on Newton's third law conceptual data taken in a calculus-based introductory mechanics class populated primarily by first- and second-year engineering majors. Unsurprisingly for a traditional introductory course, there is little change on many conceptual questions. However, the data suggest that some student ideas peak and decay rapidly during a quarter, a pattern consistent with memory research yet unmeasurable by pre-/post-testing. Furthermore, there appears to be a difference in the amount of change between low performing and high performing students.

*This research is partially supported by a grant from the Institute of Education Sciences, U.S. Department of Education (#R305H050125).

MA03: 9:35–9:45 a.m. Investigating Student Thinking About Systems in Gravitational and Elastic Contexts*

Beth A. Lindsey, Georgetown University, 506 Reiss, 37th and O Sts. NW, Washington, DC 20057; blindsey@physics.georgetown.edu

Paula R.L. Heron, Peter S. Shaffer, University of Washington

In our examination of student understanding of energy, we have found that some conceptual and reasoning difficulties are related to student thinking about systems. We will describe a set of questions that have been administered to students in introductory physics. These questions probe student thinking in situations involving both elastic and gravitational energy. The findings indicate that student responses are highly context-dependent. We will describe implications for instruction that have emerged from this research, and discuss targeted instructional materials[1] we have developed that attempt to address the difficulties that have been identified.

*This work has been funded 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).

MA04: 9:45–9:55 a.m. Student Understanding of the Direction of Magnetic Force

Thomas M. Scaife, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; scaife.7@osu.edu

Andrew F. Heckler, The Ohio State University

In a series of tests administered to introductory physics students, we examine how students answer questions about the direction of the magnetic force on a charged particle. Data have been taken using two representations of the magnetic field (i.e. field lines and magnetic poles) over a period of 17 weeks. Unique patterns are observed for different answer choices within the representations. For example, within the field line representation, the proportion of answers that indicate a sign error along the solution path increases only after instruction, unlike the proportion of correct answers, which increases during instruction. Evidence from interviews suggests that these sign errors are not due to an incorrectly executed right-hand rule, while written tests, designed to probe the nature of this difficulty, uncover several explanations such as lack of knowledge of the direction of the field between magnetic poles and belief that the cross product is commutative.

MA05: 9:55–10:05 a.m. Investigation into Undergraduate Understanding of Electromagnetism*

Isaac M. Leinweber, Dept. of Physics, University of Washington, Box 351560, University of Washington, Seattle, WA 98195; bread@u.washington.edu

Peter S. Shaffer, University of Washington

The Physics Education Group at the University of Washington is conducting a systematic investigation into undergraduate understanding of electromagnetism as a part of the ongoing design and assessment of

Tutorials in Introductory Physics.[1] Preliminary results of this investigation will be discussed. Common difficulties with various ideas, such as electric/magnetic flux, vector fields, and the dynamic relationship between electric and magnetic fields, have been identified and will be presented.

*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).

MA06: 10:05–10:15 a.m. Investigating Student Understanding of Concepts that Underlie Introductory Quantum Mechanics

Brian M. Stephanik, University of Washington, Box 351560, Seattle, WA 98195; bsteph@phys.washington.edu

Peter S. Shaffer, Lillian C. McDermott, University of Washington

Increasingly, modern physics and introductory quantum mechanics are included in first-year university physics courses. The Physics Education Group at the University of Washington is examining student understanding of some basic concepts that underpin these advanced topics and has begun to develop tutorials to supplement standard instruction.[1] We present results from pre-tests and post-tests that illustrate some common difficulties and indicate how we are trying to provide students with the requisite background for developing an understanding of these sophisticated concepts.

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

MA07: 10:15–10:25 a.m. Concept Categorization Analysis: Verbal and Written Data Sources*

Dyan L. McBride, Dept. of Physics, Kansas State University, 116 Cardwell Hall, Manhattan, KS 66506; dyanm@ksu.edu

Dean A. Zollman, Kansas State University

Our current project, which focuses on how students construct an understanding of wavefront aberrometry, has produced a significant amount of both verbal data from interviews and written data from student worksheets. Using concept categorization techniques, we present an analysis of both types of data; in particular, we focus on comparing the two data types for use with concept categorization analysis and present both advantages and disadvantages of this method for each.

*Supported by National Science Foundation grant DUE 04-27645.

MA08: 10:25–10:35 a.m. Cross Culture Comparison of Assessment Results in Scientific Reasoning

Lei Bao, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; lbao@mps.ohio-state.edu

Tianfang Cai, Beijing Jiaotong University

Jing Wang and Jing Han, The Ohio State University

Kathy Koenig, Wright State University

Using Lawson's test and newly developed questions, we collected data with students from the 3rd grade to college in both China and the United States. In this talk, we will compare the results of the Lawson test and the new questions to produce a scalable metric among these questions. We will also discuss the developmental scale and culturally based differences of each skilled dimension measured in the assessment of scientific reasoning. The results and analysis will provide a baseline for using these instruments in research and for further development of questions and methods for assessment of scientific reasoning.

MA09: 10:35–10:45 a.m. A Developmental Scale of Gender Difference in Scientific Reasoning

Xiumei Feng, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; feng.91@osu.edu

Tianfang Cai, Beijing Jiaotong University

Jing Wang and Lei Bao, The Ohio State University

Kathy Koenig, Wright State University

Research on students' scientific reasoning has attracted much attention in PER. In a large-scale quantitative study, we used the Lawson's classroom test of scientific reasoning to collect data in China and the United States with students from 3rd grade to college. In-depth analysis allowed us to explore the possible gender differences in the Lawson test results and how such differences evolve with age. We will compare results of students with different background from both countries.

MA10: 10:45–10:55 a.m. Survey of Views on Science Learning and Reasoning

Jing Han, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; han.286@osu.edu*

Tianfang Cai, Beijing Jiaotong University

Jing Wang and Lei Bao, The Ohio State University

Kathy Koenig, Wright State University

A common belief about education in science is that learning content knowledge in science and mathematics will improve students' overall scientific ability such as reasoning. However, our recent study shows that learning scientific content in the traditional education style doesn't improve students' scientific reasoning. To obtain further evidence on people's perceptions and views on science learning, we developed a survey instrument to study this issue. Our survey results show that the majority of people believe that learning science knowledge in schools will play an important role in developing students' reasoning ability. Comparisons of results from people with different backgrounds have shown interesting differences that are consistent with our previous research.

*Sponsored by Lei Bao.

MA11: 10:55–11:05 a.m. Connections Between Student Backgrounds and Scientific Reasoning Scores

Kathleen M. Koenig, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435; kathy.koenig@wright.edu

Tianfang Cai, Beijing JiaoTong University

Jing Wang, Jing Han, and Lei Bao, The Ohio State University

The Lawson Classroom Test of Scientific Reasoning (LCTSR) is becoming more widely used in PER. Unfortunately, the validity of the test is not well established and it is not known how student background impacts LCTSR scores. We present results of a correlation study that investigates the relationship between student LCTSR scores and multiple factors including school type (public vs. private), school performance index rating, prior math and science courses taken by the student, gender, and state-mandated student test scores. The results provide a general understanding of how to interpret assessment results on scientific reasoning.

MA12: 11:05–11:15 a.m. Statistical Analysis of Developmental Data of Scientific Reasoning Ability

Jing Wang, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210; wang.870@osu.edu

Jing Han, Xiumei Feng, and Lei Bao, The Ohio State University

Kathy Koenig, Wright State University

Scientific reasoning is an important ability in learning. Our recent study shows that learning of physics content knowledge does not improve students' reasoning. Chinese and U.S. college students who experienced different physics curriculum in K-12 education performed similarly in Lawson's scientific reasoning ability test. [1] To investigate the developmental process of scientific reasoning, data of precollege and college students in the United States and China were collected using Lawson's test. Factor analysis and item response modeling methods are used in analyzing these developmental data, and we will discuss the methods, the results, and implications.

1. Bao et al., to appear in *Am. J. Phys.* **76**(11), 2008

Session MB: New Ideas for High School Physics

Location: H-Water Tower
Sponsor: Committee on Physics in High Schools
Date: Monday, Feb. 16
Time: 9:15–11:15 a.m.

Presider: Laura Nickerson

MB01: 9:15–9:25 a.m. Nano Meets High School: Magnetism from a New Perspective

Tracy G. Hood, Plainfield High School, 661 Woodland Ct., Plainfield, IN 46168; thood@plainfield.k12.in.us

The National Center for Learning and Teaching in Nanoscale Science and Engineering offers a summer professional development institute for middle and high school teachers focused on developing teachers' context knowledge in nanoscience and enabling them to incorporate concepts of nanoscience and nanotechnology into their classroom practice. After attending the institute in the summer of 2008, I implemented a lesson that develops the concept of magnetism from the macro- to the nano-level. The successes and challenges of the lesson, as well as advantages to a nano-focus at the high school level, will be addressed.

MB02: 9:25–9:35 a.m. A Physics Education Resources Wiki Site

Michael Fetsko, Mills Godwin High School, 2101 Pump Rd., Richmond, VA 23238; mrfetsko@henrico.k12.va.us

This paper will discuss my work in the Hampton University Teacher Institute for Research in Physics (TIRP) program in the summer of 2008. The purpose of my project was to develop a physics teacher resource wiki site. The site has a collection of inquiry investigations, online tool resources, engineering competitions, and particle physics exercises. The site also includes a teacher forum blog that allows for an exchange of ideas between teachers. Here, participants can discuss content on the site as well as best practices in physics education. Teachers will also have the ability to add their own content to the site.

MB03: 9:35–9:45 a.m. Who Did This?

George R. Bart, Truman College, 1145 W. Wilson, Chicago, IL 60640; gbart@ccc.edu

A number of introductory physics related examples and events will be identified that have interesting historical origins that are not noted in typical physics texts. Thus, physics instructors commonly do not credit the creators and principals of key aspects of their discipline. Isaac Newton wrote to Robert Hooke that: "If I have seen further it is by standing on ye shoulders of Giants." But today, beginning physics courses often neglect the individuals who laid the foundations of our science. This gives an inaccurate picture of how physics progresses. Identifying the giants can provide colorful and inspirational personal stories to humanize physics and enrich the classroom experience. The examples and events cited here have a surprisingly common thread. Come and learn what it is.

MB04: 9:45–9:55 a.m. Reconsidering Lord Kelvin in the 21st Century

David P. Bart, Museum of Broadcast Communications/Antique Wireless Association, 8512 Kedvale, Skokie, IL 60076; david.bart@rsmi.com*

Lord Kelvin (Sir William Thomson) was once considered the greatest of the 19th century classical physicists. Largely ignored in the 20th century, his impact is now being revisited by a growing number of books and articles. During his lifetime, Kelvin published 661 papers, obtained 75 patents and received more initials after his name than any other man in the British Empire. In recognition of the 150th anniversary of the world's first Atlantic Telegraph Cable in 2008 and the centennial of Kelvin's death in 2007, this session will briefly survey his contributions to physics, telegraphy, electrical engineering, and the Atlantic Cable. An 1869 Kelvin mirror galvanometer and other 1858 Atlantic Cable related items will be shown.

*Sponsor: George R. Bart

MB05: 9:55–10:05 a.m. Historical Documents for High School Students — More Sources!

Cancelled

Alan Gnospelius, Design and Technology Academy, 5110 Walzem Rd., San Antonio, TX 78218; agnosp@neisd.net

This sesssion is a follow-up from AAPT in Baltimore. Due to the interest in the topic, I found some more historical documents that are used in my high school labs as a motivator for students. We will examine some of the documents, and websites, etc. will be presented.

MB06: 10:05–10:15 a.m. High School Physics and Top-Ranked High Schools

Susan White, American Institute of Physics, 1 Physics Ellipse, College Park, MD 20740; swhite@aip.org

Both *Newsweek* and *US News & World Report* publish lists identifying "top" US public high schools. *Newsweek* uses the number of advanced tests (AP, IB, and Cambridge tests) taken by students at a school, and *US News & World Report* bases their rankings on state accountability tests and tries to adjust for student demographics. Using data from our 2005 Nationwide Survey of High School Physics Teachers, we examine the relationship between the number of teachers teaching physics in a high school and the school's inclusion on one of the top-rated schools lists. Although we cannot infer a causal relationship, we do find that schools with more teachers teaching physics are more likely to be identified as outstanding.

MB07: 10:15–10:25 a.m. Practices of Beginning Secondary Physics Teachers in Different Class Schedules

Jennifer J. Neakrase, New Mexico State University, MSC 3CUR, P.O. Box 30001, Las Cruces, NM 88003-0029; neakrase@nmsu.edu

Julie A. Luft, Arizona State University

What does a typical day in a beginning secondary physics teacher's classroom look like? Does the type of classroom schedule for a secondary physics teacher affect their choice of instructional practices? This qualitative study examines the classroom practices of six beginning secondary physics teachers in three different class schedule types: traditional (< 60 minutes), alternate block (> 60 minutes taught on alternate days of the week), and semester block (> 60 minutes taught everyday for a single semester). The classroom practice data were gathered from both telephone interviews and classroom observations. The telephone interviews were conducted once a month and the teacher's classroom was observed every other month during the school year. From this data, we generated profiles of the "typical" instruction of beginning physics teachers who have different schedules. In addition, we are able to suggest schedule and nonschedule factors that influence instruction.

MB08: 10:25–10:35 a.m. Accelerated Physics Courses: The Fast-Paced High School Physics Model

Nicholas A. Beecher, Johns Hopkins University Center for Talented Youth, 5801 Smith Ave. Suite 400, Baltimore, MD 21209; nbeecher@jhu.edu

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

Is it possible to effectively teach physics in a highly accelerated format to bright students? For more than 25 years, Johns Hopkins University's Center for Talented Youth (CTY) has successfully done so through its Fast-Paced High School Physics course. More than 2,500 students have participated in this course and learned a full year of high school physics during a three-week summer program. In this session, we thoroughly describe the fast-paced physics model, including the curriculum, texts, schedule, and materials. We also review the data from measures such as pre- and post-tests to demonstrate the effectiveness of this teaching model.

MB09: 10:35–10:45 a.m. Ryerson University Outreach to HS Community in Greater Toronto Area

Tetyana Antimirova, Ryerson University, 350 Victoria St., Toronto, ON M5B 2K3; antimiro@ryerson.ca

Marina Milner-Bolotin, Ryerson University

The challenges of the transition from high school to the first year of university are well known and much discussed. Research findings show that the experience students have with physics at the high school level, and even before, have a significant impact on their degree of success in the introductory physics courses at university. Closing the gap between high school and university teaching and learning is the key to students' success and satisfaction with university physics. The outreach initiative to create and strengthen the ties between the university faculty and the local school teachers' community has been developed by the Department of Physics at Ryerson University. The initiative is aimed first and foremost at high school physics teachers in the greater Toronto Area. We will describe our joint activities that are aimed toward a common goal: to provide a consistent high-quality physics education in Canada at all levels.

MB10: 10:45–10:55 a.m. Let the Dialog Begin: Undergraduates — Teachers — University Faculty

Tetyana Antimirova, Ryerson University, 350 Victoria St., Toronto, ON M5B 2K3; antimiro@ryerson.ca

Marina Milner-Bolotin, Ryerson University

It is hard to find a Canadian university physics professor who would not complain about the preparation level of his/her science undergraduates. However, most of the time, the problems stem not from the lack of students' preparation, but from the lack of university instructors' knowledge of what is taught at Canadian high schools, what the requirements and expectations are, and how to help the students bridge what they have done in high school to what they are supposed to be able to do at the university. To address this gap, the Ontario Association of Physics Teachers decided to create a special student-teacher-university faculty panel during the Annual Ontario Association of Physics Teachers meeting that took place at the end of May of 2008 at Ryerson University. The detailed description of the Panel can be found at the Ontario AAPT website: www.oapt.ca. The current talk will summarize some of the findings.

Session MC: Use of Tablet PCs in the Undergraduate Curriculum

Location: H-Comiskey
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, Feb. 16
Time: 9:15–11:15 a.m.

Presider: Lili Cui

MC01: 9:15–9:45 a.m. Using Tablet PCs for Interactive Learning in Physics Courses for Pre-service Teachers*

Invited – Zdeslav Hrepic, Fort Hays State University, 600 Park St., Hays, KS 67601; zhrepic@fhsu.edu

Dean Zollman, Kansas State University

Tablet PCs have been used in inquiry-based physical science courses that target pre-service elementary and secondary teachers. Uses of the Tablet PCs included collaborative tools that offer several new models of peer interaction in any size class, collaborative data analysis, and feedback during class. We have experimented with uses of the Tablet PCs in learning environments ranging from small groups to small classes to large interactive classes. In one of the courses, student learning was closely monitored before and after the introduction of the technology. We will present examples of our use of the Tablet PCs as well as comparisons of learning gains obtained when pen-based computing technology was not used with those obtained during deployment of this technology.

*This work is supported in part by a Hewlett-Packard Technology for Teaching Grant and by NSF grants DUE-0311042 and DUE-0088818.

MC02: 9:45–10:15 a.m. Electronic Ink and Mobile Technology: Tools to Teach and Learn Physics

Invited – Lynn M. Tashiro, Dept. of Physics, Sacramento State, 6000 J St., Sacramento, CA 95819-6041; TashiroL@csus.edu

Tablet Technology makes it possible to write, sketch, draw, or annotate using electronic ink and drawing tools; to share results instantaneously; and collaborate from a distance in real time. At Sacramento State we have used electronic ink and wireless mobile communication in multiple modes of instruction including lecture, discussion, and laboratory to more critically engage students. Instructor use of electronic ink in lecture to annotate Word, Excel, and PowerPoint files will be demonstrated. Student use of Tablets as "whiteboards" combined with networking software for problem solving will be discussed as a tool for facilitating discussion. Finally, samples of student electronic lab journals will be presented. Because Tablet Technology has been used in the preparation of K-8 teachers at Sacramento State, the presentation will conclude with examples of how tablet technology has been transferred into local K-8 science instruction.

MC03: 10:15–10:45 a.m. Using Tablet PCs and Ubiquitous Presenter in Lecture and Discussion-based Classes

Invited – Edward Price, California State University, San Marcos, 333 S. Twin Oaks Valley Rd., San Marcos, CA 92096; eprice@csusm.edu

Tablet PCs, combined with software and wireless networking, can be powerful tools for teaching. For instance, with the Ubiquitous Presenter system, an instructor with a Tablet can ink prepared digital material (such as exported PowerPoint slides) in real time in class. Ink is automatically archived stroke by stroke and can be reviewed, along with the original slides, through a web browser. The system also supports in-class interaction through a web interface—students with web-enabled devices (Tablet PCs, regular laptops, PDAs, and cell phones) can make text- or ink-based submissions on the instructor's slides, or upload screenshots. The instructor can review and then project submitted slides to the class and add additional ink. I will describe our use of these tools in lecture and small-group based classes at CSU San Marcos, present data on student access of archived material, and describe the impact on the classroom environment.

MC04: 10:45–11:15 a.m. Tablet PC Use for Online Tutoring and Other Course Activities

Invtied – Duane L. Deardorff, The University of North Carolina at Chapel Hill, Campus Box 3255, Chapel Hill, NC 27599; duane.deardorff@unc.edu

Henshaw Robert, The University of North Carolina at Chapel Hill

Tablet PCs have been utilized in a limited capacity by faculty and students at the University of North Carolina at Chapel Hill. I will share lessons learned from these pilot projects that include the use of tablet PCs for online tutoring in introductory math and physics courses (using DyKnow and Adobe Connect) as well as other uses in and out of the classroom. Advantages and disadvantages regarding the use of tablet PCs will be highlighted, along with recommendations based on our experiences and reports from other institutions.

Session MD: Assessment of Teacher Preparation

Location: H-Gold Coast
Sponsor: Committee on Teacher Preparation
Date: Monday, Feb. 16
Time: 9:15 –11:15 a.m.

Presider: Eugenia Etkina

The goal of this session is to explore possible models of assessing the preparation of physics teachers.

MD01: 9:15–9:45 a.m. Assessing Knowledge and Skills for Teaching*

Invited – Stamatis Vokos, Seattle Pacific University, 3307 Third Ave., West, Suite 307, Seattle, WA 98119-1957; vokos@spu.edu

Mastery of the three kinds of content knowledge that Shulman has identified (subject matter content knowledge, pedagogical content knowledge, and curricular content knowledge) is an indispensable characteristic of effective teachers. Although mastery of such knowledge is clearly not a sufficient condition for solving all problems with recruitment, induction, and retention of highly qualified teachers, it is an absolutely necessary condition for the preparation of teachers who make a significant positive impact on student learning. However, deciding what the appropriate level of knowledge is, developing assessment instruments, and designing professional preparation experiences that foster optimal growth are very difficult tasks. The SPU Physics Department and School of Education, in close collaboration with FACET Innovations, LLC, and several school districts have embarked on a multi-year effort to tackle in situ some of these issues. In this talk, I will summarize relevant research results from our projects and outline some unanswered questions.

*Supported in part by NSF grants DRL-0455796 and DRL-0822342; The Boeing Co.; the PhysTEC project of APS, AAPT, and AIP; and the Science Initiative at Seattle Pacific University.

MD02: 9:45 –10:15 a.m. Assessing Pedagogical Content Knowledge of Inquiry Physics Teaching

Invited – David Schuster, Western Michigan University, 1903 W. Michigan Ave., Kalamazoo, MI 49008; david.schuster@wmich.edu

William W. Cobern, Brooks Applegate, Renee' S. Schwartz, Adriana Undreiu, Western Michigan University

Successful inquiry-based physics teaching demands both physics knowledge and inquiry pedagogy knowledge, a combination we call "pedagogical content knowledge of inquiry physics teaching." During their preparation, teachers take science courses and teaching methods courses. Their science knowledge is regularly assessed, but it is equally important to assess their understanding of how to teach particular topics by inquiry. We are developing and testing objective assessment items for this purpose. Items are case-based rather than about inquiry generally. We use two objective formats, MCQ and Likert. A typical item depicts a realistic teaching vignette for a particular physics topic, poses questions about instructional strategies, and offers response options reflecting teaching orientations from direct instruction through guided inquiry to open discovery. Sets of validated items form a Pedagogy of Science Inquiry Teaching Test, but equally importantly, items can be used formatively, for problem-based learning of physics inquiry pedagogy. Example items will be discussed.

MD03: 10:15–10:25 a.m. Deepening Understanding of Physical Science Cconcepts Through Research-Validated Professional Development*

Donna L. Messina, Dept. of Physics, University of Washington, Box 351560, Seattle, WA 98195-1560; messina@phys.washington.edu

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

For more than 30 years the Physics Education Group at the University of Washington has conducted an intensive six-week Summer Institute for K-12 teachers. The research-based and research-validated *Physics by Inquiry*[1] curriculum used in the Institute helps teachers develop a deep understanding of topics relevant to the K-12 curriculum, while concurrently gaining first-hand experience in learning science content through a process of inquiry. The relationship between teachers' self-reported estimates of their content understanding prior to instruction and formal assessments of their understanding at the start and end of the Summer Institute will be explored. In addition, aspects of the Summer Institute that participating teachers identified as significantly contributing to the development of their content understanding will be discussed.

*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).

MD04: 10:25–10:35 a.m. Teacher Preparation Standards Compared and Contrasted

Patsy Ann Johnson, Slippery Rock University of Pennsylvania, Secondary Education/Foundations of Education Department, Slippery Rock, PA 16057-1326; patsy.johnson@sru.edu

The National Council for Accreditation of Teacher Education (NCATE) was founded in 1954, and it currently accredits 652 colleges of education with 78 more seeking NCATE accreditation. Twenty of the 33 member organizations have submitted program standards that have been approved by NCATE for use in program review. Secondary-school physics teacher preparation programs are expected to meet the standards submitted by the National Science Teachers Association (NSTA). These standards will be compared and contrasted with standards for the preparation of the following: special education teachers, elementary school teachers, and secondary school teachers of English, foreign languages, social studies, and mathematics. Standards about assessment will be emphasized. Also, discussed will be teacher preparation standards of the International Society for Technology in Education (ISTE), the National Council on Measurement in Education (NCME), and the Interstate New Teacher Assessment and Support Consortium (INTASC).

MD05: 10:35–10:45 a.m. Teacher Enhancement for Active Middle School Science in Kansas City (TEAMSS - KC)

Elizabeth R. Stoddard, Dept. of Physics, University of Missouri-Kansas City, 257 Flarsheim Hall, 5100 Rockhill Road, Kansas City, MO 64110; stoddarde@umkc.edu

Jerzy Wrobel, UMKC, Department of Physics

Louis Odom, UMKC, School of Education

Michael Nelson, Kansas City, MO, School District Teacher

David Ketchum, Kansas City, MO, School District, Administrator

In response to an immediate shortage of 24 middle school science teachers in a single urban district this year, an institute for in-service teachers was established by the Kansas City, MO, School District and the University of Missouri-Kansas City. A set of lessons was created and modeled for teacher participants by the investigators using two primary pedagogical tools, the Learning Cycle and Concept Mapping. The content of the course included elements of life, earth, and physical sciences. The participants modified the lessons and implementeded them in their classrooms in the fall. Teacher pre- and post-content knowledge and attitudes were measured along with the attitudes and achievement of their students. Good, bad, and surprising results of the project will be presented with the benefit of hindsight. Also, we will discuss the roles of the School District, the School of Education, and the College of Arts and Sciences, and how we have maintained the strong but delicate relationship necessary for this and other collaborative efforts.

MD06: 10:45–10:55 a.m. Physics at a Distance: Toward Certification of High School Physics Teachers in Tennessee

Erica P. Johnson, University of Tennessee, 401 Nielsen Physics Bldg., Knoxville, TN 37996; ejohns22@utk.edu

Jon C. Levin, University of Tennessee

Despite having in excess of 310 public high schools in the state of Tennessee, fewer than 200 statewide offered instruction in physics in the 2007-2008 academic year, and many of those courses were taught by teachers not accredited in physics. Assisting high school teachers in obtaining certification is imperative to the progression of physics education and is the goal of our distance learning program at The University of Tennessee. The goal is to offer a professional development program designed to help physics teachers acquire the content knowledge and pedagogical skills deemed important for them to help their students to acquire scientific inquiry skills, develop conceptual understanding of essential physics concepts, and to develop a positive attitude toward physics. Currently, we are serving two Fentress County schools through a distance education program. Notable effects are evident in the cooperating teachers' understanding and progress toward obtaining certification. Details of the program will be presented.

Session ME: Researching the Use of Clickers in Physics Lecture

Location: H-Truffles
Sponsor: Committee on Research in Physics Education
Co-Sponsor: Committee on Professional Concerns
Date: Monday, Feb. 16
Time: 9:15–11:15 a.m.

Presider: Neville W. Reay

ME01: 9:15–9:45 a.m. Building Acceptance for PER-Based Reform Through Implementation of Clickers

Invited – Kathleen M. Koenig, Wright State University, 3640 Colonel Glenn Hwy., Dayton, OH 45435; kathy.koenig@wright.edu

Tom Carter, College of DuPage

Mel S. Sabella, Chicago State University

Clicker use is becoming more widespread amongst faculty as a means of engaging students. Although originally intended for large lecture classrooms, faculty and students have found benefits to clicker use in classes with as few as 20 students. These benefits are also present in diverse instructional settings with diverse student bodies. In this presentation, we presentsurvey and interview data from faculty new to the use of clickers and demonstrate how their instruction has evolved as a result of implementing the clickers. In addition, faculty and student comments regarding the use of clickers in various contexts will be presented. Findings shed light on the potential of using clickers to ease faculty and students into becoming more receptive of larger scale PER-based reforms. Successes, as well as issues we are still facing, will highlight the need for further research on the effectiveness of clicker use in promoting improved attitudes and understanding.

ME02: 9:45–10:15 a.m. When Clicker Questions Become Questionable

Invited – Lin Ding, Dept. of Physics, The Ohio State University, 191 W. Woodruff Ave., Columbus, OH 43210-1117; lding@mps.ohio-state.edu

The increasing use of clickers in physics lectures has made validation of associated questions an important priority. Validation frequently involves physics experts to confirm content and students to identify misconceptions that can be included in answers. We have found that students may approach questions differently than what we originally intended not because they possess misconceptions, but rather because they perceive and comprehend questions differently than experts. Verbal and detail-oriented "student consultants" were selected and repetitively interviewed to determine how they answered clicker questions that had been validated by physics experts. Examining these interviews within a four-stage response model, we uncovered many design issues that the experts had overlooked. We will discuss detection and resolution of issues corresponding to each of the four response stages.

ME03: 10:15 –10:45 a.m. The Technology Is Not the Pedagogy: Peer Instruction With and Without Clickers

Invited – Eric Mazur, Harvard University, 9 Oxford St., Cambridge, MA 02138; mazur@seas.harvard.edu

Nathaniel Lasry, John Abbott College/Harvard University

Peer Instruction is an instructional strategy for engaging students during class using a structured questioning process. Results from a wide variety of institutions indicate that Peer Instruction increases student mastery of conceptual reasoning and quantitative problem solving and decreases attrition rates. The technique is most frequently implemented with clickers, even though flashcards or raised hands can also be used. We recently studied the effect of clickers on the implementation of Peer Instruction and found that the benefits result more from the pedagogy than from the clicker technology alone.

ME04: 10:45–11:15 a.m. Clicker Use in Upper-Level Courses

Invited – Stephanie V. Chasteen, CU Boulder, UCB 390, Boulder, CO 80309-0390; Stephanie.Chasteen@Colorado.edu

Michael Dubson, Katherine Perkins, Steven Pollock, Noah Finkelstein, CU Boulder

At CU Boulder, clicker use with peer instruction is now the norm in all of the freshmen physics classes and almost all of the sophomore physics classes. In the last few years, we have begun to introduce interactive engagement techniques, including clicker use, in junior and senior-level courses, including Math Methods, QM1, E&M1, and StatMech. We will give a history of ongoing transformation efforts, and we will list the attributes of successful and unsuccessful clicker questions, with examples from several upper-division courses. Partially supported by NSF-CCLI Grant # 0737118 and by the University of Colorado through the Science Education Initiative.

Session MF: Making the Transition from Introductory to Upper-Level Courses

Location: H-Grand Suite 5
Sponsor: Committee on Physics in Undergraduate Education
Date: Monday, Feb. 16
Time: 9:15–11:25 a.m.

Presider: Joseph Kozminski

Much work has been done in creating more effective introductory and upper-level physics courses. However, students sometimes have difficulty bridging the gap between these two levels. In this session, speakers are asked to present how their programs ease the transition from the introductory to upper-level courses or ideas they have for helping students make this transition.

MF01: 9:15–9:45 a.m. Building a Curriculum that Facilitates Student Understanding and Success

Invited – Marty Johnston, University of St. Thomas, M.S. OWS 153, 2115 Summit Ave., St. Paul, MN 55105; mejohnston@stthomas.edu

Physics programs typically emphasize the development of analytical problem-solving skills throughout the curriculum, address laboratory skills in a limited number of courses, and deal with computational skills in a haphazard manner, if at all. Recognizing that the solutions to real-world problems require the integration of analytical, experimental, and computational skills, as well as the ability to communicate what you find, we spent the past several years working to rebalance our curriculum. This effort involved the entire department as we revised existing courses and developed new ones. We paid particular attention to the transitional courses that follow the introductory sequence and prepare students for upper-level courses and independent research. Bridge courses were developed emphasizing laboratory and computational skills. Along the way we discovered ideas that work, some that don't, and the ability to work together as a team, building a curriculum that addresses the needs of our students.

MF02: 9:45–10:15 a.m. Connecting Physics and Mathematics: Probing Student Learning in Intermediate Mechanics

Invited – Bradley S. Ambrose, Dept. of Physics, Grand Valley State University, 118 Padnos Hall, Allendale, MI 49401; ambroseb@gvsu.edu

Michael C. Wittmann, University of Maine

Since 2004, the speakers have collaborated to investigate the nature of student thinking and learning in the context of intermediate mechanics. A current focus to the research is to explore the ways in which students make—or do not make—appropriate connections between physics concepts and the more sophisticated mathematics (e.g., differential equations, vector calculus) that they are expected to use. We find that students are often unable to translate their physics knowledge into mathematical language or learn new physics from mathematical manipulation. Evidence from pre-tests (ungraded quizzes), written exams, and formal and informal classroom observations will be presented to illustrate examples of specific difficulties. We also describe the design, refinement, and assessment of instructional strategies (incorporated into Intermediate Mechanics Tutorials, developed with support from NSF grants DUE-0441426 and DUE-0442388) that seem effective in addressing these difficulties.

MF03: 10:15–10:45 a.m. Adaptation of the Paradigm of Physics Education Approach in Lectures

Invited – Jairo Sinova, Texas A&M University, 4242 TAMU, College Station, TX 77845; sinova@physics.tamu.edu

Over the past decade, studies in introductory courses of physics education have established several important factors needed in efficient student learning: 1) active learning vs simple note-taking; 2) a spiral approach that revisits common themes at increasingly more advanced cognitive levels; 3) exploring specific examples prior to going into the general theory; 4) group activities and peer instruction; and 5) a clear focus of the courses objectives with a philosophy that "less is more." Most upper-division courses depart from some or all of these principles. Upper-division undergraduates often struggle to grasp and connect the many interwoven ideas that cut across different branches of physics. The TAMU APPEAL Program merges parts of the Paradigms in Physics (PP) program, which addresses these issues at the upper undergraduate level with traditional curriculum standard upper-undergraduate physics courses. The program merges new methodologies with effective aspects of the traditional lecture courses.

MF04: 10:45–11:15 a.m. Teaching Proto-Physicists: Professional Development in the "Middle Division"

Invited – Elizabeth Gire, Oregon State University, 301 Weniger Hall, Corvallis, OR 97330; giree@physics.oregonstate.edu

The transition to upper-division physics courses can be challenging for many students, not only because the physics is harder or because the mathematics is more sophisticated, but also because students are expected to develop more sophisticated types of reasoning and problem-solving techniques that they will use as professional physicists. The physics department at Oregon State University supports this transition by offering what we call "middle division" Paradigms courses. I will talk about how these Paradigms courses use interactive teaching techniques to develop and support the culture of professional physicists, allowing students to incorporate professional norms into their own practice with the guidance of the professor.

MF05: 11:15–11:25 a.m. Building Cooperation and Community in Transitional (Introductory to Upper-Level) Physics Classes

Tim Gfroerer, Physics Dept., Davidson College, Davidson, NC 28035; tigfroerer@davidson.edu

Physics students can be fiercely independent, resisting traditional efforts to foster cooperation with their classmates. Such students often do fine in introductory courses but falter when the level of difficulty is raised. At this stage, they require collaborative approaches to problem-solving (working with and learning from their colleagues) because brain-storming is much more effective when several minds are engaged in the process. In addition, bonding and a sense of community among potential majors can help retain students in the study of physics.
For nearly 10 years, I have been using an afternoon on our campus challenge course to encourage cooperation and community at the beginning of transitional (introductory to upper-level) physics courses. While some activities involve physical infrastructure, a variety of affordable, accessible challenges are available. In this talk, I will describe my experiences with these initiatives and identify some good resources for experimenting with this endeavor at your institution.

Session NA: AAPT Plenary – Dark Matter in the Laboratory

Location: H-Grand Ballroom EF
Sponsor: AAPT
Date: Monday, Feb. 16
Time: 11:30 a.m.–12:30 p.m.

Presider: David Cook

Joseph D. Lykken

Joseph D. Lykken, Fermilab, 1707 E. Thomas Rd., Wheaton, IL 60187; lykken@fnal.gov

Most of the universe is dark matter, whose composition is entirely unknown and may involve new forces or principles of nature. Using ultra-sensitive detectors deep underground, physicists are attempting to detect dark matter particles streaming in from space. At the Large Hadron Collider, physicists hope to manufacture large numbers of dark matter particles and study their properties in the laboratory. I will describe these efforts and how impending discoveries may change our fundamental understanding of physics and the universe.

Session OA: PER: Implementing Reforms

Location: H-Skyway 260
Sponsor: Committee on Research in Physics Education
Date: Monday, Feb. 16
Time: 12:30–2:30 p.m.

Presider: Jeffrey Marx

OA01: 12:30–12:40 p.m. Predicting Introductory Physics Performance

Kenneth Heller, University of Minnesota, School of Physics and Astronomy, Minneapolis, MN 55405; heller@physics.umn.edu

Jennifer Docktor, Leonardo Santiago, University of Minnesota

Instructors often wonder whether there is a diagnostic test or some other information that can be used to determine a student's readiness for introductory college physics. To investigate this, we examine the correlation of pre-test scores from both the Force Concept Inventory and a Mathematics Skills Test with grades in introductory physics courses. These courses are taught at the University of Minnesota where part of the pedagogy is based on Cooperative Group Problem Solving. Data is analyzed separately for males and females to test for gender differences in the predictive power of these diagnostic exams.

OA02: 12:40–12:50 p.m. Student Views Regarding the Use of Questions in the Classroom**

Geraldine L. Cochran, Chicago State University, Chemistry and Physics, 9501 S. King Dr., SCI 309, Chicago, IL 60628; moniegeraldine@gmail.com*

Mel S. Sabella, Chicago State University

The instructional approach in the introductory physics class at Chicago State University (CSU) encourages the use of guided inquiry. Anecdotal evidence from these classes suggests that our students value this method of instruction in helping them understand the material. Recently, we developed a survey to quantify these observations. Our results indicate that the acceptance of this type of instruction is a resource that our population of students possess. Recently, we have revised the survey, based on interview responses, and we are now beginning to expand this study to other introductory physics classes at CSU and other universities. This work will help us answer a number of questions regarding the attitudes toward the use of questions in the classroom. Identifying and understanding these resources are important because they help foster effective collaboration.

*Sponsored by Mel Sabella
**Supported by the New York City Alliance Bridge to Teaching Program and the National Science Foundation CCLI grant DUE #0632563.

OA03: 12:50–1 p.m. Assessment for Learning and Action-Based Research: A Model for Course Design

Eugenia Etkina, Rutgers University, 10 Seminary Pl., New Brunswick, NJ 08901; eugenia.etkina@gse.rugers.edu

Anna Karelina and Maria Ruibal-Villasenor, Rutgers University

In this talk we will present a model for course design and improvement that is based on the integration of the Assessment for learning* paradigm and action-based research framework. We demonstrate how we used this new theoretical combination to design and revise an introductory algebra-based physics course for science majors. We will show how the course design matches the goals set by instructors and how formative assessment of student learning leads to the subsequent whole course reforms. We will specifically address the issues of connecting student learning outcomes to the revisions of the curriculum materials. The model that we present can be adapted for any course design. The project is supported by NSF grant REC 0529065.

OA04: 1–1:10 p.m. Effective Application of a Model-based View of Physics to Introductory Computational Activities

Seshini Pillay, University of Cape Town, Rondebosch, Cape Town, 7701; seshini.pillay@gmail.com

Andy Buffler, Roger Fearick, University of Cape Town

Fred Lubben, University of York

A model-based framework for teaching and learning physics suggests that pedagogical activities should highlight the modeling nature of physics and allow students opportunities to construct their own mental models and explore the relationships between them. The current study explores the effectiveness of the use of programming activities that require students to write and use their own programs in the formation of conceptual models. The sample cohort is from the introductory mainstream physics course at the University of Cape Town, which is based on the Matter and Interactions curriculum and introduces computation as a modeling tool using VPython. The computational tasks are designed as interactive worksheets to allow students to critically study the presented physical system in various representations. The results of this study will be used to inform the structure of further interactive programming activities designed to facilitate students' construction of appropriate mental models. Implications for the successful inclusion of computational physics in introductory physics curricula will be discussed.

*Sponsor: Andy Buffler.

OA05: 1:10–1:20 p.m. The Development of Teacher/Student Discourse When Implementing ISLE Goals

Dedra Demaree, Oregon State University, 301 Weniger Hall, Physics Dept., Corvallis, OR 97330; demareed@science.oregonstate.edu

Sissi Li, Lin Li, Oregon State University

At Oregon State University, we are undergoing curriculum reform in our large-enrollment introductory calculus-based physics sequence. As part of this reform, we are integrating course goals and materials borrowed from the ISLE (Investigative Science Learning Environment) curriculum at Rutgers and California State University, Chico. To successfully implement the scientific process approach in ISLE, it is important to appropriately discourse with students. As part of the assessment of our course reform, we are therefore studying the development of teacher/student dialogue in the lecture portion of the course in order to optimize this dialogue and prepare future teachers to lead these courses. We have observed and recorded the statements and actions in the teacher/student interactions each class period. We developed a coding rubric to analyze the types of discourse used by a teacher applying the ISLE method for the first time. The development of teacher/student discourse during the term will be presented.

OA06: 1:20–1:30 p.m. Supporting Tutorial Teaching Assistants' Buy-in to Reform Instruction

Renee Michelle Goertzen, Physics Dept., University of Maryland, College Park, College Park, MD 20742-4111; goertzen@umd.edu

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

Experienced tutorial instructors and developers are well aware that successful implementation includes establishing norms for learning in the tutorial classroom. The teaching assistants (TAs) who lead each tutorial section are important arbiters of these norms. TAs who value tutorials are more likely to convey their respect for the material and the tutorial process to the students, as well as learning more themselves. Professional development programs for TAs typically include activities to help TAs appreciate the power of tutorial instruction. Our research suggests that specific professional development activities are not likely to be effective. Instead, it appears that what we call the "tutorial infrastructure"—including classroom, departmental, and institutional levels of implementation—has the potential to strongly affect the value that TAs attach to tutorials, and probably outweighs the influence of any particular activity that we might prepare for them.

OA07: 1:30–1:40 p.m. Multimedia PreLectures in a Freshman Physics Bridging Course: Instructional Changes

Gary Gladding, University of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL 61801; geg@illinois.edu

Adam D. Smith, University of Illinois at Urbana-Champaign

This talk (part I of II) will summarize our recent instructional changes to Physics 100, a half-semester course designed to prepare entering engineering freshmen for introductory university physics. The course targets a subpopulation of students with low probabilities for success in introductory physics, as determined by demographic factors and performance on a diagnostic task. One major change has been the introduction of web-based animated multimedia presentations ("PreLectures") for the initial presentation of the material. We have also reduced the small group discussion sessions from two hours to one hour to allow for the addition of a clicker-based interactive lecture dealing with conceptual difficulties found in post-PreLecture online assessments.

OA08: 1:40–1:50 p.m. Multimedia Pre-Lectures in a Freshman Physics Bridging Course: Student Impact

Adam D. Smith, University of Illinois at Urbana-Champaign, 1110 West Green St., Urbana, IL 61801; adsmith2@illinois.edu*

Gary Gladding, University of Illinois at Urbana-Champaign

This presentation (part II of II) explores the changes in student behavior, attitudes, and performance resulting from recent alterations to our half-semester physics course for incoming engineering freshman. The alterations themselves are the subject of the first talk in this series (part I of II). The course is designed to bridge the gap between high school physics experiences and introductory university physics courses, particularly for incoming subpopulations that traditionally do not succeed in our introductory physics sequence. Future changes to enhance the course effectiveness will also be discussed.

*Sponsor: Gary Gladding

OA09: 1:50–2 p.m. Implementing Real Time Physics at the University of Central Florida

Stefanie M. McCole, McDaniel College, Box 854 2 College Hill, Westminster, MD 21157; smm013@mcdaniel.edu*

Costas Efthimiou, Dan Maronde, Tim McGreevy, and Enrique del Barco, University of Central Florida

A key question in physics education is the effectiveness of the teaching methods. A relatively new method at the University of Central Florida (UCF) is that of Real Time Physics (RTP). It is a three-part student interactive format that has met with success at other universities. At the completion of the spring 2008 semester, UCF had two semesters using RTP in some classes while keeping a Traditional Format (TF) in others. Using a pre- and post-semester test, as well as student interviews, the preliminary data indicates a successful project at UCF.

*Sponsor: Costas Efthimiou.

OA10: 2–2:10 p.m. Adopting RealTime Physics at UCF

Costas Efthimiou, Dept. of Physics, University of Central Florida, Orlando, FL 32816; costas@physics.ucf.edu

Dan Maronde, Tim McGreevy, Stefanie McCole, University of Central Florida

RealTime Physics (RTP), an activity-based curriculum developed by Sokoloff, Thornton and Laws, has been proven very effective for knowledge gain in Introductory Physics with calculus in various institutions. The curriculum was recently adopted at the University of Central Florida, a large metropolitan university in Orlando. This talk will review the results from the implementation of RTP during the past one and half years.

Session OB: Implementing Modeling Instruction in the Physics Classroom

Location: H-Water Tower
Sponsor: Committee on Teacher Preparation
Co-Sponsor: Committee on Physics in High Schools
Date: Monday, Feb. 16
Time: 12:30–2:30 p.m.

Presider: Carl J. Wenning

OB01: 12:30 –2:30 p.m. Impact of Modeling on Science Environment

Poster – Barbara C. Gottemoller, Mount Zion High School, 305 S. Henderson, Mount Zion, IL 62549; gottemollerb@mtzion.k12.il.us

Information will be presented on the impact to one school's science instruction upon the implementation of Modeling in class.

OB02: 12:30–2:30 p.m. Modeling and Conceptual Physics

Poster – Allen J. Sears, Ida Crown Jewish Academy, 2828 W. Pratt Blvd., Chicago, IL 60645; asears@icja.org

The modeling approach has led to better student discourse and interest in my Conceptual Physics classroom. Features of the method including whiteboarding and the insistence on multiple representations fits perfectly within a physics curriculum with reduced mathematical rigor. The idea of organizing the curriculum around scientific models as opposed to units or topics of study also gives the student a better understanding of the process of science.

OB03: 12:30–2:30 p.m. Overcoming Risk Aversion in the Classroom Community

Poster – Kathleen Grimes Menyhart, Young Women's Leadership Charter School, 2641 S. Calumet, Chicago, IL 60616; kgrimes@ywlcs.org

We can't blame students for expecting us to give them the answers. In most of their prior classroom experiences, our students have been taught with a traditional approach and have always looked to their teacher for the "right answer." Modeling requires a shift from teacher-centered to student-centered teaching. Students must be willing to take risks and to present a solution on a whiteboard that may or may not be correct. They must also be willing to learn from their peers and know how to give and receive constructive feedback. Setting the right climate is essential for getting students to "buy-in" to this approach. Some of the questions that this poster will address: How can teachers create a safe classroom environment where students are willing to take the required risks? How can teachers prepare students for the uncertainty they will feel with this approach?

OB04: 12:30–2:30 p.m. The Modeling Cycle

Poster – James H. Stankevitz, Wheaton Warrenville South High School, 1993 Tiger Trail, Wheaton, IL 60189; jstankev@cusd200.org

The Modeling Methodology of Physics Teaching employs a two-stage Modeling Cycle for each unit of instruction: Model Development and Model Deployment. This poster session will explore how the model development occurs during the paradigm laboratory experience as well as how the model gets deployed through carefully selected problem situations.

OB05: 12:30–2:30 p.m. Modeling as a Guide for Instructional Design

Poster – Gregg Swackhamer, Glenbrook North High School, 2300 Shermer Road, Northbrook, IL 60062; pswackhamer@glenbrook.k12.il.us

A single model often explains phenomena that are widely separated from one another in our textbooks and sometimes also in our thinking. Students often miss these fundamental similarities. Modeling can serve teachers by guiding the design of instruction to shed light on common structure among phenomena that are seemingly unrelated from the students' point of view. The "central force particle model" explains tetherballs, planets, electron motion in the Bohr model of the hydrogen atom, and charged particles in mass spectrometers. As a bonus, a contrived use of a mass spectrometer with alpha particle sources and then a beta particle source, simulated in VPython, can help students develop Einstein's mass-energy relationship and to ask why beta particles do not have consistent energy. This helps them understand why Pauli suggested the neutrino. This poster will show how this has been designed and used.

OB06: 12:30–2:30 p.m. Implementing Modeling in a Physics First Classroom

Poster – Johan N. Tabora, Northside College Preparatory High School, 5501 N. Kedzie Ave., Chicago, IL 60625; mr.tabora@gmail.com

Daniel Caldwell, Michael Coy, Nathan Harada

The Modeling Instruction for Physics framework can be used effectively in a Physics First classroom. In this poster, we talk about how we have implemented Modeling and the modifications we made to fit our college prep population.

OB07: 12:30–2:30 p.m. Diagnoser.com as a Free Learning Tool in Concept Development.

Poster – Rebecca E. Wenning-Vieyra, Cary-Grove High School, 53 Pine Ct., Crystal Lake, IL 60014; rvieyra@d155.org

The use of Diagnoser.com, a free physics website, will be discussed as a tool used by students and teachers especially for implementation with the Modeling Method of Instruction. The website can be used as a diagnostic tool to identify specific assets of conceptual misunderstanding, immediate-feedback homework practice, and as an assessment. Multiple classroom activities including the use of large and personal whiteboards will be presented.

OB08: 12:30–2:30 p.m. Active Learning and Error

Poster – Anil A. Chopra, Latin School of Chicago, 59 W. North Ave., Chicago, IL 60610; achopra@latinschool.org

Experiences that link physical and cognitive activity can be very effective active learning situations. An important model that not only bridges these two activities, but is a model that applies to many more units in physics and well beyond the physics classroom, is that of error recognition. Error recognition is an essential property of all actual measurements and the methodologies we use to handle/mitigate it is an essential aspect of all investigation. Error analysis is a key element in the elaboration and application of the models developed in this method of teaching. The importance of data evaluation, collaboration, verification, multiple trials, significant figures, and possible experimental redesign is exemplified, through error analysis and can be an important aspect of energizing student's cognitive activity during physical lab experiences.

Session OC: Highlights of the International Year of Astronomy 2009

Location: H-Comiskey
Sponsor: Committee on Space Science and Astronomy
Date: Monday, Feb. 16
Time: 12:30 –2:30 p.m.

Presider: Janelle M. Bailey

OC01: 12:30–1 p.m. The U.S. Program for IYA2009: Something for Everyone

Invited – Douglas Isbell, National Optical Astronomy Observatory, 950 N. Cherry Ave., Tucson, AZ 85719; disbell@noao.edu*

The United States is planning an ambitious and multifaceted program for the International Year of Astronomy 2009, including a new inexpensive telescope kit called the Galileoscope, dark-skies awareness education and related citizen-science campaigns, a locally replicable exhibition of the 100 greatest astronomy images, and an active New Media team. This talk will describe U.S. plans and accomplishments, and preview events such as the "100 Hours of Astronomy" in April 2009.

*Sponsor: Janelle M. Bailey

OC02: 1–1:30 p.m. Design, Educational Impact, and Assessment of IYA Cornerstone Programs

Invited – Stephen M. Pompea, National Optical Astronomy Observatory, 950 N Cherry Ave., Tucson, AZ 85719; spompea@noao.edu

The International Year of Astronomy 2009 is a celebration of astronomy—400 years after Galileo first used the telescope. More importantly, the year is the beginning of several key astronomy education programs designed to increase interest in science, to promote an understanding of the scientific process, and to improve science literacy. For IYA2009 teams of astronomy educators have designed a number of cornerstone projects with long-term value for physics and astronomy education. These projects include The Galileoscope project (with telescope teaching kits), Dark Skies Education (with light pollution teaching kit), From Earth to the Universe (an image exhibition), and the Galileo Teacher Training program (professional development program using teacher ambassadors). The goals and strategies of each of these projects will be described, with a frank assessment of the challenges facing each project. Given that the IYA2009 is largely funded by The US International Year of Astronomy 2009 is supported by the National Science Foundation. NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

OC03: 1:30–2 p.m. The Galileoscope: Bringing the Sky to Millions Around the World

Invited – Douglas N. Arion, Carthage College, 2001 Alford Park Dr., Kenosha, WI 53140; darion@carthage.edu*

Richard T. Fienberg, Andover Academy

Steve Pompea, NOAO

Tom Smith, Merit Models

Three hundred and ninety-nine years ago, Galileo turned his crude telescope to the sky and made new and amazing observations that revolutionized how we think about the universe. In commemoration of the upcoming 400th anniversary of that momentous year, the UN with the International Astronomical Union has declared 2009 the International Year of Astronomy (IYA). An extensive series of projects and programs are in development to bring the universe to people around the world. This talk will describe the Galileoscope project, which is developing, manufacturing, and distributing the Galileoscope—small, high-quality refracting telescopes to be distributed worldwide, with the goal of providing 1 million people an opportunity to observe through a telescope of their own. The presentation will cover the goals and objectives of the program, the design considerations, the manufacturing and distribution process, and aspects of the business model that is making this project possible.

*Sponsor: Janelle Bailey

OC04: 2–2:30 p.m. Research Experiences for the Public — Get Involved in Modern Science

Invited – Jordan Raddick, Johns Hopkins University, 3701 San Martin Dr., Baltimore, MD 21210; raddick@jhu.edu

Aaron Price, American Association of Variable Star Observers

In the last few years, a number of projects have arisen to bring modern scientific research to the public, and teachers have taken advantage of these projects to give students real experiences in modern science. For example, Stardust@home lets students search for interstellar dust grains from NASA's Stardust mission, and Galaxy Zoo lets students classify galaxies by shape. The U.S. International Year of Astronomy's Research Experiences for the Public Committee is committed to bringing these and other experiences to students and the public. Our keystone project is to support worldwide coordinated observations of the mysterious variable star Epsilon Aurigae, an eclipsing binary that eclipses once every 27 years. We will create a website for people to share their observations, and to hypothesize about the star's nature. Our goal is to enable students to undertake a scientific project from idea generation to publication. We will develop other ideas as well.

Session OD: Educational Technology Demonstrations

Location: H-Gold Coast
Sponsor: Committee on Educational Technologies
Date: Monday, Feb.16
Time: 12:30–2:30 p.m.

Presider: Vern Lindberg

Papers will describe use of educational technologies in physics. Space will be available with power so the technologies can be demonstrated, together with a space for a poster describing the technology.

OD01: 12:30–2:30 p.m. SAM Animation: Student-Generated Stop-Action Movies as Physics Education

Brian E. Gravel, Tufts University, Center for Engineering Educational Outreach, 474 Boston Ave., Medford, MA 02155; brian.gravel@tufts.edu

Noah Finkelstein and Laurel Mayhew, University of Colorado, Boulder

Robert Lecusay, University of California, San Diego

SAM Animation is educational software developed at the Tufts University Center for Engineering Educational Outreach. The software enables students to generate stop-action movies of physics concepts using a simple interface designed specifically for use in classrooms. Students generate scenes, take individual snapshots, and combine the images at customizable frame rates to produce animations of science content. We have found that students operating in this software environment can predict, report, and creatively represent ideas in science in meaningful ways. We have reported on the use of this tool in learning projectile motion (Church, Gravel, & Rogers, 2007)[1] and in this paper we present the software and five critical features that make it a powerful tool for physics education.

1. W. Church, B.E Gravel, and C. Rogers, "Teaching parabolic motion with stop-action movies," *Intl. J. of Engin. Educ.* **23**(5), 861-867, (2007).

Paper sponsored by Noah Finkelstein.

Project website: www.samanimation.com.

OD02: 12:30–2:30 p.m. Astronomy Simulation in a Classroom: Learning Stellar Properties

Lanika Ruzhitskaya, University of Missouri, 223 Physics, Columbia, MO 65211; RuzhitskayaL@missouri.edu*

Angela Speck, University of Missouri

The Stellar Properties is a computer-based laboratory exercise. It is designed for an introductory college-level astronomy course for nonscience major students. In order to determine properties of stars and their stellar classifications, students are engaged in a step-by-step process using different techniques of collecting and analyzing data. Learners use a computer-based simulation to collect observable properties of stars. They examine stellar spectra and employ graphs, comparison data tables, and formulas to work their way through the laboratory project until the final step—plotting stars on the Hertzsprung-Russell diagram and justifying their locations. The laboratory is an effective way for students to piece together fragments of what they learn about various properties of the stars. The reasoning process in which students are engaged throughout the entire exercise facilitates construction of a mental model of the scientific research process, while computer graphics maintains student motivation to explore diversity of stellar families.

*Sponsor: Deborah Hanuscin

OD03: 12:30–2:30 p.m. Computerized Experiment of Acoustic Standing Waves in Open-ended Tubes*

Changsoo Lee, Seoul National University, Department of Physics Education, Room 513, Building 18, San 56-1, Sillim-dong, Gwanak-gu, Seoul, Korea 151-742; sky-001@snu.ac.kr

D. Jeon, Seoul National University, Department of Physics Education

Many students experience difficulty in understanding the concept of acoustic standing waves because they are not visible. The usual way of teaching standing waves in an air column depends on the virtual experiments or abstract figures. Using an A/D and D/A converter, a microphone/amplifier and a speaker/function generator and the LabView software, we performed a computerized experiment to measure the displacement of air molecules at each position inside open-ended tubes. The frequency of the driving sound was adjusted until a resonance occurred and then the microphone was moved inside the tube using a stepper motor. We repeated the experiment using several tubes of different diameter. Although figures in common physics textbooks show that the antinode is located at the exact end of an open tube, the actual theory states that the position of the antinode does not match exactly with the end but occurs slightly outside the tube. Displaying the data from our computerized experiment as a graph (air molecule displacement vs position along the tube), we could easily observe that the antinode was located slightly outside the tube. The graphic display of the acoustic standing wave also helped students' perception of this invisible phenomena.

*This work was supported by the Brain Korea 21 project in 2008.

OD04: 12:30–2:30 p.m. Interactive Screen Experiments with Single Photons

Patrick Bronner, Didactic of Physics, University Erlangen-Nuremberg, Germany, Physikalisches Institut VI - Didaktik - Staudtstr. 7 (B2), Erlangen, Germany 91058; Patrick.Bronner@physik.uni-erlangen.de

Andreas Strunz, Jan-Peter Meyn, University Erlangen-Nuremberg, Germany

Christine Silberhorn, Max Planck institute for the Science of Light

Single photons are suitable to observe the fundamentals of quantum physics. Quantum optic experiments have been successfully used for undergraduate university courses.[1,2] We develop interactive quantum optic screen experiments to make such experiments available to students who do not have access to a real laboratory. For the interactive screen experiments the experimental setup is photographed in different settings. The photos are linked in a program with real data from the experiment. The user can change the settings of the experiment and follow the measurement results. The quantum behavior of single photons can be observed in two modes: single events and events per second. The following interactive experiments are available with explanations on our homepage www.quantumlab.de: proof of the existence of the photon, quantum-random-number generator, photon statistics, quantum-cryptography, single photon interference, quantum-eraser, Hong-Ou-Mandel dip, entanglement with violation of Bell inequalities.

1. J. Thorn et al., *Am. J. Phys.* **72**, 1210 (2004).
2. E. Galvez et al., *Am. J. Phys.* **73**, 127 (2005).

OD05: 12:30–2:30 p.m. CK12.org and The Peoples Physics Book

James H. Dann, Menlo School and CK-12, 1553 New Brunswick Ave., Sunnyvale, CA 94087; jamdann@gmail.com

James J. Dann, Natomas School District and CK-12

We will present a new technology made possible by the nonprofit CK-12.org. This web-based technology allows teachers to easily make their own textbook ('flexbook") that meets the needs of their own students (or even individual students). The technology is very easy to use and works remarkable well. CK-12 allows the user to publish one of the open source books in their database as it is or to modify the book in order to better fit their class and students. The teacher can go further and create a unique book using various sources such as chapters from other books, Wikipedia, NASA, teacher-developed worksheets, or any other open source material. Basically, the teacher has total control and freedom over the textbook, such that the book can be created to best serve the students (and not the other way around). As one example, we have written a freely available alternative textbook that is designed to acknowledge today's students and how they learn best. The book focuses on the physics alone and brings out the beauty and universality of the physics (example: we do not spend time rewriting the same equation five different ways—we assume the teacher will teach the students how to rearrange equations). We donated our book, *The People's Physics Book*, to CK-12 and encourage you to make it your own.

OD06: 12:30–2:30 p.m. A Web Crawling Tour of ScienceWithMrNoon.com

Brendan P. Noon, Rochester City School District, Edison Tech IIT, 655 Colfax St., Rochester, NY 14519; brendan.noon@rcsdk12.org

For the past five years, Brendan Noon has been developing a large variety of free physics web resources on www.sciencewithmrnoon.com including, audio notes, self-assessing web quizzes, virtual simulations, streaming video presentations, printable classroom activities, STEM projects, physics jeopardy powerpoints, and even interactive cartoon animations. Stop by this presentation and discover the many ways to use this multifaceted web resource to engage students in your physics classroom. More about this presentation can be seen via streaming video at: http://www.sciencewithmrnoon.com/tech01.htm.

Session OF: Post-Deadline Paper Session

Location: H-Columbus CD
Date: Monday, Feb.16
Time: 12:30–2:30 p.m.

OF01: 12:30–12:40 p.m. Using Kinematics to Teach Doppler Shift

Bereket Berhane, Embry-Riddle University, 600 S. Clyde Morris, Daytona Beach, FL 32114; berha4e9@erau.edu

Michael Hickey, Embry-Riddle University

Most students in their first physics course find the general Doppler shift formulas confusing despite the abundant and relatively subtle role of the velocity of the source. Most students are inclined to conclude the relative speed between the observer and the vehicle is what determines the change in pitch. We propose a kinematics problem that allows the students to discover for themselves the general Doppler shift formula and allows them to gain a better understanding of the relationships between frequency, wavelength, and speed of traveling sinusoidal waves.

OF02: 12:40–12:50 p.m. Physics for Animation Artists*

Alejandro L Garcia, Dept. of Physics, San Jose State University, One Washington Sq., San Jose, CA 95192; algarcia@algarcia.org

David Chai, School of Art & Design, San Jose State University

The Animation/Illustration Program at San Jose State University is based in the School of Art and Design. It is consistently ranked as one of the premier animation programs in the nation and, because SJSU is located in the heart of Silicon Valley, many graduates go on to work at local studios and companies such as Dreamworks, Pixar, ILM, and Electronic Arts. The authors will describe their experiences in team-teaching an upper-division animation course and the curriculum materials developed for teaching physics (primarily mechanics) to art majors.

*Supported by an NSF/CCLI grant.

OF03: 12:50–1 p.m. Project W.I.S.E. — Building Youth-Program Partnerships that Serve the Community

Gregory A. DiLisi, John Carroll University, 20700 North Park Blvd., University Hts., OH 44118; gdilisi@jcu.edu

We describe the design and implementation of our Project W.I.S.E. partnership, a multi-institutional collaboration that assembles interdisciplinary teams of high school students charged with developing STEM-focused community youth-programs. Our goal is twofold: (1) to promote young women's interest in STEM-oriented careers through an early, positive exposure to informal science education, and (2) to trial-test a model of how high schools can collaborate with universities and informal learning centers to build strong, successful youth-program partnerships that serve the local community. Our project is innovative in its youth-development strategies, the targeting plan for diverse audiences, and the focus on women's contributions to aviation and space flight.

OF04: 1–1:10 p.m. Using an Online Homework Tutorial System in the High School Classroom

Jim Kernohan, Milton Academy, 170 Centre St., Milton, MA 0186; jim_kernohan@milton.edu

I will present my experiences with using the Mastering Physics program in my Advanced Physics class. Mastering Physics is an online tutorial system where students do homework as well as concept learning activities. I will tell how I used this system and what my students think about it. While there are a few minor problems with it, my students and I are enthusiastic about it. It has enabled me to teach more physics content and to teach it better by giving students extra practice in doing problems, giving them hints when they are stuck, and saving me from having to go over all the homework problems in class.

OF05: 1:10–1:20 p.m. Five Steps to Successful Physics Recruitment and Retention

Daryao S. Khatri, University of the District of Columbia, 4200 Connecticut Ave., NW, Washington, DC 20008; dkhatri@udc.edu

Anne O. Hughes and Brenda Brown, University of the District of Columbia

Entering college freshmen, in increasing numbers in practically every public institution of higher learning are in need of one or two remedial math courses. This is particularly a big problem at the Historically Black Colleges and Universities, where a large number of remedial math course sections are offered to meet the growing demand. For most of these students, graduation is delayed by at least a year. In addition, these students continue to be taught by teaching methodologies that did not work for them even in high schools, resulting in disgust and hatred for math. This situation makes entry for these students into STEM areas difficult and is the perfect recipe for failure in STEM disciplines if they enroll in college-level courses. Because of this situation, recruiting and retaining majors in physics has become a major problem for the physics community. The situation, however, is worse when it comes to the recruitment and retaining of minority students as physics majors. The authors will present the results of three research studies we have carried out at the University of the District of Columbia (UDC) during the summers of 2006, 2007, and 2008. At UDC, we believe that we are close to a solution of this problem.

OF06: 1:20–1:30 p.m. The Use of Clicker Questions in the Teaching of Introductory Optics

R. Seth Smith, Francis Marion University, Florence, SC 29506; rsmith@fmarion.edu

Clicker questions were developed for optics presentations for Francis Marion University's introductory physics class in the fall of 2008. The clicker questions were embedded inside Power Point presentations by using Turning Point software. Students in the class responded to these questions by using radio frequency devices known as clickers. The effectiveness of this approach at engaging students in class and confronting misconceptions pertaining to optics will be discussed. A comparison to traditional chalk and blackboard methods will be presented. Specific examples of clicker questions, student materials, and classroom activities will be shown.

OF07: 1:30–1:40 p.m. Industrial Strength Physics: Making Physics Accessible to CTE Students

William (Bill) E. Semrau, VBISD, Lawrence, MI 49064; techscienceguy@yahoo.com

Throughout the last 15 years I have worked closely with Career and Technical Education (CTE) instructors, business and community members, and drawn upon life experience developing relevant and meaningful physics curricula for students enrolled in the Manufacturing Career Pathway Cluster. Lessons are also aligned with both State and National content standards, producing units of study that are both rigorous and relevant by showing students the connections between academic knowledge and real-world applications in their career fields. Many labs are multi-step, requiring higher-order thinking skills involving physics content from both high school and college text books. This presentation shares how our school incorporates certified physics teachers into the CTE programs and provides some specific examples of lessons we have developed over the years.

OF08: 1:40–1:50 p.m. Industrial Strength Physics: Students' Perspective on Integrated Physics Courses

Michael Ralicki, VBISD / Lawrence High School, 250 South St., Lawrence, MI 49064; techscienceguy@yahoo.com

Dennis Hendrickson, Gage Campbell

Students enrolled in Career and Technical Education courses at the VanBuren Intermediate School District's Technology Center will share their experience within the Integrated Academics program. The VBISD hired certified science, math, and English teachers to develop and deliver an applied academic curriculum into the 25+ career training programs offered at the Technology Center. These lessons are specific to each CTE program, and strive to connect textbook theory with real-world applications within various careers and jobs. These students will highlight a few of the integrated physics lessons they studied in their CTE programs as well as give their view of how the lessons were taught compared to the traditional classroom setting.

Session OG: Make and Take Physics Equipment

Location: H-Truffles
Date: Monday, Feb. 16
Time: 12:30–2:30 p.m.

Presider: Tom Senior

Teachers are to bring demo items or lab equipment. We want a Make and Take for 100 teachers, going around a large room and picking up / building demo items that may cost $1-5.

Session OH: Student Demonstrations

Location: H-Grand Suite 5
Date: Monday, Feb. 16
Time: 12:30–2:30 p.m.

The Pupil's Eye: DIY Demo Exhibits Created by Students

Glenbrook South Conceptual Physics Students, 4000 W. Lake Ave., Glenview, IL 60201; dberlin@glenbrook.k12.il.us*

Deborah A. Berlin, David Lieberman, and Michael J. Stancik, Glenbrook South High School

Seven classes of physics students and their teachers have gathered our favorite demos and ideas from a typical first-year physics course. We will set up exhibits around the room with hand-outs, demonstrations, and information on how to recreate these in your own classroom. Stop by for as long as you like to learn and enjoy in this relaxed yet informative session.

*Sponsor: John Lewis (Glenbrook South High School)

Session PA: Awards Ceremony / AAPT Presidential Transfer

Location: H-Grand EF
Sponsor: AAPT
Date: Monday, Feb. 16
Time: 2:30–4 p.m.

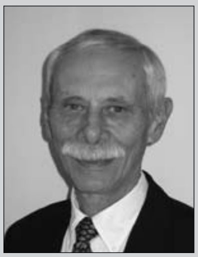
Presider: *Harvey Leff*

AAPT Presidential Transfer

Lila Adair
2008 President

Alex Dickison
2009 President

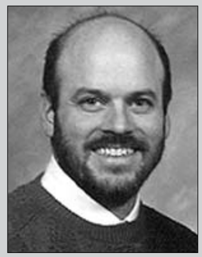
AAPT 2009 Distinguished Service Citation Recipients



Paul Hickman
Boston, MA

Charles Holbrow
MIT
Boston, MA

Bob Shurtz
Hawkins School
Gates Mills, OH



Gary White
AIP
College Park, MD

Courtney Willis
Univ. of Northern Colorado
Greeley, CO

SPS Outstanding Chapter Advisor Award 2008

Presenter: *Earl Blodgett , University of Wisconsin-River Falls*

The American Institute of Physics presents this award annually to faculty members who have excelled in the role of SPS advisor.

Samuel Lofland
Rowan Univ.
Glassboro, NJ

Dr. Samuel Lofland, Physics Dept., Rowan University, Director of Materials Research Group, Glassboro, NJ 08028-1701

Lofland completed his Ph.D. from the University of Maryland in condensed matter physics in 1995, and he joined Rowan University in 1998. He became advisor for SPS in 1999 and was promoted to Associate Professor in 2001 and Professor in 2004. He is Director of Materials Research at Rowan and a member of the University of Maryland NSF Materials Research Science and Engineering Center. His research interests include magnetism, superconductivity, thin-film technology, multifunctional composites, and bio-imaging. He has published more than 150 papers, most of which have undergraduate co-authors, and his students have gone on to pursue doctorates in physics, math, engineering, chemistry, and biochemistry.

Meeting Contributors Index

A

Abbott, David ID, BE07
Abell, Sandra BE02
Able, Daniel PST2-11
Adair, Lila AA, PA
Adrian, Brian II01
Aghemeloh, Eusibius IA05
Agrest, Mikhail M. LF10, PST2-37
Agrimson, Erick P. LF12
Akpojotor, Famous IA05
Akpojotor, Godfrey IA05
Allain, Rhett LH05
Allie, Saalih LK07
Almudí, José M. IH03
Ambrose, Bradley S. MF02
Amidon, Stevens PST2-34
Ansari, Anjum EG03
Antimirova, Tetyana MB09, MB10, PST2-10
Applegate, Brooks MD02
Arion, Douglas N. OC03
Armstrong, James D. PST1-42
Arn, Robert T. EA02
Aubrecht, Gordon IE08, IE06, IF03, PST1-09, PST1-35
Axe, Donald PST2-17
Ayars, Eric EE09, ID01

B

Bailey, Janelle M. IB, OC, PST1-39, W01, W20
Baishali, Ray PST2-35, PST2-36
Baker, Dale R. LF04
Bamberger, Marty W06
Bao, Lei MA08, MA09, MA10, MA11, MA12, PST2-18, PST2-21, PST2-22, PST2-23, PST2-24
Bardeen, Marjorie G. IE02
Barnett, R. Michael IE06
Barrett, Mary Beth W07
Bart, David P. MB04
Bart, George R. MB03
Bartiromo, Tara BC01
Bartolone, Lindsay W20
Beach, Andrea BF01, BF03
Beach, Michelle D. LF05
Bedward, John EB03, PST1-51
Beecher, Nicholas A. MB08
Behringer, Ernest EC, LB
Bell, Beverley PST2-32
Belle, Jessica H. FRI01
Belloni, Mario W13
Bennett, Deborah PST2-11
Berg, Danielle A. LC01
Berglund, Karrie M. EH01
Berhane, Bereket OF01
Berlin, Deborah A. OH
Beutlich, Scott C. LF02
Bienenstock, Arthur BG03
Blodgett, Earl, PA
Blue, Jennifer PST1-23
Bodner, George M. BE01
Bogue, Thomas B. PST1-37
Boller, Bruce R. PST2-28
Bonina, Vince PST1-05, PST1-45
Bonina, Vincent J. PST1-54
Boudreaux, Andrew LK09, PST2-19
Bowen, Samuel T07
Brandon, Ann LG01
Brecher, Kenneth EJ02
Brekke, Stewart E. LD13
Britton, Ted IG01
Bronner, Patrick OD04
Brookes, David LE04, LK06
Brown, Brenda OF05
Brown, Katrina IE04, IE09
Brown, Todd IE04, IE09
Bryan, Lynn PST1-04
Bryan, Lynn PST2-11
Bryan, Lynn PST2-15
Buffler, Andy OA04
Burciaga, Juan R. BA, EG, W25
Buxner, Sanlyn R. IB02

C

Cai, Tianfang MA08
Cai, Tianfang MA09, MA10, MA11, PST2-18, PST2-21, PST2-22, PST2-23
Caldwell, Daniel OB06
Call, Ann V. FRI08
Cameron, Don B. LC04
Campbell, Branton EC03
Capra, Neva PST1-08, PST1-30
Carter, Tom ME01
Carvalho, M. Juliana PST1-11
Cavaglia, Marco PST2-30
Ceberio, Mikel IH03
Cerena, Marcela BA01
César, Mora IA02
Chabay, Ruth EF01
Chai, David OF02
Chalasani, Ravi LF05
Chang, Wheijen PST2-31
Chasteen, Stephanie V. ME04
Chen, Rachel PST1-61
Chen, Zhongzhou LE05
Cherney, Michael G. IE08
Chien, Cheng-Chih EE05
Choi, Jungho BC05
Chonacky, Norman ED
Chopra, Anil A. OB08
Chottiner, Gary S. EC02
Christel, Michael II01
Christian, Wolfgang W13
Cise, John P. EE08
Clark Blickenstaff, Jacob PST1-31
Clark, Joy C. EB03, PST1-51
Clay, Keith IF01, IF02
Close, Eleanor W. LH06
Cobern, William W. MD02
Coble, Kim T07
Cochran, Geraldine L. OA02
Cofer, Tanya W27
Coleman, Roy LG02
Constan, Zach IE03
Cook, David DA, NA
Cook, Jerry D. EE02, LD02
Cooney, Patrick LE01, EE01, PST1-52
Cooper, Melanie M. HB03
Cosgrove, Mary BE04
Cox, Anne J. W13
Cox, Milton D. BF03
Coy, Michael OB06
Crisler, Michael B. DA03
Crowe, Daniel M. LH
Cui, Lili LD, MC
Culbertson, Robert J. LF04
Cummings, Karen LK02, LK03

D

Dann, James H. OD05
Dann, James J. OD05
D'Cruz, Noella L. PST1-40
De Armond, Mike PST1-17
de la Paz, Gabriel KA04
Deardorff, Duane L. MC04
DeBoer, George E. LI01
DeCoster, Rich PST1-46
del Barco, Enrique OA09, PST2-14
DeLine, Amy IE03
Demaree, Dedra LK07, OA05, ST2-13
Desbien, Dwain M. PST1-27
DeYoung, Paul A. BA02
Dickison, Alex PA
Dhillon, Jaz LF05
Dietz, Richard D. PST2-05
Diff, Karim CC
Digilov, Rafael M. LD09
DiLisi, Gregory A. OF03
Ding, Lin ME02
Docktor, Jennifer OA01, PST2-04, LK01, PST2-03
Dolan, Jr., Paul W27
Dompreh, Kwadwo A. IA04
Donaldson, Nancy L. BD01
Dubson, Michael ME04
Duggal, Vinay W27
Dunn, Ryan W07

E

Eblen-Zayas, Melissa EI
Efthimiou, Costas OA09, OA10, PST2-14
Eiker, Chance FRI02
Elby, Andrew LI02, OA06, PST2-12, W26
Endorf, Robert J. PST2-17
Engelhardt, Paula HA, LK
Enukpere, Emmanuel IA05

Escalada, Lawrence T. BC02, LH04, PST2-16
Escuadro, Anthony T07
Etkina, Eugenia BC01
Etkina, Eugenia LK08, MD, OA03, W12

F

Fadavi, Mehri PST1-31
Falconer, Kathleen EB, EF, BC04, BE07,
Fearick, Roger OA04
Feil, Adam LE06
Feldman, Bernard J. LC05
Feng, Xiumei MA09, MA12, PST2-21, PST2-22, PST2-23, PST2-24
Ferkinhoff, Carl D. LC01
Fetsko, Michael MB02
Fienberg, Richard T. OC03
Finck, Joseph IE03
Finkelstein, Noah BF, BF01, ME04, OD01, PST1-58
Fischer, Susan EB05
Fisher, Mark PST1-23
Flarend, Richard W08
Flood, Jane BD, JA
Flower, Terry LF12
Forinash, Kyle EE06
Foster, Thomas CA, LE03, PST2-06, W11, IF
Frank, Nathan LD14
Frantti, Mandy T02

G

Gans, Dorothy LJ03
Garcia, Alejandro L. OF02
Garcia-Castelan, Rosa Maria EE07
Gardel, Margaret L. EG01
Garland, Catherine PST1-42, EJ01
George, Kathy PST1-63
Gershman, Sophia LA04
Gfroerer, Tim MF05
Gilchrist, Pamela O. EB03, PST1-51
Gire, Elizabeth MF04
Girkin, Amy PST2-17
Giza, Brian BE05
Gladding, Gary EB04, LE04, OA07, OA08
Gluck, Stuart LD11, PST1-05
Goenaga, Gabriel FRI08
Goertzen, Renee Michelle LI02, OA06, PST2-12
Goldberg, Fred W19
Goldstein, Gary R. LF09
Golin, Genrikh BE06
Gomez, Luanna S. BC04
Gomez, Monica LA05
Gottemoller, Barbara C. OB01
Grabbe, Crockett L. LF11
Grady, Maxwell LD14
Gravel, Brian PST1-58, LF09, OD01
Greenbowe, Thomas J. HB04
Greyer, Pamela W20
Grimes Menyhart, Kathleen OB03
Grove, Eliza K. EA06
Grove, Timothy T. LD04, LD07, PST1-16, PST1-26, PST2-34,
Guerrero, Jose FRI02

Guilbert, Nicholas PST1-09, LF07
Guisasola, Jenaro IH03
Gunter, Ralf IA03, PST1-02, PST1-06
Gwinn, Elaine IG03

H

Hagedorn, Eric PST2-07
Hammer, David LI02
Hammond, Ernest C. PST1-25
Han, Jing MA08, MA10, MA11, MA12, PST2-18, PST2-21, PST2-22, PST2-23, PST2-24
Hanuscin, Deborah PST1-38
Harada, Nathan OB06
Harman, Pamela W20
Harper, Cherie IE04
Harper, Kathleen W11
Haugan, Mark PST2-11, PST2-15, LB01
Heckler, Andrew F. LK10, MA01, MA02, MA04
Heller, Kenneth OA01, PST2-04, LK01, PST2-03
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Hill, Margaret PST1-07
Hilliard-Clark, Joyce P. EB03, PST1-51
Hintz, Eric EC03
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Hoffman, Eugene PST1-25
Hoffmeister, Brent EA01, FRI04
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Hummel, Susan LF12

I

Insley, Peter LG03
Isbell, Douglas OC01
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Janiuk, Alex FRI09
Jeon, D. OD03, BC05
Jiang, Frank X. PST1-62

J

Johannsen, Bjorn F. IA07
Johnson, Angela EB01
Johnson, Erica P. MD06
Johnson, Patsy Ann MD04
Johnson, Scott C. LD12
Johnson, Timothy BC04
Johnston, Marty ED02, MF01
Jonassen, David LK04, LK05, PST2-01,PST2-02
Jones, Alister PST2-32
Jones, Robert N. PST1-25
Jose, Boby PST1-07

K

Kaback, Stephen BC09
Kadooka, Mary Ann EJ01
Kadooka, Mary Ann PST1-42
Kahn, Ronald S. KA03
Kalman, Calvin PST2-10
Kampwirth, Richard W27
Kang, Youngchang PST1-21, PST1-24
Kanim, Stephen E. PST2-19, W04
Kaplan, Steven LF13, LF14
Karelina, Anna OA03
Keefe, Pat LC02
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Kernohan, Jim OF04
Ketchum, David MD05
Khatri, Daryao S. OF05
Kim, Jiwon PST2-32
King III, B. Alex ED03
Klymkowsky, Michael W. HB03
Knight, Jocelyn C. MB08
Ko, ChihEn EE05
Kociu, Edison LF13, LF14
Koenig, Kathleen M. MA11, ME01, PST2-17, PST2-18, MA08, MA09, MA10, MA12, PST2-21, PST2-23, PST2-24
Kosheleva, Olga BE05
Koupelis, Theo T04
Kozminski, Joseph LD08, MF
Kraus, Pamela LH06
Kraus, Pamela A. W18
Krause, Stephen J. LF04
Krauss, Lawrence M. BB04
Kuhlmann, Steve LD14
Kuhn, Thomas T07
Kukreti, Anant LF05
Kupierski, Kristine LA05
Kustusch, Mary Bridget CB

L

LaCombe, Jeffrey PST1-47
Landerholm, Wayne W27
Langrana, Noshir PST1-62
Lapp, David R. LF06
Larson, R. Sam BF01
Lasry, Nathaniel ME03
Lawrence, Charles R. BB02
Laws, Priscilla LE01, EE01, PST1-52
Lecusay, Robert OD01, PST1-58
Lederman, Leon KA
Lee, Changsoo OD03
Lee, Gyoungho PST2-33
Lee, Jared A. LC01
Lee, Kevin EH, IB01, PST1-41, W31
Lee, Sungmuk PST1-21, PST1-24
Leff, Harvey FA, PA
Leif, Todd R. LC
Leinweber, Isaac M. MA05
LeSage, Heidi J. FRI03
Levin, Jon C. MD06
Lewis, John BC
Li, Lin OA05
Li, Lulu EA01, FRI04
Li, Sissi OA05, PST2-13
Lieberman, David OH
Lietz, Gerry LG04
Lightner, G. Samuel PST1-09
Lindberg, Vern OD
Lindsey, Beth A. MA03
Lister, Kim EB05
Liu, Di-Jia FRI08
Liu, Eric PST1-61
Lofland, Samuel PA
Lombardi, Doug IB03, PST1-48
Lopez, Hector BC01
LoPresto, Michael C. EJ04, PST1-43
Loranz, Daniel PST1-47
Lorentz, Glenn LF13, LF14
Lubben, Fred LK07, OA04
Lubin, Philip M. BB02
Luft, Julie IG02, MB07
Luther, Bryan A. BA03
Lykken, Joseph D. NA01

M

MacIsaac, Dan BE, BC04, BE07, EF03
Mader, Jan W03
Magleby, Stephanie EB06, LF03
Maitland, Aaron PST1-33
Maloney, David P. PST1-16, W11, W04
Mandel, Shannon LF
Marder, Michael LB02
Maronde, Dan OA09, OA10, PST2-14
Marshall, Jill LJ, PST2-07
Marshall, Thomas C. PST2-31
Martinez-Miranda, Luz BG
Marx, Jeffrey OA, LK02, LK03
Mason, Bruce T06
Mason, Kim LD05, PST1-03
Mason, Martin S. LA01, PST1-20
Massey, Catherine A. BG02
Masters, Mark PST2-33, LD04, LD07, PST1-16, PST1-17, PST1-26,
Mateycik, Fran LK04, LK05, PST2-01, PST2-02
Matis, Howard IE08
Mayhew, Laurel OD01, PST1-58
Mazur, Eric BF02, ME03
McBride, Dyan L. MA07, OA09
McCullough, Laura PST1-10
McDermott, Lillian C. HB01, LH03, MA06, MD03, W14, W22
McGreevy, Tim OA09, OA10, PST2-14
McNicholas, Sheila W27
Meltzer, David E. LH07, LI03
Messina, Donna L. MD03
Mestre, Jose LE04, LK06
Meyer, Alex FRI09
Meyer, Deseree EA01, FRI04
Meyn, Jan-Peter OD04
Michalak, Rudy PST1-60
Michelini, Marisa BC07, IH01
Micklavzina, Stanley W08
Middleton, James A. BE03
Millan, Jamie T07
Miller, Daniel R. EA02
Miller, John W07
Milner-Bolotin, Marina MB09, MB10, PST1-11, PST1-12, PST2-10, W17
Montana, Diamond LA05
Moreira, Marco A. IA01
Morgan, Jeff BC02, PST2-16
Morse, Robert W24
Mosca, Joseph PST1-33
Mukolobwiez, Nathalie LF05
Mulder, Gregory LC03
Mull-Osborn, Alex LF13, LF14

N

Nadji, Taoufik LD06, PST2-09
Nagamine, Kentaro PST1-39
Nassir, Michael PST1-42
Neakrase, Jennifer J. MB07
Nelson, Michael MD05
Nelson, Peter H. PST1-59
Neri, Luis EE07
Nichols, Michael G. PST1-57
Nickerson, Laura MB, PST1-55
Niederriter, Charles F. LC01
Noon, Brendan P. OD06, PST2-25

O

O'Connor, Jerry PST2-07
Odom, Louis MD05
Oehrtman, Michael LF04
O'Kuma, Thomas L. LA, PST1-27
Oliver, Keith PST1-29
Olsen, Julia W10
Otero, Valerie MA, EF02, W19

P

Papageorgiu, Panagos W27
Park, Jeongwoo BC06, PST2-08
Park, Mihwa PST2-33
Partridge, Bruce BB02
Pasquesi, Robert J. LG05
Patay, Heather W27
Peaslee, Graham F. BA02
Pérez, Francisco EE07
Perkins, Katherine ME04
Perry, Pamela PST1-48
Peterson, Richard W. ID02
Petrean - Troncalli, Andra LD01
Pillay, Seshini OA04
Poe, Clint H. PST1-49
Poel, Robert W02
Pollock, Steven ME04
Pompea, Stephen M. OC02, OC03
Prather, Edward E. PST1-41
Price, Aaron OC04
Price, Edward MC03
Pryjma, George W27

R

Raddick, Jordan EJ, OC04

Rademacher, Ricardo J. LE02
Radloff, Jeffrey PST2-17
Ralicki, Michael OF-08
Ramos, Roberto PST1-18, PST1-53, EA04, FRI07
Ramsey, Gordon P. BA04
Ray, Baishali PST2-31
Reay, Neville W. ME
Rebello, N. Sanjay LK04, LK05, PST2-01, PST2-02
Reeder, Justin D. FRI05
Reiland, Robert IE04, IE06
Reinfeld, Erika W20
Reynolds, Clint PST1-17
Rickert, Matthew LF13, LF14
Riendeau, Diane LF01
Robert, Henshaw MC04
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Robledo, Victor EE07
Roos, Kelly R. ED01
Rose, Sara J. EB04
Rosenblatt, Rebecca J. MA01
Roser, Robert M. DA02
Rosner, Marsha KA02
Ross, Brian H. LK06
Roudebush, Deborah M. IE05
Roy, Arunava PST2-30
Rubin, Vera AA01
Ruchti, Randy IE01
Ruderfer, Isidor W27
Ruibal-Villasenor, Maria OA03, LK08
Russ, Daniel T07
Ruzhitskaya, Lanika OD02, PST1-38
Rylander, Jeffrey IE

S

Saba, Marcelo M.F. PST1-06, IA03, PST1-02
Sabella, Mel S. ME01, OA02, T07
Sadaghiani, Homeyra R. PST2-26, PST2-27
Salgado, Roberto B. PST1-14, PST1-15
Samll, Alex PST2-27
Sandow, Barbara BG01
Santi, Lorenzo BC07
Santiago, Leonardo OA01, PST2-04
Saoulidou, Niki DA01
Sayre, Eleanor C. LK10, MA01, MA02
Scaife, Thomas M. LK10, MA04
Schenk, Andrew C. FRI06
Scherr, Rachel E. LI02, OA06, PST2-12, W26
Schleigh, Sharon BC03
Schreiner, Lee R. PST1-34
Schuster, David MD02
Schwartz, Renee' S. MD02
Scott, Alan J. PST1-19
Sears, Allen J. OB02
Sederberg, David PST1-04
Segre, Carlo U. EI01
Semak, Matthew R. PST2-05
Semrau, William E. OF-07
Senior, Tom OG
Serpa, Laura BE05
Shafer, Paul W. LA05, LH03, LK09, MA03, MA05, MA06, MD03
Shea, Robert LG06
Sherer, Jennifer Z. BF05
Sherwood, Bruce EF01
Shin, Kwangmoon PST1-21, PST1-24
Shore, Linda S. IG04
Shurtz, Bob PA
Siedell, Christopher M. PST1-41
Sieling, Jared D. LC01
Sil, Arunima PST1-62
Silberhorn, Christine OD04
Simmons, James K. BD04
Sinova, Jairo MF03
Slater, Stephanie J. EJ03, W01
Slater, Timothy F. HB02, W01
Slaton, William V. LD05
Slaton, William V. PST1-03
Smalls-McDougal, Kimberly EB03, PST1-51
Smith, Adam D. OA07, OA08
Smith, David IA06, IH04
Smith, Jenna K. EA05
Smith, Jr., Daniel M. BB
Smith, Seth OF-06
Smith, Tom OC03
Smoot, III, George F. BB02, FA
Speck, Angela OD02, PST1-38
Spinka, Hal LD14
Stancik, Michael J. OH
Stankevitz, James H. LH01, OB04
Stefanel, Alberto BC07
Stein, Keith R. ID02
Steinberg, Melvin W23
Stelzer, Tim LE04, LE06
Stephanik, Brian M. MA06
Stetzer, MacKenzie R. LH03, MD03
Stevens, Scott II01
Stewart, John C. II03, LD03, PST1-13, PST1-28
Stoddard, Elizabeth R. MD05
Strand, Michelle EE, LE
Strock, Christopher PST1-63
Strunz, Andreas OD04
Sturgess, Keith BE04
SubbaRao, Mark U. EH03
Sudhakaran, Gubbi R. EC01
Suedhoff, Hans PST1-17
Summers, Frank EH02
Suskavcevic, Milijana BE05
Suson, Daniel J. BB03
Svelnys, Derrick EB05
Swackhamer, Gregg OB0

T

Tabora, Johan N. OB06
Taroc, Dr. Roel D. PST2-20
Tashiro, Lynn M. MC02
Taylor, Jaime R. ED03
Taylor, Julian LK07
Teese, Robert LE01, EE01, PST1-52
Thomas, Frederick J. LA03
Thomas, Kevin H. EA03
Thompson, Janice LF04
Thorne-Brackett, Shannon T. LF08
Thurston, Tad PST2-34
Topasna, Gregory A. PST1-44
Turian, Emma W27
Turley, R. Steven EB06, EC03
Turner, Michael S. BB01
Tyagi, Somdev PST1-18
Tyler, Anthony EA04, FRI07

U

Underwood, Dave LD14
Undreiu, Adriana MD02
Urquidi, Jacob EG02

V

Vallieres, Michel PST1-18
van de Sande, Brett EE10, PST1-50, PST1-56
van de Sande, Carla PST1-56
Van Huele, Jean-Francois S. BD02, EC03
van Kampen, Paul IA06, IH04
Vanden Heuvel, Andrew FRI09
Vanlehn, Kurt PST1-50
Velazquez, Daniel G. LD10
Viele, Pat II02
Villastrigo, Rosa M. PST1-45
Vokos, Stamatis LH06, LI, MD01, W18
Voroshilov, Valentin PST2-29

W

Wadness, Michael J. BC08
Waechtler, Paul W07
Wampler, Wendi N. PST2-15
Wang, Eric L. PST1-47
Wang, Jing MA08, MA09, MA10, MA11, MA12, PST2-18, PST2-22, PST2-24
Watanabe, Suny IA03, PST1-02, PST1-06
Watson, Casey R. FRI06
Weaver, David LA02
Weaver, Ellen C. LJ02
Wemyss, Thomas IA06, IH04
Wenning, Carl J. OB
Wenning-Vieyra, Rebecca E. OB07
Wetherhold, Jeffrey M. EE04
Whelan, Meghan PST1-63
White Brahmia, Suzanne BC01, EB02
White, Gary EA, FRI, PA
White, Susan MB06
Wieman, Carl HB
Williams, Corinne KA05
Williamson, Sherman M. LH02
Willis, Courtney W. PST2-05, PA
Willis, Maxine LE01, EE01, PST1-52, W06
Willoughby, Shannon IB04
Wilson, Thomas LD10
Wilson, Va'Juanna EA06
Winn, Mary W03
Wisman, Raymond F. EE06
Withee, Thomas P. LE03
Wittmann, Michael C. MF02
Won, Jeongrim PST2-33
Wood, Shane IE07
Wrobel, Jerzy MD05

Y

Yale, Melissa S. PST2-11
Yang, Junbing FRI08
Yoder, Garett LD02, EE02
Yoo, Junehee BC06
Yoo, Junehee PST2-08
Young, Donna PST1-48

Z

Zaleskiewicz, Ted IE04, PST1-09
Zavala, Genaro IA, IH02, JB
Zawicki, Joseph L. BC04, BE07
Zettili, Nouredine EE03
Zoller, David T07
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Zubimendi, José L. IH03
Zwicker, Earl LG07

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Lee, Keum-Hwi
Leff, Harvey
Leigh, James
Levi, Barbara
Lewis, Edwin
Livanis, Olga
Lombardo, Charles
Luk, Kam-Biu
Luth, Vera
Maasha, Ntungwa
Mallinckrodt, A.
Mallmann, A.
Mamola, Karl
Mann, Myron
Marvin, Timothy
Mays, Katherine
Mcdermott, Lillian
Mckee, Christopher
Meisel, Mark
Mellen, Walter
Meyer, Joe
Milner-Bolotin, Marina
Misciascio, Dominick
Misner, Charles
Misra, Raj
Moldover, Michael
Monroe, Mary
Montana, Frederick
Morin, Dornis
Morris, James
Moss, Steven
Moverman, Mark
Napolitano, Carl
Nelson, Marvin
Newmeyer, Jeff
North Carolina Section-AAPT
Noriega, Erick
Odabasi, Halis
Oostens, Jean
Ousley, Philip
Parker, Paul
Partridge, Richard
Pedigo, R.
Peithman, Roscoe
Pena, Carlos
Petrache, Horia
Polchinski, Joseph
Potenza, Jack
Preece, Betty
Priebe, Frederick
Quigg, Chris
Raja, Rajendran
Rank, Ronald
Reay, Neville
Reeves, Shawn
Renault, Pascal
Riaz, Shahzad
Rigney, Carl
Ritchie, Darlene
Robertson, Charles
Robertson, Roderick
Roll, Ronald
Romeo, Martin
Rosenfeld, Carl
Said, Mohamed
Sardashti, Kamal
Saucier, Richard
Saul, Jeff
Savickas, David
Schellman, Heidi
Schutt, John
Scott, Hugh
Shaffer, Peter
Sharon, Yitzhak
Shepherd, Giles
Sherwood, Bruce
Shinners, Carl
Shochet, Melvyn
Sinclair, Kurt
Smith, Lary
Spector, Leonard
Spitzer, David
Stahl, Frieda
Stewart, Robert
Stinchcomb, Thomas
Stith, James
PASCO Scientific
Stover, David
Strenzwilk, Denis
Stuckey, Harry
Stumpf, Folden
Tam, Francis
Taylor, James
Taylor, Julius
Taylor, R.
Thiessen, David
Tillay, David
Tobochnik, Jan
Van Huele, Jean-Francois
Vernier Software
Vlahokostas, Konstantine
Voss, Howard
Voytas, Paul
Wallach, David A.
Walton, William
Research Corporation
Weingartshofer, Antonio
Williams, Jeffrey
Williams, Paul
Woodcock, Harry
Wright, Wayne
Wylie, Douglas
Young, Anne
Younghouse, Lawrence
Zach, Chet
Zimmermann, William
Zitzewitz, Paul
Zook, Alma
Zwicker, Earl
Anonymous [2]

contributions received July 1–December 31, 2008

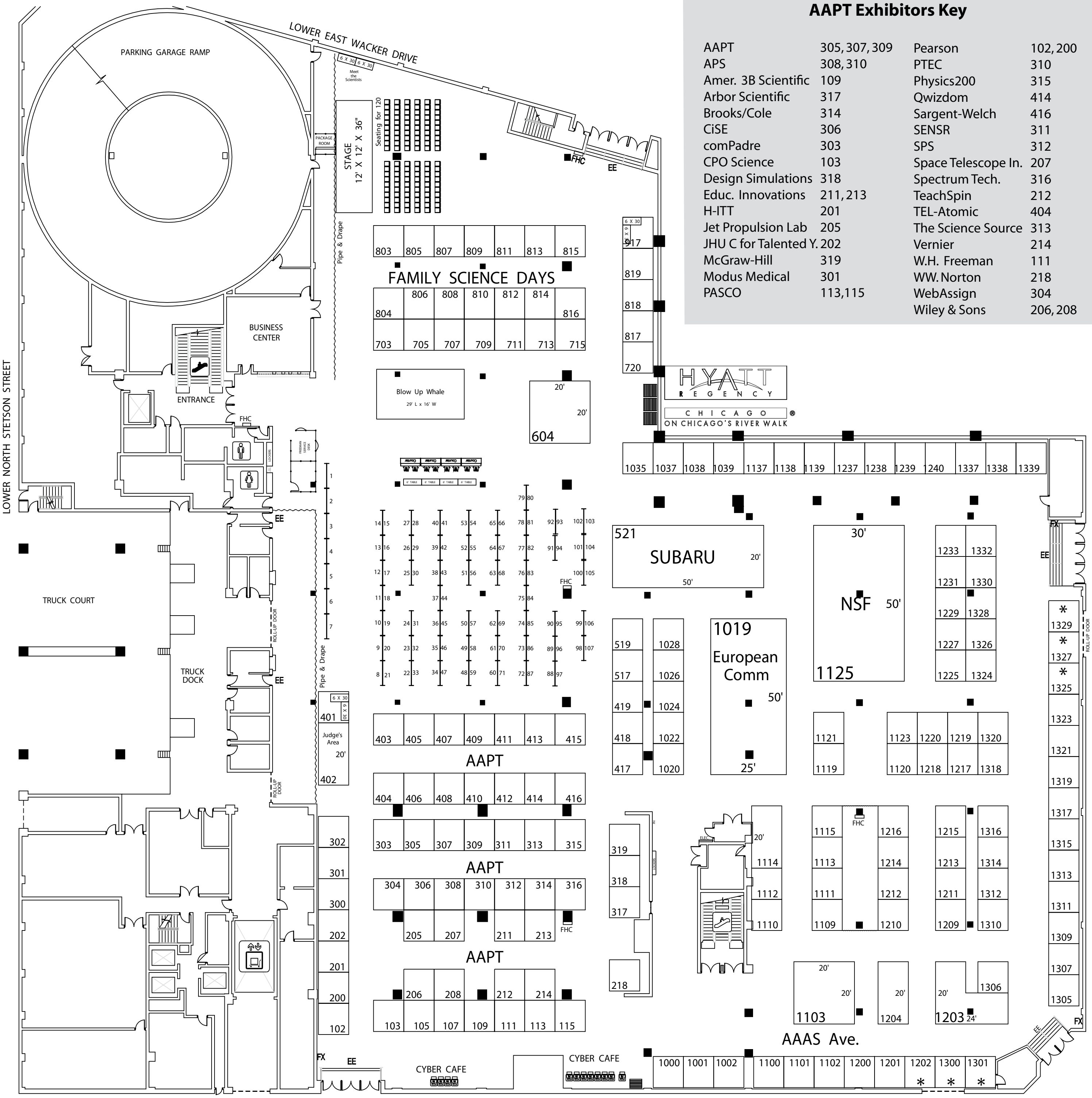
Index of Advertisers

Brooks-Cole Cengage Learning................15
CPO Science..37
Modus Medical Devices.............................35
Physics2000.com...5
Sargent Welch/Cenco Physics...................51
University of Chicago Press 7
WebAssign..13

Exhibit Hall Map

Hyatt, Riverside Center

Feb. 13–15, 2009



AAPT Exhibitors Key

AAPT	305, 307, 309
APS	308, 310
Amer. 3B Scientific	109
Arbor Scientific	317
Brooks/Cole	314
CiSE	306
comPadre	303
CPO Science	103
Design Simulations	318
Educ. Innovations	211, 213
H-ITT	201
Jet Propulsion Lab	205
JHU C for Talented Y.	202
McGraw-Hill	319
Modus Medical	301
PASCO	113,115
Pearson	102, 200
PTEC	310
Physics200	315
Qwizdom	414
Sargent-Welch	416
SENSR	311
SPS	312
Space Telescope In.	207
Spectrum Tech.	316
TeachSpin	212
TEL-Atomic	404
The Science Source	313
Vernier	214
W.H. Freeman	111
WW. Norton	218
WebAssign	304
Wiley & Sons	206, 208