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# COSMOS IN THE CLASSROOM★2004

A Hands-on Symposium on Teaching Introductory Astronomy

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July 15 – 18, 2004  
on the campus of Tufts University

**Sponsored by:**

Astronomical Society of the Pacific  
&

New England Space Science Initiative in Education

★

Co-sponsored by the American Astronomical Society

★

**With support from:**

The National Science Foundation

NASA JPL Navigator Institute for Space Science Education

The National Optical Astronomy Observatories

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The Boston Museum of Science

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## Cosmos in the Classroom 2004 Program Overview

<b>Thursday, July 15</b>		
5:30 pm	Reception for all meeting participants at the Remis Sculpture Court (15 South Campus Road, part of the Aidekman Arts complex) at Tufts University	
<b>Friday, July 16</b>		
8:30 am	Welcomes, introductions (in Cohen Auditorium)	
8:50	Overview of the Meeting – <i>Andrew Fraknoi (Foothill Coll, ASP)</i>	
9:10	Plenary Talk: Are You Really Teaching If No One Is Learning? (What Research Is Telling Us About How Our Students Learn) – <i>Tim Slater (U of Arizona)</i>	
10:00	Panel: Applying the Results of Educational Research in the Real Classroom – <i>Mary Kay Hemenway (U of Texas), moderator; Ed Prather (U of Arizona), Lauren Jones (Gettysburg Coll), Tom Foster (S. Illinois U)</i>	
10:50	Break	
11:15	One-minute Oral Summaries of Poster Papers – <i>Michael Bennett (ASP), moderator</i>	
12:00 pm	Lunch, poster papers, share-a-thon, discussions	
<i>NOTE: The afternoon workshops are in Eaton and Barnum Halls, upcampus past the Library.</i>		
<b>2:00 - 2:50 pm: Hands-on Workshops – Session A</b>		
Session	Title	Location
A1. [repeats in session B]	On-line Astronomy: Teaching Strategies and Tools – <i>Matthew Bobrowsky (Space Telescope Science Institute) and Mary Radnofsky (U of Maryland &amp; Socrates Inst)</i>	Barnum 104
A2.	Setting Your Course Goals for Astronomy 101 – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
A3.	The Astronomy Diagnostic Test: Getting to Know Your Astronomy 101 Students – <i>Beth Hufnagel (Anne Arundel Comm Coll)</i>	Eaton 202
A4.	Archaeoastronomy in the Undergraduate Curriculum – <i>Bryan Penprase (Pomona College)</i>	Eaton 333
A5.	Panel: Using a Campus Observatory for Effective Teaching <i>Organizers: Bill Waller &amp; Esther Zirbel (Tufts U)</i>	Barnum 114
<b>3:05 - 3:55 pm: Hands-on Workshops – Session B</b>		
Session	Title	Location
B1.	On-line Astronomy: Teaching Strategies and Tools – <i>Matthew Bobrowsky (Space Telescope Science Institute) &amp; Mary Radnofsky (U of Maryland &amp; Socrates Inst)</i>	Barnum 104
B2.	Strategies to Engage Your Students During Lecture – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
B3.	Implementing Peer Instruction for Astronomy – <i>Paul Green (Harvard U)</i>	Eaton 202
B4.	The Pain and Pleasure of Unlearning Astronomy Misconceptions in the Classroom – <i>Neil Comins (U of Maine)</i>	Eaton 333
B5.	Astronomy for Students with Special Needs: Resources and Strategies – <i>Noreen Grice (You Can Do Astronomy &amp; Boston Museum of Science)</i>	Barnum 114
3:55	Break	

<b>4:20 - 5:10 pm: Hands-on Workshops – Session C</b>		
<b>Session</b>	<b>Title</b>	<b>Location</b>
C1.	SkyServer: Education and Outreach with Sloan Digital Sky Data – <i>Jordan Raddick (Johns Hopkins) &amp; Beth Hufnagel (Anne Arundel Community College)</i>	Eaton 208
C2.	Teaching Astronomy 101 with Lecture Tutorials – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
C3.	How to Create An Inquiry-Based Seminar Course For Non Majors – <i>George Greenstein (Amherst Coll)</i>	Eaton 202
C4.	Student Misconceptions and How Knowing Them Should Change Your Teaching – <i>Rebecca Lindell and Tom Foster (Southern Illinois U)</i>	Eaton 333
C5.	The Astronomy of Middle-Earth – <i>Kristine Larsen (Central Connecticut State)</i>	Barnum 114
5:15	Afternoon Sessions end	
6:00	Trip to Boston Museum of Science with special planetarium show (bus departure times and locations to be announced)	
<b>Saturday, July 17</b>		
8:30 am	Plenary Talk: Teaching with Electrons and Waves: Technology in Astronomy Education – <i>Chris Impey (University of Arizona)</i> (in Cohen Auditorium)	
9:20	Panel: Using Technology in Astronomy Education: What Actually Works – <i>Kevin Lee (U of Nebraska), moderator; Larry Marschall (Gettysburg Coll), Dick McCray (U of Colorado), Kenneth Brecher (Boston U)</i>	
10:10	Break	
10:25	Panel: Engaging in Diversity in the Astronomy 101 Classroom – <i>Charles H. McGruder (Western Kentucky University), moderator; Apriel Hodari (CNA Corporation), Beth Hufnagel (Anne Arundel Community College), Rebecca Lindell (Southern Illinois University)</i>	
11:15	Plenary Talk: A Blunder Undone: The Accelerating Universe – <i>Robert Kirshner (Harvard Smithsonian Ctr for Astrophys)</i>	
12:10 pm	Lunch, poster papers, share-a-thon, and discussions	
<b>2:00 - 2:50 pm: Hands-on Workshops – Session D</b>		
<b>Session</b>	<b>Title</b>	<b>Location</b>
D1.	Project CLEA: Bringing the Universe into the Laboratory – <i>Larry Marschall &amp; Dick Cooper (Gettysburg Coll)</i>	Eaton 208
D2.	Alternative Assessment Ideas in Astronomy – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
D3.	Dealing with Disbelieving Students on Issues of Evolutionary Processes and Long Time Scales – <i>Matthew Bobrowsky (Space Telescope Science Institute)</i>	Eaton 202
D4.	Inquiry Based, In-class Activities with Hands-on Equipment – <i>Rebecca Lindell and Tom Foster (Southern Illinois U)</i>	Eaton 333
D5.	Seeing the Astronomical LITE: Light Inquiry through Experiments – <i>Kenneth Brecher and Erin Weeks (Boston U)</i>	Barnum 114

<b>3:05 - 3:55 pm: Hands-on Workshops – Session E</b>		
<b>Session</b>	<b>Title</b>	<b>Location</b>
E1. [repeats in session H]	Astronomycenter.org: A Digital Library for Astronomy 101 – <i>Marc Gagne (West Chester Coll) and Susana Deustua (AAS)</i>	Eaton 208
E2.	Improving Multiple Choice Tests for Your Course – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
E3.	How to Teach a Class of More Than 100 Students Without Lecturing Very Much, and Why It’s Worth Doing – <i>Richard McCray (U of Colorado)</i>	Eaton 202
E4.	Rejecting the Smog of Bias: Engaging Diversity in Your Classroom – <i>Apriel Hodari (C.N.A. Corp) and Charles McGruder (Western Kentucky U)</i>	Eaton 333
E5.	The Power of Exploring “What If” Questions in the Classroom – <i>Neil Comins (U of Maine)</i>	Barnum 114
3:55	Break	
<b>4:20 - 5:10 pm: Hands-on Workshops – Session F</b>		
<b>Session</b>	<b>Title</b>	<b>Location</b>
F1.	The ClassAction System: Easy-to-Use Classroom Materials for Student Discussion and Voting – <i>Kevin Lee (U of Nebraska) &amp; Tim Slater (U of Arizona)</i>	Eaton 208
F2.	Panel: Using the Planetarium in Teaching an Introductory Astronomy Course – <i>Organizer: Jerry LaSalla (U of Southern Maine)</i>	Eaton 201
F3.	Activities to Help Students Develop a Sense of Scale – <i>Mary Urquhart (U of Texas Dallas) and Niescja Turner (Florida Inst of Technology)</i>	Eaton 202
F4.	Assessing and Improving Students’ Problem Solving Abilities – <i>Rebecca Lindell and Tom Foster (Southern Illinois U)</i>	Eaton 333
F5.	What To Do with an Overhead Projector Besides Show Overheads – <i>Katy Garmany (NOAO)</i>	Barnum 114
5:15	Afternoon Sessions end	
6:00 on	Banquet/barbecue at the Remis Sculpture Court After the barbecue, we will gather in Cohen Auditorium for “Girl Meets Boy”, an astronomical stage entertainment from the Boston Museum of Science	
<b>Sunday, July 18:</b>		
8:30 am	Panel: Goals for the Astro 101 Course: What Do We Teach, Why Do We Teach It? – <i>Michael Bennett (ASP), moderator; George Greenstein (Amherst), Jay Pasachoff (Williams Coll), Phil Sadler (Harvard-Smithsonian Ctr for Astrophys) (Cohen)</i>	
9:20	Panel: Textbooks Today and in the Future – <i>George (Pinky) Nelson (W. Washington U.), moderator; Adam Black (Addison-Wesley), John Challice (Prentice Hall), Chris Hall (Brooks-Cole)</i>	
10:10	Break	
10:30	Panel: The Next Step: What Do Astronomy Instructors Need from the Astronomical Community – <i>Andrew Fraknoi (Foothill Coll), moderator; Catharine Garmany (ASP, NOAO), Richard Alvidrez (JPL), Susana Deustua (AAS)</i>	
11:15	Plenary Talk: Giant Planets: Hot News and Cool Views – <i>Heidi Hammel (Space Science Institute)</i>	
12:05 pm	Lunch, poster papers, share-a-thon, and discussions	

**2:00 - 2:50 pm: Hands-on Workshops – Session G**

<b>Session</b>	<b>Title</b>	<b>Location</b>
G1.	Some Cool JAVA Applets for Students to Explore the Cosmos – <i>Richard McCray (U of Colorado)</i>	Eaton 208
G2.	Teaching Clinic: A Burning Questions and Quenching Answers Session – <i>Timothy Slater and Ed Prather (U of Arizona)</i>	Eaton 201
G3.	Debunking Pseudo-science: How to Address Astrology, UFO's, and Moon Madness in Your Classroom and Live to Tell the Tale – <i>Andrew Fraknoi (Foothill College) &amp; Salman Hameed (Smith College)</i>	Eaton 202
G4.	How to Conduct Astronomy Education Research – <i>Rebecca Lindell and Tom Foster (Southern Illinois U)</i>	Eaton 333
G5.	Pre-service Teachers in the Introductory Astronomy Classroom: Reaching Those Doing the Teaching – <i>Jennifer Grier and R. Bruce Ward (Harvard-Smithsonian Ctr for Astrophys)</i>	Barnum 114
2:50	Break	

**3:10 - 4:00 pm: Hands-on Workshops – Session H**

<b>Session</b>	<b>Title</b>	<b>Location</b>
H1.	Astronomycenter.org: A Digital Library for Astronomy 101 – <i>Marc Gagne (West Chester Coll) and Susana Deustua (AAS)</i>	Eaton 208
H2.	The Learner-Centered Classroom: Lecture-Tutorials, Concept Maps, Portfolios, Minute Papers and Other Techniques – <i>Lauren Jones (Gettysburg Coll)</i>	Eaton 201
H3.	Bringing the Real World into the Classroom: Project-based Astronomy for Students in Two- and Four-Year Colleges – <i>Phil Sadler and R. Bruce Ward (Harvard-Smithsonian Ctr for Astrophys)</i>	Eaton 202
H4.	The Virtual Educational Observatory: Astronomical Laboratory Exercises for the Age of Information – <i>Larry Marschall &amp; Dick Cooper (Gettysburg Coll)</i>	Eaton 333
H5.	Helping Students Assess Their Own Understanding Using Concept Maps – <i>Gina Brissenden (U of Arizona)</i>	Barnum 114
4:05	Meeting formally ends (Be sure you take all your materials with you)  For those who are staying later, Tim Slater, Ed Prather, and Lauren Jones will continue their teaching clinic discussion (see session G2) in Eaton 201.	

## Abstracts for Afternoon Workshops

### Friday, 2 pm: Session A

#### A1. On-line Astronomy: Teaching Strategies and Tools

*Matthew Bobrowsky (Space Telescope Science Inst) & Mary Radnofsky (U of Maryland & Socrates Inst)*

Online science instruction is vastly different from face-to-face classroom teaching, for students as well as for the instructor, who must prepare the class in new ways. In this workshop, participants will join presenters in an online classroom environment for Astro 101 from the University of Maryland University College. With a live Internet connection, a group of participants acting as “The Prof” will create assignments, moderate on-line student discussions, and post commentary. Another group of participants playing the role of “CyberStudents” will work on assignments, ask questions, chat in the “virtual lounge,” check online resources, and contribute to a group project. The benefits and problems associated with such a different method of education will be experienced first-hand. Groups will problem-solve to come up with strategies to more effectively communicate ideas, questions, and arguments.

Matt Bobrowsky works at the Space Telescope Science Institute as a scientist with NASA’s Origins Education Forum. He also teaches astronomy (both in the classroom and online) at the University of Maryland University College (UMUC). Mary L. Radnofsky, Director of the Socrates Institute, also teaches online at UMUC, and specializes in designing new curricula and instructional strategies.

#### A2. Setting Your Course Goals for Astronomy 101

*Tim Slater and Ed Prather (University of Arizona)*

Do your students perform less well on the final exam that you would like? Do your students ask you what will be on the final exam? Do you stay up late the night before an exam agonizing about which questions to pose? If you answered yes to any of these questions, you might need to be much more explicit to your students about exactly what the goals of your course are. In fact, clearly specifying your course goals helps students rise and meet your expectations as well as helps you make critical decisions about what to do during class and exactly what should go on your exams. (This session is part of a series of programs by Slater and Prather during this conference, all taken from their teaching excellence workshops.)

Ed Prather and Tim Slater are faculty members at the University of Arizona who conduct national college teaching excellence workshops for the NASA JPL Navigator EPO program. They are members of the Conceptual Astronomy and Physics Education Research (CAPER) Team at the University, where their scholarship focuses on the teaching and learning of astronomy, and are also the Education and Public Outreach Leads in the NASA LAPLACE Astrobiology Institute.

#### A3. The Astronomy Diagnostic Test: Getting to Know Your Astronomy 101 Students

*Beth Hufnagel (Anne Arundel Community College)*

The Astronomy Diagnostic Test (ADT) is a nationally tested, carefully validated tool to measure the understanding of students taking your introductory survey course for non-science majors. I will briefly explain the process by which such a test is developed and what you should look for when selecting such a diagnostic. Then the attendees will get acquainted with the ADT by taking it for themselves; grades will not be assigned, but participants will self-grade and discuss in small groups. The student misconceptions underlying the wrong answers will be explained as requested by the participants. Interesting results from several studies using the AST101 will be shared. The workshop will wrap up with a case study of how the ADT was used in a classroom as part of a project to improve an AST101 course and the student evaluations of the course and the instructor.

Beth Hufnagel earned her bachelors in accounting in 1976 and her PhD in astronomy and astrophysics from the Univ. of California, Santa Cruz in 1995. She held two postdocs in astronomy education research at Michigan State and Univ. of Maryland, and taught for one year at Coppin State College. She is currently an associate professor at Anne Arundel Community College near Annapolis, Maryland.

#### A4. Archaeoastronomy in the Undergraduate Curriculum

*Bryan Penprase (Pomona College)*

Archaeoastronomy is a fascinating crossroads of anthropology, archaeology and astronomy, which inspires the imaginations of students, and offers many opportunities to present astronomy in a new and exciting way. In this workshop, we will discuss some

specific examples of archaeoastronomy and their role in undergraduate science education. Specific student projects from our course at Pomona College will be described, and resources useful for teaching the subject will be given. The themes of archaeoastronomy also offer many opportunities to explore the boundaries of science and religion, and the boundaries between speculation and reason. We will discuss some common themes of archaeoastronomy and possible ways to adapt the project to either a stand-alone course or a module in a more traditional astronomy course.

Bryan Penprase has been teaching courses in Archaeoastronomy and World Cosmology at Pomona College both as a seminar and lecture course for ten years. He has presented some of the student projects in archaeoastronomy at the Oxford V conference in archaeoastronomy, and has done numerous field observations with students at petroglyph sites in coastal and desert California. He received his PhD in astronomy and astrophysics at the University of Chicago in 1992, and does research in a variety of modern astrophysics topics.

#### **A5. Using a Campus Observatory for Effective Teaching: A Panel and Discussion**

*Bill Waller and Esther Zirbel (Tufts University), Facilitators*

**Panelists:** Timothy Barker (Wheaton College), Jim Dire (U.S. Coast Guard Academy), Michael Fanelli (University of North Texas), Tracy Hodge (Salem State College), and Jay Pasachoff (Williams College)

In this session, we will examine the uses of campus observatories as teaching tools for courses in introductory astronomy. Through a sequence of brief presentations, follow-up discussions, and summative reports, we will evaluate the role of campus observatories within the modern context of space-borne observatories and web-based modes of accessing astronomical data. The presentations and discussions will consider: 1. The relative merit of direct observing experiences in introductory astronomy courses; 2. campus vs. other observing venues (off-campus, internet, archival); 3. dealing with light pollution in urban settings; 4. the use of electronic detectors vs. visual observations at the introductory level; 5. educational programmatic – what is available, what is feasible at the introductory level; 6. funding and staffing issues, and more.

### **Friday, 3:05 pm: Session B**

B1. Repeat of A1 (see above)

#### **B2. Strategies to Engage Your Students During Lecture** *Tim Slater and Ed Prather (U of Arizona)*

Faculty often say that the professor-centered lecture mode is ineffective for many students, but are at a loss of what they might do instead. This session will describe ten ways to screw up a perfectly good lecture, will introduce you to techniques that intellectually engage students in the physical processes of astronomy, and demonstrate strategies to involve your students in the learning process, even in a large lecture theater. (See Session A2 for presenters' bios.)

#### **B3. Implementing Peer Instruction for Astronomy** *Paul J. Green (Harvard University)*

Peer Instruction is a method of engaging students' attention and energy by allowing them to debate astronomy concepts with each other during class. Geared primarily towards large Astronomy 101 lecture halls, Peer Instruction is coming into wide use. PI throws an element of improvisation into every lecture, and sets the class free from continual focus on the "sage on stage". While students benefit greatly from the boost in bloodflow and adrenaline engendered by PI, for the instructor the experience can feel like free fall. I will describe Peer Instruction for Astronomy, and we will share thoughts and experiences on implementing it from those who have a toe in the water, and those who are already fully immersed.

Paul Green is author of *Peer Instruction for Astronomy*, published by Prentice-Hall in 2002, and its companion free-access website. Currently a researcher at the Harvard-Smithsonian Center for Astrophysics specializing in X-ray emitting quasars and galaxies, Dr. Green has taught introductory high school and college-level physics and astronomy in Togo, West Africa, at the University of Washington, Seattle, and occasionally experiments on students at Tufts and Harvard.

#### **B4. The Pain and Pleasure of Unlearning Astronomy Misconceptions in the Classroom** *Neil Comins (University of Maine)*

Our students enter our classes believing many things that are untrue about the cosmos and the workings of nature. Some of these beliefs are superficial and easily replaced (e.g., the number of moons of Jupiter), but some are

deep-seated and are used in creating explanations of other phenomena. These latter misconceptions are especially hard to replace and students will go to amazing lengths to incorporate what we teach them into belief systems that keep their misconceptions intact. In this session, we will try a method I have been using successfully for nearly a decade to help students face their beliefs and become more open to alternatives. The process is initially painful for students, but after sufficient experience with it (six weeks is typical), they accept and then actively welcome the activities. I will discuss variations of this technique that can be done by students individually, in small groups, and using “clickers.”

Neil Comins is Professor of Astronomy at the University of Maine. He is author of two introductory astronomy textbooks and a variety of trade books, including “Heavenly Errors: Misconceptions About the Real Nature of the Universe”.

### **B5. Astronomy for Students with Special Needs: Resources and Strategies**

*Noreen Grice (You Can Do Astronomy & Boston Museum of Science)*

In this workshop, we will explore a variety of resources and strategies to make your astronomy course even more accessible and welcoming to students with disabilities (different abilities) and different learning styles. We’ll examine available tactile illustrations, books, and models, explore methods of descriptive narration and captioning, and discuss strategies to make your observing and laboratory sessions physically accessible. You will leave this workshop full of ideas and will find that almost any modifications that you make for differently-abled students will work well for lots of other students too.

Noreen Grice is Operations Coordinator of the Charles Hayden Planetarium, Boston and President of You Can Do Astronomy LLC. She is also an astronomy instructor at Bentley College, author of *Touch The Stars, Touch The Stars II and Touch The Universe: A NASA Braille Book of Astronomy* (Braille astronomy books) and writes a monthly astronomy column for *Odyssey Magazine*, a science magazine for kids.

## **Friday, 4:20 pm: Session C**

### **C1. SkyServer: Education and Outreach with Sloan Digital Sky Data**

*Jordan Raddick (Johns Hopkins) and Beth Hufnagel (Anne Arundel Comm Coll)*

The Sloan Digital Sky Survey (SDSS), an ambitious map of the night sky, has so far seen nearly 90 million stars and galaxies, and has measured spectra for more than 300,000. The SkyServer web site (<http://skyserver.sdss.org>) makes all SDSS data available, free of charge, to students and the general public. We have developed several tools and activities that use data to teach concepts from astronomy. Students can also use SkyServer for independent scientific research – they can answer their own questions by analyzing exactly the same high-quality data that professional researchers analyze. In this workshop, we will introduce the SDSS as a scientific project, and will demonstrate some of the projects available on SkyServer. We will focus on one specific project: an activity on the evolution of galaxy clusters we developed for community college teachers.

Jordan Raddick earned a M.A. in science writing from Johns Hopkins University in 2001. Since then, he has worked with the Sloan Digital Sky Survey, directing the SkyServer web site. Beth Hufnagel earned a PhD from Univ. of California, Santa Cruz in 1995. She had two postdocs in astronomy education research at Michigan State and Univ. of Maryland, taught one year at Coppin State College, and is currently an associate professor at Anne Arundel Community College.

### **C2. Teaching Astronomy 101 with Lecture Tutorials**

*Tim Slater and Ed Prather (U of Arizona)*

This workshop is for faculty who are ready to move from a professor-centered lecture classroom to a student-centered learning environment. Used to break up lecture classes, the Lecture-Tutorials are 15-minute classroom activities, to be completed in student pairs, that focus on engaging students in challenging conceptual topics that are common to many introductory astronomy classes. These activities use a Socratic-dialog approach to helping elicit, confront, and resolve their reasoning difficulties. (See Session A2 for presenters’ bios.)

### **C3. How to Create an Inquiry-Based Seminar for Non-Majors**

*George Greenstein (Amherst College)*

Inquiry-based seminar courses on tightly focused topics represent an alternate and enjoyable way to teach non-

majors. But they pose their own special problems. Most of us were not taught this way when we were students, and have little or no experience in doing it ourselves. I will briefly describe one such course (on the dark matter problem), demonstrate software that has been developed for it, and then open the floor for a discussion of the various pitfalls that can arise when using this exciting new mode of instruction.

George Greenstein teaches at Amherst College, and is interested in alternate modes of instruction (including developing multimedia exercises that go beyond what a hard-copy textbook can offer).

#### **C4. Student Misconceptions and How Knowing Them Should Change Your Teaching**

*Rebecca Lindell and Tom Foster (Southern Illinois U Edwardsville)*

Students often enter the Astro 101 classroom with deeply rooted misconceptions that are difficult to change. In this workshop we explore some of the misconceptions discovered by astronomy education researchers, as well as discuss strategies of how to overcome the difficulties students have in with replacing deeply rooted misconceptions with the scientifically correct understanding.

Rebecca Lindell is an assistant professor of physics at Southern Illinois University Edwardsville. As part of her dissertation on college students' understanding of lunar phases, she developed the Lunar Phases Concept Inventory (LPCI). She also contributed to the development of the Astronomy Diagnostic Test (ADT), and participated in its validation studies. Tom Foster is a physics educator at SIUE. His dissertation work examined the development of problem-solving skills in introductory physics students.

#### **C5. The Astronomy of Middle-Earth**

*Kristine Larsen (Central Connecticut State U)*

In this workshop you will learn how to utilize the countless astronomical allusions in J.R.R. Tolkien's classic works (including "The Hobbit," "The Lord of the Rings," and "The Silmarillion") to demonstrate astronomical principles, including creation myths, lunar phases, constellations, and the apparitions of Venus. Both in-class discussion topics and lab exercises will be shared.

Kristine Larsen is the Director of the Honors Program at Central Connecticut State University and Professor of Astronomy and Physics. The material covered in this workshop has been developed for interdisciplinary courses on Science & Society and Science & Science Fiction.

## **Saturday, 2 pm: Session D**

### **D1. Project CLEA: Bringing the Universe into the Laboratory**

*Larry Marschall & Dick Cooper (Gettysburg College)*

Project CLEA has developed modular laboratory exercises that make extensive use of modern digital data to provide realistic simulations of astronomical research techniques. In this workshop, we will provide an overview of the CLEA exercises and invite participants to try out several of our newest and several of our most popular exercises. Included will be The Measurement of the Solar Rotation using Sunspots, X-Ray Spectroscopy of Supernova Remnants, Radio Astronomy of Pulsars, The Search for Object X, and several others.

Larry Marschall is the chair of the Physics Department at Gettysburg College, and has been teaching astronomy for over one sidereal revolution of Saturn. He directs Project CLEA, serves as deputy press officer for the American Astronomical Society, and in his spare time writes a regular column for *Natural History* magazine. Dick Cooper retired from many years of teaching high school mathematics to become the outreach coordinator of Project CLEA, and a noted collector of the literature of John Blaine.

### **D2. Alternative Assessment Ideas in Astronomy**

*Tim Slater and Ed Prather (U of Arizona)*

Tired of giving multiple-choice tests that encourage students to regurgitate memorized facts? We are too. This workshop will introduce participants to various alternative approaches to getting insight into student thinking for the purposes of assigning grades – as well as helping students become better critical thinkers by focusing on concept maps, portfolio assessments, holistic rubric scoring, and other approaches. (See Session A2 for presenters' bios.)

### **D3. Dealing with Disbelieving Students on Issues of Evolutionary Processes and Long Time Scales**

*Matthew Bobrowsky (Space Telescope Science Institute)*

Sooner or later, the Astro 101 instructor encounters a student who disbelieves, or is at least skeptical of, factual information presented about the age of the earth, the age of the universe, or astrobiology and biological evolution. This workshop focuses on ways to approach these subjects so that skeptical students are more likely to consider that the facts presented have some merit. The workshop will present specific answers to questions

intended to challenge what the instructor is saying. All participants will be actively engaged, both in the role of the disbelieving student asking questions, and in the role of the instructor responding to those questions. Participants will have the opportunity to hear alternative approaches, and to contribute new ideas for dealing with disbelieving students. In addition, all participants will be provided a packet of typical challenging questions asked by skeptical students, along with the presenter's recommended responses.

Matt Bobrowsky works at the Space Telescope Science Institute as a scientist with NASA's Origins Education Forum. He also teaches astronomy (both in the classroom and online) at the University of Maryland.

#### **D4. Inquiry Based, In-class Activities with Hands-on Equipment**

*Rebecca Lindell and Tom Foster (Southern Illinois University Edwardsville)*

At SIU Edwardsville, we have recently restructured our introductory astronomy course to include hands-on inquiry-based in-class group activities. These activities utilize a learning cycle approach to cover specific astronomical concepts that traditionally resist conceptual change, such as phases of the moon and seasons, or that students have difficulty mastering, such as Hubble's law and the Hertzsprung-Russell diagram. Each group activity is designed to be completed during one 50-minute class period and utilize hands-on equipment whenever possible. In this workshop, we will discuss the design and implementation of these group activities and allow participants a chance to explore some of them. (See Session C4 for presenters' bios.)

#### **D5. Seeing the Astronomical LITE: Light Inquiry Through Experiments**

*Kenneth Brecher and Erin Weeks (Boston University)*

We are developing software, hardware, and print materials to help students learn about light, optics, color and visual perception, particularly in the context of the large introductory non-science major's astronomy courses (with NSF support: "Project LITE: Light Inquiry Through Experiments" NSF DUE # 0125992). A major strategy is to have students perform experiments at home – "homelabs" – using a kit of materials we have devised which interact with light emitted by computer screens that is controlled by software (posted at <http://lite.bu.edu>). We have also developed another software application – the "Spectrum Explorer" – that enables students to (among many other things) manipulate

blackbody spectra, explore the emission lines of atoms, compare astronomical spectra, and construct spectra of their own devising. We have also developed two inexpensive spectrometers (one a direct view handheld binocular spectrometer, the other a USB based PC spectrophotometer) to enable students to study spectra quantitatively. These and other outcomes of the project will be presented. We are particularly eager to learn from meeting participants what other aspects of light would be useful and interesting to include in the project for use in their particular teaching contexts.

Kenneth Brecher is Professor of Astronomy and Physics, and Director of the Science and Mathematics Center at Boston University. Erin Weeks is a graduate student pursuing a Ph.D. in Astronomy at Boston University.

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### **Saturday, 3:05 pm: Session E**

#### **E1. Astronomycenter.org: A Digital Library for Astronomy 101**

*Marc Gagne (West Chester Coll) & Susana Deustua (AAS)*

This workshop will introduce attendees to astronomycenter.org, a collection of digital resources for introductory astronomy teachers and students. The astronomy site is part of the ComPADRE project, Communities for Physics and Astronomy Digital Resources in Education, funded by the National Science Foundation Digital Library program of the National Science Foundation. We will give a brief overview of the project, the astronomycenter.org site, and the communities we hope to connect. Participants will take part in a 20-minute computer-based activity to prepare lectures, lab activities, and student projects and to review and assess items within the collection. Participants from the workshop will provide essential feedback as we prepare to launch the site at the end of 2004.

Prior to joining the faculty at West Chester University, Marc Gagne worked as a postdoc at the University of Colorado and Rutgers University. As editor of astronomycenter.org, he is looking for ways to keep the astronomy curriculum fresh and meaningful by connecting teachers and students via the internet. Susana Deustua is Director of Educational Activities at the American Astronomical Society. She has taught astronomy undergraduate and graduate courses, developed workshops for middle school and high school science teachers in astronomy and physics, and currently serves on the advisory boards of several education programs.

## E2. Improving Multiple Choice Tests for Your Course

*Tim Slater and Ed Prather (U of Arizona)*

When carefully constructed, multiple-choice tests can be used to effectively gauge your students' levels of understanding. This session will review some of the common pitfalls we make as amateur test writers and provide strategies to fine-tune your test writing abilities. (See Session A2 for presenters' bios.)

## E3. How to Teach a Class of More Than 100 Students Without Lecturing Very Much, and Why It's Worth Doing

*Richard McCray (University of Colorado)*

This workshop will demonstrate how we create a student-centered learning environment in a classroom of ~ 100-200 students with the aid of information technology (both web-based and classroom response devices). We employ a combination of techniques, including "just-in-time teaching" and peer instruction. Participants may want to log on to <http://stem.colorado.edu/CIC> and follow the instructions there before coming to the workshop. (This will take about 1/2 hour and will be interesting.) We'll also discuss some of the lessons learned and challenges of this type of teaching.

Richard McCray is George Gamow Distinguished Professor of Astrophysics at the University of Colorado. He is a member of the National Academy of Sciences and a recipient of the NSF Director's Award for Distinguished Teaching Scholar. He is currently a member of the NRC Board on Science Education.

## E4. Rejecting the Smog of Bias: Engaging Diversity in Your Classroom

*Apriel Hodari (C.N.A. Corp) & Charles McGruder (Western Kentucky U)*

As is often expressed in the business literature on diversity, the lack of ability to deal with diverse people impairs your ability to connect with customers and employees. This perspective is a profit-driven application of what Sondra Thiederman calls *lucrative virtue* (2004). Our task here is to adapt this idea to promote the education success of college students in physical science classrooms. As faculty members we must interact productively with diverse colleagues and students, and we must find a way to benefit from the intellectual talents of all members of the academy. For this workshop, we are assuming that you are motivated to engage diversity by your own version of lucrative virtue. This means that you approach this work informed that increasing diversity in your classroom will increase your success

and the success of *all* your students. As one step in this direction, we will participate in a jigsaw activity, centered on raising your awareness of and engagement with a controversial idea related to diversity. The goal here is to give you a starting point and some avenues to explore as you create activities that serve your classroom best.

Apriel Hodari is a research analyst in education and workforce policy at the CNA Corporation. She has conducted several major studies of educational and workforce diversity, while doing research on educational equity and the impact of bias on intimate relationships. Charles McGruder is the McCormack Professor of Physics at Western Kentucky University. He has taught thousands of astronomy non-major students, while doing research in gamma ray bursts and extrasolar planets.

## E5. The Power of "What If?" Questions in the Classroom

*Neil Comins (U of Maine)*

Asking 'What if?' questions and then following the consequences often leads students to profound insights. Not only do students learn a wide range of specific science concepts and facts in this process, they come to understand how things in nature are interconnected. In this session, I will use as an example the question "What if the Moon didn't exist?" Then we will try other questions in small groups. I will have some "what if?" questions for you to try, but you can bring your own.

Neil Comins is Professor of Astronomy at the University of Maine. He is author of two introductory astronomy textbooks and a variety of trade books, including "What if the Moon Didn't Exist?", which has been used as a text, made into at least two planetarium shows, and will soon be the theme for a pavilion at the upcoming World Expo in Nagoya, Japan.

## Saturday, 4:20 pm: Session F

### F1. The Class-Action System: Easy-to-Use Classroom Materials for Student Discussion and Voting

Kevin Lee (*University of Nebraska*) & Tim Slater (*University of Arizona*)

The ClassAction Project is creating a computer database of conceptual questions for use in collaborative student discussion and interactive voting in the introductory astronomy classroom. The databases are programmed in FLASH and are designed to be projected to a class using a computer video projection system. Separate FLASH modules are being created for each major topic area in astronomy and instructors may conveniently select from a variety of questions in each module. The questions are carefully designed to focus on tenacious student misconceptions. Most question prompts include animations, diagrams, and images that students must interpret when answering. The questions are also dynamic in that instructors have the capability to easily recast them into alternate forms based on their own preferences and feedback from the class. Considerable resources are available to the instructor to provide feedback in the form of outlines of information, images, and animations. This workshop will discuss the benefits of using interactive engagement techniques in the classroom and our experiences with ClassAction materials. Each participant will receive a CD containing all ClassAction materials developed to date.

Kevin Lee is a Research Assistant Professor at the University of Nebraska where he works on the application of instructional technology in astronomy education. Tim Slater is an Associate Professor at the University of Arizona and heads the CAPER (Conceptual Astronomy and Physics Education Research) Team.

### F2. Using the Planetarium in Teaching the Introductory Astronomy Course

*A Panel and Discussion*

Do you have a planetarium at your institution or your city? In this session, a panel of astronomy professors and planetarians will discuss how they incorporate planetarium experiences into their introductory courses and labs. We'll discuss how the planetarium can enhance student learning and understanding of important concepts such as planetary motion as well as adding appreciation of simply watching the night sky. The merits of custom presentations versus "canned" programs will be explored, as will how we can incorporate both into our teaching. Planetarians will discuss how they work

with instructors to develop and present the most valuable lessons.

The session will be led by Jerry LaSala, Associate Professor of Physics and Director of the Southworth Planetarium and the University of Southern Maine. Tentative panelists as we go to press include Jay Pasachoff (Williams College), Noreen Grice (Museum of Science), Supriya Chakrabarti (Boston University), and Owen Gingerich (Harvard University).

### F3. Activities to Help Students Develop a Sense of Scale

Mary Urquhart (*University of Texas at Dallas*) and Niescja Turner (*Florida Institute of Technology*)

Understanding the scale of the cosmos, and our tiny world's place within it, is challenging for students of all ages. Models, such as the many variations of the classic scale model solar system activity, provide an excellent opportunity for students to explore concepts of scale. These models can also be extended far beyond scale in our own solar system. In this workshop, participants will use hands-on scale modeling activities that include sizes and distances of stars, extrasolar planetary systems, and more, all using the same 1 to 10 billion scale factor for both size and distance. The scale factor and activities were inspired by the Colorado Model Solar System, a permanent scale model that has been successfully used with non-major undergraduate students at the University of Colorado at Boulder since its completion in 1987. We will also show how other hands-on activities originally developed for use in pre-college classrooms can be adapted for helping students develop a sense of scale in an undergraduate lecture or laboratory setting.

Mary Urquhart is a planetary scientist and an assistant professor of science education and affiliate professor of physics at the University of Texas at Dallas, where she teaches astronomy and physics classes for pre-service and in-service teachers and undergraduates. Niescja Turner is space physicist and an assistant professor of physics at the Florida Institute where she teaches physics and astronomy classes to undergraduate and graduate students. Both presenters developed a passion for undergraduate and pre-college astronomy education during their years in graduate school together at the University of Colorado at Boulder.

#### **F4. Assessing and Improving Students' Problem Solving Abilities**

*Tom Foster and Rebecca Lindell (Southern Illinois U Edwardsville)*

Introductory astronomy for non-majors often ignores the role of mathematical and physical problem-solving, which is philosophically central to modern astrophysics. This oversight is intentional as instructors and textbook writers fear that math will scare students away or that students will not be able to solve such problems. It remains unclear if these assumptions are true. Certainly math anxiety and math-phobia are real, but these effects maybe in the minority. Participants in this workshop will explore alternative problem formats designed to engage students in problem-solving in astronomy. (See Session C4 for presenters' bios.)

#### **F5. What to Do with an Overhead Projector Besides Show Overheads**

*Katy Garmany (NOAO)*

Simple demonstrations of physical principles and concepts can energize a class of any size. In this workshop we will demonstrate a range of possibilities, many involving only an overhead projector and a few props. Examples: using a planisphere, lunar phases, planetary positions, interstellar reddening, extrasolar planet wobble, expanding universe... You are invited to bring a favorite demo to make this session participatory.

Katy Garmany is the current President of the Astronomical Society of the Pacific, and has taught for many years, most recently as Director of a Columbia University program at Biosphere 2. She is now working in the education division at the National Optical Astronomy Observatory in Tucson.

#### **Sunday, 2 pm: Session G**

#### **G1. Some Cool JAVA Applets for Students to Explore the Cosmos**

*Richard McCray (U of Colorado)*

In this workshop we'll conduct a hands-on collaborative exercise in analyzing data to detect extra-solar planets. This workshop will be related to the workshop "How to Teach a Class of More Than 100 Students Without Lecturing Very Much, and Why It's Worth Doing" that is scheduled for Saturday afternoon. For best results, participants may want to log on to <http://stem.colorado.edu/CIC> and follow the instructions there before coming to the workshop. (This will take about 1/2 hour and will be interesting.) We'll also show a number of other open-source java applets that we have developed for students to explore physical and astronomical phenomena. (See Session E3 for presenter's bio.)

#### **G2. Teaching Clinic: A Burning Questions and Quenching Answers Session**

*Tim Slater and Ed Prather (U of Arizona)*

Do you have questions? We have answers; in fact, we have multiple answers. This round-table session is an ask-a-teaching-expert discussion where participants can pose challenging classroom questions, share meaningful events of teaching stories, and learn about various approaches to solving teaching dilemmas. Bring your toughest questions! (See Session A2 for presenters' bios.)

#### **G3. Debunking Pseudo-science: How to Address Astrology, UFO's, and Moon Madness in Your Classroom and Live to Tell the Tale**

*Andrew Fraknoi (Foothill College) with Salman Hameed (Smith College)*

Your students come into an astronomy class with a wide range of ideas about pseudo-science from the media and their peers. Whether you are ready or not, they will look to you for information about such topics as astrology, if NASA faked the Moon landings, and if the Face on Mars was left by an advanced civilization. In this workshop, you will get a "Pseudo-science Defense Kit," with lists of resources, activities, and web sites to help you answer student questions in these arenas. We'll go over such activities as Mixed-up Horoscopes, What Sign Were the Presidents, and UFO Detective. We'll explore ways to engage your students in a more general discussion of the nature of scientific inquiry and the role of evidence and experiment in scientific decision making. Salman

Hameed will discuss a short course he has taught on critical thinking and paranormal phenomena with a psychologist and a philosopher at Smith College and a survey of the beliefs of students before and after taking the course.

Andrew Fraknoi teaches astronomy and physics at Foothill College, directs Project ASTRO at the Astronomical Society of the Pacific, and is co-editor (with Sidney Wolff) of *Astronomy Education Review*. He is a Fellow of the Committee for the Scientific Investigation of Claims of the Paranormal, specializing in debunking astrology. Salman Hameed is a Five-College Astronomy Department Research and Education Fellow and has been teaching “Astronomy and Public Policy” at Smith College.

#### **G4. How to Conduct Astronomy Education Research**

*Rebecca Lindell and Tom Foster (Southern Illinois U Edwardsville)*

Astronomy Education Research (AER) is a science that is bound by the same traditions and expectations of any other science. Assessing teaching and modifying class instruction should be a common practice; however, rarely are accurate and precise measures made which could be peer reviewed and replicated. Participants in this workshop will receive a quick overview of AER standards and practices, and then explore how to design and execute meaningful AER, if only for their own classrooms. (See Session C4 for presenters’ bios.)

#### **G5. Pre-Service Teachers in the Introductory Astronomy Classroom: Reaching Those Doing the Teaching**

*Jennifer A. Grier & R. Bruce Ward (Harvard-Smithsonian Center for Astrophysics)*

Whether at small colleges or larger state schools, astronomy instructors will find the next generation of astronomy teachers in their classrooms, moving on after graduation to schools or colleges to teach science. What are the specific issues and needs of pre-service teachers, and how can these be addressed in the introductory astronomy classroom? How can instruction practice and strategies reach this audience most effectively? This interactive workshop discussion will begin with a brief review of recent research findings about what teachers know about astronomy. We will continue with a ‘Cosmic Survey’ (take away activity) as one effective example for eliciting ideas and misconceptions, and then conclude with an open discussion on effective strategies for reaching pre-service teachers in the classroom. Participants will also leave with a hand out of ideas and resources for further exploration.

Jennifer A. Grier, an educator and planetary scientist, is a member of the SEU (Structure and Evolution of the Universe) Education Forum, a collaborative Smithsonian-NASA project that creates substantive learning experiences in space science for students, teachers and the general public. Grier is a member of the AAS DPS Education Board and has particular interests in the issues facing women and minorities in space science careers. R. Bruce Ward manages two National Science Foundation astronomy education projects at the SED (Science Education Department) and is the professor of astronomy at Middlesex Community College. Ward has worked with pre-service teachers for the last 20 years.

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### **Sunday, 3:10 pm: Session H**

H1. Repeat of E1.

#### **H2. The Learner-Centered Classroom: Lecture-Tutorials, Concept Maps, Portfolios, Minute Papers, and Other Techniques**

*Lauren Jones (Gettysburg College)*

In this workshop you will try out and discuss several teaching techniques known to be effective in creating a learner-centered classroom environment, whether you have a large (over 100 student) lecture class with no lab, or a small (40 or less) classroom and a lab. Among these are lecture-tutorials, concept maps, portfolios, minute papers, pre-class surveys, and concept tests. You will get some experience with these techniques by doing them yourself and you will learn about ways you can incorporate them into your present curriculum with ease. We will also discuss methods of evaluation of these tools.

Lauren Jones is a Visiting Assistant Professor of Physics and Astronomy at Gettysburg College. She has taught in both small, liberal arts colleges and large universities (the University of Arizona). Lauren currently works with both Project CLEA (Contemporary Laboratory Experiences in Astronomy) and the CAPER (Conceptual Astronomy and Physics Education Research) Team.

### **H3. Bringing the Real World into the Classroom: Project-based Astronomy for Students in Two- and Four-Year Colleges**

*Phil Sadler and Bruce Ward (Harvard-Smithsonian Center  
for Astrophysics)*

In this workshop you will see how two experienced educators use real world scenarios and data to engage their students in discovery-based astronomy projects and journaling. Examples of student projects and journals (from the 1800s up to the Class of 2004!) will be displayed around the room for participants to examine for the first ten minutes. Following, the leaders will assist as small groups of participants begin work on a project that can be used later with one's own students. The workshop's closing discussion will include some examples of effective assessment strategies. There will be literature and handouts available at the end.

Phil Sadler is the director of the Science Education Department (SED) at the Harvard-Smithsonian Center for Astrophysics and the F.W. Wright Senior Lecturer in the Department of Astronomy at Harvard University. R. Bruce Ward manages two National Science Foundation astronomy education projects at the SED and is the professor of astronomy at Middlesex Community College. Both Sadler and Ward have used projects and journals in their classrooms throughout their teaching careers.

### **H4. The Virtual Educational Observatory: Astronomical Laboratory Exercises for the Age of Information**

*Larry Marschall & Dick Cooper (Gettysburg College)*

Project CLEA is has developed a prototype of a Virtual Educational Observatory (VIREO), a simulated multi-wavelength observatory that makes it possible to simulate a wide range of modern astronomical research and data analysis techniques in the astronomy lab. In this workshop, we will invite users to try out the latest version of the software, to see the numerous ways in which it can be used pedagogically, and to suggest new applications for it. The current version of VIREO contains a large database that covers the entire sky down to about 16th magnitude, including about 20 million stars, 20 thousand asteroids, 60 thousand galaxies, and thousands of pulsars, quasars, and other objects. Telescopes include visible, infrared, and radio receivers; instruments include imaging cameras for the visible and IR, photometers, a photon-counting spectrometer, and tunable radio receivers. Tools for blinking images and analyzing spectra are also provided. (See session D1 for presenters' bios.)

### **H5. Helping Students Assess Their Own Understanding Using Concept Maps**

*Gina Brissenden (University of Arizona)*

Students often complain about not understanding how the concepts in our courses fit together—never quite sure of the “big picture” or the extent to which they are understanding it. Having your students create Concept Maps is a very useful way of helping them with these difficulties. In this workshop we will explore different ways of using Concept Maps to help your students assess their understanding: alone or in groups, in class or at home. We will also explore different types of Concept Maps and how to incorporate them into your class. In addition, we will create our own Concept Maps so that everyone leaves empowered to give them a try.

Gina Brissenden is an instructional specialist in the astronomy department at the University of Arizona, specializing in improving assessment techniques used in Astro 101. She also conducts research on learning technologies in the classroom.

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### **Sunday, 4:05 pm**

Meeting formally ends (Be sure you take all your materials with you)

For those who are staying later, Tim Slater, Ed Prather, and Lauren Jones will continue their teaching clinic discussion (see session G2) in Eaton 201.

## Poster Papers

1. ACUMEN: Astronomy Classes Unleashed, Meaningful Experiences for Neophytes – *Michael Fauerbach, Stephan Schonberg, and Manuel J. Mon (Florida Gulf Coast U)*
2. The Internet Telescope: Remote Observing for the City Astronomy Class – *Lor Gehret, Wayne Winters, and Steven Coberly (Latin School of Chicago)*
3. Enhancing Undergraduate Astronomy Laboratory Experiences with Inexpensive Consumer-Grade Technologies – *Manuel J. Mon, Michael Fauerbach, and Stephan Schonberg (Florida Gulf Coast U)*
4. The Science in Science Fiction: Enhancing the Teaching of Astronomy with Science Fiction – *Andrew Fraknoi (Foothill College)*
5. Assessment of Learner-Centered Teaching Approaches in an Introductory Astronomy College Classroom using the Astronomy Diagnostic Test 2.0 – *William Alexander (James Madison U)*
6. My Teaching Experience Using Different Modalities – *Manju Prakash (SUNY Stony Brook)*
7. Using Latin American Great Cultures to Teach Naked-Eye Observations – *Consuelo Doddoli and Julieta Fierro (UNAM)*
8. Building a Sense of Community in an Asynchronous Online Course – *Donna Gifford (Pima Community College)*
9. Use of Blackboard in Introductory Astronomy (Online, Hybrid Format) – *J. Patrick Miller (Hardin-Simmons University)*
10. Effectiveness of GeoWall Technology in Conceptualization of Lunar Phases – *N. E. Turner, R. E. Lopez, K. M. Hamed, D. S. Corrales, and C. L. Gray (University of Texas at El Paso)*
11. Discovery Lab at University of Texas, Austin – *Mary Kay Hemenway, Daniel T. Jaffe, Marcelo Alvarez, Chad Young (University of Texas, Austin), and M. J. Tykoski (Round Rock Independent School District)*
12. Project CLEA'S Virtual Educational Observatory: The Universe on a Desktop – *Laurence Marschall, Glenn Snyder, and P. Richard Cooper (Gettysburg College)*
13. GeoVirgil: A New Tool For Planetary Exploration – *Steve McDonald (Silicon Spaceships & University of Massachusetts Boston)*
14. Teaching Through Tolkien: The Astronomy of Middle-earth – *Kristine Larsen (Central Connecticut State University)*
15. Project LITE Spectroscopy – *E. Weeks, K. Brecher, P. Carr, P. Garik (Boston U.)*
16. Astronomy in the “Hot Seat” – *Anthony Crider (Elon University)*

17. Assessment using Animated Sorting and Ranking Tasks – *Kevin M. Lee & Christopher M. Siedell (University of Nebraska, Lincoln)*
18. Astrobiology as an Alternative Integrated Science Curriculum for the General Science Requirements in Higher Education – *Harold Geller (George Mason University)*
19. Astronomy Abroad: An Astronomy Travel Class Designed for a One-month Term with Applications to More Typical Schedules” – *Tyler Nordgren and Julie Rathbun (University of Redlands)*
20. Developing an On-Line Astro101 Module to Mine a Research Database – *Beth Hufnagel (Anne Arundel Community College) and William H. Howard II (Univ. of Maryland Univ. College)*
21. Imaging the Moon: Observation and Analysis (A Two-week Lab) – *Takashi Sato (Kwantlen University College)*
22. Low Velocity Impact Craters in the Lab – *Gary Parker (Norwich University)*
23. Confronting Paranormal Beliefs in a Short Course on Critical Thinking – *Salman Hameed (Umass-Amherst/Smith College) and George Robinson and Janice Moulton (Smith College)*
24. Effects of Collaborative Learning on Communication Apprehension, Class Satisfaction and Academic Achievement – *Myung-Hyun Rhee, Sug-Whan Kim, Eun-Ju Kim, and Ju-Whan Kim (Yonsei University)*
25. Starting a Center for Spanish Language Astronomy Materials – *Stephen Pompea and Constance Walker (National Optical Astronomy Observatory)*
26. How Classroom Techniques from a Successful Graduate Astronomy Course for Pre-college Teachers can Apply to the Undergraduate Classroom – *Mary L. Urquhart (University of Texas at Dallas)*
27. Using Computer-Based Activities in Introductory Astronomy Instruction – *Irina Mullins (Houston Community College)*
28. The Use of Personal Responder Devices to Assess Student Understanding, and Student Beliefs About Their Effectiveness, in Astro 101 – *Gina Brissenden, Erin F.C. Dokter, Edward E. Prather, Jessie C. Antonellis, and Pebble Richwine (Univ. of Arizona)*
29. A Conceptual Hierarchy of Lunar Phases? – *Aaron Hines and Rebecca Lindell (Southern Illinois University Edwardsville)*
30. Is Active Learning Necessary for Teaching Lunar Phases Effectively? – *Rebecca Lindell and Steve Sommer (Southern Illinois University Edwardsville)*
31. Astronomy Education Research at Southern Illinois University Edwardsville – *Tom Foster and Rebecca Lindell (Southern Illinois University Edwardsville)*
32. The Astronomy Education Review: An On-line Journal and Magazine for those Working in Astronomy and Space Science Education – *Sidney Wolff (NOAO) & Andrew Fraknoi (Foothill College)*

33. Remote Observing in the Undergraduate Astronomy Curriculum – *Bryan Penprase (Pomona College)*
34. Utilizing Blooms’ Taxonomy of Cognition to Develop Constructivist Methodologies for Teaching Astronomy – *Brock Schroeder (Olivet Nazarene U.)*
35. Diversity and Performance in Astronomy for Non-science Majors at Western Kentucky University from 1990-2004 – *Charles McGruder, Scott Bonham, and Uzoma Nwaku* (Western Kentucky U.)
36. Preliminary Results from Project FICSS (Factors Influencing College Success in Science) – *Phil Sadler, R. Bruce Ward, and Cindy Crockett (Harvard-Smithsonian Center for Astrophysics)*
37. Introductory Astronomy for Pre-Service Science Teachers – *William H. Waller, (Tufts University and NESSIE) and Laurie Ruberg (Wheeling Jesuit University and MARSSB)*
38. Examining the Potential for Using Space Science as a Context for Teaching Among Minority-Serving Pre-Service Faculty – *Laurie Ruberg and Stanley Jones (Wheeling Jesuit University and MARSSB)*
39. JPL/Navigator’s Center for Astronomy Education – *Richard Alvidrez (JPL)*
40. Learner-Centered Teaching Techniques in Astronomy 10 – *Lauren Jones (Gettysburg Coll), Ed Prather (U of Arizona), and Laurence Marschall (Gettysburg Coll)*
41. Complete + Open Introductory Astronomy (Astronomy 101) Website – *Nick Strobel (Bakersfield Coll)*
42. Science Big Ideas for Elementary Teachers: How Much Astronomy? – *George Nelson (Western Washington U)*
43. The Astronomical Society of the Pacific: Creating Partnerships to Communicate Astronomy – *Michael Bennett, Andrew Fraknoi, Dan Zevin, Suzanne Chippindale, Marni Berendsen, and Joycelin Craig (ASP)*
44. Modeling the Universe: Student Ideas and Models as the Anchor for Teaching Introductory Astronomy” – *Jennifer A. Grier and Simon J. Steel (Harvard-Smithsonian Center for Astrophysics)*
45. Astronomy for Students with Visual Impairments – *Noreen Grice (You Can Do Astronomy LLC & Boston Museum of Science)*
46. Educational Materials Available from NASA’s Astronomical Search for Origins Education Forum – *Matt Bobrowsky (Origins Education Forum, Space Telescope Science Institute)*
47. Graduate Astro 101: Teaching Teachers – *Helen Hart (Computer Sciences Corp. & Johns Hopkins U.)*
48. Creating Interactive Teaching Methods for ASTRO 101 That Really Work – *T.F. Slater (University of Arizona), E.E. Prather (University of Arizona), J.P. Adams (Montana State University), J.M. Bailey (University of Arizona), L.V. Jones (Gettysburg College)*
49. Framework for Conceptual Change – *Esther Zirbel (Tufts U)*
50. A Comparison of Community College Astronomy Teachers’ Stated Beliefs and Observed Classroom Practices – *Elliot Richmond (Austin Community College)*

# Cosmos in the Classroom 2004

## Credits and Thanks

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**Conference Website: [www.astrosociety.org/events/cosmos.html](http://www.astrosociety.org/events/cosmos.html)**

For more information about the educational programs of  
the Astronomical Society of the Pacific, see the web site:  
<http://www.astrosociety.org/education.html>

For more about the New England Initiative in Space Science Education, see:  
<http://www.mos.org/nessie/>