COSMOS IN THE CLASSROOM 2010

EARTH AND SPACE SCIENCE:
M A K I N G
CONNECTIONS
IN EDUCATION & PUBLIC OUTREACH

JULY 31–AUGUST 4, 2010 • UNIVERSITY OF COLORADO AT BOULDER

ASTRONOMICAL SOCIETY OF THE PACIFIC/GEOLOGICAL SOCIETY OF AMERICA

PROGRAM

Welcome

On behalf of the Board of Directors and staff of the Astronomical Society of the Pacific (ASP), I'm pleased to welcome you to the EPO Symposium "Earth and Space Science: Making Connections in Education and Public Outreach" and "Cosmos in the Classroom 2010" — a national meeting in partnership with the Geological Society of America (GSA) and a host of co-sponsors.

This meeting represents the 122nd annual meeting for the ASP, founded in 1889 "to advance the Science of Astronomy, and to diffuse information concerning it," and which increasingly uses the avenue of astronomy to advance science education and science literacy.

The ASP was born, coincidentally, in the same year that Vincent van Gogh painted *The Starry Night*. For the past 121 years, the two have had a concurrent provenance, each working in its own way to inspire people to the possibilities inherent in exploring the natural world and to connect heaven and earth in impactful experience. It is my hope that this meeting, bringing together EPO professionals from a variety of disciplines and Astronomy 101 instructors who incoporate many sciences in their teaching, may also inspire you to find new ways to connect with each other in impactful ways.

We have much to share, much to learn, and many ways in which to work together. It is my hope that this meeting will provide you with many opportunities to engage in these endeavors now, and for many starry nights — and bright days — to come. Welcome to Boulder!

James G. Manning
Executive Director, Astronomical Society of the Pacific

On behalf of the Geological Society of America (GSA) I welcome you to "Cosmos in the Classroom 2010" and "Earth and Space Science: Making Connections in Education and Public Outreach." This conference is a great opportunity for the practitioners of Earth and space science education and outreach programs to meet, share and develop new strong working relationships.

Established in 1888, GSA has had a long term commitment to fostering education and outreach in the geosciences in the broader community of its members and beyond. This is reflected in GSA current strategic plan which has a goal to communicate the importance and relevance of the geosciences in a global context through education and public awareness — by supporting K–12 and two-year college educators in their Earth science teaching through the providing of resources, training, and field experiences to increase their knowledge, understanding and willingness to promote the geosciences, and leading and promoting programs that actively involve the global community in geoscience activities.

I hope that through your participation we can work together to see these and your own societies' goals become a solid reality.

Jack Hess
Executive Director,Geological Society of America

Welcome

On behalf of the Department of Astrophysical & Planetary Sciences of the University of Colorado, it is a great pleasure to welcome you to Boulder. We are especially proud and pleased to share the enormous advances that have come from the last ten years of research on science teaching at CU. Learn something new, get inspired, and take time to enjoy this beautiful part of the country.

Douglas Duncan
Director of Astronomical Laboratories, University of Colorado

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Acknowledgements

The ASP thanks the following individuals and institutions for their generous support. Our conference would not be possible without their time and dedication.

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Support and Sponsorship

The following organizations have contributed significant support to the success of this conference.

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NASA Lunar Science Institute
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General Daily Schedule

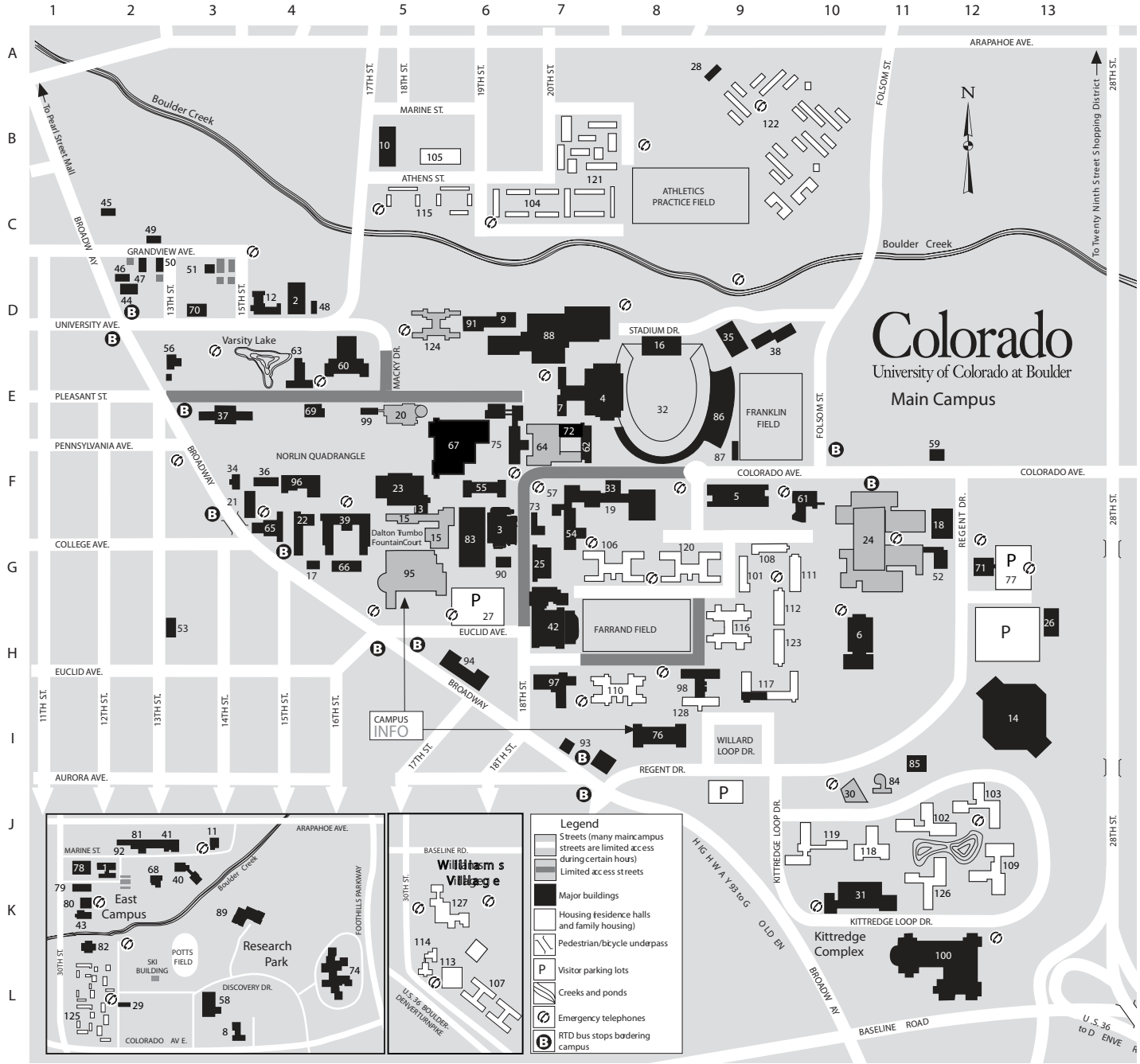
Sunday, August 1, 2010	
5:30 p.m.	Annual Members Meeting — Sommers-Bausch Observatory room S175
6:30 p.m.	Welcome Reception — Fiske Planetarium
Monday, August 2, 2010	
7:30 a.m.	Conference Registration Desk Opens
8:30 a.m.	Introduction to the Conference — Cristol Chemistry 140
8:45 a.m.	Morning Joint Plenary Session 1: EPO and Astro 101: Shotgun Wedding, Marriage of Convenience, or Meaningful Relationship? — Cristol Chemistry 140
9:45 a.m.	Coffee Break, Poster/Exhibit Set Up and Early Viewing —University Memorial Center Ballroom
10:30 a.m.	EPO Poster Presentations (1 minute talks) — Cristol Chemistry 140
10:40 a.m.	Cosmos Poster Presentations (1 minute talks) — Eaton Humanities 150
11:50 a.m.	Lunch (on your own)
1:15 p.m.	EPO Afternoon Plenary Session 1: The New Science Education Frameworks — Express Your Opinion — Muenzinger E050 Cosmos Afternoon Plenary Session 1: Taking a Scientific Approach to Science Teaching — Cristol Chemistry 140
2:15 p.m.	Break, Poster & Exhibit Viewing, Share-a-Thon for Cosmos —University Memorial Center Ballroom
3:15 p.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops
4:30 p.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops, Special Interest Group Discussion
5:30 p.m.	Poster & Exhibit Viewing, Networking —University Memorial Center Ballroom
7:30 p.m.	Public Talk "Dark Energy and the Runaway Universe" by Alex Filippenko (University of California, Berkeley) — Cristol Chemistry 140
Tuesday, August 3, 2010	
7:30 a.m.	Conference Registration Desk Opens
8:30 a.m.	Morning Joint Plenary Session 2: Teach to the Stars: How People Learn Science — Cristol Chemistry 140
9:30 a.m.	Coffee Break, Poster & Exhibit Viewing, Share-a-Thon for Cosmos —University Memorial Center Ballroom
10:00 a.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops

General Daily Schedule

11:15 a.m.	Shorter Concurrent Sessions: 10-Minute Orals, Special Interest Group Discussions
12:05 p.m.	Lunch and NASA Town Hall (12:15 pm) — Cristol Chemistry 140
1:15 p.m.	EPO Afternoon Plenary Session 2: Citizen Science Across the Disciplines — University Memorial Center 235 Cosmos Afternoon Plenary Session 2: The Day We Found the Universe: The Little Known History of How We Came to Understand the Expanding Universe — Cristol Chemistry 140
2:15 p.m.	Break, Poster & Exhibit Viewing, Share-a-Thon for Cosmos —University Memorial Center Ballroom
3:15 p.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops
4:30 p.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops, Special Interest Group Discussion
6:30 p.m.	Awards Banquet — University Memorial Center 235
9:00 p.m.	Star Party provided by members of the Boulder Astronomy & Space Society — Sommers-Bausch Observatory/Fiske Planetarium Lawn
Wednesday, August 4, 2010	
7:30 a.m.	Conference Registration Desk Opens
8:30 a.m.	Morning Joint Plenary Session 3: A World of Change: Climate Yesterday, Today, and Tomorrow — Cristol Chemistry 140
9:30 a.m.	Coffee Break, Poster & Exhibit Viewing, Share-a-Thon for Cosmos —University Memorial Center Ballroom
10:00 a.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops
11:15 a.m.	Shorter Concurrent Sessions: 10-Minute Orals, Special Interest Group Discussions
12:05 p.m.	Lunch (on your own)
1:15 p.m.	Concurrent Sessions: 10-Minute Orals, 1-Hour Workshops
2:15 p.m.	Break, Poster & Exhibit Viewing, Share-a-Thon for Cosmos —University Memorial Center Ballroom
3:00 p.m.	Concurrent Sessions: 1-Hour Workshops
4:15 p.m.	EPO Afternoon Plenary Session 3: Science — and Antiscience — in the Climate and Evolution Debates — University Memorial Center 235 Cosmos Afternoon Plenary Session 3: Tricks of the Trade: Effective Classroom Management — Cristol Chemistry 140
5:15 p.m.	Closing Discussions and "Rocky Mountain High" Happy Hour —University Memorial Center Ballroom

Conference Map

Note: Buildings used during the conference are light gray with black outlines.



Conference Map

University Buildings

1. Administrative and Research Center—East Campus (J-2) (ARCE)
2. Armory (D-4) (ARMR)
3. ATLAS Building (Alliance for Technology, Learning, and Society) (G-6) (ATLS)
4. Balch Fieldhouse (E-7) (FH)
5. Benson Earth Sciences (F-9) (BESC)
   * Bruce Curtis Building. *See Museum Collections.*
6. Business (H-10) (BUS)
7. Carlson Gymnasium (E-7) (CARL)
8. Center for Astrophysics and Space Astronomy (L-3) (CASA)
9. Clare Small Arts and Sciences (D-6) (CLRE)
   * Charlotte York Irey Studios (F-4). *See University Theatre.*
10. College Inn Conference Center (B-5) (CICC)
11. Computing Center (J-3) (COMP)
12. Continuing Education and Professional Studies (D-4) (CEDU)
13. Cooperative Institute for Research in Environmental Sciences (F-5) (CIRE)
14. Coors Events/Conference Center (I-12) (EVNT)
15. Cristol Chemistry and Biochemistry (G-5) (CHEM)
16. Dal Ward Athletic Center (D-8) (DALW)
17. Denison Arts and Sciences (G-4) (DEN)
18. Discovery Learning Center (F-11) (DLC)
    * Drescher Undergraduate Engineering. *See Integrated Teaching and Learning Laboratory.*
    * Duane Physical Laboratories (F-7). *See Duane Physics and Astrophysics, Gamow Tower, Laboratory for Atmospheric and Space Physics, and JILA.*
19. Duane Physics and Astrophysics (F-7) (DUAN)
20. Eaton Humanities Building (E-5) (HUMN)
21. Economics (F-3) (ECON)
22. Education (G-4) (EDUC)
23. Ekeley Sciences (F-5) (EKLC)
24. Engineering Center (F/G-10/11) (EC)
25. Environmental Design (G-7) (ENVD)
26. Environmental Health and Safety Center (H-13)
27. Euclid Avenue AutoPark (G-6) (EPRK)
28. Family Housing Children's Center—Main Offices (A-9) (DACR)
29. Family Housing Children's Center at Smiley Court (L-2)
30. Fiske Planetarium and Science Center (J-10) (FISK)
31. Fleming Law (K-10) (LAW)
32. Folsom Stadium (E-8) (STAD)
33. Gamow Tower (F-7) (DUAN)
34. Gates Woodruff Women's Studies Cottage (F-3) (COTT)
35. Grounds and Service Center (D-9) (GRNS)
36. Guggenheim Geography (F-3) (GUGG)
37. Hale Science (E-3) (HALE)
38. Health Physics Laboratory (D-9) (HPHY)
39. Hellems Arts and Sciences/Mary Rippon Theatre (G-4) (HLMS)
    * Henderson Building (G-4). *See Museum of Natural History.*
40. Housing System Maintenance Center (K-3) (HSMC)
41. Housing System Service Center (J-2) (HSSC)
42. Imig Music (H-7) (MUS)
43. Institute for Behavioral Genetics (K-1) (IBG)
44. Institute of Behavioral Science No. 1 (D-2) (IBS1)
45. IBS No. 2 (C-2) (IBS2)
46. IBS No. 3 (D-2) (IBS3)
47. IBS No. 4 (D-2) (IBS4)
48. IBS No. 5 (D-4) (IBS5)
49. IBS No. 6 (C-2) (IBS6)
50. IBS No. 7 (C-2) (IBS7)
51. IBS No. 8 (C-3) (IBS8)
52. Integrated Teaching and Learning Laboratory (G-11) (ITLL)
53. International English Center (G-2) (IEC)
54. JILA (G-7)
55. Ketchum Arts and Sciences (F-6) (KTCH)
56. Koenig Alumni Center (E-2) (ALUM)
57. Laboratory for Atmospheric and Space Physics (F-7) (LASP)
58. LASP Space Technology Research Center (L-3) (LSTR)
    * Leeds School of Business (H-10). *See Business, Leeds School of.*
59. Lesser House (F-11) (LESS)
    * Life Sciences Laboratories Complex (E-7). *See Muenzinger Psychology, Porter Biosciences, and Ramaley Biology.*
60. Macky Auditorium (D-4) (MCKY)
61. Mathematics Building (F-10) (MATH)
62. MCD Biology (E-7) (MCDB)
63. McKenna Languages (E-4) (MKNA)
64. Muenzinger Psychology (E-7) (MUEN)
65. Museum Collections (Bruce Curtis Building) (G-3) (MCOL)
66. Museum of Natural History, University of Colorado (G-4) (HEND)
67. Norlin Library (E-6) (LIBR)
68. Nuclear Physics Laboratory (K-2) (NPL)
69. Old Main (E-4) (MAIN)
70. Page Foundation Center (D-3) (PFDC)
71. Police and Parking Services (G-12) (PDPS)
72. Porter Biosciences (E-7) (PORT)
73. Power House (F-6) (POWR)
74. Qwest Research Park (L-4) (USW)
75. Ramaley Biology (E-6) (RAMY)
76. Regent Administrative Center (I-8) (RGNT)
77. Regent Drive AutoPark (G-12) (RPRK)
78. Research Laboratory, Litman RL1 (J-1) (LITR)
79. Research Laboratory (K-1) (RL2)
80. Research Laboratory, Life Science RL4 (K-1) (LSRL)
81. Research Laboratory, RL6 (Marine Street Science Center) (J-2) (MSSC)
82. Research Park Greenhouse (K-1) (GH-3)
83. Sibell Wolle Fine Arts (G-6) (FA)
84. Sommers-Bausch Observatory (I-11) (OBSV)
85. Speech, Language, and Hearing Sciences (I-11) (SLHS)
86. Stadium Building (E-8) (STAD)
87. Stadium Ticket Building (F-9) (STTB)
88. Student Recreation Center (D-6/7) (REC)
89. Sybase (K-3) (SYBS)
90. Telecommunications Building (G-6) (TCOM)
91. Temporary Building No.1 (D-6) (TB01)
92. Transportation Center (J-2) (TRAN)
93. University Administrative Center and Annex (I-7) (UCTR)
94. University Club (H-6) (CLUB)
95. University Memorial Center (G-5) (UMC)
96. University Theatre (including Charlotte York Irey Studios) (F-4) (THTR)
97. Wardenburg Health Center (H-7) (WARD)
98. Willard Administrative Center (H-8) (WCTR)
99. Woodbury Arts and Sciences (E-5) (WDBY)
100. Wolf Law Building (L-12) (WLFL)

University Housing

101. Aden Hall—Quadrangle (G-9) (ADEN)
102. Andrews Hall—Kittredge Complex (J-11) (ANDS)
103. Arnett Hall—Kittredge Complex (J-12) (ARNT)
104. Athens Court (B/C-6/7) (ATCT)
105. Athens North Court (B-6) (ATHN)
106. Baker Hall (G-7) (BKER)
107. Bear Creek Apartments—Williams Village (W-BC)
108. Brackett Hall—Quadrangle (G-9) (BRKT)
109. Buckingham Hall—Kittredge Complex (K-12) (BUCK)
110. Cheyenne Arapaho Hall (H-7) (CHEY)
111. Cockerell Hall—Quadrangle (G-10) (CKRL)
112. Crosman Hall—Quadrangle (G-10) (CROS)
113. Darley Commons—Williams Village (L-6) (DLYC)
114. Darley Towers—Williams Village (K-5) (DLYT)
115. Faculty Staff Court (C-5/6) (FACT)
116. Farrand Hall (H-9) (FRND)
117. Hallett Hall (H-9) (HLET)
118. Kittredge Commons—Kittredge Complex (J-10) (KITT)
    * Kittredge Complex. *See Kittredge Commons, Andrews, Arnett, Buckingham, Kittredge West, and Smith Halls.*
119. Kittredge West Hall—Kittredge Complex (J-10) (KITW)
120. Libby Hall (G-8) (LIBY)
121. Marine Court (B-7) (MRCT)
122. Newton Court (B/C-9/10) (NTCT)
    * Quadrangle (Engineering Quarangle). *See Aden, Brackett, Cockerell, and Crosman Halls.*
123. Reed Hall (H-10) (REED)
124. Sewall Hall (D-5) (SWLL)
125. Smiley Court (L-1) (SMCT)
126. Smith Hall—Kittredge Complex (K-11) (SMTH)
127. Stearns Towers—Williams Village (K-6) (STRN)
128. Willard Hall—South Wing (H-8) (WLRD)
    * Williams Village. *See Bear Creek Apartments, Darley Commons, Darley Towers, and Stearns Towers.*

DETAILED SCHEDULE BY DAY: EARTH & SPACE SCIENCE: MAKING CONNECTIONS IN EPO

MONDAY, AUGUST 2, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL 140	MUENZINGER E050	UMC BALLROOM	UMC 235	UMC 247	UMC 382+384	UMC 386	UMC 425	OTHER
7:30									Registration Desk Open
8:30 – 8:45	Introduction to the Conference								
8:45 – 9:45 Morning Joint Plenary Session 1	**CoBabe-Ammann, Prather, Fraknoi** (moderator)**:** EPO and Astro 101: Shotgun Wedding, Marriage of Convenience, or Meaningful Relationship?								
9:45 – 10:30			Coffee Break, Poster/ Exhibit Set Up and Early Viewing						
10:30 – 11:50	1-minute Poster Presentations								
11:50 – 1:15									Lunch on your own
1:15 – 2:15 Afternoon Plenary Session 1		**Schatz** (moderator)**:** The New Science Education Frameworks — Express Your Opinion							
2:15 – 3:00			Break, Poster & Exhibit Viewing						
3:15 – 4:15 1-hour Workshops 10-minute orals				***Session Chair:*** *Steinberg* **Keller:** CSU Science Teacher and Researcher (STAR) Program **Perrodin:** Teaching Astronomy Undergraduates How to Teach **Shipman:** Statewide Teaching of Astronomy in K–12 Classrooms in Delaware **Gibbs:** Capitol College Center for Space Science Education and Outreach: Building a STEM Pipeline **Wyatt:** Advertising Citizen Science: A Trailer for the Citizen Sky Project	**Hsu:** 2010 National Observe the Moon Night	**Schatz:** "Surrounded by Science": Improve Your Practice by Exploring What Research Says About Learning Science in Informal Environments	**McQuillan:** Overhaul Your Earth Science Activities Using Easily Accessible Online Seismic Data	**Carr:** Connecting NASA Research with K–12 Science Education	
4:30 – 5:30 1-hour Workshops 10-minute orals Special Interest Group (SIG)				***Session Chair:*** *Sharma* **Squires:** The Other 99.99% **Santascoy:** Wild About Social Media? **Gay:** New Media Pipeline **Mankowski:** Exploring the Public's Engagement in GalaxyZoo **Bullock:** Determining Cloud-Level Winds in the Venus Atmosphere	**Lebofsky:** A Portable/ Traveling Human Orrery	**Mendez:** NASA E/PO Networks — How to Use Them to Your Advantage *[SIG]*	**Ristvey:** Investigating Asteroids — NASA's Dawn Mission	**McCaffrey:** Climate Change Education as a Presidential Priority	
5:30 – 6:00			Poster & Exhibit Viewing, Networking						
7:30	Nontechnical Lecture: Dark Energy and the Runaway Universe by **Alex Filippenko** (UCB)								

DETAILED SCHEDULE BY DAY: COSMOS IN THE CLASSROOM 2010

MONDAY, AUGUST 2, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL CHEMISTRY 140	UMC BALLROOM	EATON 125	EATON 135	EATON 150	EATON 1B80	EATON 1B90	OTHER
7:30								Registration Desk Open
8:30 – 8:45	Introduction to the Conference							
8:45 – 9:45 Morning Joint Plenary Session 1	**CoBabe-Ammann, Prather, Fraknoi** (moderator)**:** EPO and Astro 101: Shotgun Wedding, Marriage of Convenience, or Meaningful Relationship?							
9:45 – 10:30		Coffee Break, Poster/ Exhibit Set Up and Early Viewing						
10:40 – 11:50					1-minute Poster Presentations			
11:50 – 1:15								Lunch on your own
1:15 – 2:15 Afternoon Plenary Session 1	**Pollock:** Taking a Scientific Approach to Science Teaching							
2:15 – 3:00		Break, Poster & Exhibit Viewing, Share-a-Thon						
3:15 – 4:15 1-Hour Workshops			**Greenstein:** How Can We Lead our Non-science Students to Think Critically and Creatively?	**Schneider:** Tips and Tools for Teaching Planetary Science	**Prather:** How to Engineer Learning Sequences that Motivate Students to Learn what We Want Them to Know	**Len:** Old Ideas, New Technologies — Harnessing the Power of Web 2.0 Resources for the Weary Instructor	**Walker:** Astronomy Meets the Environmental Sciences: Using GLOBE at Night Data	
4:30 – 5:30 1-Hour Workshops			**Shostak:** Getting Science to the Non-Scientists: Teaching an Astrobiology Course	**Dubson:** What Works and What Fails when Using "Clickers" or Colored Cards to Engage Students and Increase their Learning?	**Prather:** Engaging Students with Think-Pair-Share: Conceptual Questions to Increase Learning Beyond Lecture	**Lee:** Engaging Students with Simulations in the Classroom	**Bobrowsky:** Demonstrations For Astronomy Classes and Public Outreach	
5:30 – 6:00		Poster & Exhibit Viewing, Networking						
7:30	Nontechnical Lecture: Dark Energy and the Runaway Universe by Alex Filippenko (U. of California, Berkeley)							

DETAILED SCHEDULE BY DAY: EARTH & SPACE SCIENCE: MAKING CONNECTIONS IN EPO

TUESDAY, AUGUST 3, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL CHEMISTRY 140	UMC BALLROOM	UMC 235	UMC 247	UMC 382+384	UMC 386	UMC 425	OTHER
7:30								Registration Desk Open
8:30 – 9:30 Morning Joint Plenary Session 2	**Hewson:** Teach to the Stars: How People Learn Science							
9:30 – 10:00		Coffee Break, Poster & Exhibit Viewing						
10:00 – 11:00 1-hour Workshops 10-minute orals			***Session Chair:*** *Gurton* **Harold:** Addressing Misconceptions Through Physics Based Games **Dusenbery:** Discover Space: An Exhibit Program for Libraries **Dussault:** Do Learning Outcomes Escape from "Black Holes"? **Nichols:** Designing Effective E/PO Products for Museums **Thieman:** Sun-Earth Day	**Lyons:** Building Space Pods — A "Get-Dirty" Hands-On Workshop	**Walker:** Astronomy Meets the Environmental Sciences: Activities for Informal and Formal Educational Settings		**Gould:** Graphing, Gravity, and Kepler's Laws — Activities from NASA's Kepler Mission EPO	
11:15 – 12:05 10-minute orals Special Interest Group (SIG)			***Session Chair:*** *Schwerin* **Gould:** Using MicroObservatory Online Telescopes **Robinson:** African Dust Project **Brandenburg:** Options for Inexpensive, High-Quality, Student-Made Telescopes **Venner:** Engineering Design Challenge: The Search for Life	**Hurst:** Supporting Online Communities *[SIG]*	**Garmany:** Making Connections with Underserved Communities, Broadening Participation in the STEM Fields *[SIG]*		**O'Donoghue:** Teaching Climate Change *[SIG]*	
12:05 – 1:15	NASA Town Hall Meeting (12:15)							Lunch on your own
1:15 – 2:15 Afternoon Plenary Session 2			**Fienberg** (moderator)**:** Citizen Science Across the Disciplines					
2:15 – 3:00		Break, Poster & Exhibit Viewing						
3:15 – 4:15 1-hour Workshops 10-minute orals	***Session Chair:*** *Schultz* **Shostak:** Making a Science Radio Show **Backman:** The Process of Producing SOFIA's First Light News Release **White:** Partnering with Amateur Astronomers to Get Your Message to the Public **Figueiredo:** Motivations and Challenges of Women Participating in Amateur Astronomy Clubs **Johnson:** Beyond Teaching: Building the Next Generation of Science Thinkers			**Harvey:** Live From Gemini: Expanding the Walls of the Classroom Globally	**Reinfeld:** Astrophotography for All: Capturing the Colorful Cosmos with Online Telescopes	**Russell:** Radiation Storm vs. The Magnetic Shield: Superheroes of Magnetism & Space Weather Education	**Campbell:** Know Your Earth: A Fun Multi-Mission, Multi-Media View of NASA Earth-Observing Satellites and Global Climate Change	
4:30 – 5:30 1-hour Workshops 10-minute orals Special Interest Group (SIG)	***Session Chair:*** *Daou* **Kruse:** Project ASTRO and the Galileo Teacher Training Program **Johnson:** Windows to the Universe at NESTA **Schwerin:** Earth System Science Education Alliance **Slater:** New National Science Education Standards and Astronomy **Whitworth:** Digital Resources for Communicating Astronomy			**Berendsen:** Video Tips for Worry-Free Informal Presentations	**Sharma:** The Intersection of NASA Astrophysics E/PO and Higher Education *[SIG]*	**Wallace:** I'm a StarryTeller! Engage Your Outreach Audience through Their Own Sky Stories	**Wawro:** The Solar Dynamic Observatory: Let the Sun Shine In!	

DETAILED SCHEDULE BY DAY: COSMOS IN THE CLASSROOM 2010

TUESDAY, AUGUST 3, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL CHEMISTRY 140	UMC BALLROOM	EATON 125	EATON 135	EATON 150	EATON 1B80	EATON 1B90	OTHER
7:30								Registration Desk Open
8:30 – 9:30 Morning Joint Plenary Session 2	**Hewson:** Teach to the Stars: How People Learn Science							
9:30 – 10:00		Coffee Break, Poster & Exhibit Viewing, Share-a-Thon						
10:00 – 11:00 1-Hour Workshops			**Comins:** The "What If" Workshop	**Duncan:** A Successful (and Fun) Curriculum for Teaching Students to Think Scientifically and Better Understand their Own Thinking and Learning	**Prather:** Engaging Students with Lecture-Tutorials: Collaborative Learning Activities to Increase Understanding Beyond Lecture	**French:** Engaging Students with ClassAction	**Otero:** Transforming Astronomy Education Using Learning Assistants	
11:15 – 12:05 Special Interest Group Discussions			**Hufnagel:** Getting the Most Out of Your Observatory-Based Astro 101 Laboratory	**Fraknoi:** Student Learning Outcomes: The Good, the Bad, and the Ugly	**Bruning:** Astronomy Education Research: What Questions Do We Need To Answer In The Coming Decade?	**Hildreth:** The Best Online Tools And Practices for Teaching Astronomy	**CoBabe-Ammann:** Higher Education within NASA's Science Mission Directorate: How to Strengthen the Bridge to Introductory Astronomy Faculty?	
12:05 – 1:15	NASA Town Hall (12:15)							Lunch on your own
1:15 – 2:15 Afternoon Plenary Session 2	**Bartusiak:** The Day We Found the Universe: The Little Known History of How We Came to Understand the Expanding Universe							
2:15 – 3:00		Break, Poster & Exhibit Viewing, Share-a-Thon						
3:15 – 4:15 1-Hour Workshops			**Larsen:** "In the Beginning": Using Creation Myths in the Astronomy Classroom	**Slater:** An Introduction to Backwards Faded Scaffolding in the Astro 101 Laboratory Course	**Prather:** Engaging Students with Pencil-and-Paper and Computer-Delivered Ranking Tasks: Quantitative Reasoning Activities that Increase Learning	**Perkins:** Exploring Easy and Effective Ways to Use PhET's Web-based Interactive Simulations in Your Astronomy Course	**Bailey:** Using Concept Inventories to Gauge Student Understanding in Astronomy	
4:30 – 5:30 1-Hour Workshops			**Carr:** Connecting Astronomy 101 with K–12 Science Standards	**Morrison:** Dealing with Cosmophobia and Doomsday 2012	**Wallace:** Engaging Students with Cosmology Lecture-Tutorials	**Rector:** Doing Authentic Scientific Research in the Classroom with Spectroscopy	**McCray:** Simulations for Learning Astronomical Phenomena	

DETAILED SCHEDULE BY DAY: EARTH & SPACE SCIENCE: MAKING CONNECTIONS IN EPO

WEDNESDAY, AUGUST 4, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL CHEMISTRY 140	UMC BALLROOM	UMC 235	UMC 247	UMC 382+384	UMC 425	OTHER
7:30							Registration Desk Open
8:30 – 9:30 Morning Joint Plenary Session 3	**Solomon:** A World of Change: Climate Yesterday, Today, and Tomorrow						
9:30 – 10:00		Coffee Break, Poster & Exhibit Viewing					
10:00 – 11:00 1-hour Workshops 10-minute orals			***Session Chair:*** *Fienberg* **Larsen:** Assessing the Effect of a Digital Planetarium Show on the Astronomical Understanding of 5th Graders **Rosenfield:** Affordable Digital Planetariums with WorldWide Telescope **Yu:** Long-Term Audience Impacts of Live Fulldome Planetarium Lectures for Earth Science and Global Change Education **Stengler:** Interdisciplinarity and Debate as Highly Motivating Factors in Live Shows — Five Years of Success	**Johnson:** Activities Helping Students Explore the Science of Climate and Ways to Take Action for the Health of the Planet	**Morrison:** Dealing with Public Fears of Doomsday 2012	**Daou:** Highlighting the Moon: Using Lunar Education Resources to Enhance K–12 STEM Education for Classrooms and Science Centers	
11:15 – 12:05 10-minute orals Special Interest Group (SIG)			***Session Chair:*** *Garmany* **Whitehouse:** Engaging Students through Astronomically-Inspired Music **Givan:** Using Collaborative Intelligence to Increase Effectiveness and Sustainability of Scientific Outreach Programs **Bar:** In the Footsteps of Galileo Galilee **Perkins:** Science Teaching in Context: A Creative Global Sojourn with the Evolution and Emergence of Scientific Discovery	**Shupla:** Preparing for the Year of the Solar System *[SIG]*		**Pompea:** Teaching with Galileoscopes and Other Small Telescopes *[SIG]*	
12:05 – 1:15							Lunch on your own
1:15 – 2:15 1-hour Workshops 10-minute orals			***Session Chair:*** *Gibbs* **Ortiz-Gil:** Astronomical Activities for People with Special Needs During IYA 2009 in Spain **Manning:** "Yondering" IYA: How the Astronomical Society of the Pacific is Adapting its International Year of Astronomy Programs for the Long Haul	**Ensworth:** NASA SMD Earth and Space Science Education Product Review	**Shipp :** u *can* diy! Using Social Media in Science Education and Public Outreach Programs to Connect with Audiences	**Laursen:** "A Scientist Has Many Things to Do": EPO Strategies that Focus on the Processes of Science	
2:15 –2:45		Break, Poster & Exhibit Viewing					
3:00 – 4:00 1-hour Workshops				**Venner:** Accessible Astronomy: Using Universal Instructional Design to Teach Astronomy to Individuals with Varying Abilities	**Buxner:** Exploring Assessment Tools for Research and Evaluation in Astronomy Education and Outreach	**Mijic:** Computer Animations and Computer Games as Tools for Public Science Education	
4:15 – 5:15 Afternoon Plenary Session 3			**Neff** (moderator)**:** Science — and Antiscience — in the Climate and Evolution Debates				
5:15 – 6:15		Closing Discussions and "Rocky Mountain High" Happy Hour					

DETAILED SCHEDULE BY DAY: COSMOS IN THE CLASSROOM 2010

WEDNESDAY, AUGUST 4, 2010 • SESSIONS LISTED BY LEAD PRESENTER

	CRISTOL CHEMISTRY 140	UMC BALLROOM	EATON 125	EATON 135	EATON 150	EATON 1B80	EATON 1B90	OTHER
7:30								Registration Desk Open
8:30 – 9:30 Morning Joint Plenary Session 3	**Solomon:** A World of Change: Climate Yesterday, Today, and Tomorrow							
9:30 – 10:00		Coffee Break, Poster & Exhibit Viewing, Share-a-Thon						
10:00 – 11:00 1-Hour Workshops			**Urquhart:** Challenges and Strategies of Lunar Phases in Introductory Astronomy: The Use of "Mental Model Building" Methodology and Scaffolding Tools in Teaching Lunar Phases	**Shipman:** Astronomy as the Core Element for Interdisciplinary Courses	**Lyons:** Get Out From Behind the Podium: Creating Your Own Lecture-Tutorial-Style Activities that Work!	**Sparks:** Integrating the Galileoscope into the College Classroom	**Bruning:** Teaching Your First Astro 101 Course: What They Don't Tell You	
11:15 – 12:05 Special Interest Group Discussions			**Larsen:** Students as Starry Messengers: Engaging Astro 101 Students through Service-Learning and Community Engagement	**Morrison:** Teaching Astrobiology	**Slater:** Multi-Institutional Collaborative Astronomy Education Research	**Wynn-Williams:** What to Leave Out of Astro 101	**O'Donoghue:** Teaching Climate Change	
12:05 – 1:15								Lunch on your own
1:15 – 2:15 1-Hour Workshops			**Morrow:** Using Kinesthetic Learning Techniques with College Students to Improve Understanding of Spatially Rich Topics Such as Seasons and Milankovitch Cycles	**Partridge:** Dime-Store Space Curvature	**Monowar-Jones:** Using Observational Exercises in Online Astronomy 101 Courses	**Bennett:** Mastering Astronomy: On-line Homework to Build Student Understanding	**Hufnagel:** Innovative Strategies for Empowering Your Students to Become Active, Responsible Learners	
2:15 –2:45		Break, Poster & Exhibit Viewing, Share-a-Thon						
3:00 – 4:00 1-Hour Workshops				**Petersen:** You Can Create a Podcast/ Vodcast		**Wynn-Williams:** Stealth Physics 101: How to Teach Students Important Bits of Physics Under the Guise of Teaching them Astronomy	**Newbury:** Concept Mapping in Astro 101	
4:15 – 5:15 Afternoon Plenary Session 3	**Slater** (moderator), **Bruning** (scribe)**:** Tricks of the Trade: Effective Classroom Management (An Open Microphone Session)							
5:15 – 6:15		Closing Discussions and "Rocky Mountain High" Happy Hour						

Exhibits – University Memorial Center Ballroom

The following will be exhibiting during the conference in the University Memorial Center Ballroom. Please be sure to stop by during exhibit hours.

Exhibit Hours:

Monday, August 2	Noon to 6:00 p.m.
Tuesday, August 3	9:30 a.m. to 6:00 p.m.
Wednesday, August 4	9:30 a.m. to 6:00 p.m.

Astronomical Society of the Pacific

The ASP's numerous education and outreach programs include: Project ASTRO, the *Universe in the Classroom* teacher's newsletter, the NASA Night Sky Network, Astronomy From the Ground Up, Family ASTRO, Cosmos in the Classroom symposia, and the SOFIA Education and Public Outreach program. Your membership in the ASP is the first step to support the one organization whose primary mission is to advance science literacy through engagement in astronomy for students of all ages. Come visit us to learn about our latest education programs and find out how, beyond membership, you can partner with us. www.astrosociety.org

Big Kid Science

Big Kid Science (www.BigKidScience.com) features the Max Science Adventure series: *Max Goes to the Moon*, *Max Goes to Mars*, and *Max Goes to Jupiter*. Autographed books will be available at a special meeting discount. Please stop by to talk to author Jeffrey Bennett about Big Kid Science or about any of his college textbooks and books for the general public.

Digitalis Education Solutions, Inc

Digitarium® digital planetarium systems for portable or fixed domes make teaching astronomy easy, fun, and engaging for all ages. Set up a Digitarium® system and Digitalis inflatable dome in a gym for an instant planetarium that captivates audiences.

Capabilities include:

- Simulate the sky from anywhere on Earth or from other planets/moons.
- Demonstrate annual motion.
- Zoom in on or label anything in the sky.
- Show constellations from several cultures.
- Create prerecorded segments/shows using the scripting feature.
- Display images or videos from a DVD or USB pen drive.
- Play third-party fulldome video shows with surround sound support.
- And much, much more.

Come see a Digitarium® system in action.

NASA's Kepler Mission

The Kepler Mission is specifically designed to survey our region of the Milky Way galaxy to discover hundreds of Earth-size and smaller planets in or near the habitable zone and determine how many of the billions of stars in our galaxy have such planets. Results from this mission will allow us to place our solar system within the continuum of planetary systems in the Galaxy.

The Mission Education and Public Outreach Program spans across formal education, informal education and public engagement. The program funded one of the Night Sky Network kits, Shadows and Silhouettes; and has held several teacher workshops. Lesson plans, PowerPoint files, animations and orrery model instructions are available on the website.

Exhibits – University Memorial Center Ballroom

National Earth Science Teachers Association

The National Earth Science Teachers Association is a nonprofit organization, founded in 1985, whose mission is to facilitate and advance excellence in Earth and Space Science (ESS) education. NESTA's members are leading ESS teachers across the country, and we provide publications, programs and services for our members. NESTA is the new home for Windows to the Universe (http://windows2universe.org), one of the most popular ESS education websites globally (with ~16 million visitors annually and ~60 million page views). This three level bilingual (English and Spanish) educational website is an ecosystem for ESS education, with over 9000 interlinked webpages enriched with images, movies, animations, interactives, games, and classroom activities.

Pearson Education

We have the most widely trusted and respected programs in educational and professional publishing, and offer the most comprehensive range of educational programs, in all subjects, for every age and level of student, from preK-12 through higher education and on into professional life.

Our unparalleled businesses and brands include Prentice Hall, Longman, Scott Foresman, Addison Wesley, Allyn & Bacon, Benjamin Cummings, PASeries, ELLis, Celebration Press, PEMSolutions, SuccessMaker, Waterford, and Family Education Network. Pearson's other primary operations include the Financial Times Group and the Penguin Group.

Sky-Skan

In 1967, Sky-Skan began creating unique special effects projectors for planetariums. In the 1980s, SPICE Automation products synchronized shows for planetariums and large-format film theaters. In the late 1990s, SkyVision sparked a digital revolution bringing fulldome video to planetariums. Today, advances in hardware and DigitalSky 2 software have resulted in Definiti, a fulldome digital theater system capable of real-time astronomy shows in addition to other sciences, entertainment, and art. Definiti theaters include Smithsonian's National Air and Space Museum, University of Notre Dame, 'Imiloa Planetarium (Definiti 3D: world's first 3D stereo planetarium), Horizon Planetarium (Australia), and the Queen Mary 2.

SOFIA

The world's largest flying observatory is called the Stratospheric Observatory for Infrared Astronomy or SOFIA. Operated by NASA, the SOFIA Mission is a modified Boeing 747SP with a 2.5 meter infrared telescope in the fuselage. SOFIA will observe the night sky in infrared in hopes to study black holes and the organic molecules that make-up our universe. A 10' x 10' SOFIA pop up of the airplane will be in the background and a TV monitor showing SOFIA's first open door test flight.

Software Bisque, Inc.

Software Bisque entered the astronomical arena in 1986 with TheSky, a truly beautiful planetarium software package that took the astronomy world by storm. Through the years, the Bisque brothers have continued to add to and improve their formidable software line, and there truly is no equal in today's market. For those who demand the best, Software Bisque is one company that can meet and exceed expectations. Please visit our exhibit.

Space Science Institute

The Space Science Institute's Center for interactive Learning is involved in a variety of innovative projects that promote inquiry and science literacy. We foster collaboration between scientists and educators to bring the knowledge and excitement of scientific discovery to audiences across the country. Our programs include traveling museum exhibitions; award-winning educational films, videos, and websites; hands-on teaching resources and activities; educator workshops; and outreach to underserved audiences.

W.H. Freeman & Co.

Exhibit will feature market-leading introductory astronomy textbooks as well as geology textbooks across the curriculum, accompanying instructor ancillary materials, and demonstrations of astronomy and geology media resources.

Special Events

Sunday August 1

ASP Members Meeting

Sommers-Bausch Observatory Room S175

5:30 – 6:30 p.m.

Free to all ASP Members. No registration to the Conference is necessary.

Welcome Reception

Fiske Planetarium

6:30 – 8:30 p.m.

Conference participants registered for either symposium are invited to our opening reception in and around the Fiske Planetarium, including light hors d'oeuvres, drinks, and a chance to meet fellow conference attendees. During the reception there will also be a special planetarium demonstration courtesy of Sky-Skan, Inc. and the Fiske Planetarium.

Sky-Skan, Inc. Planetarium Demonstration

Fiske Planetarium

7:30 – 7:50 p.m.

Join your colleagues in the Fiske Planetarium Theater for a demonstration by Sky-Skan, Inc. of its latest full-dome video projection capabilities for presenting full-dome programs, supporting teaching goals, visualizing data, incorporating many science subjects, and making the universe as exciting as it really is!

Monday August 2

Public Talk by Dr. Alex Filippenko, University of California, Berkeley
"Dark Energy and the Runaway Universe"

Cristol Chemistry Building, Room 140

7:30 pm

In 1998, observations of very distant exploding stars provided intriguing evidence that the expansion of the entire Universe is speeding up with time, rather than slowing down due to gravity, as expected. Today, new and completely independent observations strongly support this amazing conclusion. Over the largest scales of space, our Universe seems to be dominated by a repulsive "dark energy" — energy that is stretching the very fabric of space itself. Dr. Filippenko, who is a key member of the two groups that have made some of these remarkable observations, will tell us about the discovery of our "runaway universe."

Alex Filippenko is Professor of Astronomy at the University of California, Berkeley, and a world-renowned expert on exploding stars, black holes, galaxies, and cosmology. Voted the "best professor" on the Berkeley campus seven times and winner of the 2010 Emmons Award for undergraduate teaching of astronomy, he was also named the Carnegie/CASE National Professor of the Year in 2006 among doctoral institutions. For his pioneering research , he was elected a member of the National Academy of Sciences. He has been featured in four astronomy video courses published by The Teaching Company, and won the 2004 Carl Sagan Prize for Science Popularization.

Tuesday August 3

NASA Town Hall Meeting

Cristol Chemistry 140

12:15 – 1:15 pm

The NASA Science Mission Directorate will host a NASA Town Hall, hosted by SMD EPO Lead Stephanie Stockman, to include information on its new Science Education and Public Outreach Forums (SEPOFs).

2010 ASP Award Winners

Catherine Wolfe Bruce Gold Medal

Awarded since 1889 for a lifetime of outstanding research in astronomy

Dr. Gerry Neugebauer

Amateur Achievement Award

For significant observational or technical achievements by an amateur astronomer

Allan Rahill
accepting the award on behalf of the
Clear Sky Chart team

Las Cumbres Amateur Outreach Award

For outstanding outreach by an amateur astronomer to children and the public

Wayne "Skip" Bird

Thomas J. Brennan Award

For exceptional achievement related to the teaching of astronomy at the high school level

John Blackwell

Klumpke-Roberts Award

For outstanding contributions to the public understanding and appreciation of astronomy

Marcia Bartusiak

Robert J. Trumpler Award

For a recent Ph.D. thesis considered unusually important to astronomy

Dr. Robert Quimby

Maria and Eric Muhlmann Award

For important research results based upon development of groundbreaking instruments and techniques

Dr. Michael Werner, Spitzer Project Scientist
accepting the award on behalf of the
Spitzer Space Telescope Team

Richard H. Emmons Award

For excellence in college astronomy teaching

Alex Filippenko

Tuesday August 3

2010 ASP Awards Banquet

Sponsored by W.H. Freeman and Company

University Memorial Center, Room 235

6:30 p.m. Reception followed by a Banquet at 7:15 p.m.

The ASP will present this year's awards at the Society's Annual Meeting Awards Banquet on Tuesday, August 3, 2010. The annual ASP awards recognize meritorious work by professional and amateur astronomers, science educators, and those who engage in public outreach.

Advance purchased tickets are required to attend this event. Your ticket is included with your registration packet. If your pre-purchased ticket is not in your packet, please visit the Registration Desk. Tickets will be available to purchase onsite until end of day August 2. The ASP cannot accept any refunds to this event.

Star Party

Sommers-Bausch Observatory/Fiske Planetarium Lawn

9:00 – 11:00 pm

Star Party being provided for conference participants by members of the Boulder Astronomy & Space Society, a local amateur astronomy organixation.

Plenary Sessions

EPO and Astro 101: Shotgun Wedding, Marriage of Convenience, or Meaningful Relationship?

Morning Joint Plenary Session 1
Monday August 2
8:45 – 9:45 a.m.
Cristol Chemistry 140

Andrew Fraknoi, *Foothill College & ASP,* moderator
Emily CoBabe-Ammann, *Chair, NASA SMD Working Group on Higher Education,* panelist
Edward Prather, *University of Arizona,* panelist

Astro 101 touches the widest audiences imaginable — interested generalists, future teachers (whether they know it or not), soon-to-be citizen scientists, and students who will eventually end up heading into STEM careers. NASA's Space Mission Directorate Education and Public Outreach has, as its mandate, all of these audiences as target clients — although we identify them more formally (e.g., informal and formal education, outreach, and higher education). The question on the table is this: Should there be a relationship between these two — and is there? And is that relationship taking full advantage of what the other has to offer? Or should it just be left up to the vagaries of individual instructors to find their place in the NASA SMD E/PO landscape? And should E/PO professionals assume that, within their definitions, they've covered all of the bases? Where do research-based best practices fit into both worlds? Where does the 'pipeline' fit into all of this? Join us for a lively conversation!

Andrew Fraknoi is Chair of the Astronomy Department at Foothill College and Senior Educator at the Astronomical Society of the Pacific. He conceived and was co-founder of the on-line journal *Astronomy Education Review*, and has been the chief organizer of the "Cosmos in the Classroom" symposia since their inception. A former Executive Director of the Astronomical Society of the Pacific, he started Project ASTRO and Family ASTRO, two national programs to bring training and resources to teachers and the families they serve.

Emily CoBabe-Ammann is the Higher Education Lead of both the Planetary and Heliophysics NASA Science Mission Directorate E/PO Forums, as well as co-investigator on the Colorado Center for Lunar Dust and Atmospheric Studies, an NASA Lunar Science Institute node. She is also the Education lead for NASA's Juno mission. While Head of the Office of Communication and Outreach at CU's Laboratory for Atmospheric and Space Physics, Emily worked on E/PO programs for a number of NASA missions and programs, and initiated and directed the Boulder-based REU Program in Solar and Space Physics. She was the chair of the SMD E/PO Management Operations Working Group from 2008 to 2009.

Edward Prather is an Associate Professor in the Department of Astronomy at the University of Arizona, and Executive Director of the NASA and NSF funded Center for Astronomy Education there. Ed has led several research programs to investigate students' conceptual and learning difficulties in the areas of astronomy, astrobiology, physics, and planetary science, and has led the development of education materials in support of more than ten NASA mission EPO programs. He is on the American Astronomical Society's Astronomy Education Board and the American Institute of Physics' National Committee on Physics Education.

The New Science Education Frameworks — Express Your Opinion

EPO Afternoon Plenary Session 1
Monday August 2
1:15 – 2:15 p.m.
Muenzinger Psychology E050

Dennis Schatz, *Pacific Science Center ,* moderator
Michael Wysession, *Washington University, St. Louis,* Task Force Chair
Don Duggan-Haas, *Paleontological Research Institution/Museum of the Earth,* panelist
Scott Linneman, *Western Washington University,* panelist
Eric Pyle, *James Madison University,* panelist

What should students in K–12 classrooms know about Earth and Space Science? The National Research Council is developing Science Education Frameworks that will be used by Achieve, Inc. to develop new science standards in all areas of science. Come hear from and give input to the five individuals tasked with developing the Earth and Space Science Frameworks. The session will include:

- An overview of the Science Framework's purpose and development process.
- Time to work in small groups to review the current draft of the Earth and Space Science Frameworks.
- Engage in one-on one conversations with members of the Earth and Space Science Task Force.
- Provide input for the next draft.

Panelists and members of the **Earth and Space Science Framework Task Force** (of the National Academy of Science):

Dennis Schatz is Senior Vice President at the Pacific Science Center in Seattle, WA. A research solar astronomer prior to his career in science education, he is also author of 21 science books for children, and co-author/editor of teacher curriculum resources such as the popular *Astro Adventures* and *More Universe at Your Fingertips*. He has received numerous honors, including the 1996 Distinguished Informal Science Educator Award from the National Science Teachers Association (NSTA), NSTA's 2005 Distinguished Service to Science Education and NSTA's 2009 Faraday Science Communicator Award.

Task Force Chair **Michael Wysession** is an Associate Professor of Geophysics in the Department of Earth and Planetary Science at Washington University, St. Louis. He is Chair the NSF-sponsored *Earth Science Literacy Initiative*, where he led the creation of a single document of big ideas and supporting concepts that every citizen should know about Earth science (www.earthscienceliteracy.org). The National Academy of Science is currently revising the 15-year-old National Science Education Standards, and Wysession is Earth and Space Science Team Leader for the standards framework.

Don Duggan-Haas is the Education Research Associate at the Paleontological Research Institution and its Museum of the Earth in Ithaca, NY. Don has taught at Colgate, Cornell, and Michigan State Universities, and Tapestry and Norwich (New York) High Schools. His current work focuses on teacher professional development and curriculum development that fosters understanding of the central ideas of Earth systems science by engaging students and teachers in the close study of their local environments, and using those local understandings to grok (deeply understand) larger natural systems and human roles within those systems.

Scott Linneman is an associate professor of Geology and Science Education at Western Washington University (WWU) in Bellingham, WA. Also certified as a middle/high school science teacher, he served as a Senior Fulbright Fellow working on teacher preparation in South Africa. He has directed an NSF GK-12 Catalysts for Reform Project at WWU and was co-PI for WWU's North Cascades and Olympics Science Partnership, an NSF Math-Science Partnership. He served on the executive committees for the National Association of Geoscience Teachers (as president), and the Washington Science Teachers Association.

Eric Pyle is an Associate Professor of Geology in the Department of Geology & Environmental Science at James Madison

University, where he specializes in Geoscience Education. His professional work has centered on the preparation and professional development of science teachers, the design and evaluation of instructional materials and programs, and explorations into the motivation and thinking of students in the Earth sciences. A Past President of both the West Virginia Science Teachers Association and the Virginia Association of Science Teachers, he is the 2010 Chairperson of the Geoscience Education Division for Geological Society of America.

Taking a Scientific Approach to Science Teaching

Cosmos Afternoon Plenary Session 1
Monday August 2
1:15 – 2:15 p.m.
Cristol Chemistry 140

Steven Pollock, *University of Colorado*

It is now well-documented that traditionally taught, large-scale introductory science courses often fail to teach our students the basics. In fact, these same courses have been found to teach students things we don't want. Building on a tradition of research, the physics and astronomy education research communities have been investigating the effects of educational reforms at the undergraduate level for decades. Both within these scientific communities, and in the fields of education, cognitive science, psychology and other social sciences, we have learned a great deal about student learning and environments that support learning for an increasingly diverse population of students. This presentation will discuss a variety of effective classroom practices, (with an emphasis on peer instruction, "clickers", and small group activities), the surrounding educational structures, and examine assessments which indicate when and why these do (and sometimes do not) work. After a broad survey of education research, we will look at some of the exciting theoretical and experimental developments within this field that are being conducted at the University of Colorado. Throughout, we will consider research and practices that can be of value in both physics and astronomy classes, as well as applications to teaching in a variety of environments.

Steven Pollock is a professor of Physics at the University of Colorado Boulder. He is a Carnegie Teaching Scholar, and a University of Colorado President's Teaching Scholar, as well as an award-winning teacher. His research is in the field of PER (Physics Education Research), investigating student learning in large and small-scale physics classes, and the constraints and opportunities involved in replicating "proven" curricular practice, as well as extending educational models to the upper division. He has implemented and studied "Tutorials in Introductory Physics" at CU Boulder, along with supporting and investigating 'Teaching and Learning Assistants' pedagogical development. He has been described by his students as a human electron.

Teach to the Stars: How People Learn Science

Morning Joint Plenary Session 2
Tuesday August 3
8:30 – 9:30 a.m.
Cristol Chemistry 140

Peter Hewson, *University of Wisconsin*

The effective teaching of astronomy requires that we pay attention to learning astronomy, and learning to teach astronomy. These draw from the "universe" of research on learning science, and learning to teach science, and both have major implications for teaching. A focus on learning astronomy raises questions such as: What do our students and other audiences bring to the table? How do they interact with the images, the ideas, the experiences, and the practices of astronomy? What sense do they make of their involvement with the material? Taking into account that students understand by creating meaning from various sources provides guidelines for educators through the tasks they create and the opportunities for collaborative discourse they provide. A focus on learning to teach astronomy raises questions such as: How can astronomy educators learn to teach astronomy in a way that connects more directly to the learners? What are

the pathways of our own professional development in understanding the curriculum that is our passion, the learners who are our opportunity and responsibility, and the community of practice that challenges and sustains us? Understanding that we as astronomy educators repeatedly return to roles as learners of astronomy and learners of teaching (both fields are dynamic) helps us integrate these perspectives into a continuously improving educational practice.

Peter W. Hewson is professor of Science Education at the University of Wisconsin-Madison. He teaches in the undergraduate science teacher education and graduate science education programs and has been deeply involved in the development of a conceptual-change framework that informs the teaching and learning of science. Such a framework also has major implications for teacher education and professional development. He has published extensively on these and related topics in education. In 2009 he received the Distinguished Contributions to Science Education through Research Award from the National Association for Research in Science Teaching. He received his D.Phil. in theoretical nuclear physics from the University of Oxford and taught physics and science education in South Africa before moving to the United States.

Citizen Science Across the Disciplines

EPO Afternoon Plenary Session 2
Tuesday August 3
1:15 – 2:15 p.m.
University Memorial Center 235

Rick Fienberg, *American Astronomical Society,* moderator
Pamela L. Gay, *Southern Illinois University Edwardsville,* panelist
Michael Gold, *ScienceForCitizens.net,* panelist
Gary Lewis, *Geological Society of America,* panelist

Astronomers, geologists, ornithologists, and many others across the scientific spectrum have discovered a powerful new tool for conducting research: an army of willing and enthusiastic citizen scientists. Tens of thousands of nonscientists routinely help researchers collect data, analyze it, and even interpret it, enabling scientific investigations that might otherwise be impossible. Many citizen-science projects are developed and conducted at least in part for the purposes of education and outreach, so it's appropriate to ask not only whether they're having a significant scientific impact, but also whether they're having a significant educational one. In this interactive discussion we'll address issues such as the factors that determine whether a citizen-science project is successful, whether scientists and citizens benefit equally or unequally, and whether citizen science attracts a wide cross-section of the public or only people who are already science literate, thereby limiting its effectiveness for EPO.

Before becoming the American Astronomical Society's Press Officer and Education & Outreach Coordinator in 2009, **Rick Fienberg** spent 22 years at Sky & Telescope magazine, the last 8 as Editor in Chief. He is a former chair of the AAS Working Group for Professional-Amateur Collaboration and has done research as both a professional and an amateur astronomer.

Pamela L. Gay is part of the Zooniverse Collaboration and serves on the council of the American Association of Variable Star Observers (AVVSO). The Zooniverse project has over 300,000 registered users, and engages people in the online analysis of astronomical images of the Sun (SolarStormWatch.com), Galaxies (GalaxyZoo.org), the Moon (MoonZoo.org), and Supernovae (Supernova.GalaxyZoo.org). The AAVSO takes on the much harder task of engaging people in the actual sky, and through projects like Citizen Sky (CitizenSky.org), facilitates 1000s of people around the world in measuring the inconstant light of the stars. Gay is on the faculty at Southern Illinois University Edwardsville, co-hosts the Astronomy Cast podcast, and writes for various magazines.

Michael Gold is co-founder of ScienceForCitizens.net, a new online community that aims to connect the millions of citizen scientists in the world with the thousands of science projects offered by researchers, organizations, and companies. As a telescope-toting teenager, an aspiring astronaut, a physics major, a science journalist for national newspapers and magazines, and a publishing consultant, Michael has always been in touch with his inner researcher. He is proud to have

been selected years ago as a regional finalist in NASA's journalist-in-space program.

Gary Lewis has been involved with Earth science education since the 1980s — first in Australia, then the USA and now at a global scale. Gary is the Director of Education and Outreach for the Geological Society of America and the Director of the Earthtrek Program — a global citizen science program established just last year. Gary is passionate about Earth Science and has a high level of enthusiasm for getting the community involved in real scientific research.

The Day We Found the Universe: The Little-Known History of How We Came to Understand the Expanding Universe

Cosmos Afternoon Plenary Session 2
Tuesday August 3
1:15 – 2:15 p.m.
Cristol Chemistry 140

Marcia Bartusiak, *Winner, 2010 ASP Klumpke-Roberts Award*

This will be an overview of the birth of modern cosmology in the 1920s, when the true nature and startling size of the universe was at last revealed. While today Edwin Hubble gets most of the credit, the story is far more complex, involving battles of wills, clever insights, and wrong turns made by a number of investigators before Hubble. The Hubble Space Telescope could easily have had another name if certain events had turned out differently: if Lick Observatory director James Keeler had not prematurely died in 1900 and solved the mystery of the spiral nebulae years earlier; if Lick astronomer Heber Curtis had not taken a promotion in 1920, taking him out of the game; or if astronomer Harlow Shapley, Hubble's nemesis, was not mulishly wedded to a flawed vision of the cosmos. And half the work to prove the universe was expanding was actually performed by Lowell Observatory astronomer Vesto Slipher; Hubble used Slipher's data in 1929 to establish what came to be known as the Hubble Law without citation or acknowledgment, a serious breach of scientific protocol. Even then, Hubble was never a vocal champion of the idea that the universe was expanding. Hubble always coveted an unblemished record: the perfect wife, the perfect scientific findings, the perfect friends. Throughout his life, Hubble claimed that the galaxies fleeing outward were apparent velocities. He wanted to protect his legacy in case a new law of physics was revealed that changed that explanation.

Combining her training as a journalist with a master's degree in physics, **Marcia Bartusiak** has been covering the fields of astronomy and physics for three decades. She is currently an adjunct professor of science writing at the Massachusetts Institute of Technology and has published in a variety of publications, including *Science, Smithsonian, Discover, Technology Review, National Geographic,* and *Astronomy*. She is the author of *Thursday's Universe*, a guide to the frontiers of astrophysics; *Through a Universe Darkly*, a history of astronomers' quest to discover the universe's composition; and *Einstein's Unfinished Symphony*, a chronicle of the international attempt to detect cosmic gravity waves. She went on to compile *Archives of the Universe*, an anthology and commentary on the historic discovery papers in astronomy, and most recently *The Day We Found the Universe*, on the birth of modern cosmology. Bartusiak is a two-time winner of the American Institute of Physics Science Writing Award and in 2006 garnered the AIP's prestigious Gemant Award for her "significant contributions to the cultural, artistic, or humanistic dimension of physics."

A World of Change: Climate Yesterday, Today, and Tomorrow

Morning Joint Plenary Session 3
Wednesday August 4
8:30 – 9:30 a.m.
Cristol Chemistry 140

Susan Solomon, *NOAA*

In this talk, key evidence for changes in the Earth's climate, and the causes of those changes, will be summarized. Understanding how temperatures are increasing around the world, how ice is melting at the poles, and how rain is

changing in the tropics, are among the issues that will be addressed. Observations of the greenhouse gases and aerosols that are the main reasons for these changes will also be discussed. The talk will also cover how our choices will combine with the physics of the climate system to determine how different the climate will be by 2020, 2050, 2100, and beyond.

Susan Solomon is a research chemist at the Aeronomy Laboratory at the National Oceanic and Atmospheric Administration in Boulder. An internationally recognized leader in the field of atmospheric science, she pioneered observations and explanations of ozone depletion in the Earth's atmosphere. Between 2002 and 2008, she was the Co-chair of the Intergovernmental Panel on Climate Change, which shared the Nobel Peace Prize with Al Gore in 2007. For her work she has also received the National Medal of Science (2000), the Blue Planet Prize, and the Bowie Medal of the American Geophysical Union. *Time* Magazine named her one of the 100 most influential people in the world in 2008. Her research continues to focus on atmospheric chemistry and its role in climate change.

Science – and Antiscience — in the Climate and Evolution Debates

EPO Afternoon Plenary Session 3
Wednesday August 4
4:15 – 5:15 p.m.
University Memorial Center 235

Todd Neff, moderator
Caspar Ammann, *National Center for Atmospheric Research,* panelist
David Grinspoon, *Denver Museum of Nature & Science,* panelist
Pieter Tans, *NOAA's Earth System Research Laboratory,* panelist

The Enlightenment is more than 300 years old. Those of us lucky enough to live in a developed country find ourselves entirely dependent on an array of technologies empowered by the cumulative advances of science. Yet surveys repeatedly show a large percentage of Americans to be either ignorant of science and the scientific method or outright dubious of them. Gallup polls have consistently found that more than four in 10 respondents believe that God created man in its present form. An October 2009 poll by the Pew Research Center for the People & the Press found that just 36 percent of Americans surveyed believed there was "solid evidence the Earth is warming," down from 47 percent in April 2008.

The scientific evidence supporting evolution and anthropogenic climate change is overwhelming. Yet nowhere has the battle of science versus ignorance and skepticism been more pitched than in these realms. What forces drive these antiscientific worldviews? How can scientists and their allies counter them? What can education and public outreach experts in one of science's most publicly digestible realms — space and astronomy — learn from those who have been in the trenches? How can you help build a more scientifically literate society at a time when elected leaders have needed a rational support base like never before?

Todd Neff, author of the forthcoming *From Jars to the Stars: How Ball Came to Build a Comet-Hunting Machine*, a history of Ball Aerospace and the Deep Impact mission to the comet Tempel 1 was previously the science and environment reporter for the *Boulder Daily Camera*.

Caspar Ammann, scientist and paleoclimate specialist, Climate and Global Dynamics Division, National Center for Atmospheric Research. The primary focus of his research is on natural climate variability and change over the past centuries and millennia.

David Grinspoon, curator of astrobiology, Department of Space Sciences, Denver Museum of Nature & Science, and author of *Lonely Planets: The Natural Philosophy of Alien Life*. His research focuses on understanding climate evolution on other planets, and he was the 2006 winner of the Carl Sagan Medal for public communication of planetary science.

Pieter Tans, senior scientist at NOAA's Earth System Research Laboratory in Boulder, directs the lab's Carbon Cycle Greenhouse Gases Group. The work of Tans's team to measure an array of greenhouse gases on a global basis has provided vital data showing the human influence on Earth's climate.

Plenary Sessions

Tricks of the Trade: Effective Classroom Management (An Open Microphone Session)

Cosmos Afternoon Plenary Session 3
Wednesday August 4
4:15 – 5:15 p.m.
Cristol Chemistry 140

Timothy Slater, *University of Wyoming,* moderator
David Bruning, *University of Wisconsin, Parkside,* scribe.

To close the *Cosmos in the Classroom* meeting, we want to share effective ways to help our students (and ourselves) to succeed in our classes, by setting the right course guidelines about in class and out of class behavior. What ways of helping students to become adult learners and responsible members of the college community have been most effective for you? What have you learned from colleagues in your and other disciplines that could help everyone at the session work with 21st century students in our evolving universe of classroom and home technology? Come prepared to share positive ideas (let's leave the griping about our students for the social hour that follows.)

Tribute to Mary Kay Hemenway

Mary Kay Hemenway

ASP Board Secretary, 1999–2010

Congratulations and best wishes to Dr. Mary Kay Hemenway on her retirement as Secretary of the Astronomical Society of the Pacific (ASP) after eleven years of sterling service to the Society.

Mary Kay is Senior Lecturer and Research Associate at the University of Texas at Austin, where she teaches astronomy classes and engages in astronomy education research. For many years, she has worked with the University of Texas McDonald Observatory Education and Outreach Office helping to design and implement teacher and student programs for the Observatory's Visitor Center in Fort Davis. She is also Director of the university's Educational Services Office for the astronomy department, and has been the principal investigator or co-investigator on numerous NSF- and NASA-funded projects in science education. She has been a member of the International Astronomical Union's Working Group for the 2009 International Year of Astronomy.

Mary Kay served as the Education Officer of the American Astronomical Society (AAS) from 1991–1997, and just this year was awarded the AAS Education Prize "for her leadership and dedication to astronomy education and improvement of K–20 science education at the state and national level throughout her career." And she has served as our faithful and expert secretary.

The ASP Board of Directors, staff, and membership sincerely thank Mary Kay for more than a decade of minutes-taking, record-keeping, organizing and exercising her procedural duties — essential functions without which the Society cannot operate effectively — and for her role on the Executive Committee, for being the race memory of the Society, and for her sage advice over the years. We will miss her, and wish her well in her future adventures.

Mary Kay will be honored at the ASP Awards banquet for her years of service. When you see her during the course of this year's meeting, please be sure to thank her for a job very well done!

PROGRAM

KEY

EPO poster numbers are preceded by an "E", for example, E14.
Cosmos poster numbers are preceded by a "C", for example, C12.

Monday PM EPO 10-Minute Orals

Session Chair: Dan Steinberg, Princeton University

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Session Chair: University Memorial Center 235

CSU Science Teacher and Researcher (STAR) Program: Developing "Teacher-Researchers" Through Paid Summer Research Experiences for Pre-Service and Early Career Science and Math Teachers

John Keller, *California Polytechnic State University, jmkeller@calpoly.edu*

Bryan Rebar, *California Polytechnic State University, brebar@calpoly.edu*

Susan Elrod, *Project Kaleidoscope (PKAL), Elrod@aacu.org*

The Science Teacher and Researcher (STAR) program addresses the science and mathematics teacher recruitment and retention crisis by creating a prestigious dual "teacher-researcher" career path. Founded and implemented in 2007 by the Cal Poly Center for Excellence in Science and Mathematics Education (CESaME) on behalf of the California State University (CSU) system, STAR provides cutting edge research experiences and career development for pre-service and early career teachers during early critical years. Key experiences of the STAR program are one or more summers of paid research internship experience in national laboratories or NASA research centers and weekly science education workshops and seminars. By anchoring pre-service teachers in the scientific research community, they will come to better understand what it means to be a researcher as well as an effective teacher of science or mathematics. Since 2007, the STAR program has served a diverse group of 85 Fellows from 18 different CSU campuses with disciplinary backgrounds in science and mathematics that are in career development stages ranging from junior undergraduates to new classroom teachers. During Summer 2010, the STAR program will expand nationally with funding from the NSF Noyce Scholars Program and philanthropic organizations to place 60 STAR Fellows in California and 20 in new lab partnerships in Colorado, Maryland, New York, Tennessee, and Washington. Preliminary results indicate that the program is effective at recruiting high quality science and math majors into the teaching profession and impacting their attitudes and beliefs regarding the nature of scientific research and teaching science through inquiry. When surveyed at the end of the summer 2009, STAR Fellows indicated that STAR increased their interest in teaching (89%), contributed to feeling more prestige about teaching as a profession (89%), and made them feel like they were part of a broader community of teacher-researchers (100%).

Outcomes: Participants will be introduced to one of several "Teacher-Researcher" professional development models. Related programs include the DOE Pre-Service Teacher Program, Industry Initiatives in Science and Math Education (IISME), and the Columbia University Summer Research Program for Secondary School Science Teachers (CUSRP). Programs such as these provide science and math teachers with immersion experiences in authentic science research and can influence the type and quality of classroom experiences that these teachers subsequently provide to their students.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Teaching Astronomy Undergraduates How to Teach: The Making of Reflective and Confident Teachers

Delphine Perrodin, *Franklin & Marshall College, delphine.perrodin@fandm.edu*

Andrea Lommen, *Franklin & Marshall College, andrea.lommen@fandm.edu*

In the spring of 2010, a new internship course was developed at Franklin & Marshall College in which undergraduates were trained on how to teach and subsequently gained experience teaching in a local high school. The success of this course has opened our eyes about the untapped potential of teaching undergraduates how to teach: undergraduates are much more receptive and open to discuss their teaching than graduate students and faculty in physics & astronomy departments, who can be cynical and guarded, unlikely to critique each other's teaching practice. Beyond the immediate benefits of having undergraduates learn to become well-rounded, confident and reflective teachers, we can foster an environment where discussing one's teaching is not just OK but expected. Undergraduates are also naturally receptive to learner-centered methods. Undergraduates are our future graduate students and faculty. We need good teachers. By reaching out to them in the early stages of their careers, they can help us change the culture of teaching in physics & astronomy departments around the country.

Outcomes: This presentation is useful if you are interested in: (a) training undergraduates how to teach; and (b) fostering an environment in your department where discussing teaching is encouraged and expected.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Statewide Teaching of Astronomy in K–12 Classrooms in Delaware

Harry Shipman, *University of Delaware, harrys@udel.edu*

Kelli Martin, *Department of Education, State of Delaware, kelli.martin@k12.doe.state.de.us*

Delaware has put astronomy back into its K–12 classrooms as one of eight major thematic strands. This presentation will describe how this has been accomplished by a long-standing partnership between the state's department of education and the University of Delaware. We have developed curriculum units that support the standards and are used statewide. Teachers take professional development workshops before they have access to the curriculum units and materials. Statewide assessment also supports the standards. We do not yet have data that can show the effects of our astronomy units separately. Data from the Delaware State Testing Program shows that the overall curriculum reform effort is really working. The number of students meeting the 8th grade science standard has increased from 41.69% in 2000, when few students used the curriculum, to 58.43% in 2007 when curriculum use was widespread. The formal statistical significance of this improvement is enormous (40-sigma or $p < 10\text{-}13$). Validation of this test result comes from the National Assessment of Educational Progress (NAEP). The percentage of Delaware students performing at levels of Basic and above increased from 51% (1996) to 63 % (2005), the largest gain in this time period for any state in the US. These outcomes have given us national recognition as

one of two states in the Union to make reform-based curricula work in a systemic way. The continued development of astronomy in Delaware's K–12 classrooms has been supported by a grant from NASA's Competitive K–12 grants program.

Outcomes: Participants will see how statewide reform gets done, and how university folks can work with a state's department of education and with the state's teachers in a genuine partnership.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Capitol College Center for Space Science Education and Outreach: Building a STEM Pipeline

Michael Gibbs, *Capitol College, mggibbs@capitol-college.edu*

Dianne Veenstra, *Capitol College, dveenstra@capitol-college.edu*

Capitol College, located in Laurel, Maryland, established the Center for Space Science Education and Public Outreach with the mission to assist in educating future leaders in the science, technology, engineering and math (STEM). This presentation shares emerging best practices through innovative methods to create awareness regarding STEM outreach programs and activities. The presentation also seeks to stimulate thoughts regarding hands-on educational and workforce development experiences for middle school, high school and community college students in STEM fields. The Center's hands-on programs are intended to: 1) increase student awareness of career fields that require a college education, 2) provide information on the necessary academic preparations related to STEM, and 3) initiate interest in careers within STEM fields. These goals are intended to assist in developing the pipeline for our future STEM workforce for careers in space science. Through utilizing astronomy and space science, along with leadership development, the Center strives to advance engineering and other STEM fields to solve current and future problems and to strengthen the nation's future workforce. The Center builds on and supports Capitol's Space Operations Institute (SOI) and partnership with NASA Goddard Space Flight Center. The SOI provides students with real-world learning experiences enhancing their future careers. This session will also highlight the current NASA - Capitol College relationship that encourages college students to enter the STEM workforce. SOI activities include student learning experiences as members of the Tropical Rainfall Measuring Mission (TRMM) Flight Operations Team. The research satellite is designed to assist our understanding of the water cycle in the current climate system. The SOI is also the Back-up Control Center for the Wide-Field Infrared Survey Explorer (WISE) mission that will provide a vast storehouse of knowledge about the solar system, the Milky Way, and the Universe.

Outcomes: The intended outcomes for this session are: a) Share preliminary results and best practices regarding the middle school, high school and community college outreach programs conducted during the 2009–10 academic year. b) Demonstrate the significance of the findings that hands-on workshops for students have a positive impact regarding their awareness of STEM fields for future career opportunities. c) Engage in a short discussion on key points to move us forward as professionals regarding the need to further engage middle school, high school and community college students through active learning opportunities that supplement their classroom instruction.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Advertising Citizen Science: A Trailer for the Citizen Sky Project

Ryan Wyatt, *California Academy of Sciences, rwyatt@calacademy.org*

Aaron Price, *American Association of Variable Star Observers, aaronp@aavso.org*

Citizen Sky is a multi-year, NSF-funded citizen science project involving the bright and mysterious variable star epsilon Aurigae. The project was conceived by the IYA 2009 working group on Research Experiences for Students, Teachers, and Citizen-Scientists. Citizen Sky goes beyond simple observing to include a major data analysis component, introducing participants to the full scientific process from background research to paper writing for a peer-reviewed journal. As a means of generating interest in the project, the California Academy of Sciences produced a six-minute "trailer" formatted for both traditional and fulldome planetariums as well as HD and web applications. This talk will review the production process for the trailer as well as the methods of distribution via planetariums, social media, and other venues, along with an update on the Citizen Sky Project as a whole.

Outcomes: We will show how to use a small, professionally-produced planetarium trailer to help spread word on a citizen science project. We will also show preliminary results on a study about how participation level/type in the project affects science learning.

Monday PM EPO 1-Hour Workshops

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Connecting NASA Research with K–12 Science Education and a Possible Future Common Core

Adrienne Carr, *Ohio Department of Education*

Lauren V. Monowar-Jones, *Columbus State Community College, lmonowar@cscc.edu*

We will show researchers and educators the resources being used to craft a national common core of science standards. Additionally, we will provide some examples of K–12 curriculum models (from Ohio) that demonstrate the depth and breadth of content expected to be taught in the K–12 arena. Given this information, participants will be challenged to find where their research could fit into a K–12 education. Recently, at a meeting held to discuss ideas for EPOs associated with a possible lunar mission, several ideas for creating "one NASA" and connecting NASA funded research with K–12 educators and students were presented. Participants will develop ways that K–12 students can participate in their research, which should be the basis for a successful EPO proposal. Finally, we will give some ideas to researchers about how they can develop successful EPO programs by connecting their research to actual K–12 curricula.

Outcomes: A working knowledge of the national literature being used to develop the new common core of science standards. Also, participants will walk away with an understanding of how their research could be used in a K–12 curriculum, and how K–12 students can participate in their research.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

2010 National Observe the Moon Night

Brooke Hsu, *NASA-GSFC-SSAI, Brooke.C.Hsu@nasa.gov*
Lora Bleacher, *NASA-GSFC-SSAI, Lora.V.Bleacher@nasa.gov*
Doris Daou, *NASA-ARC-Lockheed Martin, Doris.Daou-1@nasa.gov*
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Andrew Shaner, *LPI, AShaner@lpi.usra.edu*
Stephanie Shipp, *LPI, shipp@lpi.usra.edu*

We are creating a nation-wide, annual public outreach event called National Observe the Moon Night (NOMN) that provides opportunities for involving new partners in engaging the public in lunar science and exploration. The 2010 NOMN events will occur at our partner institutions: Ames Research Center (ARC; Moffett Field, CA), Goddard Space Flight Center (GFSC; Greenbelt, MD), Lunar and Planetary Institute (LPI; Houston, TX), and Marshall Space Flight Center (MSFC; Huntsville, AL). The goal of National Observe the Moon Night is to engage the lunar science and education community, our partner networks, amateur astronomers, space enthusiasts, and the general public in annual lunar observation campaigns that share the excitement of lunar science and exploration. National Observe the Moon Night events will use NASA's "Tweet-ups" model and partners' dissemination networks to promote and recruit participation in the events. All information about NOMN will be supplied on a central website, accessible to the public (http://lpi.usra.edu/nationalobservethemoonnight). Members of the public are encouraged to host their own NOMN events, and there will be a place for local astronomy clubs, schools, or other groups to post information about NOMN events they are organizing. To assist with their efforts, the website will contain downloadable documents of templates of advertising fliers, Moon maps, and activities that will be distributed at the national events, such as Moon calendar journals. After the events, participants will be able to continue using the website to follow links for more information about sites indicated on their Moon maps.

Outcomes: Participants will become familiar with National Observe the Moon Night and how to host their own events and advertise them on the NOMN website.

Session Type: 1-Hour Workshop

Location: University Memorial Center 386

More Than Just Crossing Circles: Overhaul Your Earth Science Activities Using Easily Accessible Online Seismic Data

Patrick McQuillan, *Incorporated Research Institutions for Seismology (IRIS), mcquillan@iris.edu*

Locating the epicenter of an earthquake using the "S minus P" method of triangulation is THE traditional activity in earth science classrooms. While commonly used, most variants of this activity are both scientifically and pedagogically out of date. Ready availability of seismic databases allows the development of a spectrum of alternate activities. This session will leverage the vast collection of seismic data stored at the Incorporated Research Institutions for Seismology's (IRIS) Data Management Center and a suite of online tools for accessing the databases. We will examine how collecting empirical data, developing logical arguments and skeptically reviewing results can be used to significantly enhance traditional activities. Using actual data from recent earthquakes, workshop participants will model methods for incorporating real data in earth science activities.

Outcomes: Through direct participation with content and online tools, workshop participants will: (a) explore how to access seismic data sets for educational outreach use; (b) learn how to enhance the relevance of an activity by utilizing actual three-component seismic data from recent, newsworthy earthquakes through online tools; (c) learn how to analyze three-component seismic data while emphasizing fundamental principles of geophysics; (d) explore a set of visualizations useful for explaining earthquakes and plate tectonics; and (e) model techniques for incorporating real data sets in educational activities to enhance inquiry-based learning. Concepts will be explored through active engagement in hands/minds-on modeling of earth science activities.

Session Type: 1-Hour Workshop

Location: University Memorial Center 382+384

"Surrounded by Science": Improve Your Practice by Exploring What Research Says about Learning Science in Informal Environments

Dennis Schatz, *Pacific Science Center, schatz@pacsci.org*

This session gives participants time to explore key elements of "Surrounded by Science," a new publication from the National Research Council regarding what research tells about science learning in informal environments. The presentation and associated discussion will help participants understand the implications for programs in their organizations, and how the material can be used to provide professional development experiences for people associated with their organizations. Key elements of the workshop include: (1) Participants use a "jigsaw" approach to read portions of "Surrounded by Science" and answer some of the provocative questions at the end of the chapter(s), and (2) Participants watch videos of visitor interactions with and conversations around programs/exhibits at informal science institutions. After experiencing each element, participants share the implications they identified for their programs and for providing professional development for other people associated with their organizations.

Outcomes: Participants will understand what research has to say about learning in informal environments, especially the six strands outlined in the book. Participants will be able to apply what is learned in experiences at informal science learning settings. Participants will have identified how they can apply what they learn in the session when they go back to their home institutions/organizations.

Monday PM EPO 10-Minute Orals

Session Chair: Mangala Sharma, Space Telescope Science Institute

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

The Other 99.99%

Gordon K. Squires, *Spitzer Science Center/NASA Herschel Science Center/Caltech, squires@ipac.caltech.edu*

Robert Hurt, *Spitzer Science Center/NASA Herschel Science Center/Caltech, hurt@ipac.caltech.edu*

Tim Pyle, *Spitzer Science Center/NASA Herschel Science Center/Caltech, tpyle@ipac.caltech.edu*

Carolyn Brinkworth, *Spitzer Science Center/NASA Herschel Science Center/Caltech, csb@ipac.caltech.edu*

Jacob Llamas, *Spitzer Science Center/NASA Herschel Science Center/Caltech, jllamas@ipac.caltech.edu*

"If we build it, they will come." This phrase from the film "Field of Dreams" also applies to our preconceptions for the popularity of astronomical imagery. We think (hope?) that the dazzling images produced by both ground- and space-based telescopes are surely so compelling that all we need to do is make them available, and the world will rush to revel in their wonders. Fancy websites and social media including Twitter, Facebook, Flickr, YouTube are common vehicles to share astronomical images, and convey the latest astronomical news and discoveries. But whom exactly are we reaching? In this presentation, we will examine shortcomings in current strategies, and propose an alternative way for reaching "the other 99.99%" of the population.

Outcomes: This presentation aims to challenge our conceptions over the utility and purpose of social networking, and propose ideas for reaching the population who doesn't yet know they care about astronomy.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Wild About Social Media? Choosing Appropriate Social Media & Tech Tools for Your Organization

Jessica Santascoy, *Astronomical Society of the Pacific, jsantascoy@astrosociety.org*

It's tempting to jump on the social media bandwagon and insist that your organization needs Facebook, twitter, etc. But, when funds are limited, social media & related publicity must be carefully thought out. Using the NASA Night Sky Network Social Media & Tech Plan as a case study, we'll address the necessity of understanding how to choose the appropriate social media for your organization and your target audience. The NASA Night Sky Network, which is managed by the ASP, developed widgets for websites & blogs, an iPhone app, and a Facebook presence to attract/inform/reach the next generation of amateur astronomers, with no additional work from the amateur astronomy community who are members of the Night Sky Network. Outreach professionals will gain valuable insight from our experience and may replicate this model to design their own social media/tech plan.

Outcomes: Learn from our experience and get tips on: (1) Choosing which social media to use for your organization; (2) Incorporating your organization's existing culture & comfort level into a social media plan; (3) Mobile strategy; and (4) iPhone app & a mobile-ready website.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

New Media Pipeline: From Social Engagement to Science Engagement

Pamela Gay, *SIUE / Astrosphere New Media, pamela@starstryder.com*

Adrienne J. Gauthier, *University of Arizona / Astrosphere New Media, adrgau@email.arizona.edu*

In this talk, we review how people's interactions with new media vary across the technologies of Second Life(tm), podcasting, and citizen science. We specifically address how various media impact how people self-identify changes in their engagement level as a result of involvement in online projects/experiences, what their needs are, and how they flow between projects and areas of information exchange.

Outcomes: This is a discussion of latest research results, and reviews the size audience available for different media.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Exploring the Public's Engagement in Galaxy Zoo

Trent Mankowski, *University of Wyoming, CAPER Team, avatar@uwyo.edu*

Jordan Raddick, *The John Hopkins University, raddick@pha.jhu.edu*

Stephanie Slater, *University of Wyoming, sslaterwyo@gmail.com*

Tim Slater, *University of Wyoming, timslaterwyo@gmail.com*

As the Web 2.0 world lurches forward, so do intellectual opportunities for students and the general public, to meaningfully engage in the scientific enterprise. Galaxy Zoo provides direct access to the Sloan Digital Sky Survey. In the first generation of Galaxy Zoo, participants first classify 15 galaxies as merger or single galaxy, then elliptical or spiral, and finally as spinning clockwise or anticlockwise. In the second generation of Galaxy Zoo, participants are able to quickly analyze galaxies' roundedness as well as the nature of any arms or central bulge. In an effort to assess the intrinsic motivation afforded by participation in Galaxy Zoo, we have inductively analyzed more than 1,000 contributions in the Galaxy Zoo Forum and coded posts thematically. We find that participants overwhelmingly want to meaningfully contribute to a larger scientific enterprise as well as have seemingly unique access to high quality, professional astronomical data. While other citizen science projects work through large data sets, Galaxy Zoo is unique in the motivations and retention abilities. Many of these motivations originate in the aesthetic power of astronomical images, which Galaxy Zoo successfully harnesses while not compromising the scientific value of the project. From within the data emerged several trends of motivation, the primary being: the sense of community created within the project that promotes professional-amateur collaboration; fulfilling a dream of being an astronomer, physicist, or astronaut; tapping into a potential well of interest created during the space race era; the spiritual aspect generated when the imagination interacts with Galaxy Zoo; and uniting them all, the aesthetic appeal of the galaxy images. In addition, a very powerful tool also emerged as a method of retention unique to

Galaxy Zoo. This tool, known as variable ratio reinforcement in behavioral psychology, uses the most appealing images as positive reinforcement to maintain classification rates over time.

Outcomes: Attendees to this talk will develop a deeper understanding of what motivates citizen scientists and can use these results to build stronger, more engaging, and durable citizen science projects.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Determining Cloud-Level Winds in the Venus Atmosphere with Telescopic Infrared Images of the Venus Night Side and a Team of Citizen Scientists

Mark Bullock, *Southwest Research Institute, bullock@boulder.swri.edu*

Vincent Corbett, *Denver Museum of Nature & Science, vccorby@msn.com*

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Kevin McGouldrick, *Denver Museum of Nature & Science*

Larry Stearns, *Denver Museum of Nature & Science*

Carver Thomason, *Denver Museum of Nature & Science*

Ching-Hsuan Tseng, *Denver Museum of Nature & Science*

The Venus Winds project at the Denver Museum of Nature & Science seeks to determine wind speeds in the Venus atmosphere by analyzing infrared images taken by the NASA Infrared Telescope Facility (IRTF). The atmosphere of Venus rotates up to 60 times faster than its solid body. The mechanism that drives this atmospheric 'super rotation' is not well understood, primarily for lack of observational data. A corps of citizen scientists is processing and analyzing more than 80,000 images of Venus taken since 2001. These images are of the night side of Venus, where heat from the deep atmosphere is observed at a wavelength of 2.3 microns. The patchy lower clouds of Venus appear as silhouettes, blocking the outgoing radiation where the clouds are thickest. Images are assembled into movies of the motion of Venus' lower cloud deck. The movies are then used along with geometric information to calculate wind speeds and direction across the planet. Variability in the wind field, such as the appearance and disappearance of jet streams, eddies, and waves, holds clues to the origin of Venus' atmospheric super rotation. The project uses a set of wiki pages to store the raw telescopic data, processed images at every step, instructions and methods, each collaborator's calculations, and movies generated by each of the participants. The Venus Winds project wiki pages can be found at http://wiki.boulder.swri.edu/mediawiki/index.php/Venus_Winds_Wiki. The project is partly supported by a grant from the National Science Foundation.

Outcomes: This collaboration of professional and amateur astronomers has yielded cloud-level winds in the Venus atmosphere from approximately -70 to +70 degrees latitude for the mornings of July 12 and 13, 2004. Cloud features that were seen on the morning of July 12, 2004 can also be seen in the July 13 images, having rotated about 65 degrees towards the terminator. Such consistency of features on Venus from one night to the next is very rare, and has permitted, for the first time, the determination of average wind speeds over a 24 hour time base.

Monday PM EPO 1-Hour Workshops, Special Interest Group Discussion

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

A Portable/Traveling Human Orrery

Larry Lebofsky, *University of Arizona and Planetary Science Institute, lebofsky@lpl.arizona.edu*

Michelle L. Higgins, *Sahuaro Girl Scout Council*

Donald. W. McCarthy, *University of Arizona, dwmccarthy@gmail.com*

Nancy R. Lebofsky, *Retired, lebofsky@comcast.net*

We have developed a comprehensive project for modeling the Solar System based on the construction of a semi-permanent "Human Orrery" and a traveling orrery, incorporating existing and newly-developed activities. This project allows us to model rotation and revolution, the yearly motions of the planets (both with respect to the Sun and as they appear in the sky), diurnal motion of the planets and stars, the scale of the Solar System, seasons, and seasonal constellations. Our orrery is modeled after one at Armagh Observatory, Northern Ireland. The semi-permanent orrery will normally stay at the Sahuaro Girl Scout Council's 16-acre Hacienda site in Tucson. This model consists of circular aluminum pizza pie pans representing the planets (Mercury to Saturn), the Sun, and Ceres. Our model also includes short arcs for Uranus, Neptune, and Pluto. We use rectangular aluminum pans to represent the 13 ecliptic constellations, including Ophiuchus. We have created a table so that the planets can be put in their proper positions relative to the Sun and the Earth. The traveling orrery is under development. We have incorporated this project into our existing NIRCam/James Webb Space Telescope (JWST) E/PO collaboration with the Sahuaro Council (GSUSA Astronomy Camps for Girl Scout leaders) and have also incorporated it into the Core Council outreach program for girls in Tucson and in isolated/underserved and Native American communities. The activities are flexible enough to work in a variety of venues depending on audience age and available time. This project, along with the activities being developed by the E/PO Team, will help us equip leaders from around the US to host troop-level astronomy-related activities and prepare them for the data that will be returned from NIRCam and JWST starting in 2014. Our partnership assures a continuing collaboration through the end of the JWST mission. E/PO website: http://zeus.as.arizona.edu/~dmccarthy/GSUSA.

Outcomes: While the orrery is designed to demonstrate the orbital motions of the planets, our primary goal is to link the activity with an evening observing program. Students can see the actual positions of the planets in their orbits around the Sun with the background constellations. They can then predict, using the rotation of the Earth (day and night), where they would expect to see the planets in the night sky. They can then go outside after sunset and see if their predictions match the actual positions of the planets in the night sky with the actual seasonal constellations.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Climate Change Education as a Presidential Priority: Lessons from the Climate Literacy Energy Awareness Network (CLEAN)

Mark McCaffrey, *CIRES – University of Colorado at Boulder, mark.mccaffrey@colorado.edu*

Susan Buhr, *CIRES – University of Colorado at Boulder, susan.buhr@colorado.edu*

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Anne Gold, *University of Colorado at Boulder, anne.u.gold@colorado.edu*

Reviewed and adopted by over a dozen federal agencies who participate in the US Global Change Research Program, the Climate Literacy: Essential Principles of Climate Science has become a central document in helping educators frame the basics of the climate system, which helps establish the prior understanding and concepts to appreciate the causes and impacts of human impacts on the climate system. Members of the Climate Literacy Network, who helped develop the Essential Principles, have been funded by NASA, NSF and NOAA to develop professional development programs and identify high quality digital resources that will help educators improve the quality and quantity of climate change education in the nation. One of these efforts, the Climate Literacy Energy Awareness Network (CLEAN) is developing a National Science Digital Library (NSDL) pathway that brings together climate science and energy-related solutions. This workshop will focus on lessons learned through user needs assessments and research on emerging best practices to address common climate confusion about climate topics and the role of energy consumption and climate change.

Outcomes: Participants will learn more about the Climate Literacy Essential Principles, how they were developed and endorsed by the US Global Change Research Program, what professional development and related education initiatives are being developed, and what best practices are emerging to increase the quality and quantity of climate education.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 382+384

NASA E/PO Networks — How to Use Them to Your Advantage

Bryan Mendez, *Space Sciences Laboratory, University of California at Berkeley, bmendez@ssl.berkeley.edu*

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Peggy Maher, *Penn State University, margaret.j.maher@nasa.gov*

NASA has established several nationwide networks to support the agency's Education and Public Outreach activities. These include: The NASA Museum Alliance, Solar System Ambassadors, Night Sky Network, Astrophysics Educator Ambassadors, Heliophysics Educator Ambassadors, Solar System Educators, Aerospace Educator Services Project, and the NASA Nationwide Consortium. These networks include both volunteers as well as full-time NASA personnel. Leaders from each of these networks will describe the networks, how they operate, and how to become involved or gain access to these resources.

Outcomes: Participants will learn about several of NASA's E/PO networks, who they are, and how they operate. They will also learn about opportunities to get involved in the networks and to use them for their own projects.

Session Type: 1-Hour Workshop

Location: University Memorial Center 386

Investigating Asteroids: Past, Present, Future in NASA's Dawn Mission

John Ristvey, *McREL, jristvey@mcrel.org*

Joe Wise, *New Roads School, jwise@newroads.org*

The Dawn Mission will characterize the conditions and processes of the solar system's earliest epoch by investigating Vesta and Ceres. Dawn will provide data on the role of body size and the presence of water in planetary evolution and form a bridge between the investigation of the rocky inner solar system and the icy outer solar system. In this session participants will actively engage in three activities sampling our content modules. The activities are appropriate for high school and introductory undergraduate astronomy courses for non-science majors. The Titius-Bode law led to the discovery of a "missing planet" between the orbits of Mars and Jupiter. In this activity, "In Search of?," participants become members of the Celestial Police as they hunt for the missing planet. By using a "blink test", participants in each group will have an opportunity to "search for" the missing planet. Present — The Dawn spacecraft uses ion propulsion to get the additional velocity needed to reach Vesta once it left the Delta rocket. It also uses ion propulsion to spiral to lower altitudes on Vesta, to leave Vesta and cruise to Ceres and to spiral to a low altitude orbit at Ceres. Participants learn how to design and test their own ion propulsion engine by manipulating the variables of plate charge and plate distance. Future — The presence or absence of water in soil is a concept that students are familiar with; it is a phenomenon that also relates directly to the Dawn mission. If students have watched a CSI TV show, they know how crime scene team members collect samples and trace evidence and examine and analyze spectrographs. In this final activity, participants will compare and analyze some simple spectrographs, leading to more than one possible conclusion, giving them a fairly realistic simulation of science at work.

Outcomes: Discover the missing planet using a method similar to an Italian monk named Piazzi who discovered Ceres in 1801. As participants interact with the simulation of an ion propulsion engine, they will gain an understanding of how an ion propulsion system works; and, the essential variables upon which an ion propulsion system depends. Participants analyze simulated reflectance spectra and absorption spectra to help them identify water content and soil composition respectively from remote sites. Take home materials to engage students centered on upcoming NASA mission events.

Monday PM Cosmos 1-Hour Workshops

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

How Can We Lead our Non-science Students to Think Critically and Creatively?

George Greenstein, *Amherst College, gsgreenstein@amherst.edu*

Students in introductory courses for non-majors might feel that science consists of nothing more than facts, and that they are merely being asked to memorize formulas. This can be in contrast to introductory courses in non-scientific fields, which often ask students to confront complex, difficult issues. In this workshop I will work with participants through exercises designed to do the same for our astronomy students. Examples: 1) Formulate a theory: The instructor describes a phenomenon. (i.e. the Sun is directly overhead at noon on the first day of summer in Syene, but in Alexandria it isn't.) In class, rather than explaining it, he asks students to explain it. Students and instructor work together in real time to create a theory. Ideally the process should involve false starts, in which a theory is proposed and then shown to be untenable. 2) Hypothesis testing: Often we have many conflicting theories. (i.e. the above phenomenon can be accounted for either by assuming the Earth is round, or that the Earth is flat and the Sun is near.) How can we find out which is correct? 3) "You must decide": I will describe a series of discussion/essay questions to which there is no clear "right answer." Students are asked to make a choice between competing alternatives, and to defend this choice in a well-reasoned argument. Examples include "How much money should be spent on ground- as opposed to space-based telescopes?" and "Which of the following programs has the best change of identifying the nature of dark matter: searches for MACHOS or extra-solar planets?" Workshop participants will work through these exercises, gaining familiarity with them. At every stage we will discuss how to implement them in our teaching, and to discuss the pitfalls that await the instructor who adopts such pedagogy.

Outcomes: Participants will come away from the workshop having participated in exercises designed to move introductory courses beyond a "shut up and listen" format to one which asks even non-science students to independently confront subtle scientific issues. Having done this, the participants will be more able to adopt such techniques in their own teaching.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Old Ideas, New Technologies — Harnessing the Power of Web 2.0 Resources for the Weary Instructor

Patrick Len, *Cuesta College, pmL@waiferx.com*

This workshop will demonstrate how certain tedious tasks (assessing pre-class reading assignments, appropriating copyrighted media) can be better implemented with Web 2.0 resources (online surveys, word tag analysis, weblogs, creative commons and "fair use" media catalogs). These resources are notable for their durability, accessibility, and cost (free, nearly-free, or "cheap"), as opposed to the traditional use of commercial software. Specific solutions to be shown are SurveyMonkey.com, Wordle.net, Flickr.com, search.creativecommons.org, commons.wikimedia.org, and nasaimages.org. (For an example see http://tinyurl.com/cosmosexample)

Outcomes: Demonstrations of how these resources are set up and implemented by the instructor, examples of student work, and the end results are shown. Roundtable sharing of similar solutions from participants to follow in last 15–20 minutes of workshop.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 150

How to Engineer Learning Sequences that Motivate Students to Learn what We Want Them to Know (CAE/CATS Workshop)

Edward Prather, *University of Arizona, eprather@as.arizona.edu*

Gina Brissenden, *University of Arizona, gbrissenden@as.arizona.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. The essential pathway students must be guided through in order to intellectually engage at the highest level does not occur without a significant intellectual investment on the part of the instructor. The different components to this learning pathway are not obvious but can be uncovered by answering a set of guiding questions which serve to engineer course design. Participants in this workshop will gain first-hand experience with working through a learning sequence that incorporates different learner-centered instructional strategies and makes class time meaningful for students. Successful implementation requires one to do more than just stop lecturing early and then ask students to answer some conceptual questions, or write about the main points of the lecture, or work collaboratively on a Lecture-Tutorial or Ranking Task. To truly maximize student learning requires that all aspects of instruction must be engineered to work together so that the classroom environment continuously fosters students' intellectual development. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program. For more information about creating learning sequences for ASTRO 101, please see: "The Role of Assessment in the Development of the Introductory Astronomy Course: A "How-To" Guide", Brissenden, G., Slater, T., Mathieu, R. D., & NISE College Level-One Team; Astronomy Education Review, 1(1), 2002.

Outcomes: Participants in this interactive workshop will learn how to carefully structure the many necessary steps needed to create a learner-centered classroom that maximizes students' understanding.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

Tips and Tools for Teaching Planetary Science

Nick Schneider, *University of Colorado, nick.schneider@lasp.colorado.edu*

Fran Bagenal, *University of Colorado, Fran.Bagenal@lasp.colorado.edu*

David Grinspoon, *Denver Museum of Nature & Science, dgrinspoon@dmns.org*

Planetary Science has changed dramatically from the time when instructors could do little more than teach a factual "march of the planets". The field has matured into a conceptually rich discipline, where much of the origin and evolution of planets can be explained through straightforward cause-and-effect relationships. One tenet of this approach is "comparative

planetology", in which the rules governing the behavior of planets are revealed by studying groups of planets. For example, the vast differences in the surfaces and atmospheres of the rocky, Earth-like worlds can largely be attributed to differences between their sizes, distances from the Sun, and rotation rates. Teaching introductory astronomy students about these concepts can be challenging, however, since it takes them out of their comfort zone of factual memorization. But the rewards for both students and instructors are substantial: the latest discoveries of extrasolar planets can confirm or challenge our understanding of planetary behaviors. We'll use hands-on exercises with demonstrations, clicker questions and discussion to demonstrate how to help students understand planets on a deeper conceptual level. We'll also discuss ways to take the latest discoveries beyond "wow" and turn them into teachable moments.

Outcomes: Participants will come out with modern strategies for teaching planetary science, emphasizing physical concepts and comparative principles. All will be given digital copies of video clips, demonstration descriptions, clicker questions, web links and powerpoint slidesets on recent planetary science discoveries.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B90

Astronomy Meets the Environmental Sciences: Using GLOBE at Night Data

Constance Walker, *NOAO, cwalker@noao.edu*

Stephen Pompea, *NOAO, spompea@noao.edu*

Robert Sparks, *NOAO, rsparks@noao.edu*

Many Astro101 instructors are interested in students working with real data to understand real problems and make connections between astronomy and real-life situations. One way is to engage students in citizen science. Such opportunities better enable students to become lifelong learners of science. The programs fit well in the 3-hour evening classes or labs or as citizen science experiences done outside class-time. Light pollution is a serious, growing problem worldwide. For the last 5 years the National Optical Astronomy Observatory (NOAO) has played a leadership role in the GLOBE at Night worldwide star counting program. This international citizen science program allows participants to assess the brightness of their night sky by visually noting the faintest stars in Orion or by taking measurements with a digital meter and posting their results to the Internet. The database now contains 52,000 observations from 5 annual two-week campaigns. Students can use the database to study affects of light pollution on animals, plants, human health, safety, security, energy consumption, and cost. Students can compare data over time to look for changes and trends. They can compare the data to population density or with nighttime photography and spectroscopy of lights. The data can also be used in a lighting survey, to search for dark sky oases or to monitor ordinance compliance. The workshop will bring together Astro101 instructors who have interest in participating in GLOBE at Night, using this data in their classrooms or making changes in their community. Participants will receive a CD Rom containing all GLOBE at Night data from the last 5 years in 6 different formats as well as other data files stated herein. We will model the types of comparisons and analyses that can be made. We will also share our tips and their concerns in making such a program feasible.

Outcomes: The workshop participants will 1. Receive a collection of materials (e.g., a CD Rom) with the GLOBE at Night data, data sets in environmental sciences, health, and energy conservation, and analysis tools. 2. Learn how to use GLOBE at Night data for analysis in a wide variety of ways with other types of data sets. (Bringing their computer to the workshop is strongly suggested.) 3. Have NOAO Education and Public Outreach staff as a resource for future questions. 4. Either receive a "Sky Quality Meter" or find out how to order SQMs at a reduced price.

Monday PM Cosmos 1-Hour Workshops

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B90

Demonstrations For Astronomy Classes and Public Outreach

Matt Bobrowsky, *University of Maryland, msb@umd.edu*

Bernard Beck-Winchatz, *DePaul University, bbeckwin@depaul.edu*

Jennifer Birriel, *Morehead State University, j.birriel@morehead-st.edu*

Demonstrations can be a valuable tool — for both astronomy instructors and EPO professionals. Attendees will receive a list of over 100 demonstrations that have been previously used in astronomy classes, teacher workshops, and EPO events. Some of these provide hands-on activities for the students, while others are purely demonstrations. Some demonstrations also have an accompanying (online) video that can enhance understanding of the demo. A number of the demos will be explained and exhibited, with suggestions for good ways to use them and warnings about how they can also produce misconceptions. Participants will get hands-on time with the demos, and there will be an open discussion providing everyone an opportunity to share ideas.

Outcomes: Participants will find out about new demonstrations that they may not have previously used, new ways of using old demonstrations, and cautions about demonstrations that, when used or explained certain ways, can be counterproductive.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

What Works and What Fails when Using "Clickers" or Colored Cards to Engage Students and Increase their Learning?

Michael Dubson, *University of Colorado, Michael.Dubson@colorado.edu*

Douglas Duncan, *University of Colorado, dduncan@colorado.edu*

The past ten years have seen an increasing accumulation of data that shows that peer instruction — having students discuss challenging conceptual questions during lecture — significantly increases student learning. Wireless response systems ("clickers") or colored cards are usually used to collect student responses after their discussion. At the University of Colorado,17,000 clickers are now in use, a deployment guided by Dr. Dubson. Extensive research shows that the success of clicker use is highly dependent on how a faculty member uses them. Fortunately, the faculty behaviors that lead to success are highly repeatable (as are the behaviors that lead to failure!). The same has been found with the use of colored cards: how you use them, and how you explain their use, makes an enormous difference in whether students like and accept peer instruction, and in how much they learn. In this workshop, participants will learn the behaviors practiced by the most successful peer instruction implementers, and then

practice those behaviors.

Outcomes: Participants will briefly examine the best current data that shows how peer instruction improves learning. They will learn the behaviors that lead to success, including how to explain the use of peer instruction to students (why isn't the professor telling me the right answer?), what kinds of questions work best, how to keep some students from simply copying those who sit next to them and keep others from dominating the conversations. Participants will divide into groups and practice actual classroom implementation. All participants will leave with a summary of best and worst practices, and links to several videos that show actual classroom practice.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Engaging Students with Simulations in the Classroom (CAE/CATS Workshop)

Kevin Lee, *University of Nebraska, klee6@unl.edu*

Rica French, *MiraCosta Coll, rfrench@miracosta.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. Computer simulations are valuable tools for teaching introductory astronomy as they enable students to build mental models of complex physical systems that are far beyond their everyday experience. Asking students to make predictions regarding the behavior of a simulation is a thorough test of their conceptual understanding. This workshop will focus on using computer simulations interactively in the classroom to provide formative feedback. This will be accomplished through question and answer dialogs with students as well as through worksheets where students record and reflect on their predictions. All materials of the Nebraska Astronomy Applet Project are publicly available for live use or download at http://astro.unl.edu. We would like to thank the NSF for funding under Grant Nos. 0231270 and 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

Outcomes: Participants will become familiar with the Nebraska Astronomy Applet Project — a library of sophisticated astrophysical simulations in Flash. Demonstrations will be made on using them interactively with students in question and answer dialogs as well as with worksheets. Guidelines for effective implementation will be discussed. Participants will be provided with dialog scripts and worksheets as well as shown where they are available on the web.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 150

Engaging Students with Think-Pair-Share: Conceptual Questions to Increase Learning Beyond Lecture (CAE/CATS Workshop)

Edward Prather, *University of Arizona, eprather@as.arizona.edu*

Gina Brissenden, *University of Arizona, gbrissenden@as.arizona.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. In response to the need for intellectually engaging activities for use in Astro 101, there has been a significant increase in the number of faculty making use of questioning in the classroom and the instructional strategy known as Think-Pair-Share (TPS). Think-Pair-Share allows instructors to directly interact with their students during class time, by asking conceptually-rich multiple-choice questions that challenges students understanding and provide a vehicle for student discussion. TPS is particularly enticing for instructors and students alike due to the immediate feedback provided to both on how well the students understand the topic being taught. The student-to-student discussions allow students' ideas to be explored and challenged in a less threatening environment which encourages students to investigate alternative ideas, analogies and representations while making sense of their thinking using their natural language. Participants in this workshop will gain first-hand experience by working in groups to create, critique, and implement Think-Pair-Share questions. Additionally, a significant portion of the workshop will focus on classroom management and instructional scenarios that are critical to successful implementation. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program. For more information about Think-Pair-Share, please see: "Development and Application of a Situated Apprenticeship Approach to Professional Development of Astronomy Instructors", Prather, E. E., and Brissenden, G., Astronomy Education Review, 7(2), 2008.

Outcomes: Participants in this interactive workshop will learn first hand about key steps in the implementation of intellectually engaging, learner-centered, collaborative instructional strategy that has been shown to increase students' understanding beyond what is typically achieved from lecture alone. These conceptually rich questions used during lecture offer instructors a pedagogically rich tool that will help them move their lecture-centered classroom toward a learner-centered, active-learning classroom.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

Getting Science to the Non-Scientists: Teaching an Astrobiology Course

Seth Shostak, *SETI Institute, seth@seti.org*

Jeffrey Bennett, *University of Colorado, jeffrey.bennett@comcast.net*

Planets are as common as phone poles, and there are a half-dozen worlds in our own solar system where liquid water might exist. It's becoming more and more likely that we'll find life beyond the confines of our own world. This makes it a great time to start a new course in life in the universe (astrobiology). Students love it, its interdisciplinary nature — astronomy, geology, biology, chemistry and physics — makes it a great introduction to science, and it's fun to teach. But how to do it? We'll offer suggestions to help you get underway, along with brainstorming discussions of such issues as: What students should the course target? What material should be covered? Should it be team-taught with faculty from other departments? Teaching astrobiology: after all, there's nothing more interesting than life.

Outcomes: Participants will brainstorm ideas regarding how to start and teach courses in the emerging science of astrobiology.

Tuesday AM EPO 10-Minute Orals

Session Chair: Suzy Gurton, Astronomical Society of the Pacific

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Asteroids and Rubble Piles: Addressing Misconceptions Through Physics Based Games

James Harold, *Space Science Institute, harold@spacescience.org*

Paul Dusenbery, *Space Science Institute, dusenbery@spacescience.org*

The Space Science Institute is developing a variety of asteroids related activities as part of two education projects: Finding NEO (funded through NSF and NASA SMD), and Asteroids! (funded through NSF). We present here one of these activities: Rubble, an asteroids deflection game that challenges players to push asteroids in to safe orbits before they crash in to the Earth. While these projects obviously focus on asteroids and comets for their primary content, they also present opportunities to address fundamental issues that are relevant to a broad variety of space science and astronomy topics. In the case of Rubble, we have used the open source Box2D physics engine to create a browser based Flash game that directly targets well documented misconceptions about gravity and the laws of motion. In addition to addressing basic misconceptions (e.g., that gravity stops near the Earth), the game incorporate complex objects such as "rubble piles." Representative of many (perhaps most) asteroids, rubble piles in the game can consist of as many as 60 individual rocks that gravitationally bind and separate in realistic ways. Even bombs can be modeled with sufficient physical accuracy to convince players of the hazards of trying to "blow up" incoming asteroids. The ability to easily build games based on underlying physical models allows us to address physical misconceptions in a natural way: by having the player operate in a world that directly collides with those misconceptions.

Outcomes: Participants will develop a better understanding of the current opportunities for developing affordable, physics based games using open source tools and cross-platform deployment. In addition, participants will learn how these games can be used to link engaging current astronomy and space science topics (e.g. asteroids and comets) to fundamental science misconceptions that cut across a variety of subjects.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Discover Space: An Exhibit Program for Libraries and Their Communities

Paul Dusenbery, *Space Science Institute, dusenbery@spacescience.org*

Lisa Curtis, *Space Science Institute, curtis@spacescience.org*

James Harold, *Space Science Institute, harold@spacescience.org*

In the summer of 2009, SSI launched a pilot version of the NSF-funded exhibition Discover Space. The hands-on, interactive exhibit provides science and technology-related learning experiences to library visitors. It has been well received by three Colorado libraries. Discover Space includes two exhibit areas. Space Storms introduces space weather topics. Star Quest explores how stars are born and how they die. Using a touch screen computer, visitors design interactive solar systems. An additional kiosk titled Galaxy Explorer allows visitors to explore a survey of the Milky Way Galaxy taken by the Spitzer Space Telescope. The goals for the Discover Space project are: (1) to create an extraordinary learning experience using hands-on, interactive exhibits in a library setting that will offer students and families an exciting opportunity to immerse themselves in the fields of science and technology; and (2) to provide SSI with feedback and data that will guide a statewide dissemination of an expanded version of the pilot exhibit. Through Discover Space, SSI will reach underserved populations in rural communities and inner cities, as well as those who are underrepresented in the sciences. While many families live prohibitively far from museums, or are unable to visit because of cost, families regularly use their community's public library. Bringing hands-on science learning to library patrons will further strengthen the role that libraries play as a learning resource. The exhibits become the centerpiece for auxiliary programming. SSI works with host libraries to offer public presentations by science and engineering professionals. Staff training is also an important component. The training program will, in the future, be available on SSI's website. In the interim, educational materials are posted on a Ning social network site at discoverspaceexhibit.ning.com. SSI hopes that a community of practice will emerge using the social networking features of the site.

Outcomes: Participants will: (1) Discover some of the challenges and limitations faced by libraries as potential host venues, as well as discuss possible work-around solutions. (2) Learn about the strengths and weaknesses of librarians as facilitators. (3) Hear examples of how communities of practice can be facilitated by linking libraries with area science professionals, local high schools, and nearby observatories. (4) Share project evaluation results and statistics from SSI's national library survey.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Do Learning Outcomes Escape from "Black Holes"? Summative Evaluation Data from the Smithsonian's National Traveling Exhibition.

Mary Dussault, *Harvard-Smithsonian Center for Astrophysics, mdussault@cfa.harvard.edu*

Roy R. Gould, *Harvard-Smithsonian Center for Astrophysics, rgould@cfa.harvard.edu*

Erika L. Reinfeld, *Harvard-Smithsonian Center for Astrophysics, ereinfeld@cfa.harvard.edu*

Susan Sunbury, *Harvard-Smithsonian Center for Astrophysics, ssunbury@cfa.harvard.edu*

Rucha Londhe, *Goodman Research Group, Inclondhe@grginc.com*

This presentation will report on evaluation findings from "Black Holes: Space Warps & Time Twists," a 2500 square foot interactive museum exhibition developed by the Smithsonian Astrophysical Observatory with funding from the National Science Foundation and NASA. The national traveling exhibition, which first opened at Boston's Museum of Science during summer 2009, aims to make a fascinating but challenging scientific topic accessible to diverse museum-goers. The project is a test-bed for networked exhibit technologies that allow for personalization of the visitor experience within a traveling exhibition, and a web-content authoring system that supports ongoing visitor engagement beyond the walls of the museum. Visitors who enter the exhibition can sign in to create and use their own personal bar-coded "Black Hole Explorer's Card," which allows them to collect digital

artifacts throughout the exhibition (such as images, animations, audio and video recordings of their own black hole discoveries, etc). Once visitors return home, they can use the unique bar-code number on their Explorer's Card to access their personalized online journal: a portal to further black hole exploration and a way to share their "Black Holes" experience with friends and family. Evaluators from Goodman Research Group investigated the impact of the exhibition on visitors using traditional data collection methods that included observations of visitors, exit interviews, and follow-up web surveys; but in this exhibition, we've had the unique opportunity to correlate and compare these findings to our large-sample database of visitor usage statistics that provides quantitative indicators of visitor engagement and learning. Do the experiences and learning of "card-carrying" visitors differ from other visitors? How do school groups compare to family visits? Can an exhibit on black holes help visitors learn about the role of evidence in science? Find out the answers to these questions and more!

Outcomes: Participants will: (a) increase their knowledge about how and what goals for visitor learning (knowledge, engagement, skills, behavior) were established for this designed informal astronomy learning environment; (b) learn about both innovative and traditional evaluation data collection methodology; (c) see examples of several different evaluation instruments; and (d) learn and discuss the analysis of results for the audience impact of the Black Holes exhibition.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Designing Effective E/PO Products for Museums: Preliminary Evaluation Findings from the Interstellar Boundary Explorer (IBEX) E/PO Program

Michelle Nichols, *The Adler Planetarium, mnichols@adlerplanetarium.org*

Lindsay Bartolone, *The Adler Planetarium, lbartolone@adlerplanetarium.org*

Carol Baldassari, *Program Evaluation and Research Group, Lesley University, baldasar@lesley.edu*

Samara Hoyer-Winfield, *Program Evaluation and Research Group, Lesley University, shoyerwi@lesley.edu*

The Interstellar Boundary Explorer (IBEX) mission includes a comprehensive E/PO program in astronomy and heliophysics that is overseen and implemented by the Adler Planetarium in Chicago, IL. Several components of IBEX E/PO were developed specifically for informal institutions, especially museums and planetaria. The program includes an internationally distributed planetarium show with accompanying informal education materials. Our evaluator, the Program Evaluation and Research Group (PERG) at Lesley University, Cambridge, MA, monitors the effectiveness of the E/PO program. In late 2009 through early 2010, more than 70 planetaria worldwide received the IBEX planetarium show. Of the many U.S. planetaria, the first 30 received the IBEX planetarium show and were offered the opportunity to receive, at no charge, accompanying informal education materials, including posters, lithographs, demonstration materials, lesson plans, and more. In Spring 2010, PERG staff conducted a study designed to gauge the effectiveness of the distribution process for the planetarium show, gather information on the professional development needs of the organizations, and reactions of museum staff to the IBEX informal education materials and their usefulness as companion pieces to the planetarium show. In this session, we will present preliminary findings of this study.

Outcomes: Education and Public Outreach program developers will become aware of the professional development, technical support, and educational materials needs of the astronomy education community, especially planetariums, science museums and science centers that present astronomy programs.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Sun-Earth Day: Reaching the Education Audience by Informal Means

James Thieman, *NASA/GSFC, james.r.thieman@nasa.gov*

Elaine Lewis, *NASA/GSFC (HoneywellTechnology Solutions, Inc.), elaine.m.lewis@nasa.gov*

Troy Cline, *NASA/GSFC (HoneywellTechnology Solutions, Inc.), troy.d.cline@nasa.gov*

For ten years the Sun-Earth Day program has promoted Heliophysics education to ever larger audiences through events centered on attractive annual themes. What originally started out as a one day event quickly evolved into a series of programs and events that occur throughout the year culminating with a celebration on or near the Spring Equinox. The events are often formal broadcasts or webcasts seeking to convey the science behind the latest solar-terrestrial mission discoveries. This has been quite successful, but it is clear that the younger generation increasingly depends on social networking approaches and informal news transmission for learning what is happening in the world around them. For 2010, the Sun-Earth Day team put emphasis on using informal approaches to bring the theme to the audience. The main event, a webcast from the NASA booth at the National Science Teachers Association (NSTA) annual meeting by the NASA EDGE group, took a light-hearted and offbeat approach to interviewing scientists and educators about Heliophysics news. NASA EDGE programs are unscripted and unpredictable, and that represents a different approach to getting the message across. The webcast was supplemented by a number of social networking avenues. The Sun-Earth Day program explored a wide range of social media applications including Facebook, Twitter, NING, podcasting, iPhone apps, etc. Each of these offers unique and effective methods to promote Heliophysics content and mission related highlights. The facebook site was quite popular and message posting there told the Sun-Earth Day story piece by piece. The same could be said of twittering and the tweetup held at the NSTA site. Has all of this been effective? Results are still being gathered, but anecdotal responses from the world seem very positive. What other methods might be used in the future to bring the science to a personal hands-on, interactive experience?

Outcomes: Participants will: (1) Be introduced to the Sun-Earth Day program and its evolution through a decade of programs; (2) Hear about the methods used to communicate and educate through the years and how well they have worked; and (3) Be acquainted with the latest usage of social networking and informal education approaches and how well they have worked.

Tuesday AM EPO 1-Hour Workshops

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Graphing, Gravity, and Kepler's Laws — Activities from NASA's Kepler Mission EPO

Alan Gould, *Lawrence Hall of Science – UC Berkeley, agould@berkeley.edu*

Edna DeVore, *SETI Institute, edevore@seti.org*

Pamela Harman, *SETI Institute, pharman@seti.org*

NASA's Kepler Mission, launched in March 2009, is detecting extrasolar planets by the transit method. The Mission is posting light curves on the website that are used in the "Transit Tracks" lesson plan. The lesson begins with understanding the concept of light curves, and then analyzing planet transit curves. Light curves can be generated by a model in the classroom for real time data collection and analysis, using sensor and graphic interface common to high school labs. Students using either the NASA data or data generated by classroom model will use graphing technology and computer generated light curves to develop investigation, communication and explanation skills for inquiry. Principles of gravity and Kepler's Laws will then be applied to calculate the extrasolar planets' orbital radii and size. Kepler Mission findings and technology overview, as well as the lesson will be presented by Kepler Mission Co-Investigators. NASA materials will be distributed.

Outcomes: Workshop participants will be able to provide activities for students and people in both formal and informal education settings to be able to interpret light curves (graphs), using Kepler's Laws to calculate orbital radius and planet size.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

Building Space Pods — A "Get-Dirty" Hands-On Workshop

Daniel Lyons, *University of Wyoming, CAPER, sslaterwyo@gmail.com*

Tim Slater, *University of Wyoming, CAPER*

Stephanie Slater, *University of Wyoming, CAPER*

Janice Harvey, *Gemini Observatory*

Sandra Dawson, *Thirty Meter Telescope*

Peter Michaud, *Gemini Observatory*

We know that every little kid loves stars, planets and dinosaurs, and like many of you we dream of leveraging those native interests to draw students into the earth and space sciences, and science in general. Yet, as individuals charged with enhancing teachers', students', and the public's knowledge of and attitudes toward earth and space sciences, we are often stymied by the knowledge that these constituents are pressured to focus on other scientific concepts, such as biology and the purer physical sciences. Elementary teachers in particular have many topics to teach besides astronomy in the service of teaching a broad base of science ideas. For the past five years, we have been working with the schools and community of the Big Island of Hawaii, to support the teaching of science. In response to teachers' needs reaching beyond astronomy, we have generated a series of cross-disciplinary classroom materials that reflect that wide breadth of sciences in the National Science Education Standards, but still utilize astronomy as a vehicle. In this workshop, come join your colleagues in building Space Pods to study the behavior of living things in diverse environments. In addition, we will share a little of what we have learned as we have worked to shape many of the biology and physical science standards into the most interdisciplinary of sciences: astronomy. We promise you'll get your hands dirty in this session, so be prepared for a great time!

Outcomes: Participants will become aware of classroom-tested examples of how astronomy can be used as a vehicle to teach broader scientific concepts called for in the National Science Education Standards.

Session Type: 1-Hour Workshop

Location: University Memorial Center 382+384

Astronomy Meets the Environmental Sciences: Activities for Informal and Formal Educational Settings

Constance Walker, *National Optical Astronomy Observatory, cwalker@noao.edu*

Robert T. Sparks, *National Optical Astronomy Observatory, rsparks@noao.edu*

Stephen M. Pompea, *National Optical Astronomy Observatory, spompea@noao.edu*

The arc of the Milky Way seen from a truly dark location is part of our planet's natural heritage. Yet, with half of the world's population now living in cities, many urban dwellers have never experienced the wonderment of pristinely dark skies and maybe never will. The challenge comes in explaining the importance of what they've lost to artificial sky glow, making them aware that light pollution is a concern on many fronts and convincing them that it's worthwhile to take steps, even small ones, to help redress this issue. To do this, children should be a main focus and we should use approaches that offer involvement on many levels, from cursory to committed, and via many venues. The programs and resources must be as turn-key as possible for EPO personnel and include ways to visualize the problem with simple, easily grasped and enjoyable activities. Activities like these were created by the National Optical Astronomy Observatory (NOAO) for grades 3–12 in a program called "Dark Skies Rangers". The activities address how light pollution affects safety, energy conservation, cost, health and wildlife, as well as our ability to view the stars. They are downloadable on-line and available on CD as part of a dark skies kit. The central part of the kit is the light shielding demonstration, which illustrates the reasons for lighting responsibly. The workshop will bring together EPO people who have an interest in incorporating dark skies education in formal or informal educational settings. Workshop participants will be invited to try one of four activities and report back during a discussion on incorporating the activities in their setting. Participants will receive a CD Rom containing all 8 activities on dark skies education and other helpful materials. We will share our tips and their concerns in making this program successful.

Outcomes: The workshop participants will: • Receive a collection of materials (e.g., a CD Rom) on dark skies education that can be used in formal or informal educational settings. • Experience one of four activities that illustrate light pollutions effect on in astronomy, environmental sciences, health, and energy conservation. • Be actively engaged in a discussion of how to use the dark skies education activities effectively and successfully within participants' settings. • Have NOAO Education and Public Outreach staff as a resource for future questions. • Receive a mini-dark skies kit upon committing to participate in the program.

Tuesday AM EPO 10-Minute Orals

Session Chair: Theresa Schwerin, Institute for Global Environmental Strategies

Time: 11:15 a.m. – 12:05 p.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Students Detect and Characterize Exoplanets Using MicroObservatory Online Telescopes

Roy Gould, *Harvard-Smithsonian Center for Astrophysics, rgould@cfa.harvard.edu*

Ruth Krumhansl, *Education Development Center, rkrumhansl@cfa.harvard.edu*

Susan Sunbury, *Harvard-Smithsonian Center for Astrophysics, ssunbury@cfa*

The search for habitable planets beyond our own solar system is one of the most exciting frontiers in science. Remarkably, students can participate in this search from their classrooms using the small MicroObservatory online telescopes. Other Worlds, Other Earths is an NSF-sponsored pilot project that invites middle- and high-school students to apply core concepts in astronomy, earth science, and physics in the search for other worlds. Pre-college students in seven states have now successfully detected and characterized several known exoplanets, including TRES-3, HATP-10, and HATP-12. Additional software enables students to pool and compare their data, and to model their planets' orbits and properties. In this session, we offer suggestions to educators who would like to use these materials with their audiences, especially as an entree to the existing and planned space missions that promise to revolutionize the field.

Outcomes: This session will advance the community of practice by alerting the community to a new resource for the astronomy education toolkit. Though the session is too short to go into any topic in depth, we will list the principal challenges and opportunities facing planet-hunters, and we will point attendees towards the resources and additional information.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

African Dust Project: Teachers and Students Collect Sun Photometer Measurements to Better Understand the Climatic Effects of Aerosols Including Atmospheric Mineral Dust

Dianne Robinson, *Hampton University, dianne.robinson@hamptonu.edu*

Barbara Maggi, *Hampton University, barbara.maggi@hamptonu.edu*

Hampton University, a historically black university, is currently partnering with NASA and the GLOBE program to involve teachers and students in a project to collect local aerosol measurements. This effort will allow them to study aerosol properties, behavior and their effects on the local and potentially global climate. In particular, emphasis is being placed on understanding the climatic effects of atmospheric mineral dust, building on the African Dust aerosol studies that Olga Kalashnikova is conducting at JPL. Dianne Robinson, a professor and outreach director at Hampton University, is leading the African Dust professional development efforts at a workshop for educators in Mayaguez, Puerto Rico from June 20–25, 2010. The sessions compliment the GLOBE atmospheric protocols by providing a real world inquiry based local research project for students that utilizes a hand-held sun photometer and NASA satellite data. It also provides the teachers and students with a link to a research scientist involved in an ongoing study of African dust. Studies show that mineral particles transported over the ocean affect marine biochemistry by depositing iron in the ocean. This plays a role in neutralizing acid rain, affecting the life cycle of coral reefs and influencing sea surface temperatures that affect hurricane formation and intensity. In addition, changes in atmospheric dust aerosol loading, could cause a change in the radiation balance and consequentially, surface temperatures. The African Dust Workshop being implemented in Puerto Rico builds on the highly successful NASA/ Hampton University educator workshop model developed for satellite missions CALIPSO and GLOBE. The education activities of the workshop currently support student scientific inquiry aimed at inspiring teacher and student understanding of Earth as a system, climate change and NASA satellite data. Lessons will be posted at My NASA Data, http://mynasadata.larc.nasa.gov/, and additional information about the African Dust Workshop will be available at: http://aerosols.hamptonu.edu.

Outcomes: Participants will come away from this session with a better understanding of the affects that African Dust is having on our environment and how students take local aerosol measurements with a hand-held instrument, a sun photometer. In addition, they will learn about NASA resources such as My NASA DATA and GLOBE, where teachers and students can observe satellite data and participate in taking and reporting environmental measurements with specific protocols. Additional information will be given about upcoming professional development opportunities for teachers and opportunities for scientists to partner with Hampton University on future projects.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Options for Inexpensive, High-Quality, Student-Made Telescopes

Guy Brandenburg, *Carnegie Institution of Washington, First Light Science Academy, gfbrandenburg@yahoo.com*

Julie Edmonds, *Carnegie Institution for Science, First Light Science Academy, jedmonds@ciw.edu*

Toby Horn, *Carnegie Institution for Science, First Light Science Academy, thorn@ciw.edu*

We describe the experiences of middle-school students in making their own high-quality telescopes of various designs. Experiments with various types of loose lenses eventually led to building true Galilean telescopes from two PVC pipes and two simple lenses — showing the narrow field of view, low magnification, and color problems that plagued this design. In another case, in about 2 hours, they constructed and decorated their own personal, high-quality, refracting telescopes from surplus achromatic lenses, off-the-shelf plumbing parts, hand tools, and inexpensive 0.965" commercial eyepieces. An optional mini-tripod, with a student-constructed º-20 mounting hole, put the total cost at about $25 per telescope. A more ambitious, group project involved using hand tools and power drills to make 6-inch diameter Newtonian reflectors on a Dobsonian mount. These telescopes were used in observing Comet Tempel-Tuttle, among other celestial objects. The primary mirrors had already been fabricated, and the major wooden parts already cut out. A working example of each of these

telescopes will be displayed. Parts lists, step-by-step modifiable instructions, and lists of suggested vendors for the optics will be distributed.

Outcomes: Participants will learn techniques for having students to construct their own inexpensive personal telescopes. A variety of different telescope designs will be presented, so participants can select the one best suited for their students' needs. Instead of students relying solely on a central academic observatory, they can make their own personal astronomical observations at their own houses, whenever it is convenient for them.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Engineering Design Challenge: The Search for Life

Laura Venner, *Meadowlands Environment Center / William D. McDowell Observatory, lv2008@columbia.edu*

Engaging students in scientific exploration and discovery is one of the primary goals of the NASA/JPL Solar System Ambassadors and Educators Programs. Astrobiology is the ideal discipline to help us achieve the goal of engaging students, as Astrobiology provides a unique foundation on which students with varying interests can engage in cooperative learning experiences. Astrobiology-based activities also serve to engage students in cross-curriculum learning resulting in thought-provoking questions that students can debate and explore. This two-day Astrobiology Cooperative Engineering Design Challenge: The Search for Life engages Middle and High School Students in hands-on activities that enable them to identify planets that may have the ingredients to support life. The students become specialists in one of five areas related to the search for life and water on other planets in order to participate in teams that collect and analyze data related to an arbitrary planet that is assigned to them. The students will determine whether water or life can exist on their planet and develop the best method for exploring the planet. The challenge concludes with each team presenting and launching a rover, orbiter, or probe equipped with instrumentation to collect data that they have designed and built to explore their designated planet. The robotic instruments will be created using trash in an effort to reinforce the idea of reduce, reuse, recycle. The program adheres to the New Jersey Core Curriculum Content Standards and is designed to nourish the student's inquisitive nature and provide an opportunity to work as a team and function as a scientist by making observations, performing experiments and collecting and recording data.

Outcomes: Participants will learn about the cross curricular nature of astrobiology and how they can incorporate astrobiology into their lessons. Each specialty group will be outlined for the participants and can be run autonomously in the classroom allowing educators to focus on the one aspect of planetary exploration that fits into their current lesson plan, e.g.: geology, EMR, chemistry, etc. The complete lesson plan, which adheres to the New Jersey Core Curriculum Content Standards, will be provided to each participant.

Tuesday AM EPO Special Interest Group Discussions

Time: 11:15 a.m. – 12:05 p.m.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 382+384

Making Connections with Underserved Communities, Broadening Participation in the STEM Fields

Katy Garmany, *National Optical Astronomy Observatory, garmany@noao.edu*

Rick Fienberg, *American Astronomical Society*

Michael Gibbs, *Capitol College*

Erika Grundstrom, *Vanderbilt University*

Janice Harvey, *Gemini Observatory*

Kevin McLin, *Sonoma State University*

Mangala Sharma, *Space Telescope Science Institute*

Tom Statler, *NSF Astronomy*

The U.S. faces an increasing challenge involving the decrease in the size of the highly skilled technical workforce. The underrepresented minority workforce is growing rapidly, but these workers are most likely to be under-educated for positions in science and technology. Seeing the need, NASA, the NSF and other federal agencies have expressed their renewed commitment to improving diversity. This includes preparing a diverse, globally engaged workforce in the STEM fields, integrating research with education, and expanding efforts to broaden participation from underrepresented groups and from all geographic regions. This issue is one that everyone who writes grants and proposals, who teaches at any level, or who does outreach should be considering. This special interest group will bring together those working to achieve these goals, or simply wanting more information, and offer all participants a chance to share successes and address problems. While some individuals will be asked to lead off the discussion, the goal of broadening participation mandates that much of the session will come from audience member participation.

Outcomes: Attendees at this session will leave with a clearer understanding of the rewards and challenges faced in the broadening participation enterprise. They will receive information on useful web resources, as well as have an opportunity for personal contacts with others working toward the same goals.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 247

Supporting Online Communities

Anna Hurst, *Astronomical Society of the Pacific, ahurst@astrosociety.org*

Marni Berendsen, *Astronomical Society of the Pacific, mberendsen@astrosociety.org*

Gina Brissenden, *NASA's Center for Astronomy Education (CAE), University of Arizona, gbrissenden@as.arizona.edu*

Claudia Figueiredo, *Institute for Learning Innovation, figueiredo@ilinet.org*

Suzy Gurton, *Astronomical Society of the Pacific, sgurton@astrosociety.org*

A special interest group meeting, moderated by EPO professionals with experience in this field, for people who run and/or participate in online communities. Come prepared to ask questions and share your own experiences. What are the objectives of your online community? What barriers have you experienced to reaching those objectives? What is missing from the community? What tools and techniques have been used effectively to address the barriers and achieve the objectives?

Outcomes: Participants will experience an exchange of field-tested successful techniques, tools, resources, and philosophies for supporting online communities.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 425

Teaching Climate Change

Aileen O'Donoghue, *St. Lawrence University*

In giving public presentations about climate change, we face the barriers of misinformation in the political debate and lack of science literacy that extends to science phobia for some. In climate issues, the later problem is compounded by the fact that the science — reconstruction of past climate through the use of proxy sources, such as isotopes of oxygen and hydrogen — is complex, making it more challenging for general audiences. Also, the process of science, particularly peer review, is suspected by some to be a way of keeping science orthodox instead of keeping it honest. I approach these barriers by focusing on the data and the fact that the data have been carefully acquired over decades and centuries by dedicated people with no political agenda. I have taught elderhostel courses twice and have given many public talks on this topic. Thus I have experience in this area to share with others. I would also like to learn of others' approaches to the vast amount of scientific information and getting past the politics. A special interest group on climate change will allow those of us to speak on this important topic to share how we approach both the science and the politics of this issue.

Outcomes: Participants will come away with a richer understanding of the science of climate change, and techniques for teaching the science and dealing with the politics.

Tuesday PM EPO 10-Minute Orals

Session Chair: Greg Schultz, Astronomical Society of the Pacific

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

Making a Science Radio Show

Seth Shostak, *SETI Institute, seth@seti.org*

Molly Bentley, *SETI Institute, mbentley@seti.org*

Radio has undergone an enormous transition in the past decade, as new means of distribution (especially the internet) has broadened the reach of programming from local to global. Science is, by nature, a subject without borders — of interest to people everywhere. In this presentation, we discuss how we design and produce a weekly, one-hour radio show on a broad range of topics, from astronomy to artificial intelligence, from physics to pseudoscience, and do so with wit and appeal.

Outcomes: The audience will understand what it takes to make an appealing and successful radio show about science — how to go beyond the basement podcast, and reach audiences world-wide.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

Making Sausage: The Process of Producing SOFIA's First Light News Release

Dana Backman, *SOFIA / SETI Institute, dbackman@sofia.usra.edu*

Nicholas Veronico, *Astronomical Society of the Pacific, nveronico@sofia.usra.edu*

Astrophysics mission EPO offices often include, or work side-by-side, with the public affairs people responsible for producing news releases communicating mission milestones and achievements to the public. NASA's Stratospheric Observatory for Infrared Astronomy, SOFIA, is organizationally complex, with international partners, program management at two NASA centers, instruments built at institutions across the U.S. and Europe, and a science center run by an academic consortium contractor. The process of producing a news release for the observatory's First Light observations called for months of careful navigation intended to make sure all the stakeholders would be satisfied. This talk will briefly summarize the SOFIA First Light public affairs preparations, the flight itself on May 26, the following two days of reducing the data and finalizing the news release, getting the release broadcast, and (some of) the strange and wonderful events along the way.

Outcomes: Behind-the-scenes knowledge about how space science mission results are translated into public broadcast news, helping participants better interpret (read between the lines of) future news releases.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

Partnering with Amateur Astronomers to Get Your Message to the Public

Vivian White, *Astronomical Society of the Pacific, vwhite@astrosociety.org*

Marni Berendsen, *Astronomical Society of the Pacific, mberendsen@astrosociety.org*

Kenneth Frank, *Astronomical Society of the Pacific, kfrank@astrosociety.org*

Jessica Santascoy, *Astronomical Society of the Pacific, jsantascoy@astrosociety.org*

The Night Sky Network (NSN) is a nationwide coalition of over 300 astronomy clubs bringing the science and inspiration of astronomy to the general public. Learn what these amazing amateurs are doing, the resources they currently have, and how easy it is for you to partner with them through NSN. The EPO community recognizes amateur astronomers as some of the most effective and prolific outreach partners. Their prior knowledge and enthusiasm for the subject make them perfect spokespeople for new science and education projects. Partnerships with NASA missions and the EPO community allow NSN to aid the efforts of amateur

astronomers as outreach experts in many ways. Recent collaborations have seen astronomy clubs as partners with museums, public television stations, and citizen science projects. One important aspect of NSN is the distribution of educational materials designed specifically for the settings where amateurs do outreach. These Outreach ToolKits give clubs ideas and props to help them explain the universe using simple interactive activities and demonstrations. There are currently eight in use with three more in development. Partnering with SSI and the Great Balls of Fire exhibit, the Space Rocks ToolKit looks at the impacts of small Solar System bodies. In collaboration with JPL and the Virtual Planetary Labs, an astrobiology ToolKit will help amateurs talk about the search for life in the universe. NASA EPOESS funding will make possible the release of a heliophysics ToolKit in 2012 that amateurs have been eagerly anticipating. NSN makes it easy for you to become involved in a number of ways. Enhance the network's dynamic resources with information about your projects through telecons, newsletters, online articles, and new media. There is also a simple and effective system in place to get physical materials into the hands of the clubs who regularly distribute them to the public. Need to know who's using what? Self-reporting by the clubs is built into the network to let you know how your services are being utilized. How can the Night Sky Network help your project reach its full potential?

Outcomes: Learn concrete ways to leverage the existing nationwide network of astronomy enthusiasts to enlighten the public about your project.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

What Women Want: Motivations and Challenges of Women Participating in Amateur Astronomy Clubs

Claudia Figueiredo, *Institute for Learning Innovation, figueiredo@ilinet.org*

Erin Johnson, *Institute for Learning Innovation, johnson@ilinet.org*

Eric Jones, *Institute for Learning Innovation, ecojones@uncg.edu*

Marni Berendsen, *Astronomical Society of the Pacific, mberendsen @astrosociety.org*

Judy Koke, *Art Gallery of Ontario, Judy_Koke@ago.net*

Amateur astronomy clubs are frequently described as rather homogenous in terms of their membership composition. Besides ethnic minorities and youth, women in particular tend to be underrepresented. Clubs that may be searching for strategies to involve more women in their membership may find it useful to learn about what motivates women's participation in astronomy, as well as what some of them describe as challenges for their participation. This session presents the results of an online questionnaire answered by 768 women about their motivations and challenges to participation in astronomy clubs. These results shed light into what attracts women to the hobby and explores some strategies in the areas of club environment, balancing work and home responsibility, and club foci that women answering the online questionnaire found facilitated their participation. These results will inform other public outreach areas that struggle with getting more female involvement.

Outcomes: Participants will learn what motivates and hinders participation of women in amateur astronomy clubs. This knowledge will be helpful to practitioners who intend to increase women participation in their programs.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

Beyond Teaching: Building the Next Generation of Science Thinkers

Erin Johnson, *The Institute for Learning Innovation, johnson@ilinet.org*

Claudia Figueiredo, *The Institute for Learning Innovation, figueiredo@ilinet.org*

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Amateur astronomy clubs engaged in public outreach aspire to increase public awareness and knowledge of astronomy and science by providing opportunities for the public to experience the night sky. These public outreach opportunities are frequently referred to as experiences that 'spark' an interest in astronomy, however, drawing upon a growing body of literature from the Environmental Movement, it seems that in order to create a new generation of science thinkers, these 'sparks' may need additional fuel supplied over a period of time to reach their full potential. The Institute for Learning Innovation (ILI) and the Astronomical Society of the Pacific (ASP) collaborated to conduct research aimed at understanding the culture of public outreach conducted by amateur astronomy clubs. Findings from an ethnographic study of nine amateur astronomy clubs that are highly engaged in public outreach suggest that the culture of these clubs supports many effective strategies for sustaining this spark, including some that are targeted at youth audiences. These include encouraging family memberships, providing kid friendly activities during club meetings, and instituting mentoring. This presentation will discuss these strategies and explore different ways they can impact and inform the practice of public outreach for both amateur astronomers and EPO professionals.

Outcomes: Participants will take away new philosophies and EPO strategies for sustaining the 'sparks' of science over time.

Tuesday PM EPO 1-Hour Workshops

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Know Your Earth: A Fun Multi-Mission, Multi-Media View of NASA Earth-Observing Satellites and Global Climate Change

Brian Campbell, *SAIC / NASA GSFC, Brian.A.Campbell@nasa.gov*

The "Know Your Earth" (KYE) project is a venture between NASA's Earth-Observing missions and National CineMedia (NCM). The KYE project team created a fun and educational 3-minute segment of Did You Know questions that all have a message that focuses on global climate change and literacy throughout 295 national movie theaters (Regal, AMC, and Cinemark) on lobby LCD screens during the peak summer blockbuster month of July 2010. The Know Your Earth segment will also be available to science centers, museums, airports, and will be available for anyone to download at http://www.nasa.gov/knowyourearth (web site to be public

July 2010). KYE Missions are: ACRIMSAT, Aqua, Aura, CALIPSO, CloudSat, GRACE, ICESat, Jason-1, Landsat, QuikSCAT, and Terra. The 3-minute video will have a fun and engaging feel that all audiences will appreciate. This session will focus on the newly created KYE product and will allow participants to see how they can create a similar product and/or participate in future iterations of KYE.

Outcomes: Participants will view the Know Your Earth product and will see how they can create a similar product and/or participate in future iterations of KYE with the NASA Earth Science Mission E/PO community. New skills include seeing just how a team from 11 satellite missions have worked together as one, in order to create a cutting-edge E/PO product. This will also allow for the advancement of cross-collaborations across different missions, agencies, and science groups.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

Live From Gemini: Expanding the Walls of the Classroom Globally

Janice Harvey, *Gemini Observatory, jharvey@gemini.edu*

Peter Michaud, *Gemini Observatory, pmichaud@gemini.edu*

Rich Valcourt, *Gemini Observatory, rvalcourt@gemini.edu*

Live From Gemini has been designed to share Gemini Observatory's resources with a diverse range of learners and expand the walls of the classroom globally. The program is inquiry-based and adaptable to a wide range of learners who participate in a one-on-one videoconference with an expert astronomer/educator host live from one of the Gemini control rooms. Participants will experience real science in a genuine observatory environment. Live from Gemini fills many state science requirements including: (a) understanding about science and technology implementation; (b) understanding about scientific inquiry; (c) science as a human endeavor; (d) science and technology in local, national, and global challenges; (e) interactions of energy and matter; (f) origin and evolution of the universe; and (g) nature of scientific knowledge. During the course of the program, which lasts about forty-five minutes, students are introduced to the operation of a modern astronomical observatory, the technology that makes observations possible, and a sampling of the exciting science explored by one of the world's largest astronomical observatories. In addition, programs can be customized in content areas that include: (1) the electromagnetic spectrum; (2) wavefront optics (adaptive and active optics); (3) telescopes as time-machines; (4) concepts in modern astronomy such as planetary system formation; (5) Galactic evolution, stellar evolution, cosmology; (6) spectroscopy & imaging instruments and techniques; (7) other topics on request. Programs can be scheduled at any time of the day, but require a minimum of two weeks advance booking.

Outcomes: Live From Gemini fulfills a wide range of National (and most state) Science Standards for US students as well as international education systems. With advance planning, programs can include post-videoconference activities based upon a CD-ROM Virtual Tour. All programs are approximately 45-minutes in duration and include time for a live Q&A session. Students will take away the opportunity to talk with an astronomer/educator live from a modern astronomical observatory.

Session Type: 1-Hour Workshop

Location: University Memorial Center 382+384

Astrophotography for All: Capturing the Colorful Cosmos with Online Telescopes

Erika Reinfeld, *Harvard-Smithsonian Center for Astrophysics, ereinfeld@cfa.harvard.edu*

Mary Dussault, *Harvard-Smithsonian Center for Astrophysics, mdussault@cfa.harvard.edu*

Margaret Glass, *Association of Science-Technology Centers, mglass@astc.org*

Frank Sienkiewicz, *Harvard-Smithsonian Center for Astrophysics, fsienkiewicz@cfa.harvard.edu*

This workshop will engage participants in the "Capture the Colorful Cosmos" astrophotography project, using freely available robotic telescopes, astronomical image processing, and hands-on activities. Participants will learn how to use these resources to facilitate audience-created exhibits for public display and educational programming. Please bring a laptop if you have one. Capture the Colorful Cosmos began in the spring of 2009 with an online mini-workshop; by the end of the year it had reached more than 120 astronomy educators, 2000 astrophotography exhibit creators, and 150,000 exhibit visitors. Astronomy educators from the Harvard-Smithsonian Center for Astrophysics developed the project in collaboration with the Association of Science-Technology Centers, and the Astronomy From the Ground Up program from the Astronomical Society of the Pacific. Using the new "Observing With NASA" online interface to the MicroObservatory robotic telescope network, project participants can take red, green and blue filter images and process their own full-color astronomical images. During IYA, more than two dozen informal education institutions developed their own programming using these resources. Each organization implemented 1) programs to introduce audiences to MicroObservatory and show them how to process images, and 2) an exhibit that would show off their visitors' astrophotography creations to a broader pubic. Participants in this session will use Capture the Colorful Cosmos materials to develop their own astrophotography display. Activities will include Observing With NASA, AstroPoetry, kinesthetic telescope, and image processing/RGB color imaging.

Outcomes: Participants will: (1) Learn how to use online telescopes to develop authentic observing experiences for informal education audiences. (2) Explore hands-on activities for helping diverse audiences make sense of astronomical imagery. (3) Receive tips for facilitating low-budget exhibit development by public audiences. (4) Review examples of public astrophotography creations facilitated by other astronomy educators. (5) Work with session presenters to incorporate Capture the Colorful Cosmos resources, including the Observing With NASA telescope portal, into their own education programs

Session Type: 1-Hour Workshop

Location: University Memorial Center 386

A Model for Teacher Professional Development Workshops — Radiation Storm vs. The Magnetic Shield: Superheroes of Magnetism & Space Weather Education

Randy Russell, *Windows to the Universe, rrussell@ucar.edu*

Roberta Johnson, *Windows to the Universe, rmjohnsn@gmail.com*

Magnetic and electric fields and phenomena play important roles in various situations in astronomy, planetary science, and Earth science. Students often lack an intuitive sense of electromagnetic phenomena, and therefore struggle with the complexities of planetary and stellar magnetic fields. Hands-on magnetism activities can provide students with an intuitive grasp of the basics of magnetism, preparing them for more challenging conceptual studies of magnetic phenomena. For the past six years, we have been presenting a professional development workshop for teachers covering the topics of magnetism and space weather. The workshop, which has been conducted more than 20 times for a range of audiences, blends together several simple hands-on activities, background information on space weather and geomagnetism, a collection of images, animations, and interactives that illustrate important concepts, and guidance about specific links between these topics and national science education standards. These workshops have been very well-received, and have consistently been rated highly by participants in surveys. We believe the methods used in these workshops can be applied to other topics in science education and to astronomy and Earth science education specifically. In this presentation, we will describe our magnetism and space weather workshop and demonstrate some elements of it, including some of the hands-on activities. We will describe successful aspects of the workshop and comment on ways we think this approach could be replicated for other topics. We will also display some of the interactives, graphics, and animations shown during the workshops. Resources have been added to the workshop over the years in response to recurring questions from teachers; we will comment on this process and how it might be applied to other topics. The activities and extensive background content used or referenced in the workshop are available for free on the Windows to the Universe web site (www.windows2universe.org).

Outcomes: Participants will learn about a successful model for teacher professional development workshops. We will describe aspects of the workshop which have contributed to its success and which could be applied to other topics. Participants will have a chance to try out some of the hands-on activities used in these workshops and will view some of the images, animations, and interactives displayed during the workshops. We will describe "lessons learned" during the course of presenting this material more than 20 times over the past 6 years, with an eye towards replicating this success if applied to other topics.

Tuesday PM EPO 10-Minute Orals

Session Chair: Doris Daou, NASA Ames Research Center

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 10-Minute Oral

Location: Cristol Chemistry Chemistry 140

Project ASTRO and the Galileo Teacher Training Program: Innovation in Action for K–12 Professional Development in Astronomy

Brian Kruse, *Astronomical Society of the Pacific, bkruse@astrosociety.org*

Greg Schultz, *Astronomical Society of the Pacific, gschultz@astrosociety.org*

James Manning, *Astronomical Society of the Pacific, jmanning@astrosociety.org*

The Astronomical Society of the Pacific's signature program Project ASTRO has since 1993 provided innovative professional development for the K–12 education community by partnering astronomers with teachers. A signature program of the International Year of Astronomy and Beyond, the Galileo Teacher Training Program offers professional development by incorporating Galileo's seminal observations into inquiry-based activities, teaching the process of science to students in a collaborative environment. Both programs employ networks to build communities of practice with the goal of bringing the best possible experience to teachers, and in turn inspire their students towards scientific literacy.

Outcomes: Participants will learn about the formal education programs at the Astronomical Society of the Pacific and how they have evolved to provide exemplary and innovative professional development to teachers. Participants will learn how they can get involved and become a part of the ASP formal education network.

Session Type: 10-Minute Oral

Location: Cristol Chemistry Chemistry 140

Windows to the Universe at NESTA — Opportunities for Organizations, Programs, Scientists, and Educators

Roberta Johnson, *National Earth Science Teachers Association, rmjohnsn@gmail.com*

NESTA announces that the Windows to the Universe (W2U) project (http://windows2universe.org) has joined NESTA as its new home. The William and Flora Hewlett Foundation have agreed to provide support for a critically important transition of W2U to sustainability as an Open Educational Resource. This project, which began in April 2010, involves the transition of W2U management from the University Corporation for Atmospheric Research (where it has found its home since June 2000) to NESTA. The move will provide NESTA one of the world's most popular Earth and Space science education and outreach websites as a vehicle for reaching teachers and students around the world. The project will support a major redesign and updating of the website, including implementation of new capabilities and technologies, while maintaining the website as a globally free educational resource for the Earth and Space sciences and related disciplines. Through the programs we develop, we will make it possible for partner organizations, programs, scientists and educators to share information about their research, resources, programs, products and events through the website so that it becomes a community education and outreach facility for the Earth and Space sciences. W2U content development will also continue at the UCAR Office of Education and Outreach, through on-going and new W2U projects. Development activities will be coordinated by W2U management at NESTA. The goal of this major change is to allow the W2U project (the website and our professional development programs) to flourish in support of and collaboration with the entire geosciences education community — with expanded, up-to-date content, resources, and professional development offerings in multiple languages made available through a community of contributors. Please be in touch with Dr. Roberta Johnson at rmjohnsn@gmail.com or 303-929-1606 if you are interested in finding out more about these opportunities.

Outcomes: Participants will find out about an important new opportunity for partnership in EPO and how they can access a large and diverse global audience of teachers and learners for both Earth and space sciences.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

The Earth System Science Education Alliance: A Program for Sustained Teacher Professional Development

Theresa Schwerin, *Institute for Global Environmental Strategies, theresa_schwerin@strategies.org*

Lynn Blaney, *Peak to Peak Enterprises, lblaney@1st.net*

Robert Myers, *Institute for Global Environmental Strategies, bob_myers@strategies.org*

The Earth System Science Education Alliance (ESSEA) professional development program is providing interdisciplinary geoscience and environmental education content and teaching methods to pre- and in-service teachers. Sponsored by NSF, NASA and NOAA, the network has expanded to nearly 40 institutions of higher learning committed to teacher education. The program supports participating institutions with funding, training, and standards-aligned courses and resources for participants (http://esseacourses.strategies.org). The ESSEA program's mission is to: 1) support universities and science education organizations delivering the K–12 online courses; 2) strengthen teachers' understanding of geoscience and environmental education; 3) demonstrate the ability to deliver exceptional professional development to a national audience; and 4) create a solid infrastructure to sustain the program. As of December 2009, the courses had been used by 60 faculty at 40 institutions educating over 3500 K–12 teachers environmental education. ESSEA is an innovative program with a mix of online and face-to-face courses emphasizing inquiry. Typical modules include deforestation, coastal inundation, alternative fuels, Gulf of Mexico Dead Zones, volcanoes and Arctic Oscillation. ESSEA has created a national professional development program aimed at improving the knowledge, skills, and resources of geoscience and environmental educators. This professional development program offers state-of-the-art, online courses to promote understanding of environmental education, to encourage communication and cooperation among teachers, and to facilitate the use of exceptional classroom materials. The ESSEA professional development framework emphasizes skills building and taxing the brain through inquiry. All of the ESSEA lessons model problem-based learning, group investigations or cooperative learning. Teachers develop skills in group problem solving with an emphasis on making recommendations or taking action concerning geoscience or environmental dilemmas.

Outcomes: 1. Provide geoscience research missions a means by which their data, research reports or educational materials may reach a wider audience. 2. Offer practicing K–12 teachers new geoscience and environmental materials and lessons for immediate classroom use. 3. Alert teachers to the opportunity for professional development needed for advanced degrees or certification. 4. Provide universities with an opportunity to participate as an associate member. 5. Acquaint practicing teachers with the ESSEA model used to engage students in problem solving.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

New National Science Education Standards and Astronomy: An Update on the National Scene

Stephanie Slater, *University of Wyoming, CAPER Team, sslaterwyo@gmail.com*

Tim Slater, *University of Wyoming, CAPER Team*

For nearly two decades, the first version of the National Science Education Standards have had a tremendous impact on the work of education and public outreach specialists. As our community is taking the next steps from the existing, to the new science standards, we suggest two courses of action as a means of increasing the power of the standards and their implementation in K–12 classrooms. First, we forward the notion that the entirety of the K–12 science contents standards should be focused around the learning of five to six truly core ideas. We boldly propose that these core ideas are: the Big Bang, the theory of evolution, the atomic theory, Newton's Laws, and the theory of plate tectonics. In addition, we propose that every student should exit his or her secondary education with a thorough grasp of the biogeochemical cycles that will determine our fate as a species. Second, we assert that the standards will gain far greater implementation in classrooms and curriculum construction nationwide, if teachers and scientists are provided with explicit instruction related to the standards. Our work with the National Academies of Science on the issue of standards has convinced us that the community is coming to believe that it is no more reasonable to expect a teacher or scientist to independently construct coherent meaning from a seemingly disjointed set of standards, than it would be to expect that level of broad, scientific expertise from their students. For educators, the most important guidance we can give is to explicitly describe why a particular notion needs to be taught when it is prescribed, and how that teaching is essential to students' future construction of these powerful ideas. Finally, teachers and scientists must be provided with concrete examples of what content and inquiry integration might look like, at every grade level.

Outcomes: Attendees who hear this talk will become aware of the current status and processes being used to create the next generation of National Science Education Standards, and will learn how to successfully impact the creation and review process.

Session Type: 10-Minute Oral

Location: Cristol Chemistry 140

Digital Resources for Communicating Astronomy

Christi Whitworth, *Pisgah Astronomical Research Institute, cwhitworth@pari.edu*

Michael Castelaz, *Pisgah Astronomical Research Institute, mcastelaz@pari.edu*

Pisgah Astronomical Research Institute (PARI) encourages hands-on access to the tools of radio and optical astronomy through Smiley and SCOPE. Most technology initiatives will support the necessary connections needed for these activities. These projects are supported in part by NSF DUE# 0937824. Remote access to a 4.6-meter radio telescope (affectionately known as Smiley) located at the Pisgah Astronomical Research Institute near Brevard, North Carolina: The radio telescope detects 21-cm radio waves emitted by hydrogen at the center of our galaxy and its spiral arms, supernova remnants, regions of star formation and other celestial sources. The decisions for each investigation: source selection, pointing the telescope, and taking the measurements, are determined by the user. Lesson modules such as "Doppler Shift", "Mapping Radio Sources", and "What's Between the Stars?" have been used effectively with middle and high school students, as well as college students, providing them with real-time experience in radio astronomy. The labs and hands-on experience increase users' information and technology skills while promoting student-directed critical thinking and problem solving. Enter a citizen science endeavor and begin working immediately as a member of SCOPE - Stellar Classification Online Public Exploration (scope.pari.edu). Like Annie Jump Cannon, participate and become engaged in this

classification process. PARI is gathering new and reliable classifications for future scientific use. Beginning with basic properties of stars and how they lend light to their identification and classification, participants will follow the characteristics of different stellar types throughout their lifetime. The spectroscopic data found in SCOPE is used in the H-R Diagram activity developed for this program. The historical context of the images from which this digital data has been gleaned can also be shared through PARI's Astronomical Photographic Data Archive, the basis for Time Domain Astronomy in a readily accessible archival setting.

Outcomes: Pisgah Astronomical Research Institute shares the following via this paper: Website information for lesson plans for Smiley's labs and SCOPE's H-R diagram activity.

Tuesday PM EPO 1-Hour Workshops, Special Interest Group Discussion

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

Video Tips for Worry-Free Informal Presentations

Marni Berendsen, *Astronomical Society of the Pacific, mberendsen@astrosociety.org*

Jessica Santascoy, *Astronomical Society of the Pacific, jsantascoy@astrosociety.org*

Amateur astronomers and other informal educators often express concerns when presenting to the public: What if someone asks me a question I can't answer? How do I handle questions about UFOs and astrology? How do I connect with kids? In this workshop, the ASP will introduce a series of online videos developed to convey tips for presentations. We will watch a couple of the videos, role play, and have a short discussion about presentation challenges and workable strategies. These short videos and supporting materials provide easy solutions and tips that allow informal educators to face such situations with confidence, leaving audiences and visitors excited and eager to find out more.

Outcomes: You will learn about and utilize a series of videos and tip sheets that provide strategies for informal educators to effectively connect with audiences. Share the availability of these resources with other educators and use them to train your own constituents. The videos and materials can be accessed and used in any setting from a quick refresher before a presentation to a face-to-face practice session with fellow enthusiasts.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 382+384

The Intersection of NASA Astrophysics E/PO and Higher Education: A Special Interest Group Meeting

Mangala Sharma, *Space Telescope Science Institute, msharma@stsci.edu*

Denise Smith, *Space Telescope Science Institute, dsmith@stsci.edu*

Greg Schultz, *Astronomical Society of the Pacific, gschultz@astrosociety.org*

Luciana Bianchi, *Johns Hopkins University, bianchi@pha.jhu.edu*

William Blair, *Johns Hopkins University*

The NASA Science Mission Directorate's Astrophysics Science Education and Public Outreach Forum ("Astro Forum") proposes this Special Interest Group Meeting on opportunities in Astrophysics education and public outreach (E/PO) related to higher education. Our meeting will feature facilitated discussions on effective, collaborative strategies for involvement of undergraduate students in astronomy research and E/PO; undergraduate education including that of pre-service teachers; and bolstering scientist engagement in E/PO. Our session takes advantage of the simultaneous presence of E/PO professionals and the Cosmos in the Classroom participants, and their diverse perspectives on and experiences in higher education.

Outcomes: We expect the outcomes to include: (1) Astrophysics E/PO practitioners will be more aware of the E/PO efforts of higher education professionals; (2) Astronomy instructors will have more information about NASA Astrophysics E/PO programs and resources related to higher education; (3) E/PO practitioners, astronomy instructors, and students from a variety of academic institutions will have the opportunity to connect and network; (4) Participants will explore collaborations for improving access by STEM undergraduates to astronomy research and E/PO opportunities; and (5) The Astro Forum and the Astrophysics E/PO community will have a better strategy to support scientists already engaged in E/PO and to get more scientists involved in E/PO.

Session Type: 1-Hour Workshop

Location: University Memorial Center 386

I'm a StarryTeller! Engage Your Outreach Audience through Their Own Sky Stories

Elizabeth Wallace, *Giraffe 'n' Ant Productions aka StarryTelling, efwallace@aol.com*

Dallas Taylor, *Defacto Sound, dallas@defactosound.com*

"Story is far older than the arts of science and psychology. It will always be the elder in the equation, no matter how much time passes." Clarissa Pinkola Estes became an astronomy muse, not only of scientists and space explorers, but also of children and octogenarians who are as in awe of the universe as you. What have they seen that you haven't? Everyone has a story. Perhaps about a snow-covered yard reflecting a full moon, a downy altocumulus quilt set ablaze one autumn evening, or when Jupiter, introduced through a telescope lens, silently shook your inner Galileo awake. Everyone. All of your students or visitors to planetariums, observatories and science centers. Every one. Explore the possibility of honoring their stories by making them the focus of your recurring outreach events. Not everyone will become a scientist or an engineer. But everyone is already personally engaged. Awaken them through story. On April 10, over a hundred children, parents, teachers, friends and principals woke early on a beautiful Spring Saturday morning, made their way through thick Cherry Blossom parade traffic, and sat in the dark at the NASM Einstein Planetarium. The stars rose and traipsed across the dome. They lay back in their chairs as if on nighttime grass. The voices of emerging StarryTellers, local middle school students, rose from the dusky shadows and danced with the stars. Students felt empowered by hearing their own voices on the equivalent of astronomy's Broadway. Parents and teachers admitted to goosebumps as well as tears while they beamed proud smiles. We may forget how many miles it is to the moon, or how many minutes it takes light to reach Earth from the Sun, but what are the chances of forgetting we heard our voices among the stars?

Outcomes: Workshop participants will be introduced to StarryTelling to create planetarium shows through active participation in: •Creative writing improv prompts for lightning quick plot creation, developing characters out of thin imagination, astronomical imagery and metaphors; • Telling

their story in front of a welcoming audience; • Recording their astral gems; • Sending stories off to a black hole in Dallas to be scored by a Discovery Channel sound designer; • Donning I'm a StarryTeller Tshirts and listening to their polished tales the following day. This is an advancement in learning from our audience as well as teaching and empowering them.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

The Solar Dynamic Observatory: Let The Sun Shine In!

Martha Wawro, *NASA Goddard Space Flight Center, martha.wawro@gmail.com*

Emilie Drobnes, *NASA Goddard Space Flight center, emilie.drobnes@nasa.gov*

Aleya Van Doren, *NASA Goddard Space Flight center, Aleya.VanDoren@nasa.gov*

Mark McCaffrey, *Laboratory for Atmospheric & Space Physics, mark.mccaffrey@colorado.edu*

David McKenzie, *Montana State University, mckenzie@solar.physics.montana.edu,*

Deborah Scherrer, *Stanford Solar Center, dscherrer@solar.stanford.edu*

Launched February 11, 2010, the Solar Dynamics Observatory (SDO), the first satellite under the Living with a Star (LWS) program at NASA, is taking a closer look at the Sun, the source of all Space Weather. SDO is the most advanced spacecraft ever designed to study the sun and its dynamic behavior. The spacecraft provides images with clarity ten times better than high definition television and more comprehensive science data faster than any solar observing spacecraft in history. Science findings from SDO will help researchers better understand Space Weather, which affects not only our lives here on Earth, but the Earth itself, as well as everything outside its atmosphere (astronauts and satellites out in space and even the other planets). SDO contains a suite of instruments that are already providing high resolution images and observations that are helping scientists have a more complete understanding of the solar dynamics that drive variability in the Earth's environment. Education and Public Outreach (EPO) efforts for SDO have been ongoing for several years, focusing on solar science in general and the Sun/Earth connection in particular. This workshop will highlight the satellite and its instruments, present an overview of the EPO activities, and show some of the spectacular "First Light" images taken by SDO that show never-before-seen detail of material streaming outward and away from sunspots and extreme close-ups of activity on the sun's surface.

Outcomes: Participants in this workshop will learn about the mission and its science, meet the SDO E/PO team, and explore the available SDO education resources through an active participation workshop.

Tuesday AM Cosmos 1-Hour Workshops

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 1-Hour Workshop

Location: Eaton HumanitiesEaton Humanitiesnities 125

The "What If" Workshop

Neil Comins, *University of Maine, Neil_Comins@umit.maine.edu*

Asking "What if?" questions is an activity that is engaged in by many children as young as 4 years old. It gives them the means of exploring both what is happening in the world around them and the alternatives that would exist under different conditions. We adults use these questions all the time, but most of do it without realizing it, often couched as 'Should I' questions ("Should I wear the blue shirt or the pink one?", "Should I use PowerPoint with this lecture?", "Should I date that person?"). Many scientists are among the people who continue to consciously ask "What if?" questions in their professional lives ("What if I use a power series expansion rather than a Fourier series?" or "What if the Moon Didn't Exist?"). For students at all levels, K–grad, exploring the consequences of "What if?" questions is one of the most stimulating methods of learning science. It often provides more than the usual number of "ah ha!" moments both with regard to the new situation and to the one that is being varied (i.e., the one that actually exists). In this workshop, I will help you re-learn the wonder of actively exploring "What if?" questions, so that you can share the activity with your students. Participants in this workshop will work in groups to consider one or more "What if?" scenarios. I will provide techniques for facilitating group "What if?" experiences, as well as guidance for the groups participating, so that you can see "both sides" of the activity. You will be provided with a sample list of "What if?" questions you can use in your classes.

Outcomes: From this workshop, you will develop: Understanding of the power of exploring "What if?" questions; Techniques that students can use when participating in "What if?" groups; Techniques for expediting "What if?" activities (i.e., how to help groups that get stuck) without just providing answers; Resources for doing "What if?" activities

Session Type: 1-Hour Workshop

Location: Eaton Humanities Humanities 135

A Successful (and Fun) Curriculum for Teaching Students to Think Scientifically and Better Understand their Own Thinking and Learning

Douglas Duncan, *University of Colorado, dduncan@colorado.edu*

Leilani Arthurs, *University of Colorado, leilani.arthurs@colorado.edu*

Over the past two years, we developed a supplementary curriculum that achieves considerable success getting students to understand the difference between good science and bad, and increases their confidence and ability to find reliable scientific results applicable to their everyday lives. It also improves their understanding of their own thinking and learning — their metacognitive skills. The activities and assignments make extensive use of material found on websites and YouTube videos. They continually contrast good science and pseudoscience, and help students develop the ability to tell one from the other. Some of the pseudoscience involves astronomy: 2012, astrology, and alien abductions. Some involves medicine, because students see that in their own lives. Some videos are of famous psychics and TV preachers, followed by James ("The Amazing") Randi explaining how they work. We will provide participants with a CD containing all assignments, videos, and curriculum materials. The workshop will provide practice using the science vs. pseudoscience activities, and prepare participants for typical student responses. A paper on the results is in press in the Astronomy Education Review.

Outcomes: Participants will gain experience and skills necessary to help non-science majors: 1. Distinguish good science from bad; 2. Evaluate the validity of information sources; 3. Be aware of their own thinking and learning processes.

Session Type: 1-Hour Workshop

Location: Eaton Humanities Humanities 1B80

Engaging Students with ClassAction (CAE/CATS Workshop)

Rica French, *MiraCosta Coll, rfrench@miracosta.edu*

Kevin Lee, *University of Nebraska, klee6@unl.edu*

Members of the Center for Astronomy Education (CAE), offer teaching excellence workshops which focus on how to best implement teaching strategies that have be proven to increase student understanding in the Astro 101 classroom (astronomy101.jpl.nasa.gov). Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. This workshop will provide an overview of ClassAction — a computer-based collection of peer instruction questions and resources for providing feedback. There are two overarching design goals in ClassAction: flexibility (subsets of materials and can easily be selected and adapted to a suit an instructor's particular needs) and a strong emphasis on visuals (question prompts consist of animations, images, and structured diagrams). This workshop will provide an overview of ClassAction and then focus specifically on 1) the use of follow-up questions to check student understanding, 2) designing sequences of peer instructions questions that build in complexity, and 3) using simulations to provide feedback on questions. All ClassAction materials are publicly available for live use or download at http://astro.unl.edu. We would like to thank the NSF for funding under Grant Nos. 0404988 and 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

Outcomes: Participants will learn about a state-of-the-art resource for interactive teaching in the introductory astronomy classroom. They will be shown how easy it is to create personalized sequences of peer instruction questions and accompanying resources completely tailored to their own style of teaching and to save these on their own computer for future use. They will also develop an appreciation for how useful computer simulations can be in illustrating the answer to a peer instruction question.

Session Type: 1-Hour Workshop

Location: Eaton Humanities Humanities 1B90

Transforming Astronomy Education Using Learning Assistants

Valerie Otero, *University of Colorado, Valerie.Otero@colorado.edu*

Steve Pollock, *University of Colorado*

Laurie Langdon, *University of Colorado*

The Colorado Learning Assistant model provides an easy-to-adopt

method for transforming small to large enrollment courses so that they are more student-centered and interactive. Learning Assistants are talented undergraduate students who are hired to assist small groups of students (learning teams) in classroom activities such as analyzing real astronomical data, articulating and defending their ideas, and making claims and supporting them with evidence. Courses that are transformed using LAs show great improvements in learning nearly doubling national averages. In addition the Learning Assistants themselves become better learners and better teachers, greatly outperforming their peers. In fact, at the end of one semester of serving as LAs, LAs scores on conceptual assessments look more like the scores of graduate students than like their undergraduate peers. In addition, Learning Assistants make up the pool from which new K–12 teachers can be recruited. The Learning Assistant program has more than tripled the number of K–12 physics and astronomy teachers produced at our University and we have evidence that these teachers perform better in their classrooms. Over 10 universities throughout the nation have emulated the Colorado Learning Assistant program, many with funding from national organizations.

Outcomes: We will provide an overview of the LA program and provide opportunities for participants to work through hands on activities to demonstrate the program. Live LAs will assist to answer questions and discuss their experiences. Data to support claims about sustainability, funding, and the effectiveness of the program will be discussed.

Session Type: 1-Hour Workshop

Location: Eaton Humanities Humanities 150

Engaging Students with Lecture-Tutorials: Collaborative Learning Activities to Increase Understanding Beyond Lecture (CAE/CATS Workshop)

Edward Prather, *University of Arizona, eprather@as.arizona.edu*

Gina Brissenden, *University of Arizona, gbrissenden@as.arizona.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. Lecture-Tutorials (now in their second edition) are intellectually engaging activities intended for use by collaborative student learning groups and are designed to be integrated into existing courses with conventional lectures. These classroom-ready, learner-centered activities do not require any outside equipment or drastic course revision for implementation. Each Lecture-Tutorial poses a sequence of conceptually challenging, Socratic-dialogue-driven questions, along with graphs and data tables, all designed to encourage students to reason critically about difficult concepts in astronomy. The materials are informed by research into student naïve beliefs and reasoning difficulties. The Lecture-Tutorials have been field-tested at various institutions which represent a wide range of student populations and instructional settings. Participants in this workshop will gain first-hand experience with working in groups to complete several Lecture-Tutorial activities. Additionally, a significant portion of the workshop will focus on classroom management and instructional scenarios that are critical to successful implementation. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program. For more information about Lecture-Tutorials, please see: "Research on a Lecture-Tutorial Approach to Teaching Introductory Astronomy for Non-Science Majors", Prather, E. E, Slater, T. F., Adams, J. P., Bailey, J. M., Jones, L. V., & Dostal, J. A., Astronomy Education Review, 3(1), 2004.

Outcomes: Participants in this interactive workshop will learn first-hand about key steps in the implementation of this intellectually engaging, learner-centered, collaborative instructional strategy that has been shown to increase students' understanding beyond what is typically achieved from lecture alone. These post-lecture, in-class conceptual activities offer instructors a pedagogically rich tool that will help them move their lecture-centered classroom toward a learner-centered, active-learning classroom.

Tuesday AM Cosmos Special Interest Group Discussions

Time: 11:15 a.m. – 12:05 p.m.

Session Type: Special Interest Group Discussion

Location: Eaton Humanities 150

Astronomy Education Research: What Questions Do We Need To Answer In The Coming Decade?

Dave Bruning, *University of Wisconsin, Parkside, bruning@uwp.edu*

Ed Prather, *University of Arizona, eprather@email.arizona.edu*

A community discussion session about the state of astronomy education research and where the field needs to go during the next decade. With the low-level of science literacy in the US, trouble with the STEM pipeline, and limited resources available to meet educational needs, it is critical that we focus our research priorities. In this session, we will appraise which research questions we think are most critical to answer and develop strategies that will enable us to move forward in those directions. The aim of this discussion is to create a targeted list of investigations that can serve to inform the development of future informal and formal education efforts.

Outcomes: We expect to produce a white paper on research directions and what the research community sees as essential issues and directions in Astro 101 education.

Session Type: Special Interest Group Discussion

Location: Eaton Humanities 1B90

Higher Education within NASA's Science Mission Directorate: How to Strengthen the Bridge to Introductory Astronomy Faculty?

Emily CoBabe-Ammann, *Emily CoBabe-Ammann &Associates, ecobabe@spaceeducation.org*

Greg Schultz, *ASP, gschultz@astrosociety.org*

Russanne Low, *Institute for Global Environmental Strategies*

NASA's Science Mission Directorate continues to expand and strengthen its support of higher education across the spectrum, including its relationship to faculty teaching introductory STEM courses. These courses, directed at a wide audience of non-science majors, are an important vehicle for creating a scientifically literate society. In this discussion group, we invite Cosmos in the Classroom symposium instructors to talk about where their courses are headed and what kind of NASA SMD support and resources they would find useful in the future.

Outcomes: The results of this discussion will be used to inform future efforts within the NASA SMD education forums by identifying specific support structures and resources that faculty identify as helpful for their success.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 135

Student Learning Outcomes: The Good, the Bad, and the Ugly

Andrew Fraknoi, *Foothill College, fraknoiandrew@fhda.edu*

Accrediting agencies and administrators at many institutions of higher learning (but particularly community colleges) are demanding that instructors develop and test student learning outcomes for their classes. At most colleges, astronomy instructors are developing these SLO's from scratch, with no national library of other people's work, no research on what outcomes make sense in our field, and very little institutional support. Nor is there much help in the next step, which is testing if the objectives are being met and then analyzing what the next steps should be. It doesn't have to be this way. Using the mailing list of the Astronomical Society of the Pacific, Astronomy Education Review, and the Center for Astronomy Education web site, we could develop a repository of knowledge and samples for astronomy SLO's and share our experiences. Let's begin at this meeting, by bringing our ideas for SLO's (bring 50 copies) and thoughts about ways we could all work together.

Outcomes: Participants will share their experiences and bring handouts of SLO's they have tried. They will go away with examples from colleagues and suggestions for next steps. Ultimately, we hope to develop a national library of SLO's and how they are being used.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 1B80

The Best Online Tools and Practices for Teaching Astronomy

Scott Hildreth, *Chabot College, shildreth@chabotcollege.edu*
Michele Montgomery, *University of Central Florida, montgomery@physics.ucf.edu*

How do you use the internet in your astronomy class? Whether you teach face-to-face, or completely online, what are the best online activities, homework assignments, or discussion tools that you have found in your teaching? And what are some of the best practices you've found and implemented? How have you used online homework and resource systems like Mastering Astronomy, AstroPortal, Ace Astronomy, WebAssign, or Virtual Astronomy labs? What were the best features of those systems for your style of teaching? How did they engage your students? What do you want to do that you can't do yet? How did your textbook fit into your online teaching? And regardless of what online tools you have used, how do you assess whether these tools actually help our students? This interactive, collaborative session will give you a chance to see what other colleagues have found to be successful, and a chance to share what has worked for you. We'll collect information from all attendees on what each of us is already using, what works, and what best practices we have evolved. And then we'll discuss in small groups some of the best suggestions and ideas, and share them collectively. Whether you are new to teaching astronomy, and have never used an online tool before, or you are an online veteran constantly on the web looking for great app's, this session will have something of use. But this won't be just about apps, plug-ins, and browsers. We will try to tie the tools to actual student learning, and understand how much effort it is to use them. The moderators, Michele Montgomery of Valencia Community College and the UCF, and Scott Hildreth of Chabot College, have both designed and taught online classes for many years, as well as taught hundreds of on-campus sections.

Outcomes: Participate in a brief survey sharing what online tools are being used now, and what the one or two best features of those tools seem to be; Share their own best practices in small discussion teams; Learn how others are using available tools in their classes to create student success; Share ideas for new ways to use online tools and homework systems. A summary of what we discuss, our collective best practices, the tools attendees are using, and best online activities, will be provided to the all participants after the session, along with a contact list — online, of course!

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 125

Getting the Most Out of Your Observatory-Based Astro 101 Laboratory

Beth Hufnagel, *Anne Arundel Community College, brhufnagel@aacc.edu*

Astronomy lab classes can be mind-expanding experiences for students: seeing Saturn for the first time with their own eyes is amazing! This is your chance to share and hear success stories from others who incorporate real-time observing into their laboratories. The group will self-select discussion topics, which could include: Do we stress amateur and historical skygazing; focus on uncertainty, graphing and making measurements; learn about physical laws, light and spectroscopy; or work with modern observing data from our own or national telescope archives? What is the role of computers for processing data, running simulations, and controlling telescopes? How can we track our topics with lecture — or do we even try? How do we manage a flexible schedule to take advantage of clear nights? In the era of Hubble, how do manage expectations when viewing a light-polluted sky with an 8" reflector? What difficulty level is appropriate for introductory students? What is the balance between teaching astronomy and teaching observing techniques? What is the ideal class size, and what size is economical for the college? How can a campus observatory be used for community outreach, since this is not directly funded? (Special thanks to Michael Stage for contributing many of these ideas.)

Outcomes: Participants will learn from others about the issues involved in incorporating observing into your astronomy labs and about what works and what doesn't. We will all share solutions to the challenges in this area.

Tuesday PM Cosmos 1-Hour Workshops

Time: 3:15 p.m. – 4:15 p.m.

Session Type: 1-Hour Workshop
Location: Eaton Humanities 1B90

Using Concept Inventories to Gauge Student Understanding in Astronomy

Janelle Bailey, *University of Nevada, Las Vegas, janelle.bailey@unlv.edu*
John Keller, *California Polytechnic State University, jmkeller@calpoly.edu*

In this workshop, we will look at concept inventories and their use in introductory astronomy courses. These multiple-choice instruments can be useful in determining students' pre-instructional beliefs on a focused set of topics, and in later ascertaining the areas in which students retained difficulty. Participants will learn about at least three different concept inventories (the Star Properties Concept Inventory, the Light and

Spectroscopy Concept Inventory, and the Greenhouse Effect Concept Inventory), including information about how they were developed and validated, and determine which one(s) would be best aligned for your course content and goals. Using sample student data, they will also learn basic techniques for analyzing students' responses to these concept inventories, including frequency analysis of responses, calculation of normalized gains, and the t-test to determine the statistical significance of any observed differences between pre- and post-test. Examples of how these inventories might be used will be discussed.

Outcomes: Participants will learn about at least three different concept inventories and how they can be used in an introductory astronomy course to get an indication of student understanding before and after the course. They will determine which one(s) would be most useful for their own classes and learn basic data analysis strategies that will let them know what students are learning and what difficulties remain.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

"In the Beginning": Using Creation Myths in the Astronomy Classroom

Kristine Larsen, *Central Connecticut State University, larsen@ccsu.edu*

A creation myth (or origin story) is a culturally-relevant, pre-scientific basis for cosmology. It represents a people's attempts to make sense of the cosmos and the natural processes at work in the world, and as such forms the basis for a "personal universe." Research suggests that it is not sufficient to teach scientific concepts which may counter a student's personal worldview (like evolution or the big bang) — we must first acknowledge culturally dominant alternative conceptions and allow students to analyze them in ways they have not been expected to before. Therefore a study of creation myths can be a natural part of astronomy-based courses, from the standard Astro 101 to interdisciplinary courses such as Science and Society, History of Science, and Archaeoastronomy. Although creation myths differ greatly in their details, certain underlying themes are nearly universal. For example, most creation myths: Explain how and why the universe comes into being; establish a model for the creative process; describe creation of specific pieces of the cosmos (sun, moon, stars). Although the study of creation myths is pedagogically appropriate, issues of cultural sensitivity can become problematic. For example, many students regard a "myth" as something that "other people" believe in, while their culture or tradition is the sole repository of ethical or spiritual "truth." This can initially cause tension in the classroom, which detracts from students' ability to analyze creation myths. Utilizing creation myths found in fictional universes (such as C.S. Lewis's world of Narnia, or J.R.R. Tolkien's Middle-earth) as a first example for the study of the structure and purpose of creation myths allows students to dissect a creation myth without concern before proceeding to real myths. Students can also create their own creation myths for a fictional exoplanet, and analyze the myth of a classmate as a capstone activity.

Outcomes: This hands-on workshop will introduce participants to the basic structure of creation myths, their uses in the astronomy classroom, and assessment activities. Participants will play the role of students, analyzing and comparing brief creation myths and creating outlines for creation myths germane to fictional life forms on exoplanets. In doing so, participants will see that creation myths often contain a great deal of astronomical observation and fact, and that they can be used in the astronomy classroom as the springboard to teach concepts for which students sometimes carry alternative conceptions (such as moon phases and eclipses).

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Exploring Easy and Effective Ways to Use PhET's Web-based Interactive Simulations in Your Astronomy Course

Kathy Perkins, *University of Colorado, Katherine.Perkins@colorado.edu*

Michael Dubson, *University of Colorado, Michael.Dubson@colorado.edu*

Douglas Duncan, *University of Colorado, dduncan@colorado.edu*

The PhET Interactive Simulations Project has developed over 85 simulations for teaching and learning introductory science at the high school and college levels. Many simulations — such as Blackbody Spectrum, Discharge Lamps, My Solar System, Force in 1D, Gas Properties, Charges and Fields, Energy Skate Park, Bound States, and Gravity Force Lab — are useful for teaching astronomy and astrophysics. These research-based simulations create animated, interactive, game-like environments that are designed to engage students in active thinking, encourage experimentation, and help develop visual and conceptual models of physical phenomena, emphasizing their connections to everyday life. The PhET project was started specifically to improve the way that science is taught and learned by creating sims that are aligned with and vetted through educational research. Each sim is developed by a team of scientists, software engineers, science educators, and science education researchers to facilitate learning, while often addressing known student difficulties with the content. Every sim is tested through student interviews and observations of use, and the PhET project is actively engaged in research on effective design and classroom use of interactive simulations. With a highly intuitive interface and very little text, PhET sims give teachers control over how they are used in the classroom — enabling teachers to customize their use of sims to match their environment and learning goals. This flexibility allows PhET sims to be used in class, lab or with homework, in groups or with individuals. The simulations are free, and can be run from the PhET website (http://phet.colorado.edu) or downloaded to a local computer for off-line use. In this workshop, participants will work with these simulations and explore how they can be used effectively in lecture, lab, and as part of homework assignments to improve both student learning and engagement.

Outcomes: At the conclusion of the workshop, participants will be able to: 1) effectively incorporate PhET simulations into lecture, homework, lab, or in-class activity time of their earth or space science course, 2) critique and improve a sim-based student activity to better promote student-driven exploration and learning, 3) design a sim-based clicker question and use sims to promote deeper class discussions, and 4) identify design features which make simulations uniquely powerful learning tools and provide some supporting research.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 150

Engaging Students with Pencil-and-Paper and Computer-Delivered Ranking Tasks: Quantitative Reasoning Activities that Increase Learning (CAE/CATS Workshop)

Edward Prather, *University of Arizona, eprather@as.arizona.edu*

Kevin Lee, *University of Nebraska, klee6@unl.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage

in collaborative learning. Ranking Tasks are a novel type of conceptual exercise based on a technique called "rule assessment". Typically, Ranking Tasks present students with a series of four to eight pictures or diagrams that describe slightly different variations of a basic physical situation. Students are then asked to identify the order, or ranking, of the various situations based on some physical outcome or result. The structure of Ranking Tasks makes it difficult for students to rely strictly on memorized answers and mechanical substitution of formulae. In addition, by changing the presentation of the different scenarios (e.g., photographs, line diagrams, graphs, tables, etc.) we find that Ranking Tasks require students to develop mental schema that are more flexible and robust. Participants in this workshop will gain first hand experience with working in groups to complete several pencil-and-paper and computer-delivered Ranking Tasks. Additionally, a significant portion of the workshop will focus on classroom management and instructional scenarios that are critical to successful implementation. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program. For more information about Ranking Tasks for Astro 101, please see: "Effectiveness of Collaborative Ranking Tasks on Student Understanding of Key Astronomy Concepts" (Hudgins, D. W., Prather. E. E., Grayson, D.J. and Smits, D. P.: Astronomy Education Review, 5(1), 2006.

Outcomes: Participants in this interactive workshop will learn first-hand about key steps in the implementation of intellectually engaging, learner-centered, collaborative instructional strategies that have been shown to increase students' understanding beyond what is typically achieved from lecture alone. These post-lecture, in-class conceptual activities offer instructors a pedagogically rich tool that focuses on quantitative reasoning and will help them move their lecture-centered classroom toward a learner-centered, active-learning classroom.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

An Introduction to Backwards Faded Scaffolding in the Astro 101 Laboratory Course

Stephanie Slater, *University of Wyoming, sslaterwyo@gmail.com*

Timothy Slater, *University of Wyoming*

Dan Lyons, *University of Wyoming*

P.E. Robinson, *Westchester Community College*

Kendra Sibbernsen, *Metropolitan Community College*

The Boyer Report, "Reinventing Undergraduate Education" eloquently argues that all undergraduate coursework would benefit greatly by being framed as authentic research experiences where students create and defend knowledge. Yet, our experience in guiding students to do research projects using astronomical databases has demonstrated time and time again that the most difficult aspect of engaging in scientific research is helping students identify and frame a fruitful research question itself. To scaffold students' learning experiences to help them ask better research questions, we have adopted a backwards faded scaffolding approach where students do multiple inquiry experiences, rather than a single protracted one. In this approach, we first carefully guide students through an entire astronomical inquiry sequence, from giving them the targeted research question through an accurate scientific conclusion tightly matched to the research question. Then, for their second inquiry experience, students generate their conclusions independently, with the previous experience set out as a guide. Students are required to make sense of data that has been purposefully planned, collected, and analyzed with instructor guidance. They construct and defend conclusions based upon data that is, effectively, given to them. By the time students reach their third inquiry they have been exposed to two experiences in which they were guided through the. During this third inquiry data collection and analysis becomes an independent task. By the fourth inquiry, students have received explicit instruction on the connection between the research questions and the procedure undertaken to address them three times. They are prepared to take responsibility for creating a plausible method for collecting data given a research prompt. By the fifth inquiry, students have now seen four examples of quality research questions/hypotheses, and their relationship to procedures, data collection and conclusions. At this point students are finally positioned to successfully conduct an entire inquiry.

Outcomes: Participants will be introduced to the underlying cognitive principles used to underlie a backwards faded scaffolding approach to the ASTRO 101 laboratory focusing on teaching science by inquiry. In addition, participants will personally experience the effects of many short, quick inquiries.

Tuesday PM Cosmos 1-Hour Workshops

Time: 4:30 p.m. – 5:30 p.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

Connecting Astronomy 101 with K–12 Science Standards

Adrienne Carr, *Ohio Dept. of Ed., adrienne.carr@ode.state.oh.us*

Lauren Monowar-Jones, *Columbus State Community College, lmonowar@cscc.edu*

A significant fraction of students who take Astronomy 101 are pre-service teachers. In order to better serve these teachers, and ultimately, the students they will teach, this workshop will address how Astronomy 101 content maps into the K–12 Science Curriculum. Attendees will learn to align the relevant Astronomy 101 content to the national documents that describe the K–12 Science Curriculum. Currently, the National Governors Association and the Council of Chief State School Officers have successfully promoted core curriculum standards for Mathematics and English and Language Arts. On the horizon, the National Academy of Sciences (along with the Carnegie Corporation) is beginning to create a Framework for New Science Education Standards which is largely based on the American Association for the Advancement of Science (Project 2061) Benchmarks for Science Literacy and Science for All Americans, and the 2009 National Assessment of Educational Progress (NAEP) Science Framework. In this workshop, we will present the existing national documents on which the future framework will be based and identify the relevant Astronomy 101 topics. This analysis of relevant topics for Astronomy 101, along with some discussion of how these topics will likely be assessed in the K–12 educational system, will provide much food for thought for faculty contemplating their syllabi for the fall. We will use the revised Ohio science standards and model curriculum (also based on these national documents) as a way of demonstrating both how these concepts are used in a K–12 classroom and the depth of knowledge in Astronomy 101 content needed for a pre-service teacher to be successful.

Outcomes: Participants will experience the depth of knowledge a teacher will need to be successful at implementing K12 curricula.

Session Type: 1-Hour Workshop
Location: Eaton Humanities 1B90

Simulations for Learning Astronomical Phenomena

Richard McCray, *University of Colorado, dick@jila.colorado.edu*

Participants will have the opportunity to play with Java simulations and learning modules illustrating:1. Discovery of extra-solar planets through Doppler spectroscopy; 2. Discovery of extra-solar planets through photometry (e.g., Kepler); 3. Transfer of radiation and formation of spectral lines; 4. Doppler shift; 5. Light curves of eclipsing binary stars; 6. Communication with extraterrestrial civilizations.

Outcomes: Participants will take away CD-roms and lesson plans that they can use in their classrooms.

Session Type: 1-Hour Workshop
Location: Eaton Humanities 135

Dealing with Cosmophobia and Doomsday 2012

David Morrison, *NASA Ames, david.morison@nasa.gov*
Andrew Fraknoi, *Foothill College, fraknoiandrew@fhda.edu*

Fear of astronomy (cosmophobia) is unfortunately on the rise, stimulated by sensationalistic TV shows and Internet websites. Young people in particular are expressing fear of black holes, the galactic equator, solar activity, supernovae, planetary alignments, precession, asteroid collisions, shifts in the Earth's rotation or magnetic poles, and collisions of our Milky Way Galaxy with the Sagittarius Dwarf Galaxy or the Andromeda Galaxy. Much of this concern is associated with claims that the world will end, or at least that civilization with be destroyed, on December 21, 2012. While this fear seems irrational to scientists and educators, it is very real for some of our students. As the webmaster for the NASA "Ask an Astrobiologist" site, Morrison has received threats from students as young as 11 years old to commit suicide rather than experience the "end of the world". While such reactions are extreme, they are part of the spectrum of public concern over December 2012. The purpose of this workshop is to explore the origin of these fears and explain how to use real science to counter them. Those of us who love astronomy and appreciate the beauty of the universe can explore ways to turn this fear of science into constructive learning experiences. We will discuss ways to respond if you are an astronomy or planetary science instructor, in particular the kinds of class discussions you might make, the kind of homework you might assign, and how you might make a computer based research project or lab out of this topic. A hand-out of web and print resources will be made available.

Outcomes: Participants will come away with a better understanding of some of the claims assaulting the senses of their students in the media, and of the source of these claims. They will have tools and information for how to deal with these claims and how to help their students understand the critical thinking needed to distinguish reality from pseudoscience.

Session Type: 1-Hour Workshop
Location: Eaton Humanities 1B80

Doing Authentic Scientific Research in the Classroom with Spectroscopy

Travis Rector, *University of Alaska, rector@uaa.alaska.edu*

We will demonstrate how Research Based Science Education (RBSE) can be used to teach students the process of science in an introductory astronomy class. One of the challenges in teaching introductory classes is that students rarely get to do science themselves. Instead they primarily learn science content, that is, what is produced by science. This reinforces the misconception that scientists are essentially people who have memorized the known, rather than explorers of the unknown. RBSE is a teaching method where students do authentic astronomy research projects using real data from telescopes on Kitt Peak and elsewhere. For this workshop we will demonstrate the suite of research projects that students do with spectroscopy: The study of semi-regular variable stars, the search for quasars, and the search for high-redshift galaxies. Spectroscopy is particularly important because, in most of astronomy, it is why we known what we know. We have developed a curriculum for using these projects in an introductory "stars and galaxies" laboratory course. Students learn important science content such as, e.g., spectroscopy, stellar evolution, galactic evolution, AGN, photometry and redshift. All of these topics are learned in the context of doing the research projects. Just as importantly, students learn that science is a process that requires data collection, analysis and interpretation and that there is inherent uncertainty. Most importantly, unlike traditional labs, it is a process where the answers are not known beforehand.

Outcomes: Participants will learn how to use the software and datasets to do the RBSE spectroscopy research projects. The focus will be on how they can incorporate the developed curriculum, and the RBSE pedagogy, into their own classrooms.

Session Type: 1-Hour Workshop
Location: Eaton Humanities 150

Engaging Students with Cosmology Lecture-Tutorials (CAE/CATS Workshop)

Colin Wallace, *University of Colorado, colin.wallace@colorado.edu*
Edward Prather, *University of Arizona, eprather@email.arizona.edu*

Many instructors understand that lecture by itself is not the most effective instructional approach for all their students; however, they often struggle to create a classroom environment that motivates students to actively engage in collaborative learning. For the past two years, researchers from the Center for Astronomy Education (CAE) have conducted fundamental research into introductory astronomy students' conceptual and reasoning difficulties with topics central to understanding cosmology. The results of this research inform the development of a new suite of Lecture-Tutorials designed to help students overcome their most common naïve ideas and reasoning difficulties. Like previously designed and validated Lecture-Tutorials, these cosmology Lecture-Tutorials are two to six page Socratic dialogue-driven activities that can be implemented with minimal resources in both small and large enrollment classes. Workshop participants will work in groups on a subset of the cosmology Lecture-Tutorials and learn how to successfully implement them in their own classrooms. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

Outcomes: Workshop participants will work with, and learn how to implement, some of the new cosmology Lecture-Tutorials. These Lecture-Tutorials are appropriate for introductory astronomy instructors who teach cosmology and want to engage their students with in-class, post-lecture, collaborative learning activities. When properly implemented, these Lecture-Tutorials can lead to learning gains greater than students typically achieve from lecture alone.

Wednesday AM EPO 10-minute Orals

Session Chair: Rick Fienberg, American Astronomical Society

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Assessing the Effect of a Digital Planetarium Show on the Astronomical Understanding of 5th Graders

Kristine Larsen, *Central Connecticut State University, larsen@ccsu.edu*

Marsha Bednarski, *Central Connecticut State University, bednarskim@ccsu.edu*

For many students, informal science education takes the form of one-time field trips. Although relevant research is of mixed quality and results, the general trend suggests that relevant field trips paired with in-class instruction provide a greater opportunity for student learning. However, due to No Child Left Behind and increasing emphasis placed on measuring student success, school systems are under pressure to increase classroom time devoted to test preparation. Coupled with decreases in school funding and increased transportation costs, this has resulted in a widespread reduction in field trips. For example, the Gengras Planetarium at the Children's Museum in West Hartford, CT has seen a dramatic 30% decline in field trip attendance over the past few years. Teacher surveys indicate that while they understand the value of field trips, all extracurricular activities must clearly demonstrate relevance to science testing. One of the claims is that immersive digital planetarium technologies aid in the teaching of astronomical concepts that are inherently 3-D in nature, such as the motions of the earth and phases of the moon. Studies have shown that instructional techniques using manipulation of 3-D models of the earth-moon-sun system improve the learning of these concepts. Unfortunately, there have been relatively few critical studies of the educational value of digital planetariums. In addition, widespread and deep-rooted misconceptions held by elementary school students also affect student learning of topics such as phases of the moon, eclipses, and seasons, and evidence as to the effectiveness of digital planetariums in combating these is also sparse. This talk will summarize the results of a study involving fifth grade students at three different schools who were taught these three astronomical topics using both 3-D models in the classroom and a digital planetarium show.

Outcomes: Research on the effectiveness of planetariums on astronomical understanding in general is mixed, and is even less definitive in the case of immersive digital technology. The results of this study suggest that in the case of these three schools, student understanding of eclipses, lunar phases, and seasons improved significantly through the use of a digital planetarium show in addition to the traditional classroom 3-D modeling. However, it also showed that in some cases, misconceptions were also strengthened. This information will be valuable to the planetarium community as well as classroom teachers.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Affordable Digital Planetariums with WorldWide Telescope

Philip Rosenfield, *University of Washington Department of Astronomy, philrose@astro.washington.edu*

Andrew Connolly, *University of Washington Department of Astronomy, ajc@astro.washington.edu*

Jonathan Fay, *Microsoft Research, jfay@microsoft.com*

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Conor Sayers, *University of Washington Department of Astronomy, csayres@u.washington.edu*

Planetariums are a main stay of astronomy education, be it informal education of the public, or formally educating students. Digital planetariums provide the ability to engage and educate a broader audience due to the range of experiences they can create, such as 3D visualizations of modern data sets and simulations. While there are hundreds of planetariums in the country, what limits their digital upgrade is the cost ($500K+). To overcome these issues, in collaboration with Microsoft Research (MSR) we have developed a way to digitize existing planetariums for less than the tenth of the cost. In this talk, we show how off the shelf equipment, together with MSR's WorldWide Telescope client can provide a rich experience. Our students and the public alike will be able to pan though multi-wavelength full-sky scientific data sets, explore 3D views of our Solar System, near-by stars, and the SDSS galaxy catalog, and more.

Outcomes: We expect that participants will take away the knowledge of how to construct fully digital planetariums whose curriculum can be integrated into an education and outreach environment.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Long-Term Audience Impacts of Live Fulldome Planetarium Lectures for Earth Science and Global Change Education

Ka Chun Yu, *Denver Museum of Nature & Science, kcyu@dmns.org*

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Digital Earth visualization technologies, from ArcGIS to Google Earth, have allowed for the integration of complex, disparate data sets to produce visually rich and compelling three-dimensional models of sub-surface and surface resource distribution patterns. The rendering of these models allows the public to quickly understand complicated geospatial relationships that would otherwise take much longer to explain using traditional media. At the Denver Museum of Nature & Science (DMNS), we have used such visualization technologies, including real-time virtual reality software running in the immersive digital "fulldome" Gates Planetarium, to impact the community through topical policy presentations at both state and city levels, and adult education classes, and public lectures. We have constructed three-dimensional models from well data and surface observations, which allow policy makers to better understand the distribution of groundwater in sandstone aquifers of the Denver Basin. DMNS adult education classes

on water resources, geography, and regional geology, as well as public lectures on global issues such as earthquakes, tsunamis, and resource depletion, have utilized the visualizations developed from these research models. The Gates Planetarium allows an audience to have an immersive experience — similar to virtual reality CAVEs found in the oil exploration industry — that would otherwise not be available to the general public. Public lectures in the dome allow audiences of over 100 people to comprehend dynamically changing geospatial datasets in an exciting and engaging fashion. Surveys and interviews show that these talks are effective in heightening visitor interest in the subject's weeks or months after the presentation. Many visitors take additional steps to learn more, while one was so inspired that she actively worked to bring the same programming to her children's school. These preliminary findings suggest that fulldome real-time visualizations can have a substantial long-term impact on an audience's engagement and interest in science topics.

Outcomes: Participants to this oral paper will learn about new results on the impact of digital planetarium informal education presentations on the general public. They will learn how lectures with real-time software in digital planetariums may have a substantially greater effect on audiences than comparable programming done in non-immersive or self-guided modes.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Interdisciplinarity and Debate as Highly Motivating Factors in Live Shows — Five Years of Success

Aris Erik Stengler, *Museo de la Ciencia y el Cosmos, eriks7@gmail.com*

José Montesinos, *Fundación Canaria Orotava de Historia de la Ciencia, fundacion@fundacionorotava.org*

A live show on any subject that includes experiments and continuous interaction with the audience is a well known approach for EPO activities that many are carrying out all over. We present such an initiative with some added ingredients such as interdisplinarity, the use of movie clips and especially the debate between the two presenters, a debate that is all the more attractive to the public if it not fully staged but closely represents their actual points of view. José Montesinos, from the "Orotava" Canarian Foundation for the History of Science is and plays the role of the more mature math professor that has grown weary of the overrated value given in science to mathematics and its consequences. This poses a constant challenge to his colleague, Erik Stengler, from the Science Museum of Tenerife, the young down-to-earth hands-on scientist, who defends the usual view that science and technology are to be judged by their achievements, which have brought about the advancement of modern society. With this approach and as a collaboration between our institutions, we have produced and toured highly successful activities on: Einstein and Relativity (from 2005 to 2008, "The Apple and the Moon", including a theatre play), circularity, the number PI, forces of inertia and the Newtonian revolution (in 2008/2009, "The tension between circularity and rectilinearity") and the foundations of modern astronomy (in 2009/10 "Kepler and Galileo, messengers of the stars"). Audiences were very varied — students, adult students, general public, prison inmates, teachers — and all appreciated the presentations as fun, thought-provoking and highly motivating, and valued especially the interdisciplinary character of the activity. Movie clips have shown to be especially useful to recover the attention of the young when they lose the thread due to the presently short attention time-spans they have.

Outcomes: This paper aims at providing inspiration for participants to embark in collaborative EPO projects between individuals or institutions with different approaches — in our example astrophysics and philosophy & history of science —, and to introduce in live shows the elements of the debate and the use of movie clips, that have proven, over the last 5 years, to be additional important factors to get the audiences' interest and participation.

Wednesday AM EPO 1-Hour Workshops

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Highlighting the Moon: Using Lunar Education Resources to Enhance K–12 STEM Education for Classrooms and Science Centers

Doris Daou, *NASA Lunar Science Institute – NASA Ames, doris.daou-1@nasa.gov*

Jaclyn Allen, *NASA JSC Astromaterials /ESCG, jaclyn.allen-1@nasa.gov*

A renaissance in lunar exploration and science has provided a unique opportunity to engage students in STEM education. The global scientific community has experienced a renewed focus on lunar exploration, as evidenced by a recent series of lunar science programs and missions to address the National Research Council directives for lunar space research: NASA's Lunar Science Institute, the International Lunar Network, SELENE Mission - Japan, Chandrayaan-1 Mission - India, CHANG-E Mission - China, Lunar Reconnaissance Orbiter Mission, and Lunar CRater Observing and Sensing Satellite - USA. The workshop participants will hear current science and education connections from some of the NASA Lunar Science Institute scientists and E/PO leads. With the goal of capitalizing on this renewed interest, lunar scientists and education professionals have established a wide variety of programs, resources, and projects for K–12 education in classrooms, museums, and science centers. This consortium of lunar education teams and groups will present a session showcasing their lunar education projects and programs, as well as opportunities for educators to engage students and the public in participatory exploration of the Moon. Learn how you can use the Lunar Reconnaissance Orbiter images, borrow lunar rocks for your classroom or museum, and access hands-on inquiry activities that engage students and the public.

Outcomes: Educators, and museum and science center staff will hear current lunar science. Educators, and museum and science center staff will receive a wide variety of information and education resources about lunar missions. Educators, and museum and science center staff will gain knowledge and access to education programs and materials.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

Activities Helping Students Explore the Science of Climate and Ways to Take Action for the Health of the Planet

Roberta Johnson, *NESTA and UCAR, rmjohnsn@ucar.edu*

Lisa Gardiner, *UCAR Office of Education and Outreach, egardine@ucar.edu*

Sandra Henderson, *UCAR, sandrah@ucar.edu*

Randy Russell, *UCAR, rrussell@ucar.edu*
Becca Hatheway, *UCAR, hatheway@ucar.edu*

How is Earth changing as climate warms? Can we slow or stop climate change? Can we adapt to the changes? The effects of global warming are generating many questions among students. In this session, we will explore the science of how the Earth system is changing in response to global warming. We will also explore ways that people are tackling the global warming challenge — both in terms of mitigating the impacts of climate change and adapting to new conditions. Using hands-on activities, we will investigate what is known about climate change, moving away from the doomsday scenarios often portrayed in the media and casting the concept in an appropriate scientific context. Specifically, we will look at the differences between climate and weather, familiarize participants with the methods that scientists used to explore past present, and future climates. We will highlight hands-on classroom activities that allow students to explore the impacts that climate change is having on the Earth. We will also highlight activities that allow students to explore the impact they make on the planet and which changes can help keep Earth a livable place. These topics will be approached from a STEM perspective, helping students be objective scientists as they consider solutions to climate change while fostering a "We can do it!" attitude in the classroom. Activities presented in the workshop are aligned with National Science Education Standards and provided by Windows to the Universe (www.windows2universe.org), an educational project of the National Earth Science Teachers Association and presented by the staff of the UCAR Office of Education and Outreach.

Outcomes: Participants in this workshop session will take away classroom activities that address climate change, sustainability, and mitigation for secondary students. We will provide information about the extensive climate and global change educational resources, which are available on the Windows to the Universe web site, a project of the National Earth Science Teachers Association. For EPO professionals who are involved in training educators, we will speak to the professional development strategies employed at the UCAR Office of Education and Outreach.

Session Type: 1-Hour Workshop
Location: University Memorial Center 382+384

Dealing with Public Fears of Doomsday 2012

David Morrison, *SETI Institute, david.morison@nasa.gov*
Andrew Fraknoi, *Foothill College, fraknoiandrew@fhda.edu*

Fear of astronomy (cosmophobia) is unfortunately on the rise, stimulated by sensationalistic TV shows and Internet websites. Young people in particular are expressing fear of black holes, the galactic equator, solar activity, supernovae, planetary alignments, precession, asteroid collisions, shifts in the Earth's rotation or magnetic poles, and collisions of our Milky Way Galaxy with the Sagittarius Dwarf Galaxy or the Andromeda Galaxy. Much of this concern is associated with claims that the world will end, or at least that civilization with be destroyed, on December 21, 2012. While this fear seems irrational to scientists and educators, it is very real for some students and members of the public. I have received threats from students as young as 11 years old to commit suicide rather than experience the "end of the world". Mothers have written to me about their intention to kill themselves and their children to escape this disaster. While such reactions are extreme, they are part of the spectrum of public concern over Doomsday 2012. The purpose of the proposed discussion is to explore the origin of these fears and explain how to use real science to counter them. Those of us who love astronomy and appreciate the beauty of the universe can explore ways to turn this fear of science into constructive learning experiences.

Outcomes: Participants will come away with a better understanding of some of the claims assaulting the senses of the public in the media, and of the source of these claims. This discussion will focus on how people working with the public (and often only having a short time to respond to a question) can best deal with their concerns about Doomsday 2012 and aspects of Cosmophobia.

Wednesday AM EPO 10-Minute Orals

Session Chair: Katy Garmany, National Optical Astronomy Observatory

Time: 11:15 a.m. – 12:05 p.m.

Session Type: 10-Minute Oral
Location: University Memorial Center 235

Engaging Students through Astronomically-Inspired Music

Matthew Whitehouse, *The University of Arizona, matthew4@email.arizona.edu*

I propose a 10-minute oral presentation in which I will describe a classroom activity that I have designed based on NEBULAE, my original musical composition for solo organ. NEBULAE is a musical narrative on the process of star formation, and the scientific goal of my activity is to guide students in developing an understanding of that process. The activity includes the use of images of the various stages of star formation, listening, and student participation/discussion. My proposed ASP presentation would include a brief description of the introductory exercise involving images, followed by my playing a short excerpt of the piece via a CD recording. It would conclude with a brief description of responses I have gathered from students in class discussions. I have led this activity as a guest lecturer in classes at The University of Arizona, at an outreach event at Biosphere 2, and as part of the UA Astronomy Camps (http://www.astronomycamp.org). Additionally, NEBULAE has been performed in concerts throughout the US, and will be receiving its European premiere at Notre Dame Cathedral in Paris in October 2010.

Outcomes: Participants will: (1) Gain a new idea for a class activity. (2) Experience a lesson outline that could be used with other astronomy-inspired musical compositions to teach astronomy and space science concepts. (3) Learn about how guided discussion and reflection on an astronomy-inspired musical work can guide students to a deeper understanding of astronomical concepts and phenomena.

Session Type: 10-Minute Oral
Location: University Memorial Center 235

Using Collaborative Intelligence to Increase Effectiveness and Sustainability of Scientific Outreach Programs

Ann Givan, *iReservoir.com, agivan@iReservoir.com*

Collaborative intelligence, a form of collective intelligence, is a knowledge base derived from disconnected and decentralized individuals who actively converge to create and share solutions to problems. Innovative strategies are crucial to increase and sustain the scientific literacy of our citizenry. Current paradigms of human intelligence, creativity, expertise and innovation, and its personal expression, are inadequate within our citizenry, the scientific, business, academic and political communities. The challenge is to assemble, as peers, individuals and groups for the purpose

of pooling resources, talents, collaboration and engaging in strategic dialogue specific to defined community needs. The global citizenry can no longer discount their responsibility in participating in efforts to solve local and global issues. The initial convening and establishment of strategic conversations between diverse participants will encounter numerous obstacles. To successfully catalyze and facilitate breakthrough solutions all participants must feel empowered to actively engage in the dialogue. Abundant research and resources are available for participant's use in building an effective group that can significantly impact their local communities and policy makers at all levels. To rectify the non-proficient level of public scientific literacy, this paper proposes using collaborative intelligence systems to identify obstacles, formulate a varied set of solutions integrating them into our community outreach programs.

Outcomes: Scientific communities are investing and training future scientists. Scientists will learn to engage and communicate to non-scientists about science. Public will acquire skills to evaluate scientific statements by the media. Acquiring scientific knowledge enables citizens to make informed decisions on critical science based issues. Empowering individuals and disenfranchised groups to participate and contribute to solutions of local and global problems. Rapid response of collaborative communities with solutions to challenges/issues/crisis benefits business. Allowed to develop in a continuous collaborative environment global scientific literacy will increase and sustain itself.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

In the Footsteps of Galileo Galilee

Varda Bar, *Hebrew University of Jerusalem, barvarda@zahav.net.il*

Zinn Barbara, *Hebrew University of Jerusalem, zinnb@aisj.co.il*

This paper will review Galileo's description of solar spots, his interpretation and models reflecting his special philosophy of science. The questions that Galileo was asked about the sun's spots will be presented with his answers: Why are the spots thought to be real? Why they are very far from the Earth? Why may they be attached to the Sun in spite of former descriptions of the Sun as being the most luminous perfect body? Are the spots stars? The relation between Galileo's suggested answers and his philosophy will be considered. Firstly, proof by contradiction that the spots cannot be stars (stars according to Galileo are also planets and moons, such as the moons of Jupiter) will explained by falsification. Secondly, other proofs that the spots are attached to the Sun are based on the assumption that the Sun is spherical and revolving around itself. Galileo's ideas about the nature of solar spots are obviously not accepted today. Findings from the 18th and 19th centuries leading to 20th century descriptions will be briefly discussed. Galileo's observations will be compared with those of later astronomers, and discussed in the view of the limitations of the Galilean telescope with its small objective lens and poor optics. Sunspots and phenomena related to them are the most important solar phenomena in dealing with communications and climate on this planet. Present-day students could do worse than to follow in Galileo's footsteps and make observations of solar spots, but use larger and better telescopes than the one used by Galileo.

Outcomes: Evolution of historic knowledge together with Philosophy of a science and suggestion for instruction.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Science Teaching in Context: A Creative Global Sojourn with the Evolution and Emergence of Scientific Discovery

Kala Perkins, *American Jewish University, quasar9@mac.com*

Immersed in the life paths of innumerable diverse characters, the calculus climbed its way out of the south of India over a thousand years before Newton and Leibnitz walked the Earth. Having consorted with the neural enticements of the Dravidian genius, according to our most recent historical insights, it originally emerged there in the land where zero also had its birth as a mathematical concept affiliated with debts and loans. Science, mathematics and its related processes hold a powerful draw for the non-science students when taught in immersion with their social, cultural and psychological contexts. One may now easily take students on a ten minute jaunt along the Great Wall or up the Nile with excellent video teaching materials, specifically designed to entice them into an appreciation of both the relevance to their own lives of these specific concepts and the wonder that scientific discovery holds in context. Darwin's actual process of understanding the richness of nature's evolutionary dynamics, not devoid of the sense of awe at the spirit working its way through the natural world, is easily communicated when shown with appropriate visual materials. Students are then offered a first hand experiential participation in the logic of his insights. Much rugged disputation is avoided as students are left to explore the possibility of multi-leveled streams of evolution, wherein a path of evolving material forms does not deny or negate a unique origin and evolution of consciousness, as is now being discussed at the frontiers of physics, neuro-psychology and cognitive sciences. By offering images directly juxtaposing scientific transformative potentials with social needs, students may be inspired toward a path applying scientific methodologies for social well being.

Outcomes: Science, Technology and Society / History of Science for non-science students, a one semester course, can offer a deep, inspiring experience from which they may further their participation in scientific inquiry and appreciation throughout their lives, if offered in a way which plants a minefield of magnetic insights. Personal, social and cultural relevance to their daily lives, and association with elements of life to which they are drawn internationally and cross-culturally are explored. Inspiration with the beauty, logic and reasoning underlying both processes of discovery and the natural order are the goals and methodology of such a successful course.

Wednesday AM EPO Special Interest Group Discussions

Time: 11:15 a.m. – 12:05 p.m.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 425

Teaching with Galileoscopes and Other Small Telescopes

Stephen Pompea, *National Optical Astronomy Observatory, spompea@noao.edu*

Robert T. Sparks, *National Optical Astronomy Observatory, rsparks@noao.edu*

Constance E. Walker, *National Optical Astronomy Observatory, cwalker@noao.edu*

The International Year of Astronomy (IYA) saw the creation of a wide variety

of educational programs. The Galileoscope program developed a telescope kit of optical quality to open the doors of visual observing to people all over the world at minimal cost. We have developed educational materials for use with the Galileoscope and given workshops to a people who work in a variety of settings including formal classroom teachers, museum educators, informal after school programs and amateur astronomers. Each audience has different concerns and needs to help them use the Galileoscope effectively in their programs. The Galileoscope has been used with students in a wide variety of settings ranging from Boys and Girls Clubs, formal classrooms, star parties, and a large event at the University of Arizona where students built almost 500 Galileoscopes in one sitting. This Special Interest Group (SIG) will bring together educators from around the country who have used or are interested in using Galileoscopes in their programs. We will unite those who have run successful programs and those considering using the Galileoscope in this session to share tips, tricks, and concerns they may have about setting up a Galileoscope program at their institution. Participants will receive a CD Rom containing the educational materials we have developed for the Galileoscope and be encouraged to share their own materials. Our materials include a detailed Galileoscope assembly guide, a Galileoscope Optics Guide, a Galileoscope Observing Guide, and a How To Present a Galileoscope Workshop manual. We will use these materials as a starting point for discussion and encourage participants to share their own resources as well as what types of materials should be developed for future use.

Outcomes: Special Interest Group participants will: (a) receive a collection of materials that can be used for Galileoscope education; (b) be actively engaged in discussion of how to use the Galileoscope in a wide variety of educational settings; and (c) learn how to use the Galileoscope to teach optics as well as observe astronomical objects.

Session Type: Special Interest Group Discussion

Location: University Memorial Center 247

Preparing for the Year of the Solar System

Christine Shupla, *Lunar and Planetary Institute, shupla@lpi.usra.edu*

Stephanie Shipp, *NASA SMD Planetary SEPOF*

NASA's Science Mission Directorate is celebrating the Year of the Solar System (YSS) from October 2010 through September 2012 — a Martian year! — to leverage the numerous exciting mission launches, milestones, and discoveries that will occur. The broad EPO community is invited to come learn about the planned activities and to explore how your programs can bring the Year of the Solar System to your audiences! Members of the Planetary Science Education and Public Outreach Forum (SEPOF) will share current plans and anticipated resources, and invite your input. What types of events are possible? What supporting products and activities will be available? We wanted to be sure to get your insights into these collaborative efforts! Come and join us to learn what is already being planned, to gather information to leverage your own activities, and to initiate collaborations on this new adventure!

Outcomes: Participants will learn about the ongoing plans and resources for the Year of the Solar System, and will be able to initiate collaborations in their own preparations to leverage their own programs. Participants will be able to share their thoughts and experiences to help guide the plans of the community as a whole.

Wednesday PM EPO 10-minute orals

Session Chair: Michael Gibbs, Capitol College

Time: 1:15 p.m. – 2:15 p.m.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

Astronomical Activities for People with Special Needs During IYA 2009 in Spain

Amelia Ortiz-Gil, *Astronomical Observatory – University of Valencia, amelia.ortiz@uv.es*

Pere Blay, *University of Valencia, pere.blay@uv.es*

Teresa Gallego, *Instituto de Astrofisica de Andalucia, gallego@iaa.es*

Miquel Gómez, *Astronomical Observatory – University of Valencia, miquel.gomez@uv.es*

José Carlos Guirado, *Astronomical Observatory – University of Valencia, jose.c.guirado@uv.es*

Mariana Lanzara, *Astronomical Observatory – University of Valencia, mariana.lanzara@uv.es*

Silvia Martínez, *Universidad de Alicante, Silvia.Martínez@ua.es*

In this talk, I will briefly outline the projects developed in Spain during the IYA specifically addressed to people with disabilities, both physical and cognitive. We will describe our four main projects: an astronomy book in braille ("The sky at your fingertips"), an open source software for people with motor disabilities ("Astroadapt"), a planetarium program for the visually impaired ("The sky in your hands"), and a series of astronomy talks for people with cognitive disabilities ("The life of the stars"). All the educational material we have produced is freely available, most of it can be downloaded directly from the Spanish IYA web site, or upon request to the authors.

Outcomes: This paper wants to show that working with people with special needs is not that difficult and it is very rewarding. We show some classical and new ways of communicating astronomy to these particular audiences.

Session Type: 10-Minute Oral

Location: University Memorial Center 235

"Yondering" IYA: How the Astronomical Society of the Pacific is Adapting its International Year of Astronomy Programs for the Long Haul

James Manning, *Astronomical Society of the Pacific, jmanning@astrosociety.org*

The International Year of Astronomy in 2009, the 400th anniversary of the year Galileo peeped at the heavens with his new telescope, is history. But 2010 is the 400th anniversary of the year he published, and we're now into "Beyond IYA" territory, as things developed for or during IYA are adapted for longer-term use as legacy products and programs. The Astronomical Society of the Pacific (ASP) is continuing three of its IYA efforts in this regard. The presenter will relate how the ASP's IYA Discovery Guides (online packages of theme- and object-based educational materials), Cosmic Clearinghouse (a web site with a wide variety of links to good educational materials), and Galileo Teacher Training Program (a teacher workshop using Galileo's iconic observations to teach the process of science) are being adapted for ongoing availability "over yonder", well beyond the horizon of IYA.

Outcomes: Attendees will learn about how the ASP is adapting its IYA programs for ongoing availability, how they can be used, and how they might serve in expanded or collaborative education efforts.

Wednesday PM EPO 1-Hour Workshops

Time: 1:15 p.m. – 2:15 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

NASA SMD Earth and Space Science Education Product Review

John Ensworth, *The Institute for Global Environmental Strategies, john_ensworth@strategies.org*

Theresa Schwerin, *The Institute for Global Environmental Strategies, theresa_schwerin@strategies.org*

NASA Science Mission Directorate (SMD) education products (for K–12, higher education and informal education) that will be included in the new NASA SMD E/PO online catalog need to first pass the SMD education product review. Product developers and potential reviewers are encouraged to attend this one-hour workshop that will illustrate all steps of this review process from the initial submission of a product, to the operation of the review panels, and to the final results and beyond (what if revisions are required?). A mock product review, using on-line review tools, will be conducted during the latter half of the workshop. Participants are encouraged to bring an example of the Earth or space science education product of their choice and a wireless-enabled laptop. John Ensworth and Theresa Schwerin, of the IGES, will field questions throughout the workshop and are willing to meet with product developers one-on-one, either at ASP or post workshop, to discuss and answer questions about specific products. This participatory workshop is provided by the NASA Science Mission Directorate Science Education and Public Outreach Forums as part of a conference mini-strand. For details on the review process, please visit: http://nasareviews.strategies.org/.

Outcomes: Participants, either product developers or potential reviewers, will gain a deeper understanding of the NASA SMD science education product review process.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

"A Scientist Has Many Things to Do": E/O Strategies that Focus on the Processes of Science

Sandra Laursen, *University of Colorado at Boulder, sandra.laursen@colorado.edu*

Annette Brickley, *Challenger Learning Centers, annette.brickley@gmail.com*

Scientists' involvement in education and outreach (E/O) has increased in recent years due to mechanisms such as the National Science Foundation's "broader impacts" expectations for research projects and NASA's education and public outreach requirements. But how can we engage scientists in E/O that is both effective for audiences and efficient of scientists' time? We assert that the scientists' E/O effort is best invested sharing their expertise on the nature and processes of science & the "understandings of science" that are emphasized in the National Science Education Standards, but that are both difficult to teach and poorly supported by existing curricular materials. These understandings address both the intellectual process of science & posing questions, gathering and interpreting evidence and the social process of science as a human endeavor for building knowledge. We will share several ways in which we have incorporated concepts about the nature and processes of science into E/O activities and made them focal points in their own right. Hands-on activities used at science festivals and teacher professional development workshops illustrate key scientific thinking skills such as observing, classifying, making predictions, and drawing inferences. A more comprehensive approach is exemplified by Upward and Outward: Scientific Inquiry on the Tibetan Plateau, a 20-minute educational documentary film for school science classrooms and teacher professional development. The film portrays the intellectual and human processes of science as seen through the work of an international team of scientists on an interdisciplinary geoscience research project. Evidence of the effectiveness of the film was gathered from pre/post classroom assessment responses by 350 students in grades 6–14, which show that students absorb a variety of positive messages about the intellectual and social processes of science. These messages contrast with their prior knowledge, counter common stereotypes of science and scientists, and broaden students' notions of the scientific method.

Outcomes: Participants will experience specific strategies that can be used to emphasize the nature and processes of science in a variety of E/O venues and will generate ideas for doing the same in their own E/O context. They will be introduced to one method for gathering evidence about the audience impact of such strategies. They will acquire hard copies of hands-on activities on the nature of science and DVD copies of the film for their own programmatic use.

Session Type: 1-Hour Workshop

Location: University Memorial Center 382+384

u *can* diy! Using Social Media in Science Education and Public Outreach Programs to Connect with Audiences

Stephanie Shipp, *Lunar and Planetary Institute, shipp@lpi.usra.edu*

Lindsay Bartolone, *Adler Planetarium, lbartolone@adlerplanetarium.org*

Nancy Ross Dribin, *Adler Planetarium, ndribin@adlerplanetarium.org*

Pamela Gay, *Southern Illinois University, starstryder@gmail.com*

Aleya Van Doren, *ADNET Systems / Goddard Space Flight Center, aleya.j.vandoren@nasa.gov*

Do you think "tweet-ups" are conventions held by flamingos and their feathered friends? Are you baffled when you read lol, f2f, ttfn? Do you feel faint when faced with the myriad of new ways to communicate with audiences — blogging, podcasting, vodcasting and more? Or have you simply found yourself pondering how to use social media more effectively in your science education and outreach programs? If you answered yes to any of these questions, please join us to explore how social media has been used successfully — and not so successfully — in science education and outreach programs to reach new and traditional audiences. The presenters will share their knowledge of current educational research and their experiences using social media tools for museum, mission, citizen science, and general public programs. Driven by audience questions, the presenters will provide ideas to help participants begin designing and developing social media strategies for their own programs.

Outcomes: As a result of this session, participants will: have a better understanding of the different types of social media tools and their attributes; begin to match specific social media tools with intended education outcomes;

and begin to plan social media strategies for their own programs.

Wednesday PM EPO 1-Hour Workshops

Time: 3:00 p.m. – 4:00 p.m.

Session Type: 1-Hour Workshop

Location: University Memorial Center 382+384

Exploring Assessment Tools for Research and Evaluation in Astronomy Education and Outreach

Sanlyn Buxner, *College of Education, University of Arizona, buxner@email.arizona.edu*

Matthew Wenger, *College of Education, University of Arizona, mwenger@email.arizona.edu*

Erin Dokter, *Office of Instruction and Assessment, University of Arizona, edokter@email.arizona.edu*

The ability to effectively measure knowledge, attitudes, and skills in formal and informal educational settings is an important aspect of astronomy education research and evaluation. Assessments may take the form of interviews, observations, surveys, exams, or other probes to help unpack people's understandings or beliefs. In this workshop, we will discuss characteristics of a variety of tools that exist to assess understandings of different concepts in astronomy as well as attitudes towards science and science teaching; these include concept inventories, surveys, interview protocols, observation protocols, card sorting, reflection videos, and other methods currently being used in astronomy education research and E/PO program evaluations. In addition, we will discuss common questions in the selection of assessment tools including issues of reliability and validity, time to administer, format of implementation, analysis, and human subjects concerns. Resources will include appropriate references for all instruments discussed as well as a guide to both quantitative and qualitative analysis software.

Outcomes: This workshop is targeted towards attendees who are involved in astronomy education research and evaluation and would like to discuss issues around the conscientious use of assessment tools. Workshop participants will learn about current tools used in both research and evaluation to measure knowledge and attitudes about topics in astronomy and science. Participants will engage in discussions about how to select and use these instruments and will be given resources to use to support effective assessment practices in their own work.

Session Type: 1-Hour Workshop

Location: University Memorial Center 425

Computer Animations and Computer Games as Tools for Public Science Education

Milan: Mijic, *California State University Los Angeles, mmijic@calstatela.edu*

Tony Longson, *California State University Los Angeles, tlongso@calstatela.edu*

Eun-Young Elaine Kang, *California State University Los Angeles, eykang@calstatela.edu*

We developed a series of 6–10 minutes long computer animations and a flash based computer game that aim to explain fundamental topics in relativity and cosmology to wide audiences. Each animation tells a story about one great discovery in classical cosmology, including the introduction of a historical hero characters and of a distinct flavor of epoch and science environment. In each case we provide visualization of the main physical reasoning that led to the discovery and/or to the law or relationship that encapsulates the discovery. The flash based game guides the player through the nature of time dilation in special relativity as a way out of the conflicts of a romantic relationship between the two college students. A familiar looking figure helps the player navigate through the choices offered in the game. The visual quality and engaging nature of these products provide an effective way to communicate some of the most important science concepts in a public science education environment. We provide ancillary materials, which allow for further exploration of our visualization products in a classroom setting.

Outcomes: Participants will become familiar with the short computer animations and computer game that can be utilized in public science education or classroom situations for explanation of the important topics in relativity and cosmology. We will provide the background information and supplementary materials, which will enable participants to implement delivery of our visualization products in a way suitable for their target audiences.

Session Type: 1-Hour Workshop

Location: University Memorial Center 247

Accessible Astronomy: Using Universal Instructional Design to Teach Astronomy to Individuals with Varying Abilities

Laura Venner, *William D. McDowell Observatory, Laura.Venner@njmeadowlands.gov*

Engaging "K-to-Gray" audiences with varying ability levels in scientific exploration and discovery is the main goal of the New Jersey Meadowlands Commission (NJMC) Center for Environmental and Scientific Education (CESE) and the William D. McDowell Observatory located in Lyndhurst, NJ and operated by Ramapo College of New Jersey. Perched atop a closed and reclaimed municipal solid waste landfill, our new platinum LEED-certified building and William D. McDowell observatory bring hands-on scientific experiences to the ~ 25,000 students and ~ 15,000 visitors that come to our site from the NY/NJ region each year. Our programs adhere to the New Jersey Core Curriculum Content Standards and are made accessible for the underserved communities that visit us, specifically those individuals that have mobility, sensory, and/or cognitive ability differences. The programs are conducted in a classroom setting and are designed to nourish the individual's inquisitive nature while providing the individual with an opportunity to function as a scientist by, making observations, performing experiments and recording and analyzing data. We have an $850,000, three year NSF grant that targets adults with disabilities and older adults with age related limitations in vision, hearing, cognition and/or mobility. From dip netting in the marsh to astronomical investigation of the cosmos, the CESE remains committed to reaching the largest audience possible and leaving them with a truly exceptional scientific experience that serves to educate and inspire. We would like to share the techniques and programs we have developed so that teachers can incorporate Universal Instructional Design into their lesson plans enabling them to reach a wider audience.

Outcomes: Participants will gain experience in adapting their programs to include Universal Instructional Design (UID) which will help them to reach a wider audience and enable them to communicate difficult concepts to individuals with varying ability levels. In addition, activities based on UID will be presented so that participants can develop similar activities that correspond with their specific program offerings. Participants will also create tactile representations of cosmic objects that they can take with them to reinforce the idea of UID at their respective facilities.

Wednesday AM Cosmos 1-Hour Workshops

Time: 10:00 a.m. – 11:00 a.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B90

Teaching Your First Astro 101 Course: What They Don't Tell You

David Bruning, *University of Wisconsin, Parkside, bruning@uwp.edu*

What should go into my syllabus? Do I really need a textbook? What topics can I leave out? What should I do the first day? What do I keep for college-wide assessment reviews? What happens when a student misses two exams? What's a teaching portfolio and do I need one? You may be able to "wing" the astronomical content, but there are lots of decisions regarding your Astro 101 course that aren't talked about. While some instructors manage to ignore these issues, there is increasing accountability both legally and by accreditation committees that we must all meet. And the best instructors deal with everything in their classes mindfully, from topic selection, to integrating class activities with lecture, to constructing reading assignments. This session will walk participants through development of a course story line, topical selection, organizational issues, evaluation methods and assessment topics. A teaching resource list will be provided and a question and answer session will help make sure your concerns about teaching your first course are met.

Outcomes: In this workshop, participants will: 1. develop a story line for their course; 2. outline important and legal aspects of their syllabus begin a course policy statement that augments the syllabus; 3. create an educational outcomes list; 4. initiate an assessment policy; 5. start a teaching portfolio; 6. construct a list of questions that they need to address before Day 1.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 150

Get Out From Behind the Podium: Creating Your Own Lecture-Tutorial-Style Activities that Work!

Dan Lyons, *University of Wyoming*

Timothy Slater, *University of Wyoming*

Stephanie Slater, *University of Wyoming, sslaterwyo@gmail.com*

Numerous studies on how people learn have repeatedly demonstrated that students sitting passively in a lecture hall have far less intellectual engagement than is required to develop deep and meaningful understanding. Physics education researchers have shown that there are measurable differences in the conceptual models of motion between students who received traditional, largely lecture-based instruction in physics, and those who were in courses that use active engagement as an instructional strategy. In these studies, active engagement was defined as nearly anything that was not lecture, including "clicker" questions, labs, and think-pair-share questions. To get out of lecture mode in ASTRO 101, a particular prominent teaching strategy is that of using a LECTURE-TUTORIAL approach. Although, numerous classroom-ready lecture tutorial tasks already exist, not every topic one might cover in ASTRO 101 has been developed. During the construction of the lecture tutorials that are currently available, a template and a rationale were developed. In this workshop, participants will receive a brief introduction to the means to develop a lecture tutorial for new topics in ASTRO 101, and to the cognitive reasons that lecture tutorials are effective instructional interventions. Participants will spend the majority of the session creating a lecture tutorial for a new topic to help provide more overarching coverage for ASTRO 101. Please come to the workshop with your laptop, and two or three ideas for which topics you would like to work on developing. Participants will be asked to share their work with the larger community as an internet-accessible resource.

Outcomes: Participants in this session will select a target learning concept to be taught in their ASTRO 101 course and develop a LECTURE-TUTORIAL-style activity for classroom use.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

Astronomy as the Core Element for Interdisciplinary Courses

Harry Shipman, *University of Delaware, harrys@udel.edu*

Over the past decade, many astronomers have begun to offer courses which focus on astronomy along with one or more disciplines. Perhaps the most common, or at the least most visible, have been courses on astrobiology, where a long literature and a major, NASA-supported virtual institute can provide support (1). Another way to pair astronomy with biology is to teach a course on cosmic evolution, where biological evolution is seen as the last portion of a long, logical thread that leads from the Big Bang all the way up to us (2). Science and religion courses are pretty common and usually include cosmology, Galileo, or both (3). Some institutions are teaching future elementary teachers with a course that combines the science disciplines with a science education course (4). Some combine history or anthropology into a cultural astronomy course (5). This list of examples, not exhaustive, shows the range of opportunities. Some interdisciplinary courses are team-taught; some others can be developed by teams and taught individually, and in some cases a single person may develop and teach a course individually.

1. http://astrobiology.nasa.gov/nai/education-and-outreach/products-and-resources/

2. http://www.tufts.edu/as/wright_center/cosmic_evolution

3. M. Wertheim, Zygon 30(3), 491-500, 2005.)

4. http://serc.carleton.edu/teacherprep/courses/UDN-SciSem.html

5. http://www.math.nus.edu.sg/aslaksen/teaching/heavenly.html

Outcomes: Participants in this workshop will gain from the experience of others in developing and teaching courses like the ones mentioned above. After a brief introduction, participants will be divided into groups which will deal with individual interdisciplinary courses. I will ask groups to address questions that range from ones of interest to people just beginning to set up a course as well as people who have taught a course for several years and wish to improve it. I have had experience with all the courses mentioned above, with limited experience with cultural astronomy.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Integrating the Galileoscope into the College Classroom

Robert Sparks, *NOAO, rsparks@noao.edu*

Stephen Pompea, *NOAO, spompea@noao.edu*

Constance Walker, *NOAO, cwalker@noao.edu*

Many college astronomy classes struggle to incorporate telescopic observing projects into the curriculum. Scheduling observing sessions at night can be

problematic, particularly for students who must commute longer distances to campus. One potential solution is for students to do observing projects at home and report back the next day. In order for this model to work, each student would need a telescope at home. The Galileoscope is a low cost, high optical quality telescope that was developed for the International Year of Astronomy (IYA) that is being used in college courses around the country. Each student in class can purchase a Galileoscope for a fraction of the cost of a typical astronomy textbook. The Galileoscope is capable of showing a wide variety of celestial sights including craters on the Moon, the phases of Venus, the Galilean Moons of Jupiter, the rings of Saturn and a wide variety of double stars, nebula, and star clusters. Coupled with appropriate star charts and planetarium programs (such as the free Stellarium), the Galileoscope can enhance introductory astronomy programs with a rich visual observing experience. The Galileoscope comes as a build-it-yourself kit. The process of building a Galileoscope allows students to become familiar with the optical components of a refracting telescope. Optional optics experiments can be performed during the construction process giving students insight into the focal length of lenses and the image formation process. This workshop will teach participants how to build a Galileoscope and use it in their classroom. Each participant will build and test his or her own Galileoscope. We will go over various observing and educational resources that accompany the Galileoscope as well as other free online resources that can enhance the observing experience such as free printable planispheres, free computer software, and recommended observing projects for the classroom. All participants will receive a free Galileoscope.

Outcomes: Workshop participants will: 1. Assemble their own Galileoscope and learn its various observing configurations including both as a Keplerian and Galilean telescope; 2. Practice using the Galileoscope and receive observing tips; 3. Receive a collection of observing projects that can be done with the Galileoscope; 4. Receive a CD containing a variety of free software and educational materials developed for the Galileoscope.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

Challenges and Strategies of Lunar Phases in Introductory Astronomy: The Use of "Mental Model Building" Methodology and Scaffolding Tools in Teaching Lunar Phases

Mary Urquhart, *University of Texas, Dallas, urquhart@utdallas.edu*
Manuel Mon, *Florida Gulf Coast University*

With all of the topics instructors are expected to cover in introductory astronomy, the topic of lunar phases all too often receives little classroom time. And yet, lunar phases are far more conceptually challenging for students than many instructors realize. In this workshop, we will discuss what the research literature and experience can tell us about the challenges of building student understanding of the Earth-Moon-Sun system, and explore a wide range of strategies for assisting introductory astronomy students in building their own understanding. Participants will be encouraged to share their own ideas, strategies, and lessons learned with the group. The second part of this workshop will demonstrate two specific instructional tools. The first is a methodology called "Mental Model Building" (MMB). It is most useful when students must understand abstract concepts that are not easy to visualize. MMB is a constructive methodology that allows the students to represent the content of their study in the form of drawings, diagrams or physical models. One such concept pertains to the conceptual understanding of the process leading to the cause of the varying phases of the Moon. The students come to grips with their misconceptions of the cause of this phenomenon. They achieve this by creating a concrete model based on actual visual observations. We utilized the Lunar Phases Concept Inventory (LPCI), developed by Rebecca Lindell of Southern Illinois University, for pre- and post- testing; thus attaining a measure of the conceptual knowledge gained during the MMB process. We will also introduce a new (and free) scaffolding tool and accompanying guided questions developed to assist in bridging the gap between novice learners and experts in introductory astronomy in a Masters of Arts in teaching program in Science Education. This tool was also developed with the guidance of the LPCI.

Outcomes: Participants will be have the opportunity to explore and take away resources and strategies to start or add to their own teaching tool kit for lunar phases, and more experienced instructors and fellow researchers/ curriculum developers will be encouraged to share their own insights and ideas with their peers. In addition to a summary of research in teaching and learning of lunar phases and introduction to classic teaching strategies participants will learn and understand the use of two new resources including the "Mental Model Building" (MMB) teaching methodology in the teaching of hard to visualize processes and phenomena such as the cause of the lunar phases and the Lunar Phase Wheel scaffolding tool. We will provide an example of valid assessment as pertains to the conceptual learning gained by the students of lunar phases exercises.

Wednesday AM Cosmos Special Interest Group Discussions

Time: 11:15 a.m. – 12:05 p.m.

Session Type: Special Interest Group Discussion

Location: Eaton Humanities 125

Students as Starry Messengers: Engaging Astro 101 Students through Service-Learning and Community Engagement

Kristine Larsen, *Central Connecticut State University, larsen@ccsu.edu*

According to the National Service-Learning Clearinghouse, service-learning is "a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities." Research has shown that engaging in service-learning and community outreach enhances both the personal and academic development of college students. According to the Campus Compact, over 1100 college and university presidents have affirmed their commitment to promoting these activities on their campuses. At some institutions, service-learning is mandatory, while at others it is optional. However, trends suggest that the former is increasingly growing towards becoming the norm. Posters at the last *Cosmos in the Classroom* conference demonstrated that some in our community are already engaging astronomy students in this way, through star parties, planetarium shows, classroom visitations and other activities. Conversations with colleagues at various institutions suggests that many more instructors are either personally interested in becoming involved, or are feeling significant pressure from their institutions to do so. We will discuss programs which are in existence, best practices, pitfalls, and methods of obtaining funding and buy-in from the various constituencies.

Outcomes: It is expected that as a result of this discussion colleagues at various institutions will feel empowered to offer service-learning opportunities at their institutions, and those who already take part in

such activities will gain new ideas and perspectives which will be used to improve their current programs.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 135

Teaching Astrobiology

David Morrison, *SETI Institute, david.morrison@nasa.gov*
Edna DeVore, *SETI Institute, edevore@seti.org*
Seth Shostak, *SETI Institute, sshostak@seti.org*

When an astronomer talks to the public, the subject almost always turns to either black holes or the search for life beyond the Earth. For humans, the question "are we alone" has a universal appeal. In the past two decades this interest has gained respectability as the subject matter of the multi-disciplinary field of astrobiology. Astrobiology is defined as the study of the origin, evolution, distribution, and destiny of life on the universe. As a multidisciplinary topic it can be taught as a branch of astronomy or of biology or of geology. In practice, the astronomers have been the most enthusiastic adopters, with the majority of astrobiology college courses given in astronomy departments, and most of the textbooks written by astronomers. There are a dozen universities that offer graduate programs in astrobiology and more than 100 with undergraduate courses. In addition, of course, this topic is a natural for inclusion in astronomy courses at any level including two-year colleges and secondary schools. The purpose of this interest session is to compare strategies and experiences of those teaching astrobiology at the introductory level, including users of the *Voyages Through Time* integrated high school curriculum. Discussion topics include understanding the level of preparation of students first encountering the concepts of astrobiology, dealing with preconceptions about evolution and the origin of life, examining the prospects and ethical challenges that will be faced if NASA follows the goal set by President Obama to send humans to the surface of Mars "within his lifetime", and considering the implications if any of the current SETI searches for intelligent life should succeed.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 1B90

Teaching Climate Change

Aileen O'Donoghue, *St. Lawrence University, aodonoghue@stlawu.edu*

The science of climate change often gets lost behind the political debate. It presents those of us who teach physical science both the responsibility and the opportunity to teach both the science and, as importantly, the process of science to our students and the general public. Part of the problem is that the science — reconstruction of past climate through the use of proxy sources, such as isotopes of oxygen and hydrogen — is complex, making teaching it to science-averse students and general audiences even more challenging. Also, in our times when every action and statement is suspected of having a political motivation, teaching the process of science — data gathering and analysis, hypothesis testing and peer review — as our way of keeping science as truthful as possible so that the conclusions are more than just another opinion presents as great a challenge as teaching the science, itself. (I have been teaching a course in Global Climate since 2000, have taught Elderhostel courses twice and have given many public talks on this topic. Thus I have experience in this area to share with others. I would also like to learn of others' approaches to the vast amount of scientific information and getting past the politics.)

Outcomes: Participants will come away with a richer understanding of the science of climate change and techniques for teaching the science and dealing with the politics.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 150

Multi-Institutional Collaborative Astronomy Education Research

Timothy Slater, *University of Wyoming, sslaterwyo@gmail.com*

ASP, AAS, APS, and AAPT advocate that scientists should be engaged and acknowledged for successfully engaging in astronomy and physics education research and the scholarship of teaching because these efforts serve to improve pedagogical techniques and the evaluation of teaching. However, few scientists have had the opportunity to pursue formal training in how to meaningfully engage in astronomy education research as an important scholarly endeavor. This special interest session for college and university physics and astronomy faculty, post-docs, and graduate students provides a forum to discuss the motivations, strategies, methodology, and publication routes for improving astronomy education through conducting rigorous science education research. Topics for discussion will target the value of various education research questions, strengths and weaknesses of several different research design methodologies, strategies to successfully 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. A significant portion of the special interest session will be devoted to connecting individuals from different institutions to conduct collaborative astronomy education research projects.

Outcomes: Participants in this special interest session will become more aware of issues surrounding becoming engaged in astronomy education research and individuals with similar interests will be paired with others to participate in collaborative astronomy education research projects.

Session Type: Special Interest Group Discussion
Location: Eaton Humanities 1B80

What to Leave Out of Astro 101

Gareth Wynn-Williams, *University of Hawaii, wynnwill@ifa.hawaii.edu*

The amount of information in a typical Astro 101 textbook is daunting and it is hard to cover the whole of astronomy in a single semester (or quarter). This discussion group is for those willing to consider dropping large sections out of their course, rather than trying to cover everything superficially. We will shape the discussion with the premise that on day 1 of your Astro 101 course, your Dean suddenly tells you that (say) three of your classes have to be cancelled as a cost-cutting measure. What topic(s) would you omit from what you had planned to teach? Talking faster is not an acceptable option!

Outcomes: We hope that the participants in this discussion will have very different ideas of what to drop. Whenever a candidate topic for omission is suggested, the chair will invite one of the other speakers to defend its inclusion. The overall goal would be to give younger teachers the confidence to be more critical about what they include in the course.

Wednesday PM Cosmos 1-Hour Workshops

Time: 1:15 p.m. – 2:15 p.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Mastering Astronomy: On-line Homework to Build Student Understanding

Jeffrey Bennett, *University of Colorado, jeffrey.bennett@mac.com*

No matter how good your lectures, your textbook, or your use of class time, the single best predictor of student success is the amount of time they spend studying outside of class. In the past, limitations on grading help have limited the amount of homework you could assign to students. Now, however, the Mastering Astronomy platform makes it possible to assign self-guided tutorials that will build student understanding and ensure that students spent adequate time studying. As the lead author of content for the Mastering Astronomy homework library, I will demonstrate the system, provide examples of the library content, and allow time for you to work through sample tutorials. There will also be time for questions. Participants may bring their own laptops to access the system wirelessly, or just follow along with the examples I will project from the front of the room.

Outcomes: Participants will learn about and interact with the Mastering Astronomy on-line platform, exploring the library of material that can now be assigned as auto-graded homework.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B90

Innovative Strategies for Empowering Your Students to Become Active, Responsible Learners

Beth Hufnagel, *Anne Arundel Community College, brhufnagel@aacc.edu*

The economy continues to sputter along, and the repercussions are now hitting hard at publicly-funded colleges and universities, with enrollment increasing and funding decreasing. Funding agencies are starting to look at retention and completion rates as a way to allocate scarce dollars. Improving these rates is also one way to increase the future stream of tuition; students who can't pass introductory classes like Astro 101 won't enroll and pay tuition for the next level, and they won't complete their degree. So what can you, a mere professor of astronomy, do? Tired of the "What do you want me to know?" questions? Provide your students with learner-centered structures to help them learn more deeply. Do your students resist active-engagement techniques and hate group work? Share empowerment strategies for helping students become active, responsible learners who can thrive in a learner-centered environment. Do you think that it's wrong for the freshman classes to be over-crowded, yet your sophomore classes don't get enough students or don't even exist? After using the proven curriculum of On Course, college and universities across the country have improved their retention across a wide range of disciplines (www.OnCourseWorkshop.com/Data.htm). Experience a sample of the fun and engaging activities developed over two decades to help students to: 1) accept personal responsibility 2) discover self motivation 3) master self-management 4) use interdependence 5) gain self-awareness 6) adopt lifelong learning 7) develop emotional intelligence, and 8) believe in themselves. Since this is only a one-hour workshop, we will focus on choices one and four: To be successful, students need to see themselves as the primary cause of their outcomes and experiences and to build mutually supportive relationships in our classroom and labs.

Outcomes: One Astro 101 Course-ready activity to help students accept personal responsibility. One Astro 101 Course-ready activity to help students use interdependence. Personal experience with both. Optional: Discussion of the results of your personal Self-Assessment, taken prior to or during the conference (www.cengage.com/success/Downing/OnCourseSS)

Session Type: 1-Hour Workshop

Location: Eaton Humanities 150

Using Observational Exercises in Online Astronomy 101 Courses

Lauren Monowar-Jones, *Columbus State College, lmonowar@cscc.edu*

Observation Exercises in Astronomy is a suite of astronomy exercises developed to address the needs of the Astronomy 101 population of students. This set of exercises has many features that are unique. First, the exercises involve some real observations, but they don't require any instruments. Second, the exercises use the WorldWide Telescope, which is free software that allows an individual to interact with real astronomical data. Third, this set of exercises was designed for students of Astronomy 101 — students who are non-science majors, who are not comfortable with a lot of mathematics and who feel intimidated by "real" science. These exercises are designed to engage this population of students in the process of science. Exercises take students through the process of science by having them write hypothesis statements, analyze models, develop models, analyze data, draw conclusions from data, and create models based on data. Throughout the sequence of exercises, students go from producing something that looks like a reflection paper to writing a formal lab report. The suite is designed to teach students what science is while doing some astronomy. In this workshop, we will demonstrate how to use the WorldWide Telescope and two of these exercises (Motions of the Night Sky and the Celestial Sphere and How Do We Know the Mass of Jupiter, Anyway?). We will present student feedback and work related to these exercises. These exercises are being used as homework assignments in current online courses. The feedback generated by students will inform the use of these exercises in a lab-only environment, but can also be more globally relevant to the field which teaches largely lecture-only courses.

Outcomes: Participants will walk away with at least two lab exercises that they can use, along with useful information about implementation of the lab exercises and some insight into how these exercises may enhance a typical lecture course that has no lab associated with it.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 125

Using Kinesthetic Learning Techniques with College Students to Improve Understanding of Spatially Rich Topics Such as Seasons and Milankovitch Cycles

Cherilynn Morrow, *Georgia State University, cmorrow@gsu.edu*

Michael Zawaski, *Front Range Community College, mike.zawaski@frontrange.edu*

A great deal of abstract and spatial thinking is required to understand the reasons for Earth's seasons and the longer term cyclical changes in Earth's circumnavigation of the Sun known as the Milankovitch cycles (the primary cause of the episodic nature of Earth's glacial and interglacial

periods). Kinesthetic learning techniques, often thought to be of greatest use with elementary age students, can offer a powerful approach to such topics for older learners. This workshop will offer hands-on experience with *Kinesthetic Astronomy: The Sky Time Lesson* — an inquiry-based, body-centered approach to learning about rotation vs. orbit, the day/night cycle, and the reasons for seasons. The developers of this popular lesson (also the workshop facilitators) are adapting it for use in college courses, including introductory astronomy, introductory weather & climate, and science education methods. They are also extending the lesson's content to include the Milankovitch cycles, which is of relevance to understanding natural climate change. The workshop facilitators will: 1) provide a theoretical basis for use of kinesthetic learning techniques with older students; 2) integrate attention to content and important pedagogical elements of the *Sky Time Lesson*; 3) demonstrate how the lesson can provide enhanced relevance to a particular culture; and 4) support participants' reflection on how kinesthetic learning techniques could be used to teach a topic of relevance to their own contexts for teaching and learning.

Outcomes: Participants will: 1. gain new perspectives on the value of using kinesthetic learning techniques with college-age learners; 2. be able to identify attributes of science topics that lend themselves to kinesthetic approaches to teaching and learning; 3. be empowered to adopt kinesthetic approaches to the teaching and learning of spatially-rich topics relevant to their own introductory science courses at the undergraduate level (e.g. seasons, the Milankovitch cycles, atomic & molecular structure, mechanical equilibrium, catalytic chemistry, wave motion, rotation of pulsars, center of mass in binary star and planet-star systems).

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

Dime-Store Space Curvature

Bruce Partridge, *Haverford Coll, bpartrid@haverford.edu*

Nick Vechik, *Haverford Coll, nvechik@haverford.edu*

A balloon as an analogy for curved, expanding space is a cheap demo we almost always use when teaching cosmology in Astro 101. In this workshop, we will develop this teaching tool in depth, and explore how drawing triangles on a balloon's surface can be used both to bolster your students' understanding of geometry and to introduce current observational tests of cosmic space curvature. We will start by showing how the geometrical properties of flat space change in the curved space of the rubber membrane of the balloon. Flat space and the positively curved surface of a balloon are 2 of the 3 examples of spaces of uniform curvature; we'll use a Pringle's potato chip to illustrate the third example, negatively curved space. Then we'll use the geometrical properties of curved space to motivate two standard tests of cosmological curvature. One is based on the fact that the area of a sphere is not the "usual" 4 pi R^2 in curved space. This is the physics underlying the luminosity-distance or magnitude-redshift test of cosmic curvature. The other involves the sum of angles in a triangle, again not the "usual" 180 degrees. The latter is the basis of a test using measurements of the size of fluctuations in the cosmic microwave background. This test, as performed by the WMAP satellite, has shown that the departure from flat space in the Universe is less than a percent or two. The Planck mission, now flying, will improve this result still further, thus providing the best measurement we have of cosmic curvature.

Outcomes: Refresh student knowledge of geometry. Build more intuitive understanding of curved space by getting your students to work out properties of curved space (I'll demonstrate several in-class exercises). Motivate the currently employed experimental tests of cosmic space curvature.

Wednesday PM Cosmos 1-Hour Workshops

Time: 3:00 p.m. – 4:00 p.m.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B90

Concept Mapping in Astro 101

Peter Newbury, *University of British Columbia, newbury@phas.ubc.ca*

By the end of the semester, students are often overwhelmed by the number of facts, concepts and relationships they have encountered. Remembering the material for the final exam is hampered by decaying memory ("Is aphelion nearest or farthest?"), interference between concepts ("Nuclear fusion is the carbon cycle, right?") and a lack of cues for recalling the right material at the right time ("Red giants are huge but...cool?") To help organize the material, reveal relationships and make it easier to recall later, we have developed a 1-hour concept mapping activity that we facilitate at the end of the semester. Concept mapping has a reputation of being abstract and open-ended and better suited for the Humanities, not Science. However, we designed the activity based on education research into how people learn and create lasting schemata in their memories. Our measure of success, for now, is the incredible student engagement. Students actively (sometimes passionately) discuss astronomy — astronomy! Not Glee or iPad or [insert local team name] — with their peers for 30 minutes or more. In this workshop, we'll see the activity's "choreography" first hand, from getting students up-to-speed on concept mapping, to peer instruction, to feedback and assessment.

Outcomes: Workshop participants will leave with a time line of steps for facilitating an astronomy concept mapping activity and some understanding of why we suggest that sequence of steps, from both an educational and a practical point-of-view.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 135

You Can Create a Podcast/Vodcast

Carolyn Petersen, *Loch Ness Productions., carolyn@lochnessproductions.com*

Online media are short, easy ways to deliver a "payload" of knowledge to a wide audience. With the advent of low-cost and/or free software and the use of a netbook or an iPad equipped with inexpensive headphones and microphones, anyone from scientists to students can create their own media in a matter of a few hours. This represents a unique way for students and teachers to collaborate on online "broadcasts" about science topics, particularly in astronomy. This workshop focuses on the following strands:1. How to script your media piece — perils and pitfalls to avoid; 2. should you do audio or video?; 3. How to produce your piece — from recording the narration to mixing in the music and visuals (if it's a visual piece); 4. Sources of inexpensive or free software, recommendations for hardware that won't break the bank.

Outcomes: We will discuss the "making of" an episode from ASP's "Astronomy Behind the Headlines" podcast series as an example of a podcast, and an episode from MIT Haystack Observatory's "Space Weather FX" vodcast series as an example of a vodcast. Participants will take part in small group discussions to create an example script for a podcast/vodcast — complete with visual suggestions (if a video). These will be shared with the larger group. Participants will come away with information about tools for

production and pointers for posting and distributing their online content.

Session Type: 1-Hour Workshop

Location: Eaton Humanities 1B80

Stealth Physics 101: How to Teach Students Important Bits of Physics Under the Guise of Teaching them Astronomy

Gareth Wynn-Williams, *University of Hawaii, wynnwill@ifa.hawaii.edu*

For most students who take it, Astronomy 101 is the last course they will ever take in a physical science. This workshop is for those of us who see Astronomy 101 as a tool to give students confidence in their future ability to understand scientific ideas, rather than as a catalog of cosmic phenomena. Most introductory astronomy textbooks, even the best ones, have an early chapter entitled something like "Light and Atoms" in which a broad range of very important, and sometimes subtle, physics ideas are thrown at a student in one indigestible lump. To a student, this chapter can make physics look like an annoying obstacle to be overcome, rather than a collection of beautiful ideas. I have found that it is much more satisfying to design one's course so that the interesting and important bits of physics are introduced gradually and as needed to understand a particular astronomical phenomenon. In this workshop we will first make a list of the physics ideas that we want to get across in a "Physical Science 101" class, together with constraints on the sequence in which they can be taught. Then we will try to find simple astronomical topics that can be used to introduce these ideas. Finally we will try to place these topics in a plausible sequence that can be taught as a single semester Astronomy 101 course. If time permits we will also look at astronomical topics that not naturally covered by this procedure, and discuss whether or not they need to be included in an Astronomy 101 class.

Outcomes: Participants may find ways of making their introductory astronomy course more digestible to students who are turned off by the thought of physics.

Poster Sessions

Time: Noon – 6:00 p.m., Monday
9:30 a.m. – 6:00 p.m., Tuesday – Wednesday

Poster Location: University Memorial Center Ballroom

EPO Posters

Monday, 10:30 a.m. Oral Overview, Cristol Chemistry 140

Poster presenters are invited to give a 60-second overview of their poster to conference attendees between 10:30 a.m. and 11:50 a.m. in Cristol Chemistry 140.

E1 Rocks from Space — Lunar Rocks and other Astromaterials on Loan!

Jaclyn Allen, *NASA Johnson Space Center Astromaterials / ESCG, jaclyn.allen-1@nasa.gov*

The Moon is easily observed from our backyards. Asteroids may be the next destination for human spaceflight! NASA has samples of both for you. NASA has Rocks from Space displays that educators can borrow for public events and education training. The smaller displays are located at each NASA Center with the larger displays available from Johnson Space Center (JSC). Learn how to arrange for both large and small lunar rock displays for events. Information displays are also available from JSC. Handouts will share how museums and science centers can schedule NASA staff to certify educators to borrow lunar rocks and meteorites and how museum and science center educators can be certified to borrow the Lunar and Meteorite Sample Education Disks. The NASA Johnson Space Center Astromaterials Research and Exploration Science Directorate manages the loan of Lunar and Meteorite Sample Education Disks. The Aerospace Education Service Program specialists and NASA Educator Resource staff are authorized to certify educators at museums and science centers to borrow the sample education disks. Learn how to schedule the trainings and to borrow the disks. Display information, contact information and resource websites will be included in handouts.

E2 Language Preservation: Using the Language of Science as a Bridge to the Native American Community

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In this talk, we will present a concept for building on Native American languages and incorporating STEM concepts. Recently, a student from the Navajo Dine community took it upon himself to define 28 "NASA" terms in the Navajo language. These terms included such words as space telescope, weather satellite, space suit, and the planets including Neptune and Uranus. We hope to add to this word list with geology and astronomy terms, just as we would for English-speakers learning about Rosetta. Following approval by the tribal elders, the U.S. Rosetta project would host these words on a web-site, and provide translation into both Navajo and English. A clickable map will allow the user to move through all the

words, see Native artwork related to the word, and hear audio translation. The project is expected to be expanded into other Native communities such as Cherokee, Crow, and Hawaiian. Educators in the Native American community have spoken about the value of comparative astronomy — a side-by-side presentation of Native understanding of the sky with contemporary scientific understanding, as a way to draw Native American students to understanding the marvelous images, and other data, returned from NASA space missions. Native Americans emphasize the need to know themselves and their own culture when teaching their students. One of the most important near-term problems is the preservation of Native American language. In some communities, small numbers of native speakers remain, and those are elderly. The retention of language, and need to make it relevant to the technological age, represents a large and urgent challenge. The U.S. Rosetta Project is NASA contribution to the International Rosetta Mission. Rosetta is expected to provide the keys to the primordial solar system the way the original Rosetta Stone provided a key to ancient language.

E3 Visualizing Space Plasmas and Particles: "Extraordinary Matter"

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A recent survey of museum visitors documented some startling misconceptions at a very basic level. Even in this "science attentive" group, one quarter of the respondents believed that an atom would explode if it lost an electron, one sixth said it would become a new atom or element, and one fifth said they had no idea what would happen. Only one fourth of the respondents indicated they were familiar with plasma as a state of matter. Current resources on these topics are few in number and/or difficult to locate, and rarely provide suitable context at this level. In response to this and other evidence of common misunderstandings of simple particle and plasma science, our team of space scientists and education specialists has embarked upon the development of "Extraordinary Matter: Visualizing Space Plasmas and Particles", an online NASA multimedia library. It is designed to assist formal and informal educators and scientists with explaining concepts that cannot be easily demonstrated in the everyday world. The site, with a target audience equivalent to grades 9–14, will include both existing products, reviewed by our team for quality, and new products we develop. Addition of products to our site will be in large part determined by the results of our front-end evaluation to determine their specific needs, gaps, and priorities of potential audiences. Each ready-to-use product will be accompanied by a supporting explanation at a reading level matching the educational level of the concept, educational standards addressed, and links to other associated resources. Products are intended to stand alone, making them adaptable to the widest range of uses, either individually or as a custom-selected group. Uses are expected to include scientist presentations, museum displays, teacher professional development, and classroom applications.

E4 Emergence: A Planetarium and Art Gallery Collaboration Between Visual Artist, Astronomer and Improvisational Musician

John Beaver, *University of Wisconsin – Fox Valley, john.beaver@uwc.edu*

Judith Waller, *University of Wisconsin – Fox Valley, judith.waller@uwc.edu*

Matt Turner, *turnmatt@aol.com*

We describe an unusual planetarium program and art gallery exhibition that premiered in Menasha, Wisconsin. Emergence combines fine art and improvisational music with astronomy and physics. The authors, Judith Waller, John Beaver and Matt Turner are, respectively, artist, astronomer and musician. All three acted as equal partners in planning and executing the final production. The overall goal of Emergence is to use art, music and natural science each as a point of departure to learn about the others, and to explore the interaction between humans and the natural world and the differences and commonalities between art, science and music. Of particular interest, the planetarium portion includes techniques that are, so far as we know, unique. Each night the show is different, the details chosen randomly, but always according to the same theoretical scheme. Various elements are parameterized, the show varying with time according to subroutines that dictate the overall pacing and look, but with details always chosen randomly according to pre-arranged probabilities. And so each performance is unique, but the overall look, feel and content is essentially the same. We believe that some of these techniques could be of interest to others who wish to explore the unique possibilities of the planetarium as educational performance space, especially where one wishes to avoid a linear narrative structure, but still with a particular "look and feel" and content that is carefully chosen. We argue that this provides a useful format for collaborations between artist and scientist, as scientific content can be delivered in a way that is consistent with the concerns of the artist. We describe some of the approaches taken toward these ends in Emergence, and some of the lessons learned about the process of collaboration between a scientist, a visual artist and a performing artist.

E5 Sustainable Astronomy: Students Teaching Students Teaching Students...

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Through our International Year of Astronomy outreach effort, we established a sustainable astronomy program and curriculum in the Northfield community. Carleton College offers monthly Open Houses at Goodsell Observatory and donated its recently "retired" telescopes and observing equipment to local schools. While public evenings have been popular, the donated equipment was underutilized due to a lack of trained student observing assistants. With sponsorship from NASA IYA Student Ambassador program, the sustainable astronomy project began in 2009 to generate greater interest in astronomy and train middle school and high school students as observing assistants. Carleton College physics majors developed curricular materials and instituted regular outreach programs for grades 6–12. The Northfield High School Astronomy Club was created and through weekly meetings at Goodsell Observatory, Carleton undergraduates taught high school students how to use telescopes and do CCD imaging. During the summer of 2009, Carleton students began the Young Astronomers Summer Experience (YASE) program for middle

school students and offered a two week astronomy-rich observing and imaging experience at Goodsell Observatory. In concert with NASA Summer of Innovation initiative, the YASE program was offered again in 2010 and engaged a new group of local middle school students in hands-on scientific experiments and observing opportunities. Members of the high school astronomy club now volunteer as observing assistants in the community and graduates of the YASE programs are eager to continue observing as members of a public service astronomy club when they enter the Northfield High School. These projects are training future scientists and will sustain the public interest in astronomy long after the end of IYA 2009.

E6 Exploring Outcomes for Teachers Who Engage in Astronomical Research with Scientists

Sanlyn Buxner, *College of Education, University of Arizona, buxner@email.arizona.edu*

Research on science teacher professional development over the last fifteen years has found that an effective way to engage teachers in science is by providing opportunities for them to engage in authentic research along-side scientists. Several studies and evaluations have reported that teacher participation in research experiences results in increased excitement in science, science content knowledge, and intentions to use what they have learned in the classroom. This study investigated teachers who participated in two summer astronomy research programs during which they conducted research along-side scientists. Both of these programs occurred "in the field", one in a national park and one at a major observatory. The main areas of investigation were related to changes in teachers' understandings of scientific inquiry and nature of science, their beliefs about science teaching, and the value of the experience. Data included surveys, interviews, and program observations. Participants completed surveys before and after the program as well as during the school year after teachers had returned to their classroom. Follow-up interviews were conducted with a subset of the participants six to eight months after the program was completed. Results indicated those teachers' overall understandings of scientific inquiry and the nature of science did not improve as a result of participation in the summer research programs although small changes were detected; increased sophistication and context for their understandings taken directly from their research experiences. Changes to teachers' beliefs about teaching varied depending on the experience of the teacher. Results also showed that benefits for participants included access to educational resources, the uniqueness of the experience, and a sense of improved credibility among their peers. Implications for research experiences for teachers and research on field experiences will be discussed.

E7 The Juno Mission to Jupiter: Education and Public Outreach

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The Juno mission to Jupiter, scheduled for launch in August 2011, will observe Jupiter gravity and magnetic fields, atmospheric dynamics and composition, and the coupling between the interior, atmosphere, and magnetosphere. The understanding of the origin and evolution of Jupiter, as the archetype of giant planets, can provide the knowledge needed to understand the origin of our solar system and planetary systems around other stars. The Juno mission Education and Public Outreach efforts combines experienced partners with exciting programs and products that bring to a diverse set of audiences. Highlights include: (a) Development of a comprehensive Jupiter-centered curriculum for middle school students, with emphasis on Jupiter atmosphere, magnetosphere, interior and origins. The Juno education team will have 20 fully tested lessons available prior to launch. (b) Afterschool programming and products, designed by the Lunar and Planetary Institute, for use in the Explore! Library program, but adaptable to any after school environment. (c) Teacher professional development through several national programs, including the Colorado Space Science Teacher Summit, the JPL teacher programs, and the Goldstone Apple Valley Radio Telescope (GAVRT) teacher program. (d) Development of informal educator professional development programs in support of the Giant Worlds museum exhibition from Space Science Institute. (e) Professional Development workshops for the media prior to launch. (f) Support for NASA Solar System Ambassadors program. (g) End-to-end evaluation by RMC Research, Inc. The Juno E/PO team is committed to implementing a strategy that 1) utilizes scientist involvement, 2) leverages and builds on existing programs and products, and 3) has a wide reach, in terms of target audiences, with the particular emphasis on reaching rural underserved populations. To successfully implement this strategy, Juno E/PO relies heavily on existing infrastructure and networks, so that products will have longevity beyond Juno, in support of SMD outer planets E/PO.

E8 Global Change, Local Impacts: Student-produced Digital Stories about the Regional Impacts of Climate Change

Lisa Curtis, *Space Science Institute, curtis@spacescience.org*

Scientists have observed a marked increase in the average temperature near Earth surface and in the lower atmosphere. The result of this global warming is profound: it is changing the balance of Earth complex climate system. Climate scientists around the world have reached a consensus that human activities associated with industrialization, such as burning fossil fuels that emit CO #8322 are the primary cause of global warming and climate change. And yet, as scientists sound the alarm, a recent Gallup poll reveals that the public has become more skeptical that climate change is occurring, less concerned with its consequences, and more likely to believe that there is a lack of consensus about climate change among scientists. Clearly there is a national need for effective climate education programs. The innovative Global Change, Local Impacts project will empower students to learn about climate science through both fieldwork and a creative project. The project combines emerging technologies and digital storytelling and online communities with climate science instruction; a citizen science activity; interactions with scientists; and a structured decision making tool that could support critical thinking. Participating students will be given a challenge: Create a digital story that describes what the impacts of climate change might be on your region and how people like you could respond. A digital story is generally a personal narrative that uses digital images, video clips, text, voiceover narration, and music to tell stories. The project will allow the students to explore and learn the science through both citizen

science activities and digital storytelling. Their efforts and critical thinking about the science content will be supported by a decision making tool that has been tested with adult policymakers and stakeholders in the context of addressing various environmental challenges. The students will share their stories online.

E9 NASA, National Parks and the US Fish and Wildlife Service Join Hands in Climate Change Communication

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There are over 430 million visits to national parks and wildlife refuges each year. From Cape Cod National Seashore, Gettysburg National Battlefield, and Yosemite National Park, to the Sevilleta and Blackwater National Wildlife Refuges, America national parks and refuges connect people to the cultural and natural heritage of our nation. Amidst such deeply meaningful settings, visitors see first-hand the consequences of climate change and, through NASA science, gain an appreciation of global processes at work. The opportunity for combining NASA science and educational resources with the communication capabilities, skills, and talents of the U.S. Fish and Wildlife Service and the National Park Service forms the foundation of the Earth to Sky partnership. Earth to Sky actively builds collaborative opportunities between these three agencies and the science and interpretation/education communities they support. Through professional development opportunities and the creation of educational and interpretive programs and products, the partnership continues to strengthen and expand its impact. The ultimate outcome is the enhanced experience of millions of park and refuge visitors, and a deeper understanding of climate change as it is manifested in our nation protected areas and communities. Our poster will describe the structure of the partnership, the professional development strategies we employ (founded on the Authentic Task Approach), and our innovative partnering of scientists, rangers and environmental educators. We will highlight the varied outcomes of this partnership including - climate change training programs conducted in parks and refuges - exhibits in Park visitor centers and on protected lands - teacher training workshops, and - on-line educational resources to support climate change literacy for children. We will identify opportunities for Earth Science missions to work with NPS and USFWS in the area of climate change as well as other potential areas of synergy for space-oriented NASA missions.

E10 Kepler Mission Teacher Professional Development Workshops: Assessment of Six Events

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David Koch, *NASA Ames Research Center, David.G.Koch@nasa.gov*

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NASA Kepler Mission conducted six teacher professional development workshops on the search for Earth-size in the habitable zone of Sun-like stars. The Kepler Mission launched in March, 2009. As a part of International Year of Astronomy 2009, this series of one-day workshops were designed and presented for middle and high school teachers, and science center and planetarium educators prior to and after the launch. The professional development workshops were designed using the best practices and principals from the National Science Education Standards and similar documents. Sharing the outcome of our plans, strategies and formative evaluation results can be of use to other Education and Public Outreach practitioners who plan similar trainings. A Kepler team scientist, two Education & Public Outreach staff and local hosts supported each event. The workshops combined a science content lecture and discussion, making models, kinesthetic activities, and interpretation of transit data. The emphasis was on inquiry-based instruction and supported science education standards in grades 7–12. Participants' kit included an orrery, optical sensor and software to demonstrate transit detection. The workshop plan, teaching strategies, and lessons learned from evaluation will be discussed. Future events are planned. Kepler Education and Public Outreach program is jointly conducted by the SETI Institute and Lawrence Hall of Science at UC Berkeley in close coordination with the Kepler Mission at NASA Ames Research Center. The IYA Kepler Teacher Professional Development workshops were supported by NASA Grants to the E. DeVore, SETI Institute NAG2-6066 Kepler Education and Public Outreach and NNX08BA74G, IYA Kepler Mission Pre-launch Workshops. For further information on NASA Kepler Mission, visit http://Kepler.NASA.gov.

E11 Great Balls of Fire: A National Traveling Exhibition About Comets, Asteroids, and Meteors

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Asteroids and comets are popular subjects for movies like Armageddon and Deep Impact, but they are also playing their own starring roles in NASA research. In 2005, NASA Deep Impact probe collided with Tempel 1, exploring beneath the comet surface. In 2007, NASA launched the Dawn spacecraft to the Main Asteroid Belt. With all this interest, asteroids and comets are compelling subjects for an exhibition. The National Science Foundation (NSF) is funding the development of Great Balls of Fire!: Comets, Asteroids, and Meteors. The centerpiece of the comprehensive informal education project is a 3,000-square foot traveling exhibit, and it being developed with a twist. The project includes three teams of middle school student advisors, who learn about the science content, interact with the core project team, develop an asteroids-related project for their communities, and assist with exhibit prototyping. The Astronomical Society of the Pacific is also a project partner responsible for the outreach program. Several exhibit components were recently prototyped, including the "Find an Asteroid" interactive allowing visitors to emulate traditional methods for discovering asteroids and then learn about cutting-edge techniques. The "Light Curve" computer interactive will demonstrate how 3D models of asteroids can be created from reflected light. "Water Impact" allows visitors to launch a small projectile into liquid, while a high speed camera plays back the impact. And finally, visitors using the "What if it hit my town?" interactive will be able to select different-sized asteroids or comets and a location on Earth for that body to impact. Visualizations of the resulting devastation will be displayed. SSI is developing an Education/Outreach Program for museum educators, docents, and amateur astronomers, as well as a Professional Development Program for science center and library staff and other informal education professionals. A public website will provide an interactive clearinghouse for the project components.

E12 Future Research in Interactive Planetariums

Alice Enevoldsen, *Pacific Science Center, AEnevoldsen@pacsci.org*

What is the next question facing interactive planetariums that needs

robust research and the collaboration of multiple institutions? There are few current published studies on interactivity and small planetariums in general, the most recent being a study by Mike Shanahan at the Bishop Museum in 2009. The small-planetarium community needs more research and larger studies to back up future grant proposals for all of us. This poster will elicit new ideas for research into small and interactive planetariums, and build a case for funding specific research of interest to the astronomy education community as a whole.

E13 NASA SMD Earth and Space Science Education Product Review Poster

John Ensworth, *The Institute for Global Environmental Strategies, john_ensworth@strategies.org*

Theresa Schwerin, *The Institute for Global Environmental Strategies, theresa_schwerin@strategies.org*

NASA Science Mission Directorate (SMD) education products (for K–12, higher education and informal education) that will be included in the new NASA SMD E/PO online catalog need to first pass the SMD education product review. Product developers and potential reviewers are encouraged to attend this poster presentation which is a companion to the workshop of the same name. We will offer a chance to discuss, in depth, the review process and to sign up to become a NASA science education product reviewer.

E14 Education and Public Outreach at the American Astronomical Society

Richard Fienberg, *American Astronomical Society, rick.fienberg@aas.org*

Recently the Council of the American Astronomical Society (AAS) adopted its first-ever mission-and-vision statement: (1) The Society, through its publications, disseminates and archives the results of astronomical research; (2) The Society facilitates and strengthens the interactions among members through professional meetings and other means; (3) The Society represents the goals of its community of members to the nation and the world; (4) The Society, through its members, trains, mentors and supports the next generation of astronomers; and (5) The Society assists its members to develop their skills in the fields of education and public outreach at all levels. Independently, the Astronomy Education Board (AEB), which has oversight of the Society educational activities, adopted five goals for the AAS education program, namely, to promote and support (1) training the next generation of astronomers to be successful scientific researchers; (2) training the next generation of astronomers to be successful educators; (3) research on the teaching and learning of astronomy; (4) increasing the scientific literacy of all and sharing the excitement of astronomy with the public; and (5) increasing the participation of underserved populations in astronomy. Much of the responsibility for aligning the mission-and-vision statement and AEB goals is vested in a new position: AAS Press Officer and Education & Outreach Coordinator. This presentation will describe what this new position is and isn't, describe the AAS strategic priorities for education and public outreach, and explain how they are being, or will be, achieved.

E15 Relative Benefits of Different Delivery Modes of Professional Development: Insights from the Astronomy from the Ground Up Program

Claudia Figueiredo, *Institute for Learning Innovation, figueiredo@ilinet.org*

Kate Haley Goldman, *Institute for Learning Innovation, haleygoldman@ilinet.org*

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The Astronomy from the Ground Up (AFGU) is a professional development program designed and implemented by the Astronomical Society of the Pacific to assist small science center educators increase and improve their astronomy-related programming. The program was delivered using both online and face-to-face workshops. As part of this National Science Foundation grant, the Institute for Learning Innovation conducted a summative evaluation to gauge the program effectiveness, both in its online and face-to-face versions. This poster presents some of the results from this evaluation, focusing on the relative benefits to onsite and face-to-face participants. When compared before and after their participation in AFGU, both groups showed significant gains in their astronomy programming and in individual outcomes. Data were collected using multiple methods, including an online questionnaire that was answered by 80% of the study population. Findings will be discussed and include recommendations about the conditions that were most favorable to each mode of workshop delivery.

E16 Goldilocks and the Three Planets

Matthew Fillingim, *Space Sciences Laboratory, University of California, Berkeley, matt@ssl.berkeley.edu*

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Just after their formation, the atmospheres of Venus, Earth, and Mars are though to have been very similar. Why are they so different today. We are developing a presentation that investigates the differences in the atmospheres of Venus, Earth, and Mars, and how these differences arose. The target audience is elementary school age children. The presentation is a combination of planetary images displayed on engaging spherical displays and hands on activities about the phases of matter. We recently tested and evaluated our preliminary presentation on the Lawrence Hall of Science 6-foot diameter Science on a Sphere. Our future plans include transferring this presentation onto a portable, table top spherical display system to take into classrooms.

E17 A Game of Iron Beads: An Ecology of Metallicity

Douglas Fowler, *University of Wisconsin – Fox Valley, douglas.fowler@uwc.edu*

Diana M. Ludwig, *Storm Bird Studios, diwgy2@yahoo.com*

To play within the overlap of physics, astronomy, chemistry and geology is always fun. To bring in connections to history and geography, and a sense of place in the human landscape, presents opportunities for outreach and public education in the earth sciences. This approach can even be brought back into the formal classroom. We present here an organized set of themes built around the natural history of iron. These are cross referenced with a number of activities already used successfully in a variety of public venues

including planetariums, art and art shows, museums, environmental workshops and conferences on waste and recycling. In addition, most of these activities can be successfully integrated into formal teaching. For us, an examination of the astrophysics, geology and geography of iron has been quite effective with audiences in the Great Lakes region, a broad physical, historical and sociological landscape in which iron played (and may play again) a major role. Interdisciplinary themes are not a new idea. Such approaches cropped up frequently in the history of American progressive education. We believe education becomes genuine with the use of such themes. In addition, the fact that such themes can be brought back into the formal classroom and used as a non-traditional unifying basis to build traditional physical science, points toward inexpensive ways that bring schools, colleges and universities back into the fold of their host communities.

E18 Gemini Cast: Our Spanish Podcast about Astronomy

Antonieta Garcia, *Gemini South Observatory – Chile, agarcia@gemini.edu*

Manuel Paredes, *Gemini South Observatory, mparedes@gemini.edu*

There is a great variety of podcasts in English for as many topics as one could possibly imagine. At Gemini South we thought it would be a great innovative way to inform our employees and communities about what goes on inside one of the biggest telescopes in the world, and we created our first Gemini Cast. Totally narrated in Spanish and subtitled in English, our podcasts were first available internally, soon they became a tool for our local communities and soon they will be available worldwide. We have only started this ambitious project in April 2010 and we expect to produce an average of 5 podcasts per year or according to any milestone that could occur within our science or engineering groups. We want anyone in Chile and hopefully in any Spanish speaking home in our planet to hear from us and start a discussion within their families in order to bring astronomy a lot closer to their daily lives.

E19 We Are Scientists: An Ongoing Project to Provide Images of Astronomers, Geologists and Scientists to Educators

Pamela Gay, *Astrosphere New Media Association, Pamela@starstryder.com*

Alice Enevoldsen, *Pacific Science Center, AEnevoldsen@pacsci.org*

We Are Scientists is launching! This website provides a clearinghouse for current, web-based images and bios of current scientists. It both provides an easy way for scientists and grad students to upload their own images and content, and facilitates classes and teachers browsing and downloading pictures. Our goal is show the many faces of science and the diversity of ways people make it a part of their lives.

E20 The Capitol College Space Operations Institute: A Partnership with NASA

Michael G. Gibbs, *Capitol College, mggibbs@capitol-college.edu*

Angela Walters, *Capitol College, awalters@capitol-college.edu*

Ken Dolan, *Capitol College, skdolan@capitol-college.edu*

This poster presentation describes and provides an update on the Capitol College Space Operations Institute (SOI) partnership with NASA and the real-world learning experiences provided to college students. The partnership with NASA works to directly encourage and support students to enter careers in the science, technology, engineering and math (STEM) disciplines and advance the cause of improving science literacy. The Capitol College SOI serves as a back-up control center for two NASA missions. The first is the Tropical Rainforest Measurement Mission (TRMM), which is a research satellite designed to help our understanding of the water cycle in the current climate system. By covering the tropical and semi-tropical regions of the Earth, TRMM provides much needed data on rainfall and the heat release associated with rainfall. The second is the Wide-field Infrared Survey Explorer (WISE) mission that is providing a vast storehouse of knowledge about the solar system, the Milky Way, and the Universe. The poster session highlights the two missions and best practices from the learning experiences that the SOI provides college students in serving as a real-life back-up control center.

E21 Global Systems Science and Hands-On Universe Course Materials for High School

Alan Gould, *Lawrence Hall of Science – UC Berkeley, agould@berkeley.edu*

The University of California Berkeley Lawrence Hall of Science has a project called Global Systems Science (GSS). GSS produced a set of course materials for high school science education that includes reading materials, investigations, and software for analyzing satellite images of Earth focusing on Earth systems as well as societal issues that require interdisciplinary science for full understanding. The software has general application in analysis of any digital images for a variety of purposes. NSF and NASA funding have contributed to the development of GSS. The current NASA-funded project of GSS is Lifelines for High School Climate Change Education (LHSCCE) that aims to establish professional learning communities (PLCs) to share curriculum resources and best practices for teaching about climate change in grades 9–12. The project explores ideal ways for teachers to meet either in-person or meet using simple yet effective distance-communication techniques (tele-meetings), depending on local preferences. Skills promoted include: how to set up a website to share resources; initiating tele-meetings with any available mechanism (webinars, Skype, telecons, moodles, social network tools); easy ways of documenting and archiving presentations made at meetings. Twenty teacher leaders are forming the PLCs in their regions or districts. This is a national effort in which teachers will share ideas, strategies, and resources aimed at making science education relevant to societal issues; improve students' understanding of climate change issues and contribute to possible solutions. Although the binding theme is climate change, the application is to a wide variety of courses: Earth science, environmental science, biology, physics, and chemistry. Moreover, the PLCs formed can last as long as the members find it useful and can deal with any topics of interest, even if they were distantly related to climate change.

E22 The Use of Archived Astronomical Images as a Vehicle for Introducing Scientific Methodology to Non-Scientists

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One of the serious problems facing contemporary science is the lack of understanding on the part of a significant fraction of the general public and indeed, to some extent, even within the scientific community itself as to how science and the scientific method operate. In this EPO presentation we

describe hands-on protocols in which observations of binary stars identified in the Moving Object and Transient Event Search System (MOTESS) images, and/or in follow-up observations, can be employed as a vehicle by which individuals are led through the entire process of an observational science project, starting with the procurement of original data, followed by a "hands-on" use of the techniques employed in the reduction of these data, culminating in a final publishable result. It is felt that an individual emerging from this experience will do so with a far better understanding of the mechanics behind the scientific process and thus become a better informed citizen on many of the science-related societal issues of our day. The methodology we describe is sufficiently adaptable so as to be useful in a wide variety of venues, including corporate, community and teacher training workshops and seminars, amateur astronomy club projects, and also as an important study unit which can be integrated into both science and non-science courses at a variety of educational levels ranging from K–12 to the upper division courses at a college or university.

E23 PlayDoh Astronomy One Year Later: The Size and Scale of the Earth-Moon System

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Vast distances, such as those that pervade astronomy, are difficult concepts to grasp. We are all a part of the Earth-Moon system, however most people do not comprehend the sizes and distances involved. In a pilot study, the authors found that an intervention using both discussion and kinesthetic modeling resulted in students of all ages (children up through adults) acquiring a more accurate mental representation of the Earth-Moon system. At the end of the 2008–2009 school year, we devised and implemented a curriculum unit in three middle-Tennessee 5th grade public school classrooms. In it, we used PlayDoh as the kinesthetic modeling tool. At the end of this (2009–2010) school year, we will go back to the students (now 6th graders) and evaluate their retention rates and their attitudes toward science. We also evaluate students who did not participate in the curriculum unit. We will describe our findings in this presentation — in accordance with pilot study results, we expect the students who participated in the curriculum unit to have a better sense of size and scale. This work is supported in part by grants from the Vanderbilt University Learning Sciences Institute (LSI) and the Institute of Educational Sciences (IES).

E24 Combining Outreach and Education with Space Field Test Activities by PISCES

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We shall highlight the combined outreach and education activities performed in conjunction with the second PISCES ISRU Field Test comprised of American, Canadian and German Space Agencies (NASA, CSA, DLR) along with industry partners held January/February 2010 on Hawaii Island focusing on In-Situ Resource Utilization technologies. School visits, University events (Onizuka Day), and county Science & Engineering Fair were incorporated to bring the remote work to the students and public. Additionally, undergraduates (and some recent graduates) of UH-Hilo were present and active in the test activities

E25 MyStar: Learning Stellar and Planetary Evolution with Your Own Personal Solar System

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With funding through the Space Telescope Science Institute and the Space Science Institute (SSI) Alien Earths project, SSI has been developing MyStar: an online, multi-user stellar and planetary evolution game. The game is closely aligned with the national science standards and is designed to introduce players to the basic concepts of stellar and planetary evolution: stars are born, live, and die, and their lives are controlled by their initial mass. Visitors to the MyStar site can form their own star, then observe and study it as it evolves in scaled real time (a million years per minute). Over the course of days or weeks, players can receive email or text message prompts as their star and accompanying planetary system enter new phases. Perhaps life will arise; perhaps not. If the system includes a giant planet it might clear the debris from the solar system and save the inhabitants from destruction by bombardment or, if positioned poorly, the giant planet might simply eject the terrestrial planet. In the end, the system will meet a fate determined by the mass of the star: either the planets will be overwhelmed by the envelope of the red giant, or be obliterated by the searing heat and gamma ray blast of a supernova. The game framework uses the "sporadic play" model typical of some Facebook games and incorporates a currency system that lets players earn funds to be invested in more stars, the seeding of life, etc. while they attempt to complete various "feats". In this poster we will discuss the current state of the game and its use in classroom environments.

E26 Integrating the GalileoScope into Successfully Established as well as New Outreach Programs at Gemini Observatory

Janice Harvey, *Gemini Observatory*

Peter Michaud, *Gemini Observatory, pmichaud@gemini.edu*

The annual Journey Through the Universe program is a flagship Gemini Observatory public education/outreach event that engages the public, teachers, astronomers, engineers, thousands of local students, and staff from all of the Mauna Kea observatories. Now going into it seventh year in Hawaii, the 2010 program has integrated the GalileoScope as an integral part of the weeklong program with teacher workshops, classroom telescope kits and a new teacher resource package developed for the program. As part of our Family Astro program workshops will be held for students and their families, each family receiving a GalileoScope to take home. Workshops will be offered to the girl and boy scouts, the County Hawaii summer programs with the Department of Parks and Recreation, the Boys and Girls Club of Hawaii and other community organizations. Each participant, after going through a workshop or coordinated event, will receive a GalileoScope.

E27 The Ultimate Astronomical Field Trip: Observing Experiences for Teachers

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John Lacy, *University of Texas at Austin, lacy@astro.as.utexas.edu*

Since January 1998 a group of Texas grade 6–12 science and math teachers

have met several times per year to learn first-hand about how about scientific instrumentation and its use. They followed the development of the SOFIA Echelon Cross Echelle Spectrograph (EXES) and its prototype ground-based instrument TEXES. In addition to learning about the technology of astronomical instrumentation, they explored scheduling and preparation for observing runs, as well as a wide range of astronomical topics. Participating in observing runs with TEXES at Gemini North and the NASA IRTF in Hawaii provide the ultimate field trip. The participants report their increased knowledge of astronomical concepts and of the culture of professional astronomy. The participants have shared their experiences with each other, other teachers, and their students. Support from the National Science Foundation AST-0607312 is gratefully acknowledged.

E28 Lunar Quest in Second Life, Lunar Exploration Island, Phase II

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Second Life is a virtual 3D metaverse. Second Life hosts 200 educational and institutional "islands" or sims. At any one time there may be 40,000–50,000 users on line. Users develop a persona and are seen on screen as a human figure or avatar. Avatars are able to move around by walking, flying, or teleporting. The Second Life education group hosts an educational mailing list of over 1,800 and Second Life conferences conduct education related strands. Information on downloading the Second Life browser and joining can be found on the Second Life website: www.secondlife.com. This poster details Phase II in the development of Lunar Exploration Island (LEI) located in Second Life. In Phase I LEI highlighted NASA LRO/LCROSS missions. Avatars enter LEI via teleportation to an orientation room with information about the missions, the Second Life project, and a sim map. A central hall of flight houses interactive exhibits on the LRO/LCROSS missions including full size models of the two spacecraft and launch vehicle. Storyboards with information about the missions interpret the exhibits while links to external websites to provide further information on the missions, both spacecraft instrument suites, and EPO. The sim includes several sites for meetings, a conference stage to host talks, and a screen for viewing NASATV coverage of mission events including launch and impact. In Phase II the LRO/LCROSS exhibits are updated to reflect on-going mission highlights and discoveries. A new section of LEI is being developed to showcase NASA Lunar Quest program and other lunar related activities such as My Moon and NLSI EPO. A new exhibit hall with Lunar Quest information has been designed and is being populated with Lunar Quest information models and kiosks. An area of the hall will be set aside for video viewing and in-world presentations.

E29 LSST Education and Public Outreach

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In this poster, we describe the LSST Education and Public Outreach (EPO) program structure and how it will be used to promote classroom research projects, deliver an ongoing program of citizen science, and facilitate unprecedented visualization possibilities. LSST EPO programs are being developed that will actively engage a broad audience in many venues. We are emphasizing Internet-based activities to reach larger numbers of users, with additional face-to-face elements that enhance both classroom learning and informal learning experiences. The LSST project will provide cyberinfrastructure and web-based data access tools to enable student and public participation in the process of scientific discovery. In collaboration with the LSST Data Management group, an EPO database is being designed to accommodate anticipated user load and deliver required data products. These tools and products and their use in prototype Citizen Science projects will be described. www.lsst.org

E30 CSU Science Teacher and Researcher (STAR) Program: Developing "Teacher-Researchers" through Paid Summer Research Experiences for Pre-Service and Early Career Science and Math Teachers

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Susan Elrod, *Project Kaleidoscope (PKAL), Elrod@aacu.org*

The Science Teacher and Researcher (STAR) program addresses the science and mathematics teacher recruitment and retention crisis by creating a prestigious dual "teacher-researcher" career path. Founded and implemented in 2007 by the Cal Poly Center for Excellence in Science and Mathematics Education (CESaME) on behalf of the California State University (CSU) system, STAR provides cutting edge research experiences and career development for pre-service and early career teachers during early critical years. Key experiences of the STAR program are one or more summers of paid research internship experience in national laboratories or NASA research centers and weekly science education workshops and seminars. By anchoring pre-service teachers in the scientific research community, they will come to better understand what it means to be a researcher as well as an effective teacher of science or mathematics. Since 2007, the STAR program has served a diverse group of 85 Fellows from 18 different CSU campuses with disciplinary backgrounds in science and mathematics that are in career development stages ranging from junior undergraduates to new classroom teachers. During Summer 2010, the STAR program will expand nationally with funding from the NSF Noyce Scholars Program and philanthropic organizations to place 60 STAR Fellows in California and 20 in new lab partnerships in Colorado, Maryland, New York, Tennessee, and Washington. Preliminary results indicate that the program is effective at recruiting high quality science and math majors into the teaching profession and impacting their attitudes and beliefs regarding the nature of scientific research and teaching science through inquiry. When surveyed at the end of the summer 2009, STAR Fellows indicated that STAR increased their interest in teaching (89%), contributed to feeling more prestige about teaching as a profession (89%), and made them feel like they were part of a broader community of teacher-researchers (100%).

E31 Project ASTRO: A Network of Professional Developers in Astronomy for K–12 Education

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Project ASTRO is a signature program of the Astronomical Society of the Pacific and has partnered astronomers and classroom teachers since 1993. With fifteen Project ASTRO sites around the country the program has impacted tens of thousands of students. As teacher and student needs change the Project ASTRO network is positioned to provide astronomy educators a venue to share best practices and develop innovative programs to reach out to K–12 educators.

E32 Astronomy EPO and the 2012 Hysteria: Your Personal Guide to Joining the Battle

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By now everyone in the astronomy EPO community has come face to face with the 2012 phenomenon, whether in the form of questions about the end of the world from concerned members of the general public, inquiries from local news media, or personally sitting through the film 2012 or one of countless scientifically inaccurate specials on cable television. It would be too easy to collectively shake our heads at this madness and hope calmer and better-informed heads will prevail before long, but experience has shown us that unless we as a community of individuals become actively involved, misinformation will increasingly replace reason in the collective consciousness of the general public. Thankfully, individual members of the astronomical community have, in recent months, begun to take up the charge and rally against a vast army of pseudoscience, superstition, and snake oil salesmen. EPO specialists and facilities are in a unique and vitally important position to move to the forefront of this battle, given our long-standing dedication to improving the astronomical education of the general public. We have over two years to prepare for the arrival of the date in question; an army of talented and dedicated teachers, planetarium staff, and professional astronomers; engaging programming and technology; and a general public who hungers for information. We can therefore take the king-sized lemon that is the 2012 movement and apply the sufficient pressure necessary to turn this pseudoscience into an opportunity to reintroduce the general public to all that the astronomy EPO community has to offer. This poster will document concrete ways in which the astronomy EPO community can (and should) combat the 2012 movement.

E33 Professional Development Workshops for K–8 Teachers at the Planetary Science Institute

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The Planetary Science Institute, in partnership with the Tucson Regional Science Center, offers a series of professional development workshops targeting elementary and middle school science teachers in Tucson, Arizona. Using NASA data sets, the results of currently funded research investigations, and a team of Earth and space scientists and educators, these workshops provide teachers with in-depth content knowledge of fundamental concepts in astronomy, geology, and planetary science. By participating in hands-on exercises using images, maps, and the results from their own experiments, the teachers model the processes and skills scientists use. With a stronger knowledge of science content and of how science is actually conducted, the workshops instill greater confidence in teachers' ability to teach Earth and space science. Eighty elementary and middle school science teachers from 60 schools in the Tucson area have attended eight offerings of our three workshops: Moon-Earth System, Exploring the Terrestrial Planets, and Impact Cratering. Workshop participants teach approximately 5,400 students from grades 1 through 9. Teachers who have participated in our workshops represent schools with minority student populations ranging from 46% to 95%.Our current workshops are supported by NASA E/PO awards: The Explorer Guide to Impact Craters, Motivating Learning about STEM Careers, Research, and Content through the Study of Impact Craters, and Planets are Places Too! Inquiry-based Professional Development Workshops for K–8 Teachers (2007–2009), and Planets are Places Too: Professional Development Workshops for Elementary and Middle School Teachers. We are developing an additional workshop, Volcanoes of the Solar System. We have recently received another NASA grant: Workshops in Science Education and Resources (Wiser): Planetary Perspectives. With this grant we are developing the following workshops: Deserts of the Solar System, The Asteroid-Meteorite Connection, and Astrobiology and the Search for Extrasolar Planetary Systems). Details of our workshops can be found at www.psi.edu/epo/pdworkshops.

E34 Communicating with Kids on Complex Topics: NASA New Climate Change Web Site for Kids

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Can we successfully communicate complex topics such as climate change with elementary school aged children? What tools do we have in our "communications toolbox" that can help us to be successful in these efforts? Can we support elementary school classroom and out-of-school learning on this topic. These were some of the questions that we asked ourselves as we looked at the possibility of creating a kids companion web site to the successful NASA Climate Change page (climate.nasa.gov). Our poster session will address the process that we went through to determine 1) whether the need for such a web site or if other sites already served the need, 2) whether or not such a topic was appropriate for an elementary school audience and would support their other learning experiences, and 3) what tools could we use to communicate the complex concepts associated with climate change to young people. We will include specific illustrations of the role of attractive graphic, humor, interactivity, and age-appropriate language in outreach to this target audience.

E35 Building an Astronomy Public Outreach Program with Very Little Time, Some Money and A Lot of Energy

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The 15-year history of the development of Henry Ford Community College Astronomy Public Outreach Program will be traced from its nonexistent beginnings in 1995, though the expansion of its planetarium program, partnership in a telescope project with neighbor University of Michigan-

Dearborn and construction of a walk-through solar system model, to the thriving school field trip and public programs that are offered today. Information about the development of each facet of the program including the resources involved will be made available as an example for those at similar institutions that may wish to take on similar projects, with similar concerns about and constraints on manpower and funding.

E36 NASA Climate Resources for Formal and Informal Education

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This poster will highlight some of the key NASA educational tools and resources for education and outreach related to global climate change. These tools and resources can be used in a range of educational settings, from k–12 classrooms, higher education and informal education venues.

E37 The Undergraduate ALFALFA Team: A Model for Undergraduate Participation and Outreach in Large Research Collaborations

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The Arecibo Legacy Fast ALFA (ALFALFA) blind neutral hydrogen survey is an ongoing project that includes an innovative undergraduate outreach component promoting the participation of students and faculty at undergraduate-focused institutions in a large, multi-year research collaboration. The survey, which will ultimately detect ~30,000 gas-rich galaxies, provides resources and authentic opportunities for undergraduates and faculty, including a high fraction of women and minorities, through the Undergraduate ALFALFA Team (UAT), an NSF-sponsored consortium of 18 participating institutions. With ALFALFA Team faculty and graduate student mentoring, undergraduates observe at the Arecibo Observatory, reduce and analyze data, and contribute their research findings to our understanding of structure, HI gas, and the group environment in the local universe. The UAT experience features annual undergraduate workshops at the Arecibo Observatory where both students and faculty benefit from on-site lectures, group activities, tours, observing runs, and the preparation and submission of an observing proposal to the Observatory. Graduate students on the Cornell ALFALFA team help plan and facilitate the undergraduate workshops, provide telescope training for both on-site and remote observers, lead observing runs, enhance team communication through social media, and benefit by developing their own skills as mentors and project supervisors. To date, Team faculty have overseen more than 45 summer and academic year (e.g. senior thesis) projects making use of ALFALFA observations and databases, with more than 70 undergraduates participating in the program over the first three years. The UAT is developing online lesson plans and activity guides that make use of the ALFALFA online data archive and of innovative, inquiry-based learning techniques supported by astronomy education research. This work has been supported by NSF grants AST-0724918, AST-0725267, and AST-0725380.

E38 AstroBITS: An On-Line Course for High School Teachers

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Take an astronomer from the National Optical Astronomy Observatory, a chemistry teacher, communication via a wiki and a blog, funding from Science Foundation Arizona and a diverse group of science teachers, and you have Astrobits, an online course. The course has run three times in the past year, reaching 32 teachers. The results depend on the teacher. Some gain beginning computer skills such as how to make screen shots and use a blog. Other teachers have been enabled to share their passion for astronomy with their students and taken their classes observing at Kitt Peak National Observatory and the U Arizona observatory on Mount Bigelow. One teacher has had 7 of his students present astronomy projects at the state science fair. The course has 9 modules. Using Weins law and spectroscopy, teachers learn how astronomers measure the temperature of stars and construct the Hertzsprung Russell diagram. Teachers learn image and spectral analysis with the software ImageJ, graphical analysis and excel as they work through the modules. The course is low cost because it is presented on a wiki and blog. The astronomer and teacher provide guidance and support. The end result is a community of teachers working with astronomers from the National Optical Astronomy Observatory.

E39 Near Infrared Camera (NIRCAM): Making Models, Building Understanding

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The Astronomy Camp for Girl Scout Leaders is a science education program sponsored by NASA next large space telescope: The James Webb Space Telescope (JWST). We are developing a long-term relationship with adult trainers from all GSUSA Councils that directly benefits troops of all ages, not only in general science education but also specifically in the astronomical and technology concepts relating to JWST. Since 2003, the E/PO team for JWST Near Infrared Camera (NIRCam), in collaboration with the Sahuaro Girl Scout Council, has been training and equipping adult Girl Scout leaders so they can in turn teach young women essential concepts in astronomy, i.e., the night sky environment. We model what astronomers do by engaging people in the process of scientific inquiry, and we equip leaders to host astronomy-related activities at the troop level. It is GSUSA goal to foster girls' interest and creativity in Science, Technology, Engineering, and Math (STEM); it is crucial to create an environment that not only encourages their interests early in their lives, but also creates a safe place for girls to try and fail, and then try again and succeed. We have trained over 150 leaders in 13 camps since 2003.While many of the camp activities are related to the "First Light" theme, many of the background activities relate to two of the other JWST and NIRCam themes: "Birth of

Stars and Pro-toplanetary Systems" and "Planetary Systems and the Origin of Life." The latter includes our own Solar System. A few of our activities are highlighted below: 1. Earth and Moon: Day and Night; Rotation and Revolution. 2. Earth/Moon Comparisons. 3. Size Model: The Diameters of the Planets. 4. MacramÈ Planetary (Solar) Distance Model. 5. Lookback Time in Our Daily Lives. 6. Planet Sorting Cards. 7. Human Orrery. NIRCam E/PO website:http://zeus.as.arizona.edu/~dmccarthy/GSUSA

E40 Using Telescopic Observations to Mentor High School Students in STEM

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Over the past two summers (2009/2010) the NASA E/PO Group at Sonoma State University has sponsored local high school students in a summer science internship program at the University. The students, chosen from Sonoma County high schools in a competitive selection process, work in various STEM fields throughout the School of Science and Technology at SSU. The two interns sponsored by the E/PO Group each summer use GORT, the NASA/Fermi-sponsored robotic observatory operated by the Group, to monitor active galaxies. They are mentored in their projects by E/PO Group personnel and by SSU undergraduates who have experience with the telescope. The students learn about the sky, telescopes and the active galaxies they observe. They also learn how to make telescopic observations and how to reduce the CCD images obtained. Interns also participate in weekly meetings with other interns working on different projects around campus. At the end of the summer all the interns present their research results at a symposium held on campus. The symposium is attended by the interns themselves, their parents and sponsoring high school science teachers, and university faculty and administrators. The program has had a positive impact on how our interns view science, as reported by themselves, and specifically on their view of astronomy, in the first year of the program.

E41 IRIS Active Earth Display: Free Earth Science Content for Your Museum, Planetarium or School

Patrick McQuillan, *Incorporated Research Institutions for Seismology (IRIS)*

The IRIS Active Earth Display is a free online-tool that uses a PC or Mac computer and monitor to deliver earth science content to audiences through a museum style kiosk. While initially designed for free-choice learning environments such as visitor centers or museums, this tool can have useful application in the public spaces of a school such as a school lobby or media center. In addition to its usefulness as a tool to deliver content to self-directed learners, the Active Earth Display represents a novel medium for performance assessments of student learning. Since the Active Earth Display uses a template driven format that requires little to no knowledge of HTML, students or groups of students can easily create content within the existing templates as a demonstration of their content mastery. Further, such an exercise is a great interdisciplinary student project which overlaps science, computer science and language arts. This poster will provide an overview of the Active Earth Display.

E42 A New 648-Megapixel All-Sky Mosaic Image

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Between October 2007 and August 2009, a digital all-sky mosaic image was assembled from more than 3000 individual CCD frames. Using a SBIG STL-11000 camera, 70 fields (each covering 40∞ ◊ 27∞) were imaged from dark-sky locations in South Africa, Texas and Michigan. In order to increase the dynamic range, three different exposure times (240 s, 15 s and 0.5 s) were used. Five frames were taken for each exposure time and filter setting. The fields were photometrically calibrated using standard catalog stars and sky background data from the Pioneer 10 and 11 space probes. This way, the part of the night sky background resulting from artificial light pollution, air glow and zodiacal light could be eliminated while preserving large-scale star and dust clouds. The new panorama has an image scale of 36 arcsec/pixel, a limiting magnitude of approx. 14 mag and an 18 bit dynamic range. Using multiresolution display techniques (where only the parts that best match the selected view and resolution are loaded), the multi-gigabyte image can be displayed on computer screens or planetarium domes without requiring excessive amounts of memory. Due to its high dynamic range and resolution, this all-sky image is a valuable educational tool for showing the distribution of star clouds and dust in the night sky, as well as demonstrating the effects of artificial light pollution.

E43 Community Science Outreach: Building Sundials in Local Spaces/Parks

Vesna Milosevic-Zdjelar, *University of Winnipeg Physics, v.milosevic@uwinnipeg.ca*

Limited resources and funding in schools do not need to be an obstacle for science education and increasing scientific literacy of students and general public. Astronomy provides opportunities to reconnect people with natural cycles. Our experience shows that it is possible to get schools, university, wide variety of professionals and companies involved in a project of building a sundial in a local park/space. Students in a local school are planning technical and artistic design, with the help of science students through University Science Outreach Partnership program. Engineering companies and local businesses are willing to donate materials and manufacture parts. The assembly of a sundial in a community space is a group effort, fun, educational and rewarding for all involved.

E44 Embracing the Wave: Using the Very Small Radio Telescope to Teach Students about Radio Astronomy

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Vincent L. Fish, *MIT Haystack Observatory*

Alan E. E. Rogers, *MIT Haystack Observatory*

Michael Doherty, *Andover High School, MA*

Steven Minnigh, *Nashua High School South*

Martina Arndt, *Bridgewater State College*

Jonathan Marr, *Union College*

The Very Small Radio Telescope (VSRT) is a low-cost educational tool appropriate for laboratory demonstrations of the nature of radio waves and the principles of interferometry for use in both high school and undergraduate physics/astronomy classes. The system consists of small direct broadcast antenna dishes and other commercially available parts and can be assembled for under $500. A complete teaching unit has been developed and tested by high school physics teachers to demonstrate radio wave transmission and exponential absorption though materials (Beer law), the polarization of electromagnetic waves (Malus' law), the inverse square law, and interferometry. These lessons can be used to explore the properties

of electromagnetic waves, including similarities and differences between radio and visible light, while challenging students' misconceptions about a wavelength regime that is important to both astronomy and everyday life. In addition, the VSRT can be used as a radio astronomical interferometer to measure the diameter of the Sun at 12 GHz. Full details, including a parts list, comprehensive assembly instructions, informational memos, teaching units, software, and conformance to national and Massachusetts educational standards, are available on the web at http://www.haystack.mit.edu/edu/undergrad/VSRT/index.html. Development of the VSRT at MIT Haystack Observatory is made possible through funding provided by the National Science Foundation.

E45 The Sanford Center for Science Education: Translating the Content, Excitement and Promise of the Deep Underground Science and Engineering Laboratory for Educators, Students and Lifelong Learners

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The Deep Underground Science and Engineering Laboratory (DUSEL) is a major research facility of the National Science Foundation that is in the preliminary design phase, with a final decision on funding to be made in 2011. Scientists using DUSEL will go deep to study some of the most compelling questions about the history and fate of our universe by installing huge detectors a mile underground, with which they will search for direct evidence of dark matter, explore the nature of neutrinos and study the origin of the elements. Geoscientists and geo-microbiologists are already taking advantage of the 370 miles of tunnels in the former Homestake gold mine that make up a laboratory that will extend 8000 ft below the surface of the Earth. A major science education center, the Sanford Center for Science Education (SCSE), is in the planning stages as the education component of DUSEL, leveraged with a generous private donation. The mission of the SCSE — slated for completion in 2016 — is to draw upon the science and engineering of DUSEL, its human resources, its unique facility, and its setting within the Black Hills to develop and facilitate rich, innovative learning experiences that engage and connect diverse audiences of students, educators, scientists, engineers, and the general public, inspire and prepare future generations of scientists, engineers, and science educators, and deepen understanding of science. As the design of the building, the institution, and the programs and exhibits therein proceeds, early work has progressed towards establishing programs that build the capacity and partnerships and begin to prototype the exhibits and educational programs needed to meet the educational vision of the SCSE.

E46 Undergraduates Learning to Teach Collaboratively in High School Classrooms

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In the spring of 2010, five undergraduates from Franklin & Marshall College conducted visits at J.P. McCaskey High School in Lancaster PA, under the umbrella of the Mid-Atlantic Relativistic Initiative in Education (MARIE). They introduced high school students to advanced topics in astronomy such as dark matter, gravitational lensing and cosmology. The outreach program not only benefited the high school students who were introduced to "sexy topics" in astronomy, but the undergraduates also gained teaching experience in a high school setting, learned to create lesson plans and to implement teaching techniques that engage students as active learners. They acted as role models for the high school students who were just a few years younger. Additionally, they learned useful skills such as presenting information clearly and confidently, and with the use of journals they reflected on their teaching practice and shared reflections with the group throughout the semester, learning to become confident and reflective teachers.

E47 Lessons Learned from Cosmic Serpent, a Professional Development Project for Informal Educators on Science and Native Ways of Knowing

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How can one engage native communities and the public alike in understanding nature and our universe? Our approach has been to bring together practitioners at informal science centers, cultural museums, and tribal museums to develop relationships cross culturally, learn about different ways of studying and learning about nature and our universe, and start to develop informal education programs or exhibits at their institution through their new understandings and peer networks. The design of the grant has been to provide an initial week-long professional development workshop in a region in the Western U.S. with a follow-up workshop in that region the following year, culminating in a final conference for all participants. We focus on three regions: the southwest (SW - Utah, Arizona, New Mexico and Colorado); the northwest (Alaska, Washington, and Oregon); and California. We are in our third year of our four year grant and have in this time organized and run three regional week-long workshops and a follow-up workshop in the SW. We have learned many lessons through this work, including: the importance of incorporating workshop participants as presenters in the workshop agenda; how the content of astronomy, ecology, and health resonates with these museum professionals and can easily be discussed with different world views in this type of cross cultural science education; and how to best present different ways of knowing how nature and our universe work (science) in a manner that provides a context for science educators and museum professionals. In our poster presentation, we will share these and other lessons we have learned from the leadership perspective of bringing together such a diverse and under-represented-in-science group of educators.

E48 A Real-Life Example of an Evaluation of a NASA-funded Project

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Mary Kay Hemenway, *The University of Texas Department of Astronomy, marykay@astro.as.utexas.edu*

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We recently completed a NASA-funded 2-tiered Teacher Professional Development project delivered via videoconferencing. In our program, the Texas Connection, we first prepared science specialists from 14 of the 20 state Education Service Centers and Texas Regional Collaboratives to be co-facilitators for the videoconferences. Then we worked with these co-facilitators to offer teacher professional development to 330 K–12 teachers via 24 separate videoconferences. We will provide a step-by-step explanation of how we conducted the evaluation for this program including what worked well and what didn't, how we used evaluation from earlier projects to help inform the initial design of this project, the 10 different instruments we created and/or modified to evaluate this project, and how we disseminated the project findings.

E49 Action Research: A Proven Model for Unifying Research and Practice

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This poster describes a model of action research, a method of gaining information about a practice, such as an educational program, while engaging in the practice. For example, information collected on museum visitors during the running of an exhibit could be used to improve the exhibit. Action research is distinct from formal evaluation because action research is conducted by practitioners, such as educators, in the course of their practice. Research and practice are one and the same. This particular model of action research comes from formal education research. The strength of the model is that it has been empirically validated — it has been proven that following the steps laid out in this model results in students learning more. The approach has not yet been validated in informal education. Two of the key steps are setting up the context of the problem and deciding what kinds of data to collect. Come to this poster to learn how to improve your educational programs while you are running them! Let us know how you are using action research in your existing programs, so we can begin to study the effectiveness of using action research in informal settings.

E50 Black Holes Don't Suck: Working with Youth to Make Museum Exhibits More Accessible

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This poster examines the experience of professional and youth exhibit developers on the 2,500 square foot traveling museum exhibition "Black Holes: Space Warps & Time Twists." We present three models for youth collaboration, developed between 2007 and 2009, and their impact on the museum exhibition and visitors themselves. A goal of the Black Holes project was to make the exhibition subject matter more accessible to museum audiences by involving teens as co-creators of exhibit content. Urban high school students from the Youth Astronomy Apprenticeship program in Boston, MA developed three prototype components for the exhibit formative evaluation session; two of these were selected for inclusion in the final exhibition. Teen docents at the Chabot Space & Science Center in Oakland, CA developed three multimedia projects for the exhibition website, while Girl Scouts in Baltimore, MD developed and tested a series of hands-on education activities about black holes. Evaluators from the Goodman Research Group interviewed the professional and teen exhibit developers, as well as museum visitors, to determine what aspects of these collaborations had the greatest impact on the exhibit and its visitors, and to assess how the specific structure and nature of youth-adult partnerships benefit their participants and the project itself. This poster presents the lessons learned from these collaborations, as well as recommendations for developing successful partnerships between professional exhibit developers and youth programs. Examples of other collaborations inspired by the "Black Holes" experience will illustrate the impact of this work.

E51 Engaging Teachers and Students in the Rio Grande Valley in Earth and Space Sciences

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We will report on our experience and the outcome of our planned Earth and Space Science workshops in the Rio Grande Valley of Texas in June 2010. The Texas Space Grant Consortium, the Rio Grande Valley Science Teachers' Association, in partnership with the University of Texas Pan Am will conduct the workshops, which are designed to address the need to get teachers qualified to teach 4th year capstone science courses. These courses were recently introduced into the Texas State Curriculum, and go into effect in 2012. As an example, teachers will obtain and analyze core samples from the Rio Grande delta, and carry out basic astronomical navigation. They will also be instructed with the necessary background information for GPS navigation. Faculty and researches from UT PanAm and the University of Texas will conduct the experiments. The Rio Grande Valley Science Association science specialist will also lead a fossil-finding expedition. The participants will take home all the required equipment, and we hope the knowledge necessary to implement the activities in their schools. This work is supported by NASA Grant NNXI0AD31A.

E52 Las Cumbres Observatory Global Telescope Network: Keeping Education in the Dark

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Las Cumbres Observatory Global Telescope Network (LCOGT) is creating a network of telescopes to be placed around the world providing 24/7 sky coverage of both the Northern and Southern hemispheres. These telescopes will range in size from 0.4m to 2.0m and will be available for scientific and educational uses in both real-time and in a queue-scheduler. The educational uses of LCOGT will be primarily online through our website (www.lcogt.net) where there will be how-to guides, ideas for activities,

opportunities for participating in research projects with our astronomers, full access to the public archive, as well as an online community built through forums and groups. Content will be visible to all, although registered users will have the ability to add resources, post on blogs and forums, comment and rate existing pages and resources, collaborate in world-wide projects, and much more. The current network includes the two 2.0m Faulkes Telescopes on Haleakala, Maui and at Siding Spring, Australia. A 0.8m telescope located at Sedgwick Reserve in the Santa Ynez Valley is nearly commissioned and will be used both for local outreach events as well as on the LCOGT network. The first pair of 0.4m telescopes has been deployed to Maui and are enclosed inside the clamshell dome with FTN, but still have some time to go before they are fully commissioned. The site in Chile is currently being prepped for three 1.0m and two pairs of 0.4m telescopes with the site in South Africa to follow shortly. Other sites include the Canary Islands, a site in North America, one in Asia, and another site in Australia. The 0.4m telescopes will be deployed by pair and the 1.0m telescopes will be deployed in groups of two or three, all with research grade instrumentation.

E53 Sun-Earth Geometry & Passive Solar Energy Teambuilding Activity

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This activity illuminates the impact that our nearest star has on life on Earth. Students learn about the apparent motion of the Sun and how we use that motion to heat/cool our homes. In this hands-on activity, students put to use what they learned about the tilt, rotation/orbital pattern of Earth and the reasons for the seasons by designing and building a scale model of a passive solar house. This poster will illustrate the methods used to engage students in teamwork by designing and building a scale model of a passive solar house. The project is interactive as the students present their house to the class, helping them build oral presentation skills. The presentation ultimately demonstrates their understanding of Sun-Earth geometry and the logic behind the design of their house. Students simulate the apparent path of the Sun on the summer/winter solstices and fall/spring equinoxes to test how the climate in the house will be affected. Students then self-evaluate their design by predicting whether the house will achieve the goal of keeping the house cooler in the summer and warmer in the winter with the use of a passive solar design.

E54 HELIO-lab — Combining Direct Observation of the Sun with Near Real-Time Data

Hanna Sathiapal, *UASNW Switzerland, hanna.sathiapal@fingertip.ch*

The Sun can be observed with simple means and observations carried out during daytime. These are two reasons for using the Sun to introduce space science to a young public and spark interest in research among people without previous experiences with science. Participants start by making observations of sunspots and comparing them to near real-time images of solar activity and space weather. The underlying idea of this approach is that personal experiences provide the basis for connecting to images from actual science projects. Background information is not a prerequisite for the activities but is provided when questions turn up. This concept is realized by HELIO-lab, a part of the EPO of the EU-funded project HELIO. It is a series of complementary EPO modules based on the principle of combining direct observation of the Sun with near real-time data from observatories like SOHO and SDO. A website showing how to set up your HELIO-lab at home and providing instructions on how to observe the Sun. The site also provides access to near real-time data and a toolkit containing a HELIO-lab for scientists to set up in elementary schools and use with students. A toolkit of supporting material readily usable at science fairs, open house days and other similar events. The modules are designed to be used independently or in combination. They should work in a variety of contexts and match the different educational cultures in Europe. HELIO-lab is a work in progress creating a bottom up example of a low budget EPO. We expect that it will help convincing stakeholders in Europe of the necessity to increase interest in science among a broad part of society, to involve teachers without scientific experiences and to inspire students at a young age.

E55 New York K–6 IYA Contest: A Pilot Project

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The Center for Radiophysics & Space Research (CRSR) EPO program offered an IYA Contest for grades K–6 for any school in New York. Our experience with the 2009 contest can be used as a model for future astronomy contests in New York and other states or locations. We publicized the contest through our educator e-list and the state Science Teachers Association network. This first pilot attempt at a statewide contest yielded participation from 14 schools (263 students). It may take a few years to build up awareness of the contest and increase the number of participating schools. The majority of schools that participated were parochial schools. We created a flier and an entry form and made them available on our website, along with links to helpful resources for the teachers. Four grade-appropriate projects were described. The Kindergarten students created original art that depicted "Me and the Sky." First and second graders created labeled artwork that depicted "My favorite objects in the sky." Celestial objects were limited to natural objects. Third and fourth graders created a piece of art with a slogan for the International Year of Astronomy. Fifth and sixth graders created individual and class entries of "Universe Travel Agency" brochures. This category was the most fun to review and we were amazed by the quality of work and level of creativity displayed by the students. It appeared that the students had fun and were able to unleash their creativity while learning about the Universe around us. Astronomy is a subject we typically connect with science in school, but we also created connections to culture, literature, and art, demonstrated by the entries. This project reveals an innovative way to explore astronomy in the classroom in new and different ways. The contest was announced in September and the deadline was December 21 (the Winter Solstice). The entries were judged by the graduate students who host the website "Curious? Ask an Astronomer," where the winning entries are displayed. Prizes were provided by the New York Space Grant Consortium, and included NASA backpacks; astronomy books; NASA stickers, bookmarks, and pencils; and NASA posters and classroom resources for the teachers. We plan to offer a contest in 2010 with a new theme to replace the International Year of Astronomy and continue to increase interest and knowledge, and reach new schools we have not had the opportunity to work with.

E56 Reaching Special Needs and At-Risk Youth through Science

Deborah Scherrer, *Stanford University, dscherrer@solar.stanford.edu*

Youth in Juvenile Detention Facilities do attend (in-house) school, but rarely receive any instruction in science. We report on a new program to bring science to students at county juvenile detention facilities in the

San Francisco Bay Area. Working in partnership with the Knock Out Dog Fighting campaign put together by the non-profit For Pits Sake, Inc., our program provides alternatives to inappropriate behavior so often seen in inner city environments by introducing students to hands-on, inquiry based science activities. Likewise, we report on using similar materials to provide hands-on science opportunities to special needs students through "Take Flight for Kids" and "Day in the Sky" events, where amateur pilots offer special needs students rides in light aircraft and invite them to explore science and other activities through a community fair hosted by hundreds of local organizations. The fair highlights science opportunities and is supported and attended by a wide variety of NASA, NSF, and other science-related organizations. The poster will focus on techniques and materials we use to excite special young people about science and provide them with alternatives to inappropriate behavior.

E57 The Little Thompson Observatory in Berthoud, CO

Andrea Schweitzer, *Little Thompson Observatory, schweitzer@frii.com*

The Little Thompson Observatory is a community-built E/PO observatory located on the grounds of Berthoud High School in northern Colorado. The observatory is open most nights of the year, and is run entirely by volunteers. Typically we have 350–450 visitors per month. We are a part of the Telescopes in Education project, a member of the ASP Night Sky Network, and a founding member of Colorado Project ASTRO-GEO. The observatory offers high school astronomy courses open to all students from the surrounding school districts. Public Star Nights with a featured speaker are held on the third Friday of every month (except in July when we are closed for maintenance).The observatory was hand-built by our dedicated volunteers, with significant support from the local community. We have an 18-inch telescope, are now completing another dome to house a second telescope from TIE: the retired 24-inch telescope from Mount Wilson Observatory in California. We are honored to have such an historic telescope come to the LTO! The LTO has enjoyed celebrating the International Year of Astronomy 2009, and will continue supporting several IYA programs into the future. The Little Thompson Observatory web site is: www.starkids.org.

E58 NASA Astrophysics E/PO Resources for Engaging Girls and Young Women in Science

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NASA SMD Astrophysics E/PO Community

A new collaboration among the NASA SMD Astrophysics E/PO community is to engage non-science-attentive girls in science through the library setting. The collaboration seeks (i) to improve how girls view themselves as someone who knows about, uses and sometimes contributes to science, and (ii) to increase the capacity of E/PO practitioners and (school- and public-) librarians to engage girls in science. As part of this collaboration, we are collating the research on audience needs/best practices and SMD E/PO resources/activities/projects that focus on or can be recast toward engaging girls in science. This poster highlights several available resources and individual projects, such as: Afterschool Universe, an out-of-school-time hands-on astronomy curriculum targeted at middle school students, and an approved Great Science for Girls curriculum; Big Explosions and Strong Gravity, a Girl Scout patch-earning event for middle school aged girls to learn astronomy through hands-on activities and interaction with actual astronomers; The JWST-NIRCAM Train-the-Trainer workshops and activities for Girl Scouts of USA leaders; etc. The NASA Astrophysics E/PO community welcomes the broader E/PO community to discuss with us how best to engage non-science attentive girls in STEM, and to explore further collaborations on this theme.

E59 Tour through the Solar System: A Hands-on Planetary Geology Course for High School Students

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We have developed a course in planetary geology for high school students where our primary goals are to help students learn how to learn and encourage them to develop an interest in STEM fields. Our emphasis in this course is on active learning, each lesson is organized around hands-on laboratory experiments. The course has been offered at Hawaii Upward Bound Programs for the past three summers, 2008 –2010. Students enrolled in these programs are predominantly low income, from families in which neither parent holds a bachelor degree, and are of Native Hawaiian and/or Pacific Islander heritage. We begin the course by giving the students a learning questionnaire so we can assess the students learning styles. The classes for the past three years were dominated by students that need to receive the same information in multiple formats. What provided the best results was to have the students work with the subject kinesthetically with the hands-on projects and supplement it with short PowerPoint presentations using Iclickers. Despite the fact that we kept the PowerPoint presentations short, 10–20 minutes, we found the students had trouble paying attention. Using the Iclickers excited and revitalized the students and provided instantaneous feedback. Immediately we could see if the students understood the material and if they were paying attention. Daily quizzes also proved to be beneficial. Types of questions that the majority of the class got incorrect were repeated on subsequent quizzes. This helped to show the students not only that they needed to do more than simply memorize information, but also demonstrated the level of understanding they needed. We also gave the students knowledge surveys and found a good correlation between the final test and the final knowledge survey. All of the course materials for this course are available online at http://www.soest.hawaii.edu/curriculum/TourThroughTheSolarSystem/index.html.

E60 Great Observatories Image Unveilings: Behind the Scenes

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The Great Observatories Image Unveilings offered education and public outreach institutions nationwide an opportunity to host events that built awareness of both astronomical discoveries and educational resources amongst the public and the media. This poster highlights the story behind the scenes and provides insights that you can transfer to your own education and outreach activities. What types of institutions are interested in hosting events like this? Is it the usual suspects or new faces? How do you get the word out? Once you do, what should you expect, and what will

they be expecting from you? What types of programming do they offer their audiences, and what tools can you provide to support their education and outreach goals as well as your own? Come talk with the authors to learn the story behind the images and the ingredients that made the Great Observatories Image Unveiling collaboration a success for both the participating and sponsoring institutions.

E61 The Research Experience for Undergraduates Program in Solar and Space Physics at the University of Colorado

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The Research Experience for Undergraduates (REU) program in Solar and Space Physics is a collaboration between the University of Colorado Laboratory for Atmospheric and Space Physics (CU/LASP), the National Center for Atmospheric Research High Altitude Observatory (NCAR/HAO), The National Oceanic and Atmospheric Administration Space Weather Prediction Center (NOAA/SWPC), Southwest Research Institute (SwRI), and Northwest Research Associates' Colorado Research Associates (NWR/CoRA). The goal of the program is to give students real-world, hands-on experience doing research with scientist mentors and to further their intended careers. Our program began in 2007 and is entering its fourth year. Mentors from the member institutions have supervised over fifty research projects dealing with all aspects of Solar and Space Physics. The students begin their 8-week visit to Boulder with a week of classes on the Sun-Earth system as well as practical courses on data analysis and the IDL programming language. The students give a 30 minute oral presentation of their project as well as a poster in a student symposium at the end of the program. Throughout the summer, the students give progress reports at weekly brown-bag lunch meetings. In addition to their own research projects at their host institution, the students' tour and meet scientists from the partner institutions as the weekly lunches rotate from site to site. There are also opportunities for students to network with scientists in an informal way at the excursions we organize, which include barbecues and weekend outings.

E62 Authentic Astronomy Research Experiences for Teachers: The NASA/IPAC Teacher Archive Research Program (NITARP)

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The NASA/IPAC Teacher Archive Research Program Team

How many times have you gotten a question from the general public, or read a news story, and concluded that "they just don't understand how real science works"? One really good way to get the word out about how science works is to have more people experience the process of scientific research. The way we have chosen to do this, since 2004, is to provide authentic research experiences for teachers using Spitzer data. (The program used to be called the Spitzer Teacher Program for Teachers and Students, and has newly been rechristened NITARP, the NASA/IPAC Teacher Archive Research Program.) We partner small groups of teachers with a mentor astronomer, they do research as a team, write it up, and present it at an American Astronomical Society (AAS) meeting. The teachers incorporate this experience into their classroom, and their experiences color their teaching for years to come, influencing 100s of students per teacher. Applications are now being accepted for the program to start in January 2011! Please see our website for more information: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/teacher_research/.

E63 A Model of Student Exchange

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Many colleges and universities hire students to work on research projects during the summer. Why not take advantage of this to increase the breadth of experience of your students by a simple student exchange? We will describe a simple student exchange among three institutions in Maryland during the summer of 2009. This program was funded by a grant under NASA Minority Serving Institutions Partnership Development competition. Three aerospace engineering students each from the University of Maryland College Park, the University of Maryland Eastern Shore, and Morgan State University were sent to one of the other campuses to work with a mentor on a research project. Each of the campuses have a unique set of research areas and facilities that allowed the students to participate in an area of research that might not be available at their home institution. Students were provided with a stipend and housing allowances. At the end of the summer the students presented their results at a seminar hosted by NASA Goddard Space Flight Center. Exchanges of this type can provide students from smaller universities with a broader exposure to their field of study. Choices of partners to exchange students with can also meet other university goals in recruiting, regional collaboration, and student diversity. Students also expand their networking potential beyond their own campus and learn about potential institutions at which they might pursue advanced degrees. We will discuss the experiences and lessons learned from the project, from the student, mentor, and program management perspectives.

E64 From Comic Books to Embedded Teacher Workshops: Unusual Approaches in Space Science Educational Outreach

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From the beginning, the EPO team for the joint NASA/Air Force Coupled Ion Neutral Dynamics Investigation (CINDI) had significant challenges. Just how does one make the science and technology of CINDI (an ionospheric explorer that returns no "pretty pictures") understandable,

relevant, and interesting to students, educators, and the general public? In order to build upon the in-house expertise of The University of Texas at Dallas (UTD) Department of Science/Mathematics Education (SME), we made the decision to focus on formal education and teacher professional development. Our formal education strategy has been to create engaging and usable materials and professional development opportunities that meet teachers' needs and integrate well into existing curriculum in today era of high stakes testing. Throughout most of the United States, the majority of Earth and Space Science concepts are taught during the middle grades (6th, 7th and 8th). Our curricular materials and teacher workshops initially focused on middle school for this reason. In order to explain the science of CINDI in a manner attractive and accessible to middle schoolers, we created the popular CINDI comic book. CINDI in Space is available for free online in both English and Spanish on our EPO website (cindispace.utdallas.edu/education), and more than 50,000 copies were downloaded in the first year of release. A new comic book, CINDI in the Electric Atmosphere will be completed in summer 2010. In addition to the traditional offerings of workshops at teacher conferences, we embedded them into long-term professional development programs already in place at UTD. Research on these embedded workshops has helped us refine our standalone workshops, and ensure a high-quality professional development experience for teachers, and through them reach our ultimate target audience: their own students. This presentation will detail these and other unusual approaches and our lessons learned.

E65 SDOisGO: Using Social Media to Build Community

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In this poster we will outline the efforts of the Solar Dynamics Observatory (SDO) Education and Public Outreach (EPO) team surrounding Launch and First Light. Through the use of Twitter, the EPO team was able to extend the launch experience to include over 5,000 students, 50 teachers, and thousands of individuals globally. Twitter, the newest wave in social media, re-defines our understanding of community. No longer are people confined by geography, but rather communities are formed through individuals seeking out others of like mind, creating groups with common beliefs and interests without the constrains of distance. NASA has begun hosting "tweetups," or meet-ups of twitter followers interested in NASA and space. The initial tweetups were based purely on gathering in a single location and sharing a unique experience. By taking the approach that tweetups shouldn't be limited by location, the SDO team was able to include and inspire a larger community of space-enthusiasts and newcomers than were able to be present at the launch and first light events. The #SDOisGO Launch #NASATweetup had three components: On-Site Tweetups at Kennedy SC and Goddard SFC; Independent Tweetups and Events; and School Events. Fifty "tweeps" were invited to watch launch at Goddard, while fifteen "Twitter Correspondents" were invited to view launch from Kennedy and act as on-site journalists and EPO staff, engaging the public through their tweets and pictures. More than 30 independent events were held nation wide from living rooms and libraries, while over 5,000 students were inspired by seeing a launch through the eyes of our Twitter Correspondents. First Light events were similarly structured, with "Solar Dynamics Observatory" appearing as a trending topic for 24 hours. The next step is to examine the data we have collected and formulate a solid evaluation plan for future events. http://sdo.gsfc.nasa.gov/mission/launch/launchepo.php

E66 Bringing the Planets to Virginia and Beyond: Exhibits at the University of Virginia Leander McCormick Observatory and the Science Museum of Virginia

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Opportunities abound for engaging the public interest in NASA-funded missions to the outer Solar System, from producing planetarium shows, creating museum exhibits, and bringing traveling exhibits to local museums. Educational supplements to NASA-funded research programs supported the development of 'Icy Worlds', a planetarium show at the Science Museum of Virginia (SMV) in Richmond, created an exhibit of Cassini images and movies at the University of Virginia Leander McCormick Observatory, and supported the display of 'Spectacular Saturn' a traveling exhibit of Cassini images at the SMV. In addition, virtual visits to elementary school classrooms around the country via Skype deliver the latest images and results from missions such as Cassini and enable face-to-face interaction with students anxious to learn more about how 'real' science is done.

E67 High-Altitude Balloon Launches and Hands-On Sensors for Effective Student Learning in Astronomy and STEM

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Students creating and flying experiments into NearSpace using a low-cost High-Altitude Balloon Platform (HARP) greatly advance understanding in Introductory Astronomy and advanced classes across several disciplines. Remote sensing above 98% of the uncharted atmosphere using cameras, intensifiers, IR and UV sensors provide access to the heavens and large regions of the Earth. Insitu and limb atmospheric gas measurements, near-space stratosphere measurements, and cosmic rays engage students on planetary atmospheres to supernova acceleration. This new capability is possible by exposing students to recent advances in MEMS technology, nanotechnology, wireless telecommunication systems, GPS, DSPs and other microchip miniaturizations to build < 4 kg payloads. The HARP program provides an engaging laboratory, gives challenging STEM field experiences, reaches students from diverse backgrounds, encourages collaboration among science faculty, and provides quantitative assessment of the learning outcomes. Over a seven-year period Taylor University, an undergraduate liberal art school, has successfully launched and recovered over 230 HARP systems to over 30 km (100% success with rapid recovery) with flight times between 2 to 6 hrs. The HARP payloads included two GPS tracking systems, cameras and monitors, a 110 kbit down link, an uplink command capability for educational experiments (K–12 and undergrad). Launches were conducted during the day and night, with multiple balloons, with up to 10 payloads for experiments, and under varying weather and upper atmospheric conditions. The many launches in a short period of time allowed the payload bus design to evolve toward increased performance, reliability, standardization, simplicity, and modularity for low-cost launch services. Through NSF and NASA grants, the program has expanded leading to over 52 universities trained at workshops to implement high altitude balloon launches in the classroom. Two spin-off companies now sell the turn-key high-altitude balloon system (StraoStar Systems LLC) or a low cost ride-for-hire into near-space (NearSpace Launch).

E68 Dark Skies from the Ground Up: Before, During and After GLOBE at Night

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With half of the world population now living in cities, many urban dwellers have never experienced the wonderment of pristinely dark skies and maybe never will. Light pollution is obscuring people long-standing natural heritage to view stars. The GLOBE at Night program (www.globeatnight.org) is an international citizen-science campaign to raise public awareness of the impact of light pollution by encouraging everyone everywhere to measure local levels of night sky brightness and contribute observations online to a world map. GLOBE at Night has been the most productive light pollution monitoring campaign in the last 5 years, collecting over 53,000 observations in a two-week period annually. This year, during the moonless two weeks in March, the campaign set a record high of over 17,800 measurements from people in 86 countries. In the United States, 49 states plus the District of Columbia contributed more than 10,900 measurements. Foundational resources are available to facilitate the public participation in promoting dark skies awareness. The GLOBE at Night website explains clearly the simple-to-participate-in 5 step program and offers background information and interactive games on key concepts. The program has been expanded to include trainings of the general public, but especially educators in schools, museums and science centers, in unique ways. Education kits for dark skies awareness have been distributed at these training workshops. The kit includes material for a light shielding demonstration, a digital Sky Quality Meter and "Dark Skies Rangers" activities. The activities are on how unshielded light wastes energy, how light pollution affects wildlife and how you can participate in a citizen-science star-hunt like GLOBE at Night. In addition, projects are being developed for what to do with the data once it is taken. The presentation will provide an update and take a look ahead at the program plans. For further information, visit www.globeatnight.org.

E69 MY-Astronaut.org: Vote for and Fund Suborbital Space Heroes or Earth Stewardship=Your Ticket to Space

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Apollo 8 astronauts gave us a photo of Earthrise, a new perspective of our home. Apollo 11 heroes took us for a lunar walk and we, the whole world, cried together "We did it!" The seeds of possibility for a planetary identity were planted. But then, what happened? Light pollution. Global warming. Wars continued. We still admire astronauts, but many of today youth see no part in the space effort for them. The snapshot of our planet, while beautiful, is 2D. You can see the planet of Avatar in 3D. Let make it possible for students of today to aspire to space and see our home in three dimensions for five minutes in zero gravity. Why? We can't afford not to. When I asked Astronaut Grunsfeld if he thought a shift in Earth stewardship could occur if more people saw her from space, he said yes. How many would it take? 535, the number of people we elected to Capitol Hill. But they'll never go, he said. Well, then, what boons from new brain synapses and insights could writers, artists, dancers, loggers, fishermen, and energy workers bring back? Sixty per cent of young students say they want to go to space. Let make it possible. Let bring back the "tickertape parade" enthusiasm of the 60 for science and exploration. If you want to be an astronaut, we challenge you to be an environmental or humanitarian activist first. Through your actions, you can inspire the world, through social networking and fundraising, to vote for and fund you to ride the first chartered suborbital flight for My Astronaut. At the Spaceport America launch, we grassroots investors will cheer "That MY Astronaut up there!" Earth stewardship could be YOUR ticket to space! And Earth ticket back to good health.

E70 Georgians Experience Astronomy Research in Schools (GEARS)

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Georgia Department of Education and its partners at Columbus State and Georgia Southern Universities are engaged in creating a comprehensive program to institutionalize high quality astronomy in its high schools. The goal of the Georgians Experience Astronomy Research in Schools (GEARS) project is to transform the way high-school Astronomy is taught in 100% of GA public schools by 2012. GEARS will be an innovative and rigorous, NASA research-infused Astronomy curriculum, which will reach thousands of students in rural, urban, and suburban areas and will be taught by highly trained teachers. GEARS project leaders have two objectives. The first objective is to develop and implement an online high-school Astronomy course for inclusion in the GA Virtual School portal. The GEARS course will be a progression through inquiry-based research experiences culminating in authentic data analysis and data mining activities selected from the NASA archives. The GEARS framework and units will meet the new Georgia Performance Standards in Astronomy and will be incorporated into teacher workshops being taught in summer 2010 and beyond. Units will be pilot tested by selected teachers beginning in fall 2010. The second objective is to ensure the sustainability and utilization of GEARS both online and in a blended classroom approach by providing teacher professional development, integrating it into Space Science for Teachers graduate courses, and by developing a network of Georgia Astronomy Resource Teachers who will teach GEARS astronomy and mentor other teachers in their local areas. This project is funded by NASA Office of Education Grant NNX09AH83A through the GADOE, supported by CSU and GSU. The project website is http://cheller.phy.georgiasouthern.edu/gears.

E71 Free-Choice Family Learning Experiences at Telescope Observing Events

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This study examines family experiences at nighttime telescope observing events, also known as Star Parties. The goal was to understand how families make meaning of their experiences at star parties, and how they incorporate the experiences with their prior cultural background. The primary question guiding this investigation was: How do family members make sense of their experiences at star parties? Sub-questions included: what are the families agendas and motivations for attending? And how are agendas and identity interacting with the construction of meaning for family visitors to observing events? For this study two families were recruited for each of three observing events, one of which is the focus

of this case study. "Expert" families were identified by local facilitators of telescope observing events and were eligible to participate if they had previously attended telescope observing events. "On-site" families were recruited from the self-selected audience that attended the observing event. Qualitative methods, consisting of interviews, paired-family self-administered interviews, night-shot video observations, stimulated recall, and novel reflection video "blogs" were utilized in this study to capture information about family culture as well as the negotiation of meaning at star parties. This poster describes a case-study of one families' star party experience, the participants' motivations and agendas are described. The analysis revealed evidence of both meaning making and identity negotiation during, and related to the educational leisure activity of attending a star party. Since one of the primary purposes of a family is to support the learning of its members, understanding how families use various learning resources is of interest to both learning researchers as well as providers of family learning opportunities such as telescope observing events.

Cosmos Posters

Monday, 10:40 a.m. Oral Overview, Eaton Humanities 150

Poster presenters are invited to give a 60-second overview of their poster to conference attendees between 10:40 a.m. and 11:50 a.m. in Eaton Humanities 150.

C1 Making Cosmic Connections in the Nature of Science

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Presenting the rich heritage of astronomy includes exposing the process of science, warts and all. This study reveals the changes in student attitudes and critical thinking skills as a result of integrating nature of science lessons into course material. *Making Cosmic Connections in the Nature of Science* is a powerful tool for engaging Astro 101 students and for removing the stigma of "untouchable" science. Nature of science studies strengthen Astro 101 core objectives including: a) developing critical thinking skills, b) understanding scientific methodologies, c) and applying logic. In addition, traditionally "science-challenged" students are unsuspectingly lured into the ivory towers of science through interactive learning strategies [1]. Sensational "science" sells. Savvy students must distinguish science from hype, non-science and pseudoscience. Current events, philosophers of science, Hollywood, uTube and SyFy flicks offer abundant resources to engage students and their scientific sensibility. Studies show students retain much more material if it is relevant to their lives [2]. Understanding where science ends and philosophy, dogma, or superstition begin is an essential tool in the 21st century. The year 2010 marks 500 years of scientific revolutions. *Making Cosmic Connections in the Nature of Science* is an attempt to take learning to the next level by giving teachers revolutionary tools to examine existing and past paradigms in science. College-level science courses without critical analysis, without exposing bias and limitations of science, is simply a rehashing the K–12 nature of science frameworks.

1. Alexander Rudolph, Ed Prather, Gina Brissenden, David Consiglio, Vicente Gonzaga. 19 April 2010. A National Study Assessing the Teaching and Learning of Introductory Astronomy Part 11: The Connection between Student Demographics and Learning. *Astronomy Education Review*.

2. Jay M. Pasachoff, Rosa M. Ros, Naomi Pasachoff, eds. 2008. Innovations in *Astronomy Education*, Cambridge University Press.

C2 Using the Big Ideas in Cosmology to Teach College Students

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Recently, powerful new observations and advances in computation and visualization have led to a revolution in our understanding of the origin, evolution and structure of the universe. These gains have been vast, but their impact on education has been limited. We are bringing these tools and advances to the teaching of cosmology through research on undergraduate learning in cosmology as well as the development of a series of web-based cosmology learning modules. In order to investigate student ideas about the structure, composition, and evolution of the universe, our group has developed an open-ended cosmology survey. We administered the survey prior to instruction and conducted follow-up student interviews using the survey. Preliminary results regarding student misconceptions in cosmology, student attitudes toward inquiry, and directions for instruction in cosmology will be presented.

C3 "Extreme" Inquiry-Based Learning: Engaging Non-Science Students with the WOW Factor and Science Portfolios

David Baker, *Austin College, dbaker@austincollege.edu*

We present two unique inquiry-based approaches that stimulate non-science undergraduate students to overcome their fear of science: 1) an engaging, nontraditional course topic with a WOW factor, and 2) Science Portfolios that encourage students to do their own science. "The Most Extreme Places in Our Solar System" is a freshman-level introductory course at Austin College, a selective liberal arts college in north Texas with a total enrollment of 1300 students. This course is one of 20 "freshman seminar" courses. The instructor serves as an academic mentor for the students during their four-year college career. Surprisingly, the majority of students in this science class are non-science majors — the WOW factor draws them in. Each student becomes an expert on an extreme place of her/his choosing: perhaps the tallest mountain (Olympus Mons), the longest-lived storm (Jupiter's Great Red Spot), or possible life in the dark (Europa). Along the way, students compare and contrast their extreme place with similar places throughout the Solar System. The fun doesn't stop there. Science Portfolios utilize a true inquiry-based learning approach. Students document their own observations, ask their own scientific questions, develop their own hypotheses, design their own experiments, and evaluate their scientific growth. It is an open-ended exercise with few constraints. The effectiveness of Science Portfolios has been assessed with pre-/post-surveys, focus groups, and the portfolios themselves. The results are impressive. At first, students are hesitant to take scientific risks — their confidence is low. But as the semester progresses, they develop as scientists

and obtain ownership of their learning. As one student remarked, "After starting this portfolio, I realized that it is fun to try to figure out things myself...it feels like I am following the ways of great scientists."

C4 Characterizing Online Tutorial Systems for Introductory Astronomy

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The multitude of textbooks for "Astronomy 101" is now associated with a number of online homework/tutorial systems. The best-known of these is probably MasteringAstronomy, but others also exist, and there is not much information available to help instructors choose between them. The poster will compare the characteristics of various online systems (e.g. Mastering, ARIS, and SmartWork): number and type of questions, available features, instructor tools, and other properties.

C5 A $1.00 CCD Spectrograph for Use on Small Telescopes in the Introductory Astronomy Lab (But You Provide the CCD Camera)

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We describe preliminary tests on a very low-cost system for obtaining stellar spectra for instructional use in introductory astronomy laboratory. CCD imaging with small telescopes is now commonplace and relatively inexpensive. Giving students direct experience taking stellar spectra, however, is much more difficult, and the equipment can easily be out of reach for smaller institutions, especially if one wants to give the experience to large numbers of students. We have performed preliminary tests on an extremely low-cost (~$1.00) objective grating that can be coupled with an existing CCD camera (or even a low-end digital SLR camera) and a small telescope typical of introductory astronomy labs. With this equipment we believe it is possible for introductory astronomy students to take stellar spectra that are of high enough quality to distinguish between many MK spectral classes, or to determine rough B-V color indices. We present observational tests of this objective grating used on an 8" Schmidt-Cassegrain with a thermoelectrically cooled SBIG ST7 camera, as well as with a low-end, consumer digital SLR camera. Several low-cost strategies for reducing the raw data are compared, with an eye toward projects ranging from individual undergraduate research projects to use by many students in a non-majors introductory astronomy lab. Toward this end we compare various tradeoffs between complexity of the observing and data reduction processes and the usefulness of the final results. We also describe some undergraduate astronomy education projects that this system could potentially be used for. Some of these projects could involve data-sharing collaborations between students at different institutions. We describe efforts to develop useful observing procedure cookbooks and data reduction routines that would be made freely available.

C6 Using Astrology to Teach Research Methodology

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Deborah Scherrer, *Stanford Solar Obs. Group, dscherrer@solar.stanford.edu*

The scientific method taught in school is not how science works and lab class "experiments" are closer to recipes for self-conducted science demonstrations than true experiments. As a result, students rarely get exposed to the ways of scientific research until graduate school, and consequently have gross misconceptions of the nature of scientific inquiry. Popular statements such as "Evolution is just a theory" underscore that these misconceptions are epidemic. A lot of science goes into experiment design and this is done for students out of necessity: good experimental design requires plenty of time and experience, which are not abundant in science classes. This expediency denies students the chance to exercise their creativity and critical thinking skills in science class and gives them a false impression of the nature of research. We have found that testing the claims of astrology offers students a wonderful chance to explore the nature and methods of science. Since the basics of astrology are widely known, this subject is tractable. Working in groups, students do a 'literature search' on astrology and write summaries of the claims of astrology. The class analyzes these descriptions critically and discusses them. Then each group identifies some specific claims of astrology and submits them to the class for analysis and discussion with an eye to designing tests. Tests are designed and run with discussion and analysis and finally each group interprets the results and presents the interpretation to the group for discussion and review. Students are invited to comment on the experiment, itself, which provide some interesting insights. Anecdotal evidence indicates that experiments which are closer to the nature of scientific research, involving more creativity and critical thinking are less popular than the traditional recipe-like activities.

C7 The Center for Astronomy Education (CAE) and Our NSF CCLI Phase-III Collaboration of Astronomy Teaching Scholars (CATS) Program: Our Community-Based Model for Astronomy Education Research

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The Center for Astronomy Education (CAE) has been devoted to improving teaching & learning in Astro 101 by creating research-validated curriculum & assessment instruments for use in Astro 101 & by providing Astro 101 instructors professional development opportunities to increase their pedagogical content knowledge & instructional skills at implementing these curricula & assessment materials. To create sustainability and further expand this work, CAE, in collaboration with other national leaders in astronomy education & research, developed the Collaboration of Astronomy Teaching Scholars (CATS) Program. The primary goals of CATS are to: 1) increase the number of Astro 101 instructors conducting fundamental research in astronomy education; 2) increase the amount of research-validated curriculum & assessment instruments available for use in Astro 101; 3) increase the number of people prepared to develop & conduct their own CAE Teaching Excellence Workshops. In our first two years we have concluded our national study assessing the effectiveness of interactive learning strategies and the relationship between students' personal characteristics and learning gains. We have also begun field-testing of our Solar System Concept Inventory. Additionally, research into students' beliefs and reasoning difficulties on topics in Cosmology is underway, and we are field-testing a suite of Lecture-Tutorials to help students overcome these difficulties. We have made many content and functionality additions to the ClassAction electronic learning system. Our national archive of multiple-choice questions for use in supplementing an instructor's implementation of Think-Pair-Share or for their assessment purposes is nearly complete, and we are developing the Question Complexity Rubric (QCR) to hierarchically rank them. We are developing an assessment instrument designed specifically for Astro 101 instructors

to evaluate the effectiveness of instruction on improving students' attitudes & beliefs about science, which is being informed by several of our studies and community input. In addition, our Guest Moderator program has really increased the involvement of the greater CAE community in discussions about the nature of teaching and learning on our academic listserv, Astrolrner@CAE.

C8 A New Course on Cultural Astronomy

David Bruning, *University of Wisconsin, Parkside, bruning@uwp.edu*

Cultural Astronomy may provide your department with an opportunity for a new or different general education course. At UW-Parkside, we were limited to a single one-term astronomy course that met general education requirements. But students requested another astronomy course and the opportunity to do so came through our university's graduation requirement for "ethnic diversity in the United States." The poster describes the storyline this course uses, resources about Native American Astronomy, student projects (Wiki) and integration into our First Year Experience, particularly the reading and writing assignments used to develop academic skills. Cultural astronomy is as much sociology, anthropology and archaeology as it is astronomy, but with the right resources you can master those topics as you weave the story as to how astronomy develops in different cultures. The Parkside course is limited primarily to North America because of legal requirements, but between lecture and student presentations, we discuss the Apache, Blackfeet, Crow, Dine, Hocak, Hopi, Native Hawaiian, Inuit, Iroquois, Lakota, Maya, Pawnee, Seminole, Tlingit, Zuni, as well as Babylonian, Chinese, Islamic and Sumerian astronomies. This course has filled every semester it has been offered and some student experiences will be shared. The course has since been cross-listed in Ethnic Studies and is the only science-based diversity course in the Univ. of Wisconsin system.

C9 A Novice Instructor's Perspective on Learner-Centered Teaching Techniques in Introductory Astronomy

Katherine Brutlag, *Pima Community College, kbrutlag@gmail.com*

I explore the trials, tribulations and triumphs of my first year of teaching introductory astronomy and chronicle the implementation of learner-centered techniques, laboratory activities and demonstrations in my classroom. I also present data from two consecutive semesters showing the improvement in student comprehension of and satisfaction with laboratory activities upon implementation of new, more interactive, labs. I describe my first attempt at facilitating collaborative test taking, my decision to forego a traditional textbook, and student reactions to peer review of their work.

C10 A 20-Year Study of Undergraduate Astronomy Students' Beliefs and Knowledge in Science and Technology

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Science literacy is an important goal of both science educators and policy makers in the United States and across the globe. Although there is no broad agreement on the definition of science literacy, it is generally agreed that it is important for citizens to be scientifically literate in order to make informed decisions in everyday life. This poster presents data from a twenty-year study into the science literacy of undergraduates enrolled in introductory astronomy courses. The survey instrument included a set of forced-choice and open-ended items derived from the National Science Foundation (NSF) Science and Engineering Indicators (1989) and work by Miller (1987), as well as a series of Likert-scale items assessing students' attitudes about science and technology issues. Responses from almost 10,000 undergraduate students from 1989 to 2009 have been analyzed. We present students' responses to both science literacy and belief questions by year and demographic variables, as well as trends in open-ended responses. Analysis revealed that demographic variables accounted for only 7% of the variance in students' science literacy scores. The strongest predictor of a student's overall science literacy score was how many science courses they had completed, yet this only accounted for 4% of the variance explained. Students' beliefs regarding science and technology issues were not predictive of their overall science literacy score. Our findings call into question the claim that students' beliefs are predictive of their overall scientific literacy, and have implications for instruction specifically designed to address different categories of beliefs, such as beliefs in astrology and pseudoscience. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C11 Meeting the Needs and Expectations of Millennial Generation Astronomy Students

Erik Christensen, *South Florida Community College, christensene@southflorida.edu*

This poster will describe the redesign of an online introductory astronomy class to meet the needs and expectations of Millennial Generation students (born between 1981 and 2000). Each of the common traits associated with Millennial Generation students (Strauss and Howe, 2003) will be discussed along with examples of how each trait can be addressed in an online or technology-enhanced face-to-face learning environment to provide a meaningfully and engaging, active-learning setting. Strategies and techniques that have worked well in the author's classes to enhance student engagement and persistence will be shown with the hope that this will inspire you to build upon these ideas in your classes.

C12 The NASA Science Mission Directorate Education Forum Working Group for Higher Education: Building and Supporting a Network that Targets the Next Generation of STEM Workforce

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As part of the new NASA Science Education Forums, the NASA Science Mission Directorate has identified higher education as one of its primary audiences and established a cross-forum working group to coordinate efforts in this area. The Higher Education Working Group, composed of the higher education leads from the Astrophysics, Earth Science, Planetary Sciences and Heliophysics forums, as well as outside members, will work over the next 4 years in several areas of higher education support. Targeted audiences include those teaching: 1) Undergraduate students in STEM fields 2) Introductory astronomy and earth science courses 3) At minority-serving institutions 4) At community colleges 5) Pre-service teachers. Support structures, including clearing houses, professional development workshops,

virtual classrooms opportunities, and partnership development.

C13 A National Study Assessing the Teaching and Learning of Introductory Astronomy, Part II: The Connection between Student Demographics and Learning

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This is the second in a series of reports on a national study of the teaching and learning of astronomy in general education, non-science major, introductory astronomy courses (Astro 101). We report here on the analysis of how individual student characteristics affect student learning in these classes, and whether the demonstrated positive effect of interactive learning strategies on student learning differs based on these characteristics. This analysis was conducted using data from nearly 2000 students enrolled in 69 Astro 101 classes taught across the country. These students completed a 15-question demographic survey, in addition to completing the 26-question Light and Spectroscopy Concept Inventory (LSCI) pre- and post-instruction. The LSCI was used to determine student learning via a normalized gain calculated for each student. A multivariate regression analysis was conducted to determine how ascribed characteristics (personal demographic and family characteristics), obtained characteristics (academic achievement and student major), and the use of interactive learning strategies predict student learning in these classes. The results show dramatic improvement in student learning with increased use of interactive learning strategies even after controlling for individual characteristics. In addition, we find that the positive effects of interactive learning strategies are the same for strong and weak students, men and women, across ethnicities, and regardless of primary language. The research strongly suggests all students benefit from interactive learning strategies. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program, and Award No. AST-0847170, a PAARE Grant.

C14 An Online National Archive of Multiple-Choice Questions for Astro 101 & the Development of the Question Complexity Rubric

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We are developing a national archive of multiple-choice questions for use in the Astronomy 101 classroom. These questions are intended to supplement an instructor's implementation of Think-Pair-Share or for their assessment purposes (i.e. exams and homework). We are also developing the Question Complexity Rubric (QCR) to guide members of the Astro 101 teaching and learning community in assisting us with hierarchically ranking questions in this archive based on their conceptual complexity. Using the QCR, a score is assigned to differentiate each question based on the cognitive steps necessary to comprehensively explain the reasoning pathway to the correct answer. The lowest QCR score is given to questions with a reasoning pathway requiring only declarative knowledge. The highest QCR score is given to questions with a reasoning pathway that requires multiple connected cognitive steps. When completed, the online question archive will provide users with the utility to 1) use the QCR to score questions 2) search for and download questions based on topic and/or QCR score, and 3) add their own questions to the archive. Stop by our poster to test your skills at determining question complexity by trying out the QCR with our sample questions. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C15 Student Feedback on Learner-Centered Astronomy Education

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Learner-centered education techniques are now a major force in ASTRO-101 education. Innovations such as Think-Pair-Share (Peer Instruction), Lecture Tutorials, and Ranking Tasks are now commonly used in numerous ASTRO-101 classes. In this study, we report anonymous feedback from over 1000ASTRO-101 students over six semesters from instructors using learner-centered techniques. We present student's perceptions of the utility of these techniques, and common concerns about these techniques.

C16 The CAE/CATS Guest Moderator Program: Fostering Better Astronomy Education Through Professional Discussions

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The Center for Astronomy Education (CAE; http://astronomy101.jpl.nasa.gov/) sponsors many professional development opportunities intended to aid astronomers in improving astronomy education. One of these activities is the Astrolrner@CAE listserv (astronomy101.jpl.nasa.gov/discussion), which is intended for everyone who is interested in improving college-level astronomy teaching and learning. Astrolrner@CAE is now over a decade old, with over 2700 posts from astronomy educators at numerous institutions. In order to ensure high-quality discussions, the listserv is moderated, and in 2007,CAE, through the Collaboration of Astronomy Teaching Scholars (CATS)program, created the Guest Moderator program. Guest Moderators are chosen from members of the greater CAE community. The program was created to elevate members of the CAE community who had shown themselves to be advanced in their pedagogical content knowledge through their own postings to Astrolrner@CAE. An additional goal was to create particular conversations about issues related to instruction by having Guest Moderators offer a monthly posting of instructional issues they, themselves, have been considering. We detail the insights gained from the first three years of the guest moderator program, and provide evidence of increased discussion due to this interaction. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C17 Mathematics in Intro Astronomy: A Less Anxious Model

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Using math in introductory astronomy can be the kiss of death. For many students, it all comes down to testing and a small amount of math can produce large anxieties. In the model I present here, problems involving math are given apart from traditional short-answer tests. Allowing students to use class notes while working these problems reduces math-anxiety. Some might argue whether this gives a student too much of an advantage. I would counter with this: Is it better to introduce little or no math whatsoever? The math is limited to basic algebra including the use of logarithms. Mathematical ideas are introduced through any number of in-class demonstrations, hand-built models and group activities. Basic problems are built from the following standard topics: Scaling and comparing distances, Newton' Law of Gravitation, Kepler's Laws, The power output of the Sun as a basis for defining luminosity, The Wien Displacement Law, Relations between the surface area of a star, surface temperature and luminosity, The Mass-Luminosity Relation, The Distance Modulus, and Hubble's Law. These topics are introduced in most introductory astronomy texts but are often glossed over in an effort not to intimidate students. By taking the time to develop a few of these ideas, and testing on them in a less threatening way, we can provide some small bit of help to our non-science majors when encountering the hurdle of math-anxiety. Most students have to fulfill some math requirement for graduation. Ideally, the model used here may give them a little practice with applied mathematics before encountering formal exams in their first college math course. For students and instructors, astronomy is presented a bit more realistically. After two semesters, this approach shows a good deal of promise at the University of Wisconsin, Fox Valley.

C18 Cosmic Philately: Using Stamps in the Astronomy Classroom

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We will discuss the hobby of astronomical stamp collecting, the Astronomy Study Unit of the American Topical Association, and how images on stamps can be used to liven up a lecture, a handout, or a paper in Astronomy 101. Many countries issued special stamps for the International Year of Astronomy and some of them show modern astronomy to good advantage. For those participants who (for some mysterious reason) don't collect astronomical stamps, this might awaken the urge. More generally, it can add some visual interest to activities participants are already doing.

C19 Using Virtual Worlds Creatively in ASTR 101

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Virtual worlds like Second Life® offer unique opportunities for undergraduate students to demonstrate understanding of general astronomy content in creative, immersive, and interactive ways. There are also chances for instructors to design and use 3-dimensional interactive models to assist in student learning. Four semesters of reflection on using Second Life in the non-science major "Exploring Life in the Universe" class will be presented alongside ideas and suggestions for future uses. A general overview of "science in Second Life" will be included as well as a guide on how to get started in Second Life.

C20 Phenomenological Primitives in Daisyworld

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Educating the public about global climate change is challenging because the phenomenon is driven by multiple, nonlinear interactions between the biosphere, the atmosphere and human activity. These interactions obscure the resiliency level of global and local climates to global temperature changes. An effective, climate change educator needs to be aware of the cognitive structures novices rely on when exposed to the evolution in time of nonlinear systems. In our investigation we designed a class activity for students in a college introductory astronomy course where students conduct a set of computer simulations modeling the interaction of a biosphere and planet temperature subject to a variable insolation with time. Students use a Daisyworld simulation that includes genetic mutations to plant albedo so that locally and globally the planet can reach near optimal temperature range even when students increase the level of insolation provided that the rate of change in insolation is less than the rate of mutation. Students are asked to explain why the planet is resilient to change and why the planet can suffer catastrophic decline in flora with a high rate of change in insolation. We evaluate student responses through qualitative data analysis, which codes for conceptual frameworks and phenomenological primitives (p-prims).

C21 Enhancing Astro 101: A Course in Telescope Construction

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We describe an enhanced "Astro 101" lab, in which the students constructed a 10" f/4.5 (45" focal length) Dobsonian reflecting telescope. John Dobson introduced the design in 1968 when he "and two of his students started the San Francisco Sidewalk Astronomers [dedicated to] public service in astronomy 1) giving the people of this planet a chance to see, with their own eyes, celestial objects through good-sized telescopes, and 2) providing them with information about what they are seeing." (http://www.sidewalkastronomers.us/id1.html). These are the goals of the laboratory component of a "good" Astro 101 course; we enhanced this experience though construction of the telescope. Dobsonian telescopes are reflectors with simple, portable, easy-to-build alt-az mount s (e.g., http://www.raycash.us/sfsidewalk/intro.htm, which we modified and followed). Learning goals included (1) gaining a basic understanding of telescopes, through lectures and use of commercial telescopes (8" and goto 11" Celestron reflectors, and the Coronado 40 mm H-alpha solar telescope) at the Hofstra University Observatory (a teaching observatory developed in part with NSF support), (2) gaining a basic understanding of design and construction of the Dobsonian telescope, (3) learning measurement, the use of tools, and safety by participating in construction, (4) gaining hands-on experience with focal properties, geometric optics, alignment and collimation, and (5) using and enjoying their own telescope, having become stakeholders by participating in its construction. In particular, students learned the importance of measurement, when the first mirror was shipped with the wrong focal length, and a decision was made to seek a replacement (which was gladly sent). Students observed a variety of objects (Venus, Mars, Saturn, moon craters, star clusters) using eyepieces of focal length 8 mm (the Televue 8-24 mm zoom eyepiece) through 40 mm. Overall the class was a success and provided an exciting experience. Future plans will also be discussed.

C22 Development of the Solar System Concept Inventory

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The Solar System Concept Inventory (SSCI) was developed in order to provide a pre-/post-instruction assessment instrument suitable for use in an introductory solar system course. The topics included on the SSCI focus on formation mechanisms, planetary interiors, atmospheric and surface effects, and small solar system bodies. These topics were selected by having faculty identify the key concepts they address when teaching about the solar system. Student interviews were then conducted to identify common naive ideas and reasoning difficulties relating to these key topics. As of December 2009, the SSCI has been through four semesters of both pre- and post-instruction classroom testing, involving over 2000 students and 11 institutions (ranging from two-year colleges to doctoral/research universities). After each semester of testing, item analysis statistics such as point biserial, percentage correct on pre- or post-testing, and frequently-chosen distracters (incorrect answers) were used to flag ineffective questions. Flagged questions were revised or eliminated. We present an overall outline of the SSCI development as well as our question-flagging criteria and question analyses from the latest round of field-testing. We would like to thank the NSF for funding under Grant No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C23 Dark Energy and Dark Matter in the Astronomy Classroom: Strategies and Approaches

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Dark Matter and Dark Energy are at the forefront of cosmological research, and yet are not easy ideas to convey to students. From the concept of what "dark" really means in the context of astronomical observations and indirect evidence, to the strangeness of matter and energy beyond our everyday experience, these subjects are often both fascinating and frustrating. We will present ideas for teaching these subjects developed as part of a NASA educational outreach grant partnering UT Dallas astrophysicists Dr. Mustapha Ishak-Boushaki, a NASA-funded cosmologist, and Dr. Mary Urquhart, a physics/astronomy education specialist, on a project to bring dark energy and dark matter into high school astronomy classrooms in meaningful ways. Through hands-on analogies for the universe and its expansion, image data, and discussions with the scientists, participants in our teacher workshops explore the science behind how gravity tells us about the unseen, how we know that the universe is expanding, why it appears the expansion is accelerating, the idea of dark energy, what other possibilities might explain the same data. We also show how these cutting-edge cosmological topics can be tied into fundamental ideas of gravity, light, and redshift. For Cosmos in the Classroom, we will highlight how some of the same strategies that work for introductory astronomy in high school can be used to build student interest and understanding in college classrooms.

C24 Addressing Central Student Misconceptions Regarding the Greenhouse Effect

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The Greenhouse Effect Concept Inventory (GECI) and a lecture tutorial activity have been developed to address fundamental misconceptions regarding the greenhouse effect. These two educational instruments were developed and validated through work involving over 3,600 undergraduate non-science majors enrolled in introductory astronomy and planetary science courses at the University of Arizona. Central topics of the concept inventory and lecture tutorial include: 1) the energies of light given off by the sun and absorbed and given off by Earth's atmosphere and surface, 2) energy balance, 3) abundant greenhouse gases, 4) mental models of how the greenhouse effect works, and 5) distinctions between the natural greenhouse effect and global warming. These instruments were also utilized to compare student pre-instruction understanding of the greenhouse effect between 2006 at the University of Arizona (n=273) and 2008 at California Polytechnic State University in San Luis Obispo (n=159). Despite enhanced public media attention toward global climate change, pre-instructional mean scores from samples of two student populations were identical (27% correct prior to instruction). Post-instructional scores from classes that used the lecture tutorial at the two different campuses showed no statistically significant difference, with a post-instructional mean of 58% for the Arizona class (n=69) and 56% at Cal Poly (n=58).

C25 Bringing the Cosmos Down to Earth: Assessing Student Learning in a Non-major Online Astronomy Course

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One of the double-edge swords of the classic university general education system is that students often find themselves thrust out of their comfort zones into disciplines which may emphasize completely different sets of knowledge and academic skills. An example of this is non-major science courses, which have historically suffered from bad press among the student body; they are often considered to be a rite of passage to be suffered through rather than an opportunity to acquire valuable knowledge or hone important skills such as effective communication or critical thinking. While there has been much attention paid to improving these courses in the past decade, including Astro 101, the question remains: just how much do students actually learn in these courses, and how to we know that they are in fact learning? Couple this with the increasing popularity of online courses and we have an excellent opportunity for a paradigm shift in non-major astronomy courses. With this should come not only a change in how we deliver such courses, but how we assess student learning as well. Given the apprehension of the students, crafting assignments which will simultaneously challenge students to learn the material in a deep and meaningful way, and to demonstrate that learning in a way which might even be considered fun is certainly a challenge. In keeping with Bloom's taxonomy, assignments should avoid asking students to merely list, define, or explain and instead force them to interpret, criticize, assess, predict, and appraise. What I have found to be a useful in developing such assignments is to have the students relate the material to their personal experiences and prior knowledge whenever possible. Engaging students with the material in a meaningful way has been key to the evolution of my online course.

C26 What They've Always Wondered: Questions Students Ask on the First Day of Astro 101

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Tapping into students' native curiosity is one of the most effective ways to motivate students in an introductory astronomy course. I present the results of a multi-year campaign to collect one question about astronomy from each student at the first lecture of a large, college-level astronomy course for non-science majors. I show how the questions that students submit not only identify which topics interest them, but provide insight into their concepts of what astronomy is and their understanding of the nature of science itself.

C27 Teaching a General Education Astronomy Class in a Non-traditional Setting: Not Your Traditional Astronomy 101 Class!

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After more than a decade teaching General Education (GenEd) Astronomy and Planetary Sciences classes at the University of Arizona (UA), I now teach a "similar" class at The Art Center Design College (TACDC), an accredited college with campuses in Tucson and Albuquerque. Unlike the large (150+ students) classes at UA, my TACDC class was only 15 students. The setting and small class provided me with an opportunity to focus on the skills students need at graduation. It was clear that the skills these students needed were not very different from UA students and aligned well with GenEd science goals and how GenEd science differs from the traditional Astronomy 101.The Art Center Mission is to educate "students to excel in the fields of Fine Arts, Design, Advertising, and Visual Communication." Therefore, while teaching Astronomy, I need to teach with art and design skills in mind. Also, students need to be prepared for the real world: able to work with others, to communicate both visually and in writing, and to produce assignments on time. UA GenEd student goals are very similar: understand the nature and application of science, apply ideas and processes beyond the classroom, recognize the complexity of many scientific issues as opposed to dualistic thinking, speak and write about scientific knowledge, perform appropriate mathematical calculations, and read and understand scientific literature from popular sources. Literacy, science literacy, and science process are as important as the science content of the class. Unfortunately, many students in both programs have poor reading and writing skills, communications skills, and math and critical thinking skills, all of these are essential to whatever field they go into. A good GenEd science course needs to be taught with this in mind. This poster shows a variety of ways in which we have addressed these issues.

C28 ClassAction: A Computer Database of Interactive Classroom Materials

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Think-pair-share (or peer instruction in the terminology of Mazur) is an important instructional technique for promoting interactive engagement in the classroom. It focuses on posing conceptual questions to students for discussion and voting. ClassAction is a computer database of conceptual questions programmed in FLASH and designed to be projected to a class using a computer video projection system. The collection is quite substantial as instructors may choose from over 500 questions which are grouped by topic and can be searched by keyword. The questions are also dynamic in that instructors have the capability to easily recast them into alternate forms for follow-up questions to check student understanding. A major goal of ClassAction is the development of students' critical thinking and metacognitive skills and many questions emphasize this through the organization of information in schematic diagrams, Venn diagrams, flow charts, and tables. Considerable resources are available to the instructor to provide feedback in the form of outlines, images, and over 100 computer simulations. ClassAction is an extremely flexible tool. Instructors may adapt in the classroom by choosing questions based on student responses to previous questions. ClassAction is easily tailored for an instructor's unique teaching situation as any subset of materials can be saved in any order for future use. All ClassAction materials are publicly available for live use or download at http://astro.unl.edu. We would like to thank the NSF for funding under Grant Nos. 0404988 and 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C29 Promoting Student Promptness and Awareness in Introductory Astronomy Laboratory with Current Events Quizzes

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Students are assigned to look up sun rise/set times and moon phases, read selected online articles on current astronomy events, and take a short current events quiz during the first 10 minutes of lab (sample questions at http://tinyurl.com/currenteventsquestions). This motivates students to show up promptly to lab, as the time cut-off for the quiz is strictly enforced. Resources and results from sample current events questions are shown. Pre- and post-instruction shifts in student attitudes (e.g., "I am interested in news that is related to astronomy," "Astronomy has little relation to what I experience in the real world," "I know where and how to look up astronomy information"), as measured by the Astronomy Laboratory Learning Survey (ALLS) are analyzed (ALLS described at http://tinyurl.com/ALLSresults).

C30 Uncovering the Stories Behind the Science: Infusing Astro 101 with the History of Modern Cosmology

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The history of astronomy tells the story of how we have come to know what we know, and utilizing it enhances students' understanding of science. Cosmic Times provides this historical context to a variety of modern topics taught in upper level high school and Astro 101 courses. Cosmic Times is a modular suite of curriculum materials that examines cosmology over the past 100 years, from Einstein's theory of gravity, to Hubble's determination that the universe is expanding, to the discovery of dark energy. The centerpiece of Cosmic Times is a series of front-page newspapers tied to key moments in this history, with articles written to trace our evolving understanding of the expansion of the universe, the changing cosmic distances (and how we measure them), and the nature of supernovae. Each issue of Cosmic Times is accompanied by 4 to 5 lessons, which reinforce key science concepts, highlight the process of science, and underline social aspects surrounding the scientific events. This suite of materials was designed to be modular, allowing instructors to use some or all of the articles and lessons in the classroom. The materials can be used with existing Astro 101 topics to provide historical context or to solidify scientific concepts. Or the materials can be combined to trace one of the Cosmic Times dominant themes. Or, taken as a whole, Cosmic Times can provide a modern cosmology framework around which an Astro 101 course might be taught. This framework combines history, science, and

science readings to give students a firmer grounding in the science and the process of science. The Cosmic Times materials are available at http://cosmictimes.gsfc.nasa.gov/.

C31 Astronomical Misconceptions

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Misconceptions that students bring with them to the introductory science classroom are especially prevalent in astronomy. One way to identify and possibly dispel some of these misconceptions is through the use of a Misconceptions Survey. The poster will encapsulate the survey itself, a short report on its development, and implementation and some initial results of its use. Participants will be able to use the survey at their own institutions if they wish, or construct a similar one based on our model.

C32 Adapting the RBSEU Nova Search Project for Use in Intro Astronomy at Truckee Meadows Community College: A Case Study

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In 2009, Truckee Meadows Community College (TMCC) became part of a cross-institutional collaboration to adapt and implement the research-based science education (RBSE) astronomy curricula developed earlier by faculty at the University of Alaska, Anchorage and Indiana University. This RBSE astronomy curriculum includes a suite of projects that involve students in authentic research experiences which are packaged such that the research is accessible to typical students enrolled in the typical non-majors intro astronomy course. Already an effective part of the science instruction at U. of Alaska, the question became whether the RBSE curricula could be successfully exported to other colleges and under what scenarios. This poster will present a case study of how the RBSE Nova Search project was adapted and implemented for use at TMCC.

C33 Assessing Changes to Student Attitudes and Beliefs about Science & Astronomy

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We have begun a mixed methods study that uses longitudinal and interview data to inform our understanding of student's beliefs and attitudes about the role of science within our society and their understanding of the nature of science within the context of astronomy. Additionally, we are seeking the input of the broader Astronomy 101 teaching community about their own beliefs and attitudes about what is important for students to understand about science and its role in society. The results of this work will be used to inform the development of a multiple-choice pre-/post-assessment instrument designed to determine how different instructional environments change students' beliefs and attitudes as a result of participating in an introductory astronomy course. We describe specific attitudinal categories that the survey questions are being designed to address. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant, for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C34 "MyUniverse": A Java-based Classroom Tool to Visualize and Understand Relativistic Cosmology

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Observations of distant supernovae established that our universe entered the state of accelerated expansion when it was about 70% of the present size. The interpretation of this discovery is that the content of the present day universe is dominated by "dark energy," a cosmological fluid with anti-gravitational properties, akin to or perhaps identical to a vacuum state of some yet undetermined quantum field. We completed an interactive Java based application that provides a visual and physically correct understanding of this discovery and puts it in the larger context of relativistic cosmology. In a self-guided, game-like manner, students are led through process of searching for and measuring supernovae, building a redshift-magnitude Hubble diagram, and selecting the cosmological model that provides the best fit to the data. We implemented a sophisticated computational routine that provides accurate determination of cosmological solutions for any user defined model with up to five possible cosmological fluids. Besides matter, dark matter, radiation, and cosmological constant, we also included domain walls and cosmic strings, to illustrate the range of effects that the relativistic equation of state has on the nature of gravity and expansion. The application is suitable for use at both college and pre-college levels. It is supplemented with level appropriate user guides and laboratory manuals.

C35 Developing a Celestial Sphere Display for Lecture Tutorials for Introductory Astronomy

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One of the major innovations in education for introductory astronomy classes for non-science majors (ASTRO-101) in the last decade is the advent of learner-centered astronomy techniques. One aspect of this effort that has been widely adopted is the Lecture Tutorials for Introductory Astronomy. We present a cost-effective manipulative display to aid students in some of the introductory Lecture Tutorials concerning the position and motion of celestial objects. This object, which we refer to as a Celestial Sphere Display (CSD), was inspired bythe work of Coles (2007), and can be easily constructed in large numbers. We give suggestions as to how to use these CSDs successfully, and give preliminary feedback from students.

C36 Using Time Zones and Celestial Mechanics to Teach the Phases of the Moon

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The phases of the moon are typically presented to introductory astronomy classes in a diagram showing the position of the moon, its appearance and elongation at each phase, and the time of each phase's transit. Though wonderfully compact and efficient at conveying information, I have found it to be overwhelming to non-science major students. Much of their difficulty arises from their vague definition of time which must be broadened for them to understand the different rising, transit and setting times for the phases of the moon. Working with time zones helps them recognize that the time on their watch is relative to a particular longitude

and the transit of the sun at that longitude. Celestial Navigation extends this to the transit of all celestial objects and helps them re-define "time of day" to a position on Earth relative to the Earth-Sun line in a practical way. Once they understand why a given object transits at the same time for all time zones, extending this to the moon is much simpler. My students are quickly able to identify the transit times of the various phases of the moon, and with some additional instruction, quickly learn how to figure out their rising and setting times as well. On this poster, I will include images from Power Point animations and the student exercises I use to help them understand the concepts. Though I have too small a sample for statistical analysis (24 students/semester), I have found that student scores on moon phase questions on exams has improved since I incorporated time zones and celestial navigation into my course.

C37 Learning by Teaching: Implementation of a Multimedia Project in Astro 101

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ASTRO 101 students have deep-seated pre-conceptions regarding such topics as the cause of moon phases or the seasons. Beyond addressing the topics in a learner-centered fashion in the classroom (including the use of props, animations, Lecture Tutorials and Mastering Astronomy tutorials), I wanted to take this a step further. In a conceptually-intense course such as astronomy, "learning by teaching" enables students to truly master concepts. I wanted each of my 25 students to have a chance to teach the cause of Moon phases. Using classroom time for this did not seem realistic. I therefore created a "multimedia/video project" for the course, where groups of 3 students taught the cause of Moon phases to 3–5 participants (not enrolled in the course) and taped the whole session. They were to edit the filming and produce a 10-minute final movie highlighting their teaching techniques and showing students in the process of learning the concepts. This "experiment" turned out to be a great success for a few reasons. First, students gained experience explaining conceptually-challenging topics, making them learn the material better, which was the original aim for this project. Additionally, they learned to apply learner-centered techniques, most likely learning to teach for the first time. Finally, this project provided the students a connection between the classroom and the rest of the college, making them responsible for applying and sharing their knowledge with their peers.

C38 Using Gamma-Ray Burst Research in an Online Introductory Astronomy Course

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Non-science majors should benefit from an introduction to current professional research such as gamma-ray burst science from the INTEGRAL, Swift and Fermi satellite telescopes. The goals for this online lab exercise are to provide a state-of-the-art research experience so that students may (i) appreciate modern scientific research, (ii) 'participate' in that research, (iii) develop excitement and wonder for research beyond pretty pictures, and (iv) develop a better understanding of 'argument' in science. This paper describes an online laboratory exercise that guides students through data reported via the 'Gamma-ray Burst Real-time Sky Map' at grb.sonoma.edu. Students generate a spreadsheet with directional data and explore the time-dependent nature of the signals. Online abstracts and publications provide additional sources of insight and controversy.

C39 A National Study Assessing the Teaching and Learning of Introductory Astronomy; Part I: The Effect of Interactive Instruction

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We present the results of a national study on the teaching and learning of astronomy taught in general education, non-science major, introductory astronomy courses (Astro 101). Nearly 4000 students enrolled in 69 sections of Astro 101 taught at 31 institutions completed (pre- and post-instruction) the Light and Spectroscopy Concept Inventory (LSCI) from Fall 2006 to Fall 2007. The classes varied in size from very small (N<10) to large (N~180) and were from all types of institutions, including both 2-year and 4-year colleges and universities. To study how the instruction in different classrooms affected student learning, we developed and administered an Interactivity Assessment Instrument (IAI). This short survey, completed by instructors, allowed us to estimate the fraction of classroom time spent on learner-centered, active-engagement instruction such as Peer Instruction and collaborative tutorials. Pre-instruction LSCI scores were clustered around ~25% (24±2%), independent of class size and institution type; however, the gains measured varied from about (-)0.07-0.50. The distribution of gain scores indicates that differences were due to instruction in the classroom, not the type of class or institution. Interactivity Assessment Scores (IAS's) ranged from 0%–50%, showing that our IAI was able to distinguish between classes with higher and lower levels of interactivity. A comparison of class-averaged gain score to IAS showed that higher interactivity classes (IAS > 25%) were the only instructional environments capable of reaching the highest gains (<g> > 0.30). However, the range of gains seen for both groups of classes was quite wide, suggesting that the use of interactive learning strategies is not sufficient by itself to achieve high student gain. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C40 Gravity and Tides: How Students Don't Get It

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Misconceptions in astronomy constitute an issue that has received considerable attention. In order to overcome these persistent obstacles in the students' made-up minds, a number of new educational tools have been implemented. For instance, lists of common misconceptions have been published in books. Most of astronomy textbooks highlight and discuss most common misconceptions within the relevant chapters. Numerous studies have been conducted and presented in a number of journal papers. Quite a few websites have been created by astronomy educators and enthusiasts to provide a valuable resource for instructors trying to address these misconceptions in introductory classes. Lecture tutorials, 3D virtual learning environments and anything in between have been developed in order to remedy these misconceptions. As such, it would appear that little more can be said about this topic. Unfortunately, every new semester we fight the same fight. And at the end of the semester, have we really won? It seems that certain incorrect preconceived mental models are rooted in physics and geometry. Thus it makes sense that when students come across a new concept in astronomy it they have trouble mastering it since

it is being built on a faulty foundation. We present the results of a series of quiz-, homework-, and exam questions that show that students on the one hand demonstrate an apparent mastery of a physical concept such as that the force of gravity between two bodies is equal in magnitude on both of them, yet on the other hand, the students rather miserably fail at answering a slightly rephrased question. We identify the underlying causes for this contradictory behavior, and we present a somewhat different approach for addressing and rectifying the misconceptions that originate in counterintuitive physical laws.

C41 'Discoveries in Planetary Sciences': Slide Sets Highlighting New Advances for Astronomy Educators

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Planetary science is a field that is still evolving rapidly, and it can take several years for new advances to work their way into college textbooks. Yet it is important for students to have exposure to these new advances for a number of reasons. In some cases, new work renders older textbook knowledge incorrect or incomplete. In some cases, new discoveries make it possible to emphasize older textbook knowledge in a new way. In all cases, new advances provide exciting and accessible examples of the scientific process in action. To bridge the gap between textbooks and new advances in planetary sciences, we have developed content on new discoveries for use by undergraduate instructors. Called 'Discoveries in Planetary Sciences', each new discovery is summarized in a 3-slide PowerPoint presentation. The first slide describes the discovery, the second slide discusses the underlying planetary science concepts, and the third presents the big picture implications of the discovery. A fourth slide includes links to associated press releases, images, and primary sources. Topics for the slide sets span all sub-disciplines of planetary science. This effort is generously sponsored by the Division for Planetary Sciences of the American Astronomical Society. In this presentation we will discuss our motivation for this project, our implementation approach (from choosing topics to creating the slide sets, to getting them reviewed and released), and give examples of slide sets. We will also present information in the form of web statistics on how many educators are using the slide sets, and which topics are most popular. We will also present feedback from educators who have used them in the classroom.

C42 A Lunar Phases Planisphere

Stephen Shawl, *University of Kansas, shawl@ku.edu*

This paper describes a lunar phases planisphere with which a user can answer questions about the rising and setting times of the Moon as well as questions about where the Moon will be at a given phase and time. We will show figures that can be photocopied to make the planisphere.

C43 Teaching Math and Astronomy Together: How Students Can Measure the Mass of the Galactic Center Black Hole Using a Ruler and Ratio Tables

Harry Shipman, *University of Delaware, harrys@udel.edu*

Astronomy 101 instructors have struggled mightily on how to use, or not use, mathematics in their courses. For a long time, the tendency was to eliminate the use of mathematics as much as possible. Our goal was to teach science, after all, and if math was an obstacle, let's eliminate it. However, for a variety of reasons, I've now concluded that the total elimination of math is a mistake. However, we don't simply want to bring back lots of plug-and-chug little problems; the physics research leading up to the Force Concept Inventory Test demonstrated that these types of end-of-chapter problems do not necessarily lead to student understanding. Several years' experimentation with various ways of bringing math back into science courses has resulted in the development of a few activities which challenge my students enough but not too much. The activity I will demonstrate with a poster is one. A teaching device called a "ratio table", in use in many middle school curricula, brings enough of my students' mathematical competence back without treating them as middle schoolers. Students will then use the video produced by Andrea Ghez's group at UCLA and a ruler in order to measure the dimensions of a stellar orbit around the Milky Way's central black hole. Ratio tables permit them to convert these measurements into units which permit an easy application of Kepler's Third Law. Their performance on exams has demonstrated that a worthwhile fraction of students do learn from this activity.

C44 Measuring Understanding of Inquiry in Introductory Astronomy Laboratories

Kendra Sibbernsen, *Metropolitan Community College, ksibb@cox.net*

One of the objectives of most undergraduate general science laboratory courses is that a student will understand the nature and processes of scientific inquiry. However, recent research has shown that learners in traditional undergraduate science laboratory environments are not developing a meaningful understanding of this important objective. This study evaluated students in an introductory astronomy laboratory course that used inquiry-based exercises. Results were determined by examining the change in responses from the pretest to the posttest administration of the Views of Scientific Inquiry (VOSI) survey, the increase in scores on laboratory exercise, and observations from the instructor. The techniques that were used in the analysis will be presented and the results summarized.

C45 Solar System Lecture Tutorials for Intro Astronomy

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Lecture Tutorials, short worksheets completed by small groups of students during class, have been shown to increase student learning in both astronomy and geology classes. Lecture Tutorials address topics with which students commonly have misconceptions or other difficulties. They can be included in classes of any size as an easy way to make the lecture more interactive and student-centered. However, published astronomy Lecture Tutorials do not currently cover all the topics instructors may cover in their classes, and are particularly lacking in surface features and characteristics of planets and moons. This poster will present Lecture Tutorials designed to cover solar system topics addressed in Introductory Astronomy classes. Topics include: Earth's surface features, the Moon's surface, the positions of the planets, terrestrial planets, jovian planets, asteroids, and Pluto. These Lecture Tutorials are available for instructor use and can be downloaded from http://faculty.ccri.edu/kkortz/lt.shtml. These Solar System Lecture Tutorials were created after consultations with the authors of the published Lecture Tutorials for Introductory Astronomy. They were written based on research on how students learn, and are designed to constructively build upon students' prior knowledge using guided questioning while directly addressing misconceptions. They have been tested and rewritten multiple times based on classroom experience and student feedback. In addition to writing Solar System Lecture Tutorials, the authors have published the workbook *Lecture Tutorials for Introductory Geoscience*.

C46 Astronomy: A Vital Link in Interdisciplinary Education

Raphael Steinitz, *Ben Gurion University, raphael@bgu.ac.il*

To cope with the ever growing flood of new information, students should acquire (at all levels) strong, wide range tools. These enable them to analyze by themselves problems and situations they have not yet encountered before. A good and interesting interdisciplinary program can present such tools. Here are two examples: (1) Energy transport through convection [refrigerating, cooking, climate, plate tectonics]. Tools: convection in stars; conditions for this mode to be operative. (2) Exoplanets [discovering planets, conditions to start and sustain life] Tools: Doppler; Light Curves, Colors, Spectroscopy. This is an example of an interdisciplinary subject, linking biology, chemistry as well as astronomy. Our experience shows that interdisciplinary programs increase substantially motivation to learn more (students describe this approach as "gaining power"). We shall discuss some difficulties in implementing a program of this kind, as well as possible solutions. These include teams of more than a single teacher appearing in class together, complementing each other with their personal expertise. How to choose between two different subjects while delivery time is only available for one? Criteria relevant to this common situation will be discussed.

C47 Promoting Access, Retention and Interest in Astronomy Higher Education: Developing the STEM Professionals of Tomorrow in New Mexico

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Stephen Cook, *New Mexico State University, scook@projectworldview.org*

Economic stability and success are becoming increasingly tied to the successful acquisition of basic academic skills, with the emergence of a computer and data-oriented society. The recent doubling of the statewide requirement for laboratory science courses at the college level in New Mexico thus represents both an opportunity to further aid in the development of math and science skills in our general population, and an added barrier to degree completion. Couple this to a geographically dispersed population of non-traditional students, with work force and family responsibilities which compete directly for time with academics, and we have a compelling need for alternate methods of teaching science in New Mexico. We will present a set of NASA- and NSF-sponsored resources under development to aid in teaching astronomy as a laboratory science at the college level, with usage results for a pilot group of students. Primary components include a self-review database of 10,000+ questions, an instructor review interface, a set of laboratory exercises suitable for students working alone at a distance, and interviews with diverse STEM individuals to help combat stereotype threat. We will discuss learning strategies often employed by students without substantial scientific training, and ways to incorporate these strategies into a conceptual framework which is based on the scientific method and basic techniques for data analysis.

C48 Students' Reasoning Difficulties in Cosmology

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Edward Prather, *University of Arizona, eprather@email.arizona.edu*

We are studying students' understanding of cosmology and developing Lecture-Tutorials that will help them overcome common difficulties. We report the preliminary results of our study, including students' responses to a conceptual cosmology survey. Samples from the draft versions of the new Lecture-Tutorials are also shown. We acknowledge the NSF for funding under Award No. 0715517, a CCLI Phase III Grant for the Collaboration of Astronomy Teaching Scholars (CATS) Program.

C49 PARI's Online Tools for Astronomy Education

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Michael Castelaz, *Pisgah Astronomy Research Institute, mcastelaz@pari.edu*

Pisgah Astronomical Research Institute (PARI) encourages student focused access to the tools of radio and optical astronomy through Smiley and SCOPE. Most classroom technology initiatives will support the necessary connections needed for these activities in the classroom. These projects are supported in part by NSF DUE# 0937824. Remote access to a 4.6-meter radio telescope (affectionately known as Smiley) located at the Pisgah Astronomical Research Institute near Brevard, North Carolina: This radio telescope detects 21-cm radio waves emitted by hydrogen at the center of our galaxy and its spiral arms, supernova remnants, regions of star formation and other celestial sources. The decisions for each investigation: source selection, pointing the telescope, and taking the measurements, are determined by the user. Lesson modules such as "Doppler Shift", "Mapping Radio Sources", and "What's Between the Stars?" have been used effectively with middle and high school students, as well as college students, providing them with real-time experience in radio astronomy. The labs and hands-on experience increase students' information and technology skills while promoting student-directed critical thinking and problem solving. Enter a citizen science endeavor and begin working immediately as a member of SCOPE - Stellar Classification Online Public Exploration (scope.pari.edu). Like Annie Jump Cannon, participate and become engaged in this classification process. PARI is gathering new and reliable classifications for future scientific use. Beginning with basic properties of stars and how they lend light to their identification and classification, participants will follow the characteristics of different stellar types throughout their lifetime. The spectroscopic data found in SCOPE is used in the H-R Diagram classroom activity developed for this program. The historical context of the images from which this digital data has been gleaned can also be shared through PARI's Astronomical Photographic Data Archive, the basis for Time Domain Astronomy in a readily accessible archival setting.

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The NASA Lunar Science Institute is a new organization that supplements and extends existing NASA lunar science programs. Supported by the NASA Science Mission Directorate (SMD) and the Exploration Systems Mission Directorate (ESMD), the NLSI is managed by the NASA Ames Research Center and is modeled on the NASA Astrobiology Institute (NAI) with dispersed teams across the nation working together to help lead the agency's research activities related to NASA's lunar exploration goals. Competitively selected team investigations will focus on one or more aspects of lunar science--investigations of the Moon (including lunar samples), from the Moon, and on the Moon.
Mission Statement
The Mission of the NLSI and its member investigators is to advance the field of lunar science by:
1) carrying out and supporting collaborative research in lunar science, investigating the Moon itself and using the Moon as a unique platform for other investigations;
2) providing scientific and technical perspectives to NASA on its lunar research programs, including developing investigations for current and future space missions;
3) supporting development of the lunar science community and training the next generation of lunar science researchers; and
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Lunarscience.nasa.gov

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Founded in 1889 in San Francisco, the Astronomical Society of the Pacific long ago outgrew its regional-sounding name to become one of the nation's leading organizations devoted to improving people's understanding, appreciation, and enjoyment of astronomy and space as an avenue for advancing science literacy. Serving research astronomers, educators of all descriptions, and amateur astronomers, the ASP publishes both scholarly and educational materials, conducts professional development programs for formal and informal educators, and holds conferences, symposia, and workshops for astronomers and educators who specialize in astronomy education and outreach. The ASP's education programs are funded by its own members, corporations, private foundations, NASA, and the National Science Foundation.

The ASP's numerous education and outreach programs include Project ASTRO, the *Universe in the Classroom* teacher's newsletter, The NASA Night Sky Network, Astronomy from the Ground Up, Family ASTRO, Cosmos in the Classroom symposia, and the SOFIA Education and Public Outreach program.

Thank you for your generous support of the Astronomical Society of the Pacific. The Society is able to thrive because of donations from individuals, corporations and private and public foundations. Clearly, you share our desire to advance science literacy through astronomy, and we thank you for considering gifts to the Society in the future.

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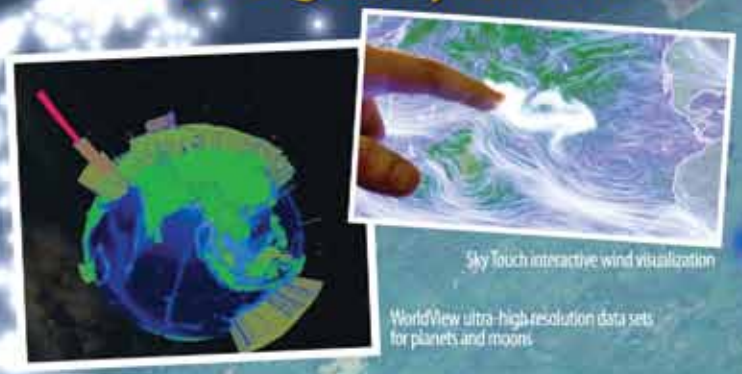

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