Canada's water is under escalating pressure from a host of threats. Increasingly, our water is being tainted, misused and over allocated. Experts have identified a multitude of threats to water quantity and quality. Among them, climate change impacts on water supply, and the effects of pesticides, pathogens, industrial waste, urban runoff, and rising demands. These and other threats are the roots to a serious shortage of high quality, safe water sources. In the 1990s, waterborne diseases have re-emerged as one of the primary health issues on a national and global scale. This seven-part video series brings science voices together and provides a nationwide context. The first six programs in the series explore regional concerns: Rocky Mountains, Prairie Waters, Northern Waters, Great Lakes Basin, St. Lawrence and Atlantic Canada. The final program covers the national and international perspectives.

ED51C-1225 0830h POSTER

Cosmic Origins: A Traveling Science Exhibit and Education Program

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The Space Science Institute of Boulder, Colorado, is developing a 3,000 square-foot traveling exhibition, called Cosmic Origins, which will bring origins-related research and discoveries to students and the American public. Cosmic Origins will have three interrelated exhibit areas: Star Formation, Planet Quest, and Search for Life. Exhibit visitors will explore the awesome events surrounding the birth of stars and planets; they will join scientists in the hunt for planets outside our solar system including those that may be in "habitable zones" around other stars; and finally they will be able to learn about the wide range of conditions for life on Earth and how scientists are looking for signs of life beyond Earth. Visitors will also learn about the tools scientists' use, such as space-based and ground-based telescopes, to improve our understanding of the cosmos. Exhibit content will address age-old questions that form the basis of NASA's Origins and Astrobiology programs: Where did we come from? Are we alone? In addition to the exhibit, our project will include workshops for educators and docents at host sites, as well as a public Web site that will use a virtual rendering of exhibit content. The exhibit's size will permit it to visit medium sized museums in underserved regions of the country. It will begin its 3-year tour to 9 host museums and science centers in early 2005. A second 3-year tour is also planned for 2008. The Association of Science-Technology Centers (ASTC) will manage the exhibit's national tour. Current partners in the Cosmic Origins project include ASTC, the Denver Museum of Nature and Science, Lawrence Hall of Science, NASA Astrobiology Institute, NASA missions (e.g. PlanetQuest, SIRTF, and Kepler), New York Hall of Science, the SETI Institute, and the Space Telescope Science Institute. The exhibition is supported by grants from NSF and NASA. This report will focus on the Planet Quest part of the exhibition.

ED51C-1226 0830h POSTER

Involving Students, Educators and Amateur Astronomers in the Search for Extrasolar Planets

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Due to advances in telescope and digital imaging technology, the search for extrasolar planets can now be performed by dedicated students, educators and amateur astronomers. The applicability of off-the-shelf telescopes, hardware and software to the detection of extrasolar planets using the transit method is described. Data reduction techniques are discussed that can theoretically reveal the presence of an extrasolar planet slightly larger than earth using such equipment. Finally, educational outreach efforts conducted by an amateur astronomer involved in the search for extrasolar planets are described, including a pilot partnership with a local community college.

ED51D MCC: 3012 Friday 1020h

Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom II *(joint with OS, P, C)*

Presiding: **I Hawkins,** Space Sciences Laboratory, University of California, Berkeley**; C E Walker,** National Optical Astronomy Observatory

ED51D-01 1020h INVITED

Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom

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Research Experiences for Teachers (RET) are a fundamentally different kind of professional development (PD) than the more typical teacher PD workshop format. In the past decade RET has evolved from "a great summer research experience with slides to show students" to an equal emphasis on transfer to the classroom so students "learn science by doing science" as they engage in authentic scientific research. Different models for RET have evolved as well as methods to increase the transfer to the classroom of thelearning-science-by-doing-science pedagogical paradigm. In the Elementary, Secondary, And Informal Education (ESIE) division at NSF, different RET models have been developed through program emphases such as Teacher Leadership, Research Experiences for Teachers and Students programs and most recently through Teacher Retention and Renewal programs. Some of them include the Research Based Science Education I project at NOAO, Research Experiences In Industry at Mississippi State, QuarkNet at Fermilab, The Cosmic Ray Observatory Project at University of Nebraska-Lincoln, the Teacher Experiencing Antarctica/the Arctic program, oceanographic research in The Teacher ARMADA project at the University of Rhode Island, and the Science Research in High School project at SUNY-Albany. Regardless of the RET model, one of the critical results is the development of a professional learning community that outlives the research experience and the RET program. RET programs exemplify the integration of science disciplinary research and education, which is a critical component of NSF's strategic plan.

URL: http://www.nsf.gov

ED51D-02 1035h

The Cosmic Ray Observatory Project: A Statewide Outreach and Education Experiment in Nebraska

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The Cosmic Ray Observatory Project (CROP) is a statewide education and research experiment involving Nebraska high school students, teachers, and college undergraduates in the study of extensive cosmic-ray air showers. A network of high school teams construct, install, and operate school-based detectors in coordination with University of Nebraska physics professors and graduate students. The detector system at each school is an array of scintillation counters recycled from the Chicago Air Shower Array in weather-proof enclosures on the school roof, with a GPS receiver providing a time stamp for cosmic-ray events. The detectors are connected to triggering electronics and a data-acquisition PC inside the building. Students share data via the Internet to search for time coincidences with other sites. Funded by the National Science Foundation, CROP has enlisted 21 schools in its first four years of operation with the aim of expanding to the 314 high schools in the state over the next several years. Similar school-based cosmic ray efforts (WALTA, ALTA, CHICOS, etc.) and the continent-wide consortium, NALTA, will also be described.

URL: http://www.physics.unl.edu/research/crop/crop.html

ED51D-03 1050h

Teachers in Industry: Connecting the Workplace to the Classroom

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The National Science Foundation has funded Mississippi State University to conduct professional development projects involving research/industry experiences for teachers and students providing them with real world applications of academic knowledge. Transition to the Workplace Through Manufacturing Experiences: Learn To Work (NSF ESI-9555646, 1996-2002) and Research Experiences in Industry (REI) (NSF ESI-9911885, 2000-2003) have enabled science, mathematics and technology teachers to learn the role of research and development in the workplace, develop skills to make the connection between the workplace and the classroom, enhance their content knowledge, and learn skills and competencies required by a highly skilled and technology-oriented workforce. Industry partners include Peavey Electronics, Northrop Grumman, Tennessee Valley Authority, Mississippi Lignite Company's Red Hills Mine, and Pickering Engineering. Student-Teacher Research Institute - the Delta Experience (STRIDE) (NSF ESI- 9731286, 1998 - 2002) and Career & Research Exploration for Students and Teachers (CREST) (NSF GEO-0224540, 2003-2004) are models for middle school teacher-student teams participating in research/industry experiences. STRIDE teams worked with over 50 research scientists from fourteen government agencies to learn how to conduct research and to become aware of scientific career preparation and opportunities. Through a partnership with Red Hills Mine, teachers and students learn academic content and research methods relative to the development and utilization of a lignite coal resource by working with scientists and participating in on-going research projects at the mine and in the local area.

ED51D-04 1105h

Implementing Authentic Astronomy Research in the Classroom: The TLRBSE Experience

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The Teacher Leaders in Research Based Science Education (TLRBSE) is an NSF-funded program which has as one of its primary goals the implementation of authentic research in the classroom. To achieve this goal, TLRBSE provides an in-depth professional development experience for teachers which includes a semester-long on-line course on research pedagogy, research tools (such as image processing), and astronomy content knowledge. Participants come to the National Optical Astronomy Observatory (NOAO) in Tucson in the summer for two weeks in order to hone their skills and interact with scientists. They also pursue research projects led by a TLRBSE leader in one of several astronomy areas including novae, active galactic nuclei, solar magnetic fields, and spectroscopy of variable stars using research telescopes at Kitt Peak National Observatory. The teachers have access to the data they have taken at the telescope as well as to extensive archival data sets taken by previous TLRBSE teachers. These ongoing research projects are then brought back to the classroom where teachers and students can continue their research in these areas. The student research results are then submitted for review and publication in NOAO's Research Based Science Education Journal. The TLRBSE model is being extended by providing a variety of additional research experiences for teachers and students during the school year, using the same telescopes at Kitt Peak National Observatory used in the summer program. Teachers and students from the program apply for additional research time during the school year and can come to the observatory to make observations for new or continuing projects. As remote telescopes become more widely available, the teachers and students will be able to observe from their home locations and access their observations directly over the internet. Some of the key issues in our program are teacher selection, organization and logistics of the distance learning course, workshop length, choice and organization of the research projects and team, and the transfer of research to a variety of classroom conditions.

URL: http://www.noao.edu/education/noaoeo.html

ED51D-05 1120h

The QuarkNet Collaboration

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QuarkNet is a long-term high school education project, supported by NSF and DOE and carried out by a collaboration of university and laboratory research groups. These research groups are part of major international particle physics experiments, including those at CERN in Switzerland, Fermilab in Illinois, and SLAC in California. Goals and Objectives:
A major goal is to engage students and teachers in authentic scientific research; they gain a first-hand understanding of research and its application in the inquiry method of learning. Teachers enhance their content knowledge, increase their abilities to solve science-related problems, engage students in scientific inquiry, and develop responsibility for their own professional development. Students learn fundamental physics and are motivated by current research questions as they analyze real data. A second goal is to engage particle physicists with current issues in science education, including their understanding of the National Science Education Standards and local science education needs and what constitutes age-appropriate content. Project Design:
Working with physicists nationwide, we have established a project framework with three program areas-teacher research experience, teacher development programs, and online resources and inquiry-based activities. Eight-week research appointments allow teachers to experience scientific research first-hand. In teacher institutes the next summer these teachers and scientists lead a group of teachers through a short research scenario lasting two to three weeks and assist them in creating similar scenarios for their students. When fully implemented QuarkNet will support centers associated with 60 particle physics research groups at universities and laboratories in the U. S. The QuarkNet website provides:
- Experimental data for use in inquiry-based activities.
- Opportunities for communication and collaboration among physicists, teachers and students.
- A place for students to publish and share their ideas.
- Resources including background information, simulations, ideas for data analysis, inquiry activities, etc.
Future Scope:
Many students are engaged in research in their schools, but in the second five years, we will add a student component to the summer research experience.

URL: http://QuarkNet.fnal.gov

ED51D-06 1135h INVITED

Evaluation of Teacher Research Programs

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Science education reform advocates students learn science the way it is done. But, few science teachers get the experience of "doing science," so are not well acquainted with scientific inquiry. Several programs for teachers have been conducted that bring teachers into laboratories to work with scientists. Over several years evaluating such projects, (e.g., the Department of Energy Teacher Research Associates Program, Fermilab's QuarkNet program and the National Optical Astronomy Observatories' Teacher Leaders in Research-Based Science Education program) common elements that make the programs successful have emerged. ("Success" means teachers provide students with authentic scientific inquiry experiences.) Common elements include some form of follow-up after the initial research experience, constructive interactions with research scientists, and providing teachers with a global view of how the specific research they are doing fits into a larger picture. Evaluation of these programs has included obtaining multiple perspectives from scientists, teachers and their students, data on classroom implementation, and data on changes in classroom practice as a result of teachers engaging in a research experience. The evaluations provide insight into how best to provide formative and summative feedback for such programs, how scientists can most effectively provide teachers research experiences, and factors that promote transferring knowledge into the classroom to best address science education reform.

ED51D-07 1150h INVITED

Developing Authentic Research Experiences Using EarthScope Data

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EarthScope, a decade-long experiment to understand the formation, structure, and evolution of the North American continent, will carry-out active investigations in nearly every county in the US. The excitement of a huge science experiment in one's own backyard piques interest, but teachers need resources and professional development experiences to capitalize upon this excitement and create opportunities for their students' learning. The EarthScope Education and Outreach Network will provide the interface to make EarthScope science, and the advanced technology and modern approaches used to understand Earth, relevant and beneficial to K-16 educators vested in advancing Earth science education. Three obstacles must be overcome for success in carrying out authentic EarthScope research in the classroom. First, scientists and teachers must work together to identify relevant and developmentally appropriate research questions for the target audience. Second, teachers will need professional development experiences that engage them in authentic research and that provide support for introducing a similar research experience in their own classroom. Third, the outcome of the research experience must have value to the scientist, teacher and student to motivate sustained participation by all.
The dense array of seismometers being deployed in the USArray component of EarthScope will permit students and the public to see first-hand Earth's dynamic response to both human and natural events in their hometown and around the country. Targeted local experiments will make EarthScope's scientific investigations and discoveries relevant for educational efforts on a region-by-region basis. Combining the real-time seismic data streams from USArray with data and instrumentation from the growing US Educational Seismic Network (USESN) opens up endless possibilities for student-centered research. In this paper, I will discuss the lessons learned from eight years of leading a high school educational seismology program in Arizona and how those lessons can be applied to developing research experiences for teachers and students within EarthScope and USESN.

ED51D-08 1205h INVITED

Building a Global Science Education System to Undertake Genuine Astrophysics

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The Hands-On Universe (HOU) Project has developed powerful tools for students to undertake and model aspects of professional astronomy research. Building on a slowly evolving International Virtual Observatory and a network of small telescopes, plus other data bases of professional grade astronomy images, student can undertake many of the activities and processes of modern astronomy. This system has met with good enthusiasm from teachers and astrophysicists from around the world, and over 1000 teachers have been trained in HOU oer the past decade. We have developed scalable teacher training tools, and endeavor to scale our professional astrophysics scientific collaborators, who are essential for on-going support and inspiration.

URL: http://handsonuniverse.org/

ED52A MCC: 3012 Friday 1340h

Teacher Professional Development Programs Promoting Authentic Scientific Research in the Classroom III *(joint with OS, P, C)*

Presiding: **S K Croft,** National Optical Astronomy Observatory**; S M Pompea,** National Optical Astronomy Observatory

ED52A-01 1340h

Solar Astronomy as a Means to Promote Authentic Science Research in a Teacher Professional Development Program

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Teacher Leaders in Research Based Science Education (TLRBSE) is an NSF-funded Teacher Enhancement Program hosted by the National Optical Astronomy Observatory (NOAO) in Tucson, AZ. Consistent with national priorities in education, TLRBSE seeks to retain and renew middle and high school science teachers. Within the exciting context of astronomy, TLRBSE integrates the best pedagogical practices of Research Based Science Education with the process of mentoring. One means by which participants are provided training in astronomy content, pedagogy, image processing, research and leadership skills is through a 15-week distance-learning course and an in-residence, two-week institute at Kitt Peak National Observatory and the National Solar Observatory (NSO). Throughout the program, teachers work with professional astronomers and education specialists. At the in-situ, two-week institute, teachers are the researchers on one of four research projects, including solar astronomy. Preparation for the solar project dictates much of the design of the program (e.g., development and feasibility testing of the observing program, the reduction and analysis software, the preparatory documents for the teachers). The program design of the solar project is centered on teachers experiencing the scientific process. Initially through a staff-facilitated guided inquiry and then on their own as a team, the teachers propose a research question and discuss alternative hypotheses. They operate the solar telescope and take, calibrate, reduce and analyze the data. Teachers interpret and report results to their peers and pundits. Ultimately the observing experience and knowledge gained by the teachers is transferred to the classroom, where students learn science by doing science. Staff astronomers and education specialists provide continuing support with the goal of sustaining a professional learning community that outlives the research experience. Further observing experience is available during the academic year. Students submit research papers to the RBSE on-line journal. Teachers and their mentees present at national NSTA meetings. These aspects of the solar project, outcomes, lessons learned and future directions will be described. The TLRBSE Program is funded by the National Science Foundation under ESI 0101982, funded through the AURA/NSF Cooperative Agreement AST-9613615. NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

URL: http://www.noao.edu/outreach/tlrbse/

ED52A-02 1355h

Positive Outcomes of a Teacher Professional Development Program Promoting Science Research in the Classroom

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