Promoting Inquiry in Science Education: Project PRISE in Piñon

Robert Sparks & the NOAO PRISE Team

Left: NOAO scientist Katy Garmany shows teachers how to use a Sunspotter solar-projection telescope. Center: Teachers in the Piñon PRISE workshop built spectroscopes in their exploration of light. Right: Master teacher Karina Leppik assists teachers with liquid explorations.

Staff members from the NOAO educational outreach group have been instrumental in presenting a series of professional development workshops for teachers at schools on the Navajo and Hopi Nations. These workshops were held in Piñon, Arizona, in the far northeast corner of the state as part of a creative project called Promoting Inquiry in Science Education (PRISE).

Funded by the Arizona Department of Education, Project PRISE is a partnership between the University of Arizona; the National Optical Astronomy Observatory; the Navajo Nation Office of Diné Science, Math and Technology; and the Piñon Unified School District. Oliver Monti (University of Arizona Chemistry Department) is the Principal Investigator, and Selina Johnson at the University of Arizona's Science and Math Education Center provides logistical support for the project. The NOAO team led the professional development effort in the physical sciences for these elementary and middle-school teachers, while the University of Arizona will lead the biology teaching efforts in the second half of the project.

The NOAO team conducted two-day teacher workshops monthly for six months starting in August 2007. Teachers participated in an online component of the workshop using the University of Arizona's D2L Web site. Over 45 teachers from Navajo and Hopi schools attended. Participating schools included Piñon Elementary School, Piñon Advanced Middle School, Hopi Day School, Black Mesa Elementary School, First Mesa Elementary School, Jeehdeez'A Academy, and Cottonwood Elementary School.

The materials selected for the workshops focused on content knowledge in the physical sciences. Each workshop used a teaching guide in the exemplary *Great Explorations in Math and Science* (GEMS) series developed at the Lawrence Hall of Science at theUniversity of California, Berkeley. The GEMS guides were supplemented with activities on other important topics in the physical sciences.

Each workshop was taught by a combination of master teachers and educational outreach scientists. Master teachers focused on teaching the GEMS guides, showing how the material applies to the classroom. They also provided links from the materials to national and state science standards. The scientists provided more in-depth content knowledge by giving talks and leading activities that build upon the basic activities in the GEMS guides.

The NOAO team consisted of master teachers Karriaunna Scotti and Karina Leppik, and NOAO staff members Stephen Pompea, Connie Walker, Robert Sparks, Steven Croft, Katy Garmany, and John Glaspey.

A unique aspect of Project PRISE was the use of Navajo and Hopi cultural experts to review the instructional materials and activities to ensure that the instruction was sensitive to their cultural beliefs. Navajo and Hopi cultural experts attended two of the physical sciences workshops and also gave presentations on traditional Navajo and Hopi beliefs about the natural world.

The workshop presenters left Tucson early on Friday mornings to drive to Piñon. A late afternoon arrival left just enough time to set up before the teachers arrived for the start of the workshop at 5:00 pm. The workshop lasted until 10:00 pm on Friday night and sometimes continued later with star parties. The second day (Saturday) workshop started at 8:00 am and ended at 5:00 pm.

Activities were chosen from the GEMS guides *Secret Formulas, Sifting Through Science, Bubbleology, Liquid Explorations, Color Analyzers,* and *More Than Magnifiers.* Karina and Karriaunna reinforced both the teachers' content knowledge as well as the pedagogy needed to effectively use these units in the classroom. The teachers were actively engaged doing the activities.

The scientists gave talks on a wide variety of topics, including astronomical images, the nature of light, water in the Solar System, convection, auroras, lightning, and science experiments you can do at the dinner table.

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Promoting Inquiry in Science Education continued

At the final physical sciences workshop in January, the teachers from the various schools presented lessons based on what they had learned throughout the PRISE project. These lessons frequently blended science-content knowledge with Native American stories in entertaining and creative ways.

Although the physical sciences portion of the workshop is now complete, with very favorable evaluations, we are still providing support to the PRISE teachers through the D2L distance-learning Web site. We look forward to seeing their progress this spring as the teachers implement these physical sciences units. We hope to apply some of the experience gained from Project PRISE to our expanding outreach activities with the Tohono O'odham Nation in the region around Kitt Peak.

An Informal Visit to CADIAS

Katy Garmany & John Glaspey

On an observing trip to Chile in early January, we had an opportunity to visit the site of the Centro de Apoyo a la Didáctica de la Astronomía (CADIAS), the astronomy outreach center funded by NOAO and Gemini Observatory in Altovalsol, just outside of La Serena, Chile.

We were fortunate to be there on a night when a group of students and their parents were present for a workshop as part of the Universidad de los Niños program. CADIAS occupies an older, ranch-style building, but it has sufficient interior space for an inflatable Starlab planetarium (shown in figure 1) as well as a small, Internet-connected library and a computer lab, which give it the feel of a community science center. An additional room is being equipped with monitors and panels to have the look and feel of the Gemini control room.

Figure 1: CADIAS Director David Orellana (NOAO and Universidad de La Serena) introduces a group of students to some familiar constellations after they made star wheels. Katy Garmany of the NOAO educational outreach group also helped the students get their bearings.

As noted on their Web site (*www.ctio.noao.edu/AURA/CADIAS/*), multiple organizations support CADIAS, and not just financially. To encourage the students to learn more about astronomy and to investigate further, Cerro Tololo Inter-American Observatory donated a complete set of the ESO Sky Survey. The NOAO Public Affairs and Educational Outreach group has also contributed a variety of books, posters, handouts, computers, and telescope equipment.

Figure 2: NOAO South outreach coordinator Hugo Ochoa (middle) and Katy Garmany (right) show one of the transparencies of the ESO Sky Survey to a parent attending the event.

Our visit was a pleasure for us and, we hope, added something to the workshop experience for the children.

We would strongly urge anyone passing through La Serena as part of an observing run to inquire about visiting CADIAS. You will get to see a small but extremely important educational resource for the children of an area where astronomy has become an important part of the local economy and culture. You may even be able to help out with some of the activities for the kids!

Spitzer-NOAO Research Program for Teachers Makes News at AAS

Douglas Isbell

A team consisting of astronomers from NOAO and Spitzer Science Center, high school teachers, and their students presented their discovery of dark matter in accretion disks—and its potentially large implications for several branches of astronomy—during a press conference at the AAS meeting in Austin on January 9.

As part of a continuing, joint, outreach project called the Spitzer-NOAO Observing Program for Teachers and Students, the research team observed the interacting binary star WZ Sagittae (WZ Sge) using the 2.1-meter and WIYN 0.9-meter telescopes at Kitt Peak National Observatory and the Infrared Array Camera (IRAC) on NASA's Spitzer Space Telescope.

WZ Sge is an interacting binary star located in the constellation Sagitta, the arrow of the archer Sagittarius. The pair consists of a white dwarf star (a compact star about the size of the Earth, but with a mass near that of the Sun) and a larger, but less massive and much cooler, companion star. The companion, a brown dwarf in this case, has material ripped off its surface by the stronger gravity of the white dwarf. This material flows toward the more massive star and, in the process, forms a disk surrounding the white dwarf, known as an accretion disk.

"We were very surprised to see the contrasting results obtained with the optical telescopes on the ground and the infrared telescope in space," said Steve B. Howell, an NOAO astronomer and leader of the Spitzer-NOAO research team (figure 1). "The much larger size of the infrared-emitting portion of the accretion disk around WZ Sge was immediately obvious in the data. Our observations strongly imply the presence of dark matter in these structures, which are ubiquitous throughout the Universe."

Whether they form in cataclysmic variable systems or they surround the massive black hole hearts of active galaxies, accretion disks have been well observed and modeled using measurements obtained across much of the electromagnetic spectrum, from X-rays to the near

Figure 1: NOAO astronomer Steve B. Howell presents the team's results during the "black hole press briefing" at the January 2008 AAS meeting.

infrared. The derived picture of the "standard accretion disk" model is a geometrically thin disk of gaseous material surrounding the white dwarf or black hole. Accretion disk models, bolstered by observation, are generally composed of hot gas having a temperature distribution within them, being hottest near the center and falling off in temperature toward the outer edge.

In order to confirm the general accretion disk models and extend them into the mid-infrared portion of the spectrum, Howell's team obtained the first time-series observations of an accretion disk system at 4.5 and 8 microns with the Spitzer Space Telescope. At nearly the same time, they obtained optical observations of WZ Sge at Kitt Peak. The optical observations confirmed the standard view of the accretion disk size and temperature, values known for over a decade.

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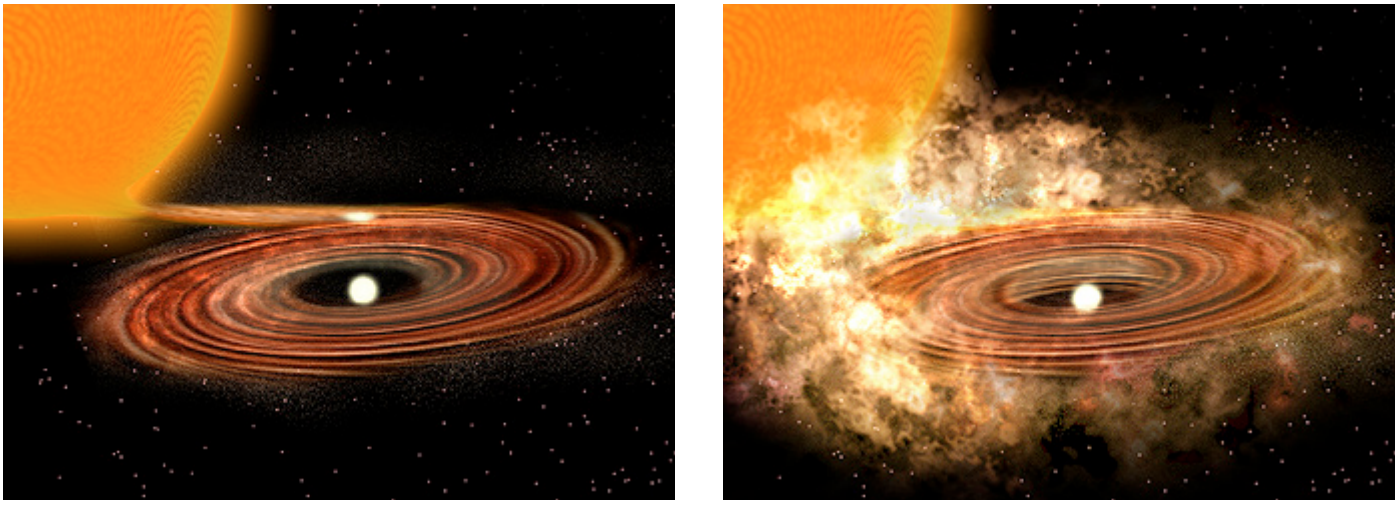

Figure 2: An artist's concept comparing the previous view (left) and the new view (right) of the accretion disk around WZ Sge. Credit: P. Marenfeld and NOAO/AURA/NSF

Spitzer-NOAO Research Program continued

The results from the mid-infrared observations, however, were completely unexpected and revealed that a larger, thicker disk of cool, dusty material surrounds much of the gaseous accretion disk (see figure 2). This outer dust disk likely contains as much mass as a medium-size asteroid. The newly discovered outer disk extends about 20 times the radius of the gaseous disk.

"This discovery suggests that our current model for accretion disks of all kinds is wrong," said team member Donald Hoard of the Spitzer Science Center. "We will need to rethink and recast these models for accretion disks, not only in interacting binary stars, but also in distant, highly luminous active galaxies."

The implications from such a discovery are far reaching, affecting not only the theoretical models (since the formation and evolution of the disks are modeled based on their size, temperature, and composition—all quantities that may now need to be revised), but also nearly all previous observations of systems containing accretion disks, from binary stars to supermassive black holes.

For example, the dust disk (which is thicker than the known gaseous disk) blocks infrared light emitted by the compact central object and the inner hot regions of the gaseous disk. Not knowing that some mid- to far-infrared light is blocked by the newly discovered outer dust ring can lead observers to significantly underestimate the total luminosity of the central object. "The amount of this underestimation is not yet accurately known from our initial discovery, but may be as large as 50 percent," Howell said.

The observational program making this discovery was a joint effort between research scientists Howell, Hoard, and Carolyn Brinkworth of Spitzer Science Center, and high school teacher Beth Thomas and student Kimmerlee Johnson (Great Falls Public Schools, Great Falls, MT), teacher Jeff Adkins and student John Michael Santiago (Deer Valley High School, Antioch, CA), and teacher Tim Spuck and student Matt Walentosky (Oil City High School, Oil City, PA). See figure 3 for a photo of most members of the Spitzer-NOAO program who attended the Austin AAS.

Figure 3: Members of Spitzer-NOAO Observing Program for Teachers and Students in attendance at the January 2008 AAS meeting in Austin.
Credit: M. Newhouse and NOAO/AURA/NSF

The work was funded by Spitzer Science Center as part of a joint project with NOAO to expand the national observatory's Research Based Science Education (RBSE) program to include observations with the Spitzer Space Telescope. RBSE, a professional development program for teachers, has been training groups of 20 teachers in the research process (including regular observations at Kitt Peak National Observatory) every year for more than a decade, using funding support from NSF.

This discovery was covered by a variety of news media, including BBC News, National Geographic News, and Astronomy.com, several astronomy blogs, and local newspapers and radio programs in the teachers' hometowns of Great Falls, MT, Brentwood, CA, and Pittsburgh, PA. NL

REU 2008 Begins at CTIO

Styliani Kafka

On Tuesday, 15 January 2008, a new Research Experiences for Undergraduates (REU) program started at CTIO. Six US students joined two Chilean students, participants of the parallel Practica de Investigación en Astronomía (PIA) program, in La Serena (Chile), where they will spend the southern summer working on research projects with CTIO and Gemini staff members.

During their 10-week internship at CTIO, the REU and PIA students have the chance to visit the Tololo, Gemini, and Las Campanas facilities; observe at Cerro Tololo; attend seminars and colloquia; and sample the rich social and cultural life of the CTIO compound and Chile. At the end of their tenure, the students will present their research in a two-day workshop held in La Serena.

The 2008 REU students are Adele Plunkett (Middlebury College), Matt Schenker (Dartmouth College), Emma Crow-Willard (Occidental College), Emily Lynch (Dartmouth College), Peter Mares (Cornell University), and Amit Misra (Case Western Reserve University). The 2008 PIA students are Macarena Campos (Universidad de Concepción) and Regis Cartier (Universidad de Chile).

We all wish them an enjoyable stay in La Serena.