Education with Infrared Astronomy & Spitzer

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We present education and outreach results using our experiences involving the Spitzer Space Telescope project, Star Formation in High Redshift Clusters with Spitzer. The project is a collaboration between the Spitzer Science Center and the National Optical Astronomy Observatory. Using the Spitzer Space Telescope, we measured star formation rates in three galaxy clusters at intermediate redshifts. Six teachers were chosen for the program, each with an interest and involvement in astronomy education. From this project, lesson plans, public outreach, lectures and demonstrations were generated which better the understanding of infrared astronomy, multiwavelength astronomy, galaxy and star formation, and cosmology. The teacher mentors are Dr. Gregory Rudnick (NOAO), Dr. Rose Finn (Siena College), and Dr. Vandana Desai (Caltech/SSC). Please see the companion posters by Emily Petroff, Zak Schroeder, and Thomas Loughran, et al, for information concerning the science results.

Educating the Public

The general public are our largest base of support for government- funded research programs. They need to understand why such research is beneficial. All gain a sense of excitement about the discoveries of science. Within this group are strong supporters of astronomy research – amateur astronomers, informal and non-science educators and scientists and engineers.

Rosa Hemphill and Emily Petroff:
October 2006 Portland, OR: The Rose City Astronomers (RCA) club and Oregon Episcopal School hosted guest speaker astronomer Catherine Garland. Dr. Garland spoke to elementary, middle school, and high school students at our school and to the general public at an RCA meeting about several topics, including light, spectra, and astronomy as well as her own work. At Dr. Garland's presentation to over 150 amateur astronomers at the RCA meeting, Emily and Rosa hosted a table with posters and materials introducing the Spitzer telescope, its background, and images from the telescope.

John Blackwell:
August 2007 Concord, NH: Presentation given at the Christa McAuliffe Planetarium about the Spitzer Space Telescope, IR astronomy, multiwavelength astronomy and the Spitzer Star Formation project. He used a USB webcam to show IR light coming from remote control units as well as the film, *Infrared - More than Your Eyes can See*.

Ardis Herrold:
September 2006 Gladwin, MI: Ardis was the keynote speaker at the *Great Lakes Star Gaze*, a star party with about 250 participants. The talk covered general information about the Spitzer Space Telescope, IR astronomy, and the Galaxy Clusters Star Formation rates project. It was well received and a portion of the talk ended up on YouTube! As a result of this, she received several offers to come and speak to local astronomy clubs.

Ardis Herrold and Zackery Schroeder:
September 2007 Milford, MI: A two-day poster session at the *Astronomy at the Beach* star party at Kensington Metropark. There were a few thousand attendees over the two nights of the party. The poster specifically focused on the Star Formation Rate project, but also introduced general topics such as galaxy clusters, infrared astronomy and the Spitzer Space Telescope. As a result, they received two offers to come and speak to local astronomy clubs.

Zackery Schroeder and Emily Petroff:
May 2007 Albuquerque, NM: Zak and Emily presented the results of their Spitzer research at the Intel International Science and Engineering Fair. They spent an entire day at their projects educating the general public and many local students who attended the public viewing of the projects. See Figure 3.

Teacher Training

In order to teach more effectively about astronomy and research, teachers need specific education about content and ideas for demonstrations and classroom activities. Teachers who have adequate mastery are more likely to implement new learning activities and to share them with other colleagues. Bringing teachers together gives them opportunity to share ideas and to build networks for extended communication and interaction.

John Blackwell:
June 2007: Exeter, NH. Phillips Exeter Academy hosted their first astronomy education conferences for high school astronomy teachers. Thirteen teachers with a variety of background and experience attended. The key goal of the conference was to impart a sense of how astronomy as a science is changing, and primarily due to rapid changes in technology. The Spitzer Space Telescope and other space-based observatories are key components to the understanding of modern astronomical pursuits.

Ardis Herrold:
May 2006: Grosse Pointe, MI. North High School hosted an all-day workshop for teachers on infrared astronomy and the Spitzer Space telescope. Teachers worked with infrared astronomy kits, an infrared webcam and viewed media about Spitzer and infrared astronomy. The Grosse Pointe Woods Fire Department brought a thermal imaging camera and did a special session for teachers using it for infrared portraits and experiments.

September 2006: Ann Arbor, MI. Michigan Earth Science Teachers Conference
October 2006: Southfield, MI. Metro Detroit Science Teachers Conference
Ardis presented one-hour teacher sessions on the Spitzer Space telescope and infrared astronomy at each of these conferences.

Rosa Hemphill:
October 2006: Roseburg, OR & October 2007: Portland, OR. Rosa presented one-hour teacher sessions at the OR Science Teachers Conference on astronomy resources, introduced the infrared part of the spectrum using a FLIR thermal imaging camera and the video *Infrared - More than Your Eyes can See.*

April 2007: Portland, OR. Rosa and a FLIR Trainer held a workshop for local teachers to learn how to use thermal imaging for science inquiry and for classroom use (see Figure 1) The video Infrared - More than Your Eyes can See was shown as an introduction.

June 2007: Portland, OR. Rosa conducted an after school workshop for local area teachers to assemble and experiment with SOFIA kits. The teachers produced eight working photocell detector assemblies and transmitter circuits for students to use.

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Figure 1. Alka Seltzer tablets in hot and cold water, seen with a FLIR camera.

Figure 2: The support scientists, teachers and students at the Spitzer Science Center.

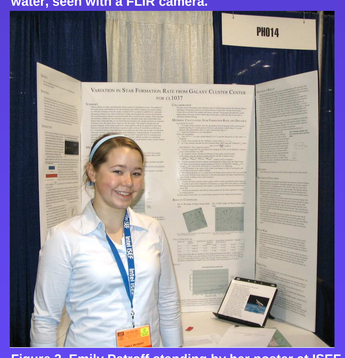

Figure 3. Emily Petroff standing by her poster at ISEF.

Figure 4: Teacher Tabby Eldredge tries "listening" to infrared light during an infrared astronomy workshop at Grosse Pointe North High School.

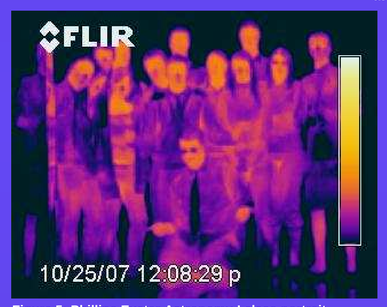

Figure 5: Phillips Exeter Astronomy-I class portrait

Figure 6: Astronomy Intern: David Friedlander-Holm with his IR reflection in the whiteboard.

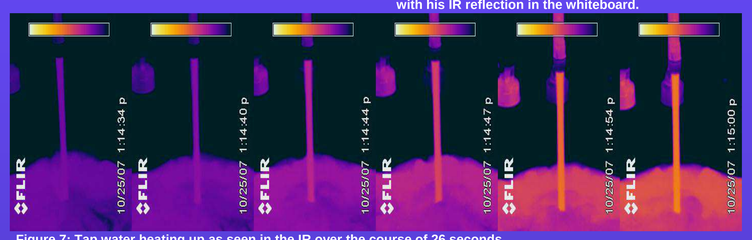

Figure 7: Tap water heating up as seen in the IR over the course of 26 seconds.

Figure 9: Grosse Pointe Woods police officer demonstrates a thermal camera to a teacher group.

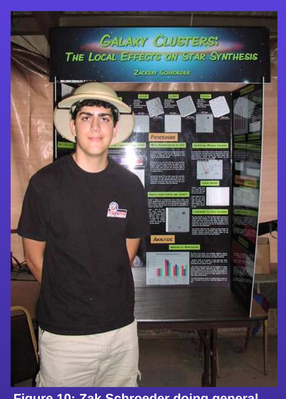

Figure 10: Zak Schroeder doing general public outreach education at the Astronomy at the Beach star party.

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Mining the Online Astronomy and Educational Resources of the Spitzer Space Telescope Project. February 2006. http://www.canby.com/hemphill/SpitzerResourcesRH0206.htm

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Careers in Science

Students who are exposed to the process of science through classroom activities and research come to understand the requirements for a career in astronomy and physics. Through research, they develop important ancillary skills such as the ability to do professional presentations to communicate their results. By working with professional astronomers students learn what career opportunities exist in astronomy and gain some insight in the daily life of astronomers.

Rosa Hemphill and Emily Petroff:
Emily Petroff, a high school student participated as a member of the Spitzer Teacher Program. The experience fed her interest in pursuing a career in astronomy.

John Blackwell:
Phillips Exeter Academy's pedagogy is centered on an experience-based education, titled the Harkness Method. Students engage in learning by doing as much as possible in order to discover insights to reality in science. Students have been given the raw data from this study and given time to brainstorm towards analysis plans and arrive at overall understanding. All throughout this process, students are reminded that the process in which they are engaged is very much what astronomers experience.

Ardis Herrold and Zackery Schroeder:
Zak came away from the Spitzer project with a four-year full academic scholarship as a result of his science fair and research experiences. He is currently in his first year of college pursuing a career in chemical engineering.

Classroom Applications

Teachers implemented the Spitzer data in the classrooms and with their students in a variety of settings. In addition, the Spitzer opportunity afforded them to teach standard topics using new methods. Below are some of the specifics:

Rosa Hemphill and Emily Petroff:
Emily used the Spitzer data collected on cluster 1037 as the basis for an independent research project. She presented her work at the Oregon Junior Academy of Science, the Aardvark Science Expo and at the International Science and Engineering Fair (ISEF). At ISEF, her work was recognized with a Pricilla and Bart Bok Second Place Award

Two teams of students used a thermal imaging camera, borrowed from FLIR, Wilsonville, Oregon, as a part of their chemistry independent projects. One team compared the oscillations of the Briggs-Rauscher reaction in the visible with those in the infrared. A second team tried to use the FLIR camera to compare the amount of heat produced by redox reactions with different metal salts. They presented their work at the Aardvark Science Expo.

As part of class introduction to light and spectra, a FLIR camera let students "see" in the infrared. Students took thermal portraits of each other and class portraits of elementary classes. They experimented to see what lab materials would block or pass IR light. The FLIR camera showed how chemical and physical changes appear in the IR. SOFIA kits provided audible clicks to detect IR light.

John Blackwell:
Blackwell worked with students in his Astronomy-I class to determine SFRs for all three galaxy clusters and arrived at values consistent with those found by other team members.Results were presented to the class and to the Science Department as a whole.

The electromagnetic spectrum is presented to students in both physics and chemistry with specifics of quanta and energy levels primarily discussed in chemistry courses. Students then investigate first the visual spectra using hand held spectroscopes and are presented with visual stellar spectroscopes followed by the use of a CCD-based spectrograph attached to an 11" telescope. The CCD is sensitive to near IR and near UV, giving students a taste of the data that goes beyond their normal comfort level. At this time, a FLIR camera is brought into the class to allow students the opportunity to "see" in the IR and perform simple short experiments:

- Observing classmates, teachers in IR.
- Testing the IR transparency of various visually transparent materials.
- Fischer burners, heated copper and glass rods.
- Cool water vs. hot water.
- Submergence of hands into a fish tank.
- Reflections of IR images on the white board and by glass windows.

Ardis Herrold and Zackery Schroeder:
Students in the Advanced Topics in Astronomy class (winter 2006) worked through a variety of infrared experiments, evaluating them for use in classroom applications. Some of these students served as helpers during the subsequent teachers workshop on infrared astronomy (May 2006).

During the school year 2006-07, Zak did an independent science research project using Spitzer data and presented the results of his research in the Junior Science and Humanities Symposium in Detroit, at the Southeast Michigan Science Fair, and at the Intel International Science Fair in Albuquerque, New Mexico. In addition, Zak presented the results of his research to students in the Astronomy classes and to the Radio Astronomy Team (an after school astronomy club) at Grosse Pointe North High School.

Student Mentoring

Rosa Hemphill and Emily Petroff:
Spitzer educational materials—posters, folders, and bookmarks—have been used by Lilia Hernandez Smith, a reading teacher, at San Antonio Preparatory Academy, a preK-8 school with primarily Hispanic students. She uses the materials as incentives to encourage reading, especially for 4th-6th grade students who receive extra help in reading. Mrs. Smith says that the Spitzer materials inspire reading and excite students about learning, especially in a school with few science resources. Spitzer posters also are used to introduce astronomy and the spectrum in the higher grades. Inspired by a Spitzer spectrum poster, the 6th grade class made CD-spectroscopes.