Spitzer - Hot & Colorful Student Activities

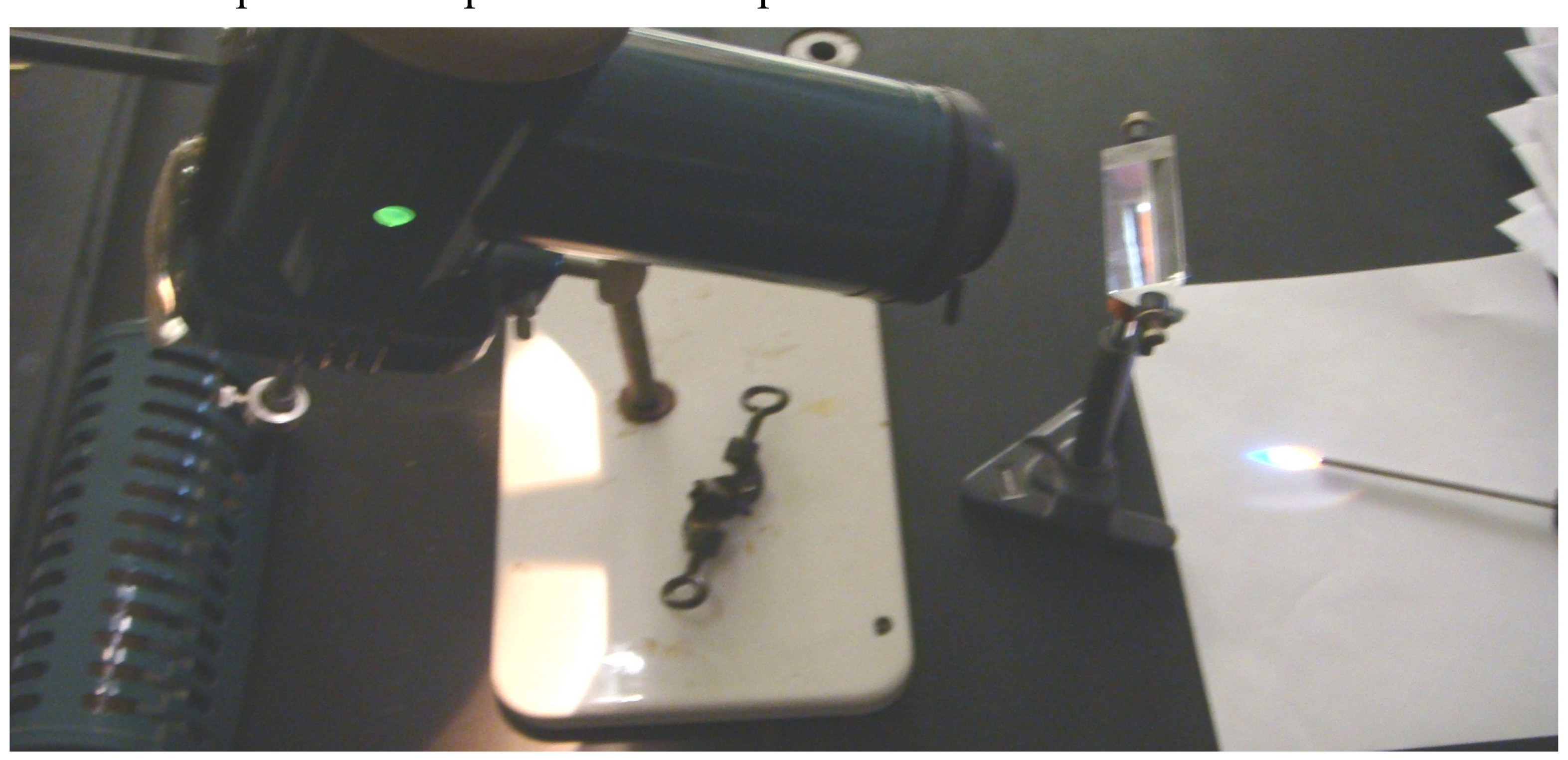
David W. McDonald (jswords@mcn.net), Jacob McDonald, Blair Troudt, Brandy Wilkinson (Sidney High School, Sidney MT),
Support Scientist Dr. Luisa M. Rebull (SSC, Caltech, Pasadena, CA),
Cris DeWolf, Trevor DeWolf, Stephen Brock, Justin Boerma, (Chippewa Hills High School, Remus, MI),
Pete Guastella, Ashley Peter, William Wassmer, Rose Haber, Alex Scaramucci, (Manhasset High School, Manhasset, NY),
Chelen H. Johnson, Grant Bemis, Katherine Paulsen, Nathan Yueh (Breck School, Minneapolis, MN),
John Schaefers (Ingomar Middle School, Pittsburgh, PA),
Lead Teacher Tim Spuck, Jennifer Butchart, Alix Holcomb, Brent Karns, Shana Kennedy, Rachele Siegel, Alexis McCool, (Oil City Area Sr. High School, Oil City, PA),

Abstract: In this poster, we present the results of several activities developed for the general science student to explore infrared light. The first activity involved measuring infrared radiation using an updated version of Newton's experiment of splitting white light and finding IR radiation (Herschel IR experiment). The second used Leslie's cube to allow students to observe different radiators, while the third used a modern infrared thermometer to measure and identify IR sources in an enclosed box. The last activity involved students making false-color images from narrow-band filter images from data sets from Spitzer Space Telescope, STScI Digitized Sky Survey and other sources. Using computer programs like Adobe Photoshop and free software such as ds9, Spot and Leopard, poster-like images were created by the students. This research is funded by the Spitzer Science Center (SSC) and the National Optical Astronomy Observatory (NOAO). Please see our companion poster, Johnson et al., on the science aspect of this program, and another poster on the educational aspects, Guastella et al

Newton's/Herschel Experiment Revisited

The following question was posed to second year physics students:

Can IR radiation be measured using a computer-interface probe?
Students explored this question in two parts.



1. Can computer probes be used to measure the splitting of white light going through a prism like Newton's experiment in 1665?

With both a CdS cell and Vernier Light sensor, no results were reported. Suggestion is to get a Vernier Light Probe sensitive to IR and visible light rather than levels of light.

2. Can computer probes be used to measure the invisible IR radiation like Herschel in 1800?

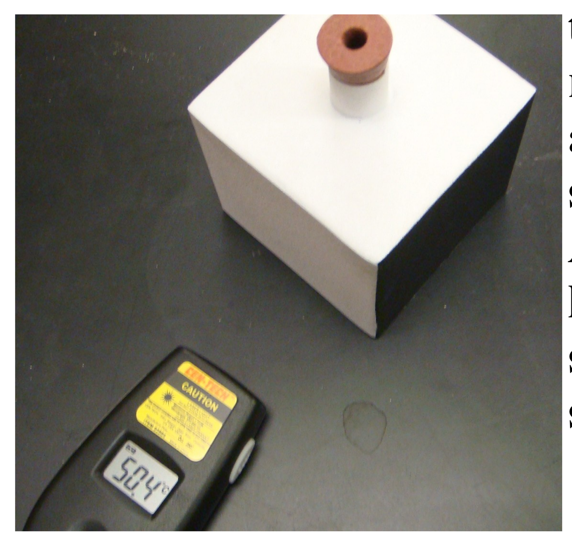
Trial 1: Using a Vernier temperature probe and a pinhole image of the sun.
After a number of attempts no noticeable temperature difference was measured between the IR (red) end of the spectrum and the blue end.
Possible cause of non results:

a. hard to keep the temperature probes in the radiation as the sun moved
b. temperature probes do not have a fast enough response time or
c. need absorbent material around the temperature probe.

Trial 2: Using a carbon-arc lamp as a light source
Again no noticeable difference was measured between the IR (red) end of the spectrum and the blue end.
Possible cause of non results:

a. Not sufficient energy in the white light carbon-arc lamp to be viewed on the computer temperature
b. temperature probes do not have a fast enough response time or
c. need absorbent material around the temperature probe.

http://coolcosmos.ipac.caltech.edu/cosmic_classroom/classroom_activities/herschel_experiment.html



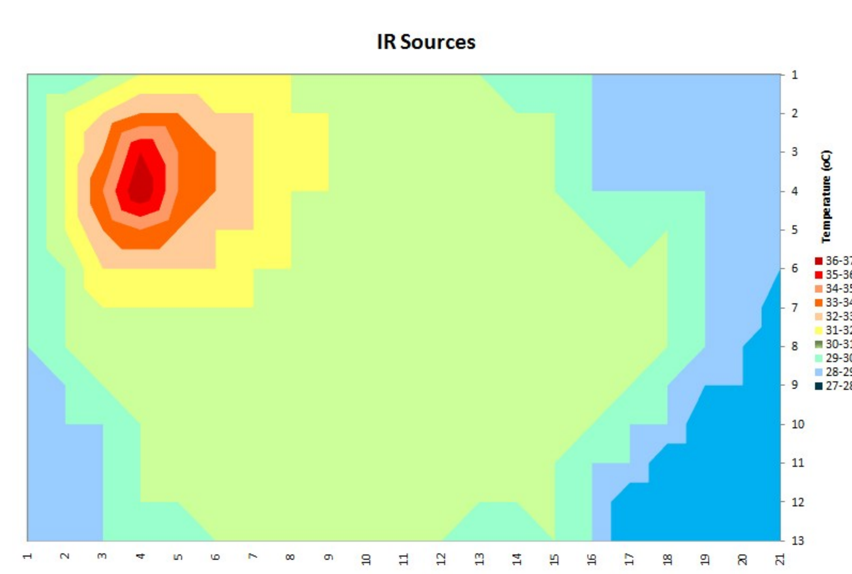
Leslie Cube and radiation:

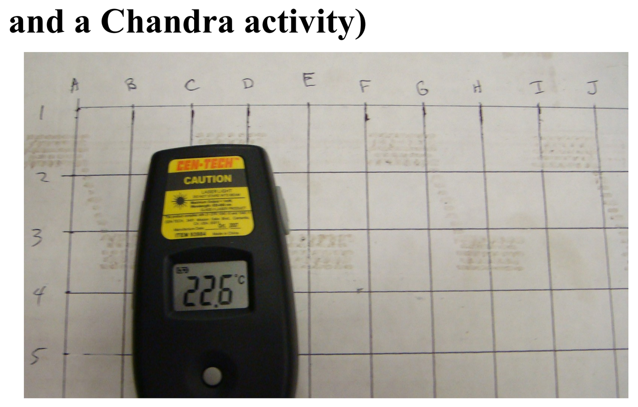
Using an IR thermometer students experimented with radiant heat using a cubical box filled with hot water. In 1804 Sir John Leslie showed that radiation was greatest from the black side and negligible from the polished side.
Students first determined that the temperature reading on an IR thermometer is proportional to the amount of heat energy. Then observing the Leslie cube determine that the black surface radiates the most energy (highest temperature) and the polished brass surface radiates the least. Note: White surfaces radiate about the same as the black surfaces as white surfaces look fairly black in the IR
Assessment of student understanding showed a lack of distinction between radiation through surfaces and reflection and absorption from surfaces.

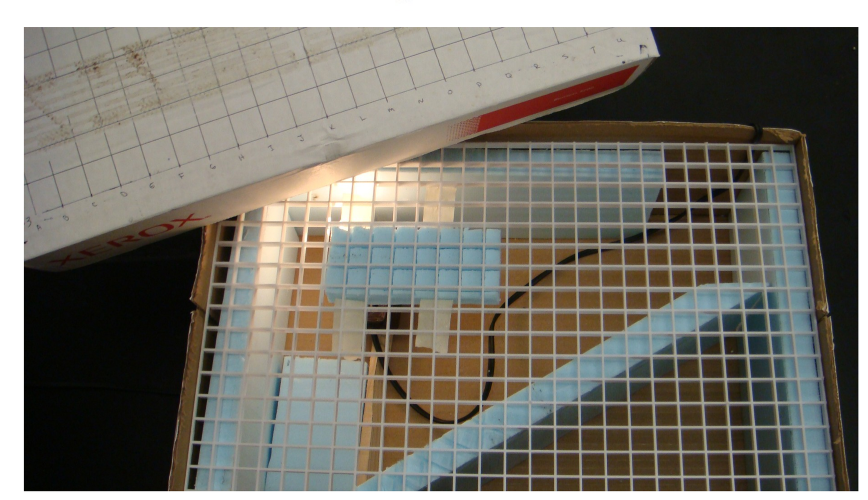
Hide and seek with IR sources

A hidden heat source is located using an IR thermometer. A thermally-isolated box with internal heat sources and baffles is constructed. The lid has a two-dimensional grid to guide the collection of IR data. When the data is plotted on a 3-D graph using Excel, the placement of the heat source and baffles can be visualized and determined. The data was easy to collect and students spent most of their time manipulating the data to best reveal the internal placement of the heat source and baffles.

(based on 3D activities by D McDonald and a Chandra activity)

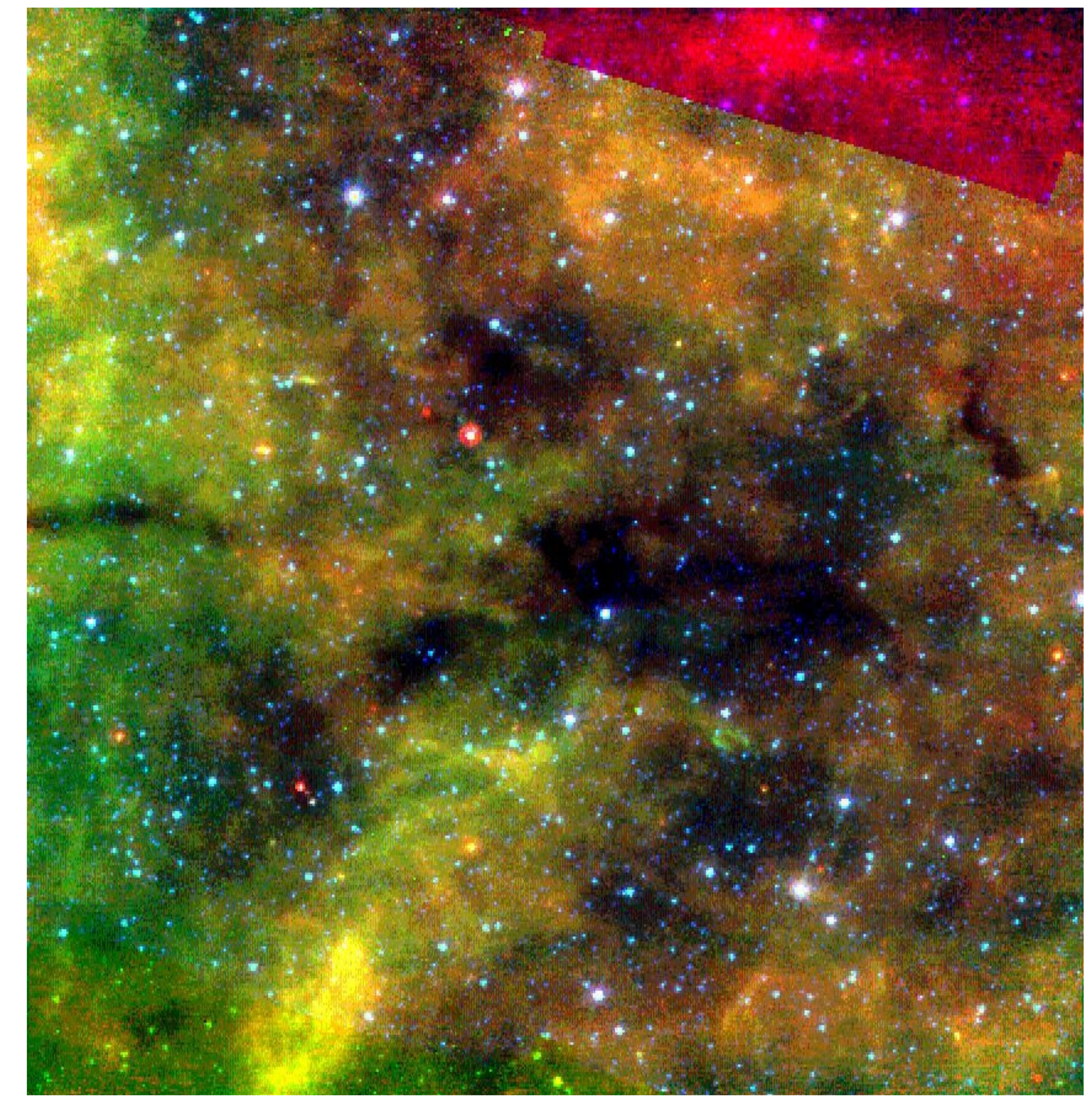




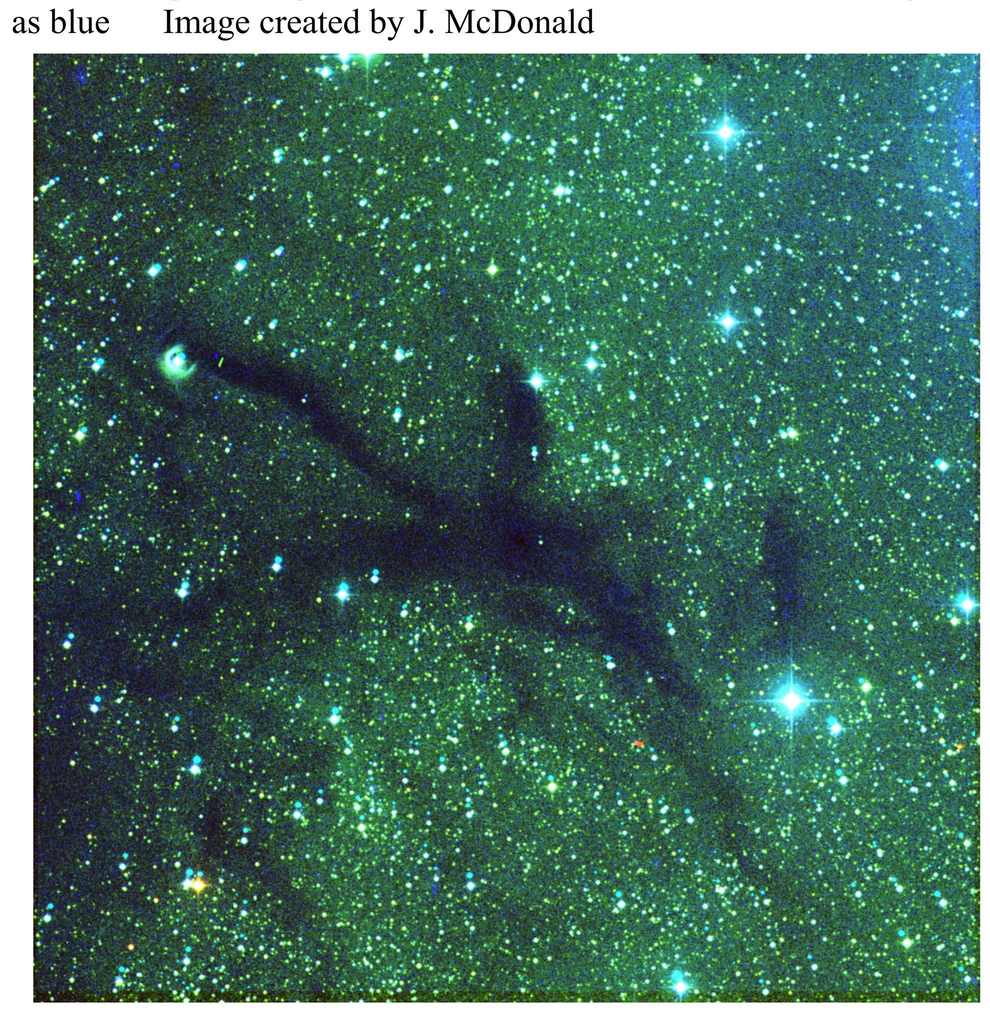


False-color images

False-color images of astronomical objects are created by students using data from narrow-band filters images. Students select data sets from sources such as Spitzer Space Telescope, STScI Digitized Sky Survey and others. Each narrow-band image provides one slice of a total image, such as reds, which can be blended with other images in the greens and blues to produce an artistically-pleasing false-color image. Students use computer programs like Adobe Photoshop and free software such as ds9, Spot and Leopard, to blend the red/green/blue images and to create the poster-like images that can be printed in a variety of sizes.



LDN 981—3 color plot using IRAC channel 1 as red, Irac channel 4 as green and MIPS 1 as blue Image created by J. McDonald



LDN 981—3 color plot using filter images from "The STScI Digitized Sky Survey" http://archive.stsci.edu/cgi-bin/dss_form
Image processed using Photoshop Elements.

Directions for creating false color images using Photoshop Elements at:
https://coolwiki.ipac.caltech.edu/images/a/a9/Mcdonald_images_4.0.pdf

Lynds Cloud Spitzer group—Teachers and student at the Spitzer building on the Caltech campus in Pasadena CA