Research Based Astronomy in the Secondary Classroom
Lessons Developed For Investigating YSO's Using APT, Excel, and MOPEX

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ABSTRACT

We present several learning approaches that were performed to explore YSO's within LDN 425 and 981. Classroom instruction on the characteristics of YSO's was supplemented with hands-on learning of software needed to search Spitzer mosaics for YSO candidates. Structured activities were used to teach the intricacies of MOPEX, APT and Excel. Excel worksheets were developed to help students convert flux densities into magnitudes. These magnitudes were then used to create Spectral Energy Distributions (SED), plotting the energy against the wavelength of each candidate YSO. This research was made possible through the Spitzer Space Telescope Research Program for Teachers and Students and was funded by the Spitzer Science Center (SSC) and the National Optical Astronomy Observatory (NOAO). Please see our companion education poster by McDonald et. al. titled "Spitzer - Hot and Colorful Student Activities" and our research poster by Johnson et. al. entitled " Star Formation in Lynd's Dark Nebulae."

Teacher Outreach – Programs and Presentations

Teachers implemented the Spitzer data in the classrooms and to their peers at local regional and national conferences.

Below are some of the specifics:

Pete Guastella of Manhasset High School – Pete has 10 students in his research program that have developed research projects directly or indirectly from the Spitzer project. He has presented talks at the NCSSMST and the International Science and Engineering Fair on the use of Astronomy in Research Based Science Education.

John Shaefers of Ingomar Middle School has developed new lessons to teach the concepts of infrared to his students. He was a recipient of the First Energy Mathematics, Science,& Technology Grant .
"Hearing Infrared Light" Implementing the IR package with some new things to do, try and experiment with.
First Energy is an electric Company provider

Cris DeWolf of Chippewa Hills High School has prepared a presentation for the Michigan Science Teachers Association 2009 Conference entitled "Infrared Astronomy: Seeing the Invisible."

The Students

Manhasset High School,Manhasset, NY
Ashley Peter, William Wassmer, Rose Haber, Alex Scaramucci

Oil City Area Sr. High School, Oil City, PA
Jennifer Butchart, Alix Holcomb, Brent Karns, Shana Kennedy, Rachele Siegel, Sandy Weiser

Sidney High School, Sidney MT
Jacob McDonald, Blair Troudt, Brandi Wilkinson

Chippewa Hills High School, Remus, MI
Trevor DeWolf , Stephen Brock, Justin Boerma

Breck School, Minneapolis, MN
Grant Bemis, Katherine Paulsen

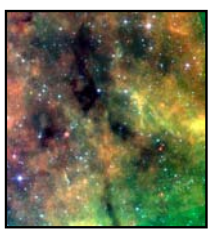
Group photo taken at Spitzer Science Center
Four day Summer Conference June 2008

Happy Faces at Ingomar Middle School, Pittsburgh, PA

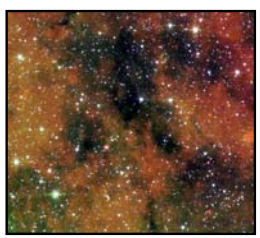
Even middle schools students enjoyed learning to work with Spitzer Pride tools

Below is a section of a take home assignment given to Ingomar Middle School students

Spitzer: Leopard: INSTALL AT HOME: http://ssc.spitzer.caltech.edu/propkit/spot/
***Query/Target Name (LND881 , LND 425 or LND981)/**
click on : Simbad (not NED)/
Resolve Name/
Select/ OKAY/
Select (on right side chose wavelength)
See Base Image controls on right
See Controls on Left
Try: top bar image selections

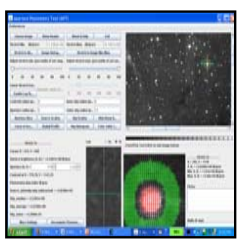


Student-generated color overlay of LDN 425
Image developed by **Jennifer Butchart, Oil City, PA**

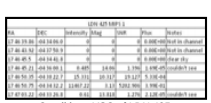


Student-generated color overlay of LDN 981 using FITS Liberator
Image developed by **Jennifer Butchart, Oil City, PA**

Manhasset students say hello to the Oil City counterparts during a Skype Conference in early December



Students developed the skills to use complex software.



Candidate YSO of LDN 425

Technology Transfer

Communication = Education
Communication through Various Modalities

Students explore the world of infrared imaging

Teleconference
Teachers met regularly to discuss fundamental techniques prior to data acquisition
Teachers discussed school progress and problems
Handled Housekeeping

WIKI
This Wiki is a dynamic environment for the participants (teachers, scientists, and students) to interact as their research projects evolve over time.

SKYPE
Maximizing web technology
Although this was just a fun way for students to interact at first. This tool grew to be an excellent instrument for students to discuss project goals and review findings

--JenniferButchart 06:58, 3 December 2008 (PST) I'm back again... I looked at what Luisa thought were interesting targets, and I found that some of ours correspond with hers. They aren't exact, but they're pretty close. They are:
Ra/Dec
20 59 33.1/50 12 02.4
21 00 17.27/50 19 40.6
21 00 37.16/50 21 02.6
21 00 49.26/50 15 44
21 00 49.27/50 15 45.7

Student interaction on the WIKI. Active, timely discussions of student and mentor work

Face to Face
Spitzer Teachers
First meeting at January 2008 AAS (Austin Texas)
Received basic training in Infrared Technology
Meet with Dr. Rebull – Discussed possible study
Developed Criteria for Lynd Cloud Selection
Assigned Tasks

Spitzer Teachers and Students
4 day conference Spitzer Science Center June 2008
Lectures :
YSO selection techniques
Magnitude and Flux Density
Use of available software: Spot, Leopard, MOPEX, APT and Excel Spreadsheet

JenniferButchart 10:49, 29 October 2008 (PDT) I got on ADS today and found the same article (by Quanz, S. P.; Apai, D.; Henning, Th.) titled Dust Rings and Filaments around the Isolated Young Star V1331 Cygni. It is the same one as Shana found. I do believe these are the points they identified:

--Sandy 13:22, 30 October 2008 (PDT) This is sandy's test comment.

--JenniferButchart 05:29, 31 October 2008 (PDT) I just read that entire article on astro-ph (found here: astro-ph) and it says V1331 Cygni is, mostly likely, the only star that has formed in LDN 981 (it formed in isolation). However, they stated that stars may form along the filaments of the cloud since it it undergoing a gravitational collapse.

Student interaction on the WIKI. Active, timely discussions of student and mentor work

Learning By Doing

As students practiced with software like APT, they shared their ideas via the Wiki, e-mail, and Skype web conferencing. Students developed a list of possible YSO candidates, converted counts to magnitudes in 5 channels and produced Spectral Energy Distributions (SED).

An excerpt from the Wiki

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Of the 14 candidates above, we found references for 6
candidates: candidates 1, 3, 6, 7, 11, and 13.
We followed Mr. Spuck's directions and came up with an
overlay of 3 wavelengths: MIPS 24 in red, IRAC 8 in
green, and IRAC 4.5 in blue. We located the stars that
appeared to have a red ring (dust) and added them to our
list of candidates.
Here is the list of candidates we found using this
method of overlaying:
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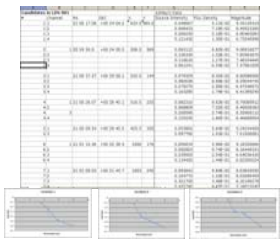

SED's developed from Candidate List (above)

•Summary

•Students And Teachers Learned
- The instrumentation used in infrared astronomy and the necessity of space-based telescopes
- The physical properties of light, such as wavelength and flux and about emission and absorption.
- How stars evolve from birth to eventual death

•Students And Teachers Became Hands On Learners:
- Compared the images obtained by IRAC and MIPS
- Produced false-color images that enhance the features of young stellar objects and the interstellar cloud
- Extracted data tables of sources and fluxes at each wavelength.
- Using authentic data students were able to generate color plots

•State/National Science And Technology Standards.
- The national science standards addressed in this project are the structure and properties of matter, interactions of energy and matter, the origin and evolution of the Earth system, and the abilities of technological design.

•In the Future
- The false-color images that this group produced will be useful in future public presentations
- Dramatic illustrations of YSOs and star-forming regions will be shared with other teachers via workshops and presentations. .
- Students will be able to access the data sets in the *Spitzer* archive
- Lessons that address STEM skills and concepts will be developed by this *Spitzer* teacher group and disseminated to teachers nationwide.

•Conclusion
- Students assumed an active role in the process of project development, teamwork, data collection and analysis, interpretation of results, and formal scientific presentations.
- These workshops and lessons promoted an inquiry-based learning experience and peaked interest in science, technology, and space research.